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EDITORIAL STREAM



KNOWLEDGE BASED ON EXPERIENCE: CASE STUDY ISSUE 2022

The Case Study Special Issue in EverythingAboutWater, has always been the most popular and sough-after issue over the years. Professionals love to learn about the experiences of other users from across the world, and benefit from the same.

The Harvard Business School started the Case Study approach to managerial education in the early 1960s. Based on real-life situations and commonly used in business schools now, case studies present decision-makers with a dilemma or uncertain outcome. Events, people and the factors that influence the final decision get captured in a case study, enabling readers to identify with those involved.

Users in government and industry continues to grapple to find answers to the complex (and not-so-complex) problems in water. Our collective knowledge and understanding continues to grow, and professionals are still learning new solutions from each other. Thus solutions to water problems require the involvement and interaction of different sets of people. A Case Study approach captures this aspect wonderfully.

Complete information on various parameters and situations is never available to the user. A computer or a software program could give the solution, if all the inputs were known. Unfortunately, it never is and that is where the collective judgment and wisdom of the "experts" comes to the fore. Ability to extrapolate, assume and estimate the extent of a problem depends on one's experience and expertise. A case study derives from factual situations of the worldly kind, where a water professional has to work in the "unknown" and find solutions.

While it may look extremely simple, transparent and uncomplicated, centuries of wisdom and human understanding have gone behind producing safe and pure water for any application. So there is much complexity and detail behind a simple drop of water. Many streams of knowledge are contained in the background.

High level physics is used for extracting, pumping and conserving water. The most complex civil and hydraulic engineering goes behind transporting and distributing water from source to the point of usage. A high degree of chemistry and process knowhow is involved in producing and purifying water. Mechanical design and engineering is needed for developing various equipments, plants and infrastructure. Cutting-edge electronics and instrumentation often goes into monitoring and controlling various water parameters.

Our issue covers various cutting-edge technologies in the mechanical, chemical, civil and instrumentation fields.

We have tried to cover diverse issues with an international appeal, and talk of the most current technologies and solutions. I hope that you enjoy this issue of Case Studies and get value out of it. Through this edition we are sharing knowledge based on experience for all of the global water sector.

thanks & regards,
Deepak Chaudhary
Editorial Incharge

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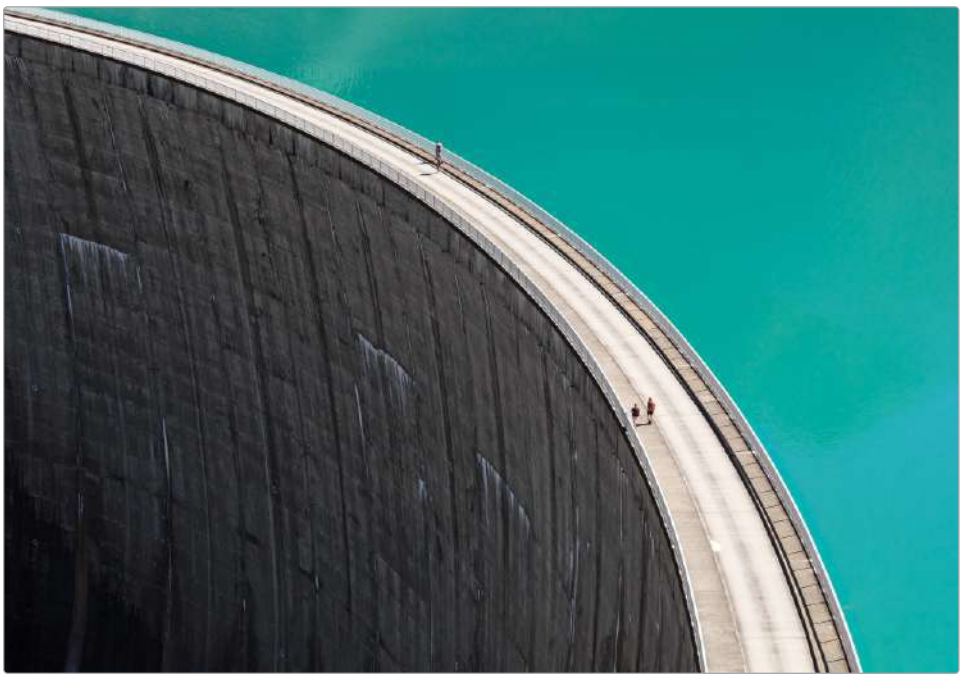
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DIGITAL INTEGRATOR COHESIVE GROUP ACQUIRES VETASI, LEADING PROVIDER OF IBM MAXIMO MANAGED SERVICES

Enhancing its Position as a Global Partner for EAM Operational Excellence, Expanding Market Capacity and Geographical Reach



EXTON, Pa. – Dec 02, 2022 – Bentley Systems, Incorporated (Nasdaq: BSY), the infrastructure engineering software company, today announced that its Cohesive Group digital integrator business has acquired Vetasi, a leading international consultancy specializing in enterprise asset management (EAM) solutions, with a strong focus on IBM Maximo.

Vetasi brings to Cohesive the largest IBM Maximo consultancy team across Europe, Africa, and ASEAN countries, with headquarters in the United Kingdom and operations based in Poland, Indonesia, South Africa, Spain, Ukraine, and Australia. In addition to EAM resources, Vetasi deepens the Cohesive team with additional strategic advisory capabilities and adds to the Cohesive services catalog Maximo cloud hosting capabilities, expertise in low-code development, and strong real estate and facilities management domain knowledge. By virtue of the combination with Cohesive, Vetasi's clients can benefit from the multidiscipline scope of a world-leading digital integrator, combining greater global scale with local agility to leverage more value from their asset portfolios.

Cohesive was founded by Bentley in 2020 as a digital engineering systems integrator to help infrastructure owner-operators deliver transformational and sustainable outcomes. Cohesive has achieved consistent significant growth and continues to win substantial new projects, notably in the utilities, transport, and energy sectors. Prior to Vetasi, Cohesive has acquired multiple organizations in the EAM and digital twin advisory space to increase service delivery capacity, including prioritizing geographical reach for significantly growing opportunities in the EMEA and especially Asia Pacific regions.

David Hollister, Bentley Systems' chief investment officer, said, "The acquisition of Vetasi, with over 200 colleagues in EMEA and Asia Pacific, contributes substantially towards our objectives for Cohesive as an independent digital integrator, largely filling any remaining gaps to achieve comprehensive global self-sufficiency and economies of scale across the full lifecycle of infrastructure assets. Additionally, Vetasi significantly accelerates Cohesive's learning curve in cloud hosting provisioning for Maximo. Cohesive's growing success will show the way for engineering firms to create and curate digital twin data-centric cloud services for infrastructure owner-operators, increasing opportunities for Bentley's market-leading iTwin Platform."

Mark Bew, CEO of Cohesive, said, "Acquiring Vetasi enables Cohesive to consolidate its position as a global leader in digital engineering systems integration. This significantly scales out our global platform to build long-term, high-value partnerships with our clients. By advancing Maximo implementations to function within digital "infinity twins," Cohesive can help to transform asset-owners' businesses from an operational perspective while also improving their ESG performance. On behalf of Cohesive's talent force of now over 700 colleagues everywhere, we warmly embrace the Vetasi team and look forward to the next step in our shared journey."

Jarosław Łukasiewicz, CEO of Vetasi, who joins Cohesive along with other executive partners James Fair and Trevor Roberts, said, "We are delighted to join Cohesive and contribute to its mission of delivering transformational and sustainable outcomes through the built and natural environment. Becoming part of Cohesive enables us to expand our partnerships with our clients and build further upon Vetasi's vision of delivering solutions that deliver real value."

DANFOSS INDIA CELEBRATES 3000 LTI FREE DAYS AT ITS CHENNAI CAMPUS

- Danfoss India Chennai Campus accomplished 3000 LTI (Loss Time Injury) Free Man Days, which is above 25-million-man hours of safe operations over a period of 8.5 years since the facility's commissioning in the year 2014 as a greenfield project.
- Danfoss' global "Safety First" program, is a systematic approach that enhances th focus on safety for all Danfoss employees, visitors, and all other people working within or for Danfoss.
- Recently Danfoss India EHS team was recognized with the "Occupational Health & Safety Excellence Award 2022" in the Gold Category by the Safety Engineers Association (SEA).



Oragadam - December 6, 2022: Danfoss India's Oragadam facility accomplished a safety milestone of 3000 LTI (Loss Time Injury) free days. It amounts to more than 25-million-man hours of safe operations over 8.5 years since the factory's commissioning in the year 2014 as a greenfield facility. The event was attended by CMK Raj--Director Gen. of Factory Advice Service & Labour Institutes, GOI (Retd.), Veeraraghavan Janakiraman, Head of EHS, Southern Railways, Purushothaman Venugopal, Regional Head of EHS, Blue Star, G Subhash, GM- ZF SHE, Ravichandran Purushothaman, President- Danfoss India, Danfoss India leadership, other dignitaries, and employees.

At the heart of safe workplace culture is Danfoss' "Safety First" program, a systematic approach that enhances the focus on safety for all Danfoss employees, visitors, and all other people working within or for Danfoss. Danfoss India has deployed multiple safety best practices including sharing day-to- day safety observations, creation of experience center, periodic trainings, monthly reviews, and safety focussed campaigns etc. to raise awareness of safety amongst all the employees.

Speaking on the occasion, Ravichandran Purushothaman, President- Danfoss India Region said, "We at Danfoss India believe that a safe workplace is a happy workplace. Safety comes first in everything we do. The 3000 LTI free man days milestone is a manifestation of years of conscious efforts and well- managed safety practices at the workplace. This success is due to the joint commitment of both the leadership and the entire workforce. We look forward to continue this safety journey and attain new safety milestones in the years to come."

Danfoss Chennai campus is spread overs 50-acres and is IMS accredited (14001:2015& 45001:2018) facility. In line with the company's vision of going carbon neutral across all its global campuses by 2030, especially in Scope 1 and Scope 2 emissions, the facility has clear action plan in place for energy efficiency and reduced carbon footprints. This LEED platinum rated manufacturing campus has achieved an average 12K+ tons of CO^2 reduction per annum in the last 2 years alone through various sustainability measures like 12.5 MW Solar power plant, 275 KW/ Hr Energy storage system, dependency on renewables, 3600 KL Rainwater harvesting pond, IoT based Water monitoring and consumption, Zero liquid discharge, 10K+ trees on campus especially through Miyawaki forest, use of Danfoss' own Energy efficiency products and solutions amongst many others.

"The safety culture is very much ingrained in the Danfoss' DNA exemplified by our employees, especially in Supply Chain and Operations is inspirational. It is an

affirmation of Danfoss' commitment to safety for all our internal and external stakeholders", said Muralidhar V S, Head of Global Services, Asia Pacific& India. We congratulate and thank each and one for their whole-hearted contribution and commitment to Danfoss safety, which has made this achievement possible," he added.

Recently Danfoss India EHS Team was recognized with the "Occupational Health & Safety Excellence Award 2022" in the Gold Category by the Safety Engineers Association (SEA). The team now aspires to work towards an ambitious 5000 LTI free man days milestone.



BINNIES CELEBRATES 100 YEARS OF WATER EXCELLENCE IN SINGAPORE, LOOKS AHEAD TO A SUSTAINABLE WATER FUTURE ENABLED BY DIGITAL TECHNOLOGY

Through partnerships with PUB on many of Singapore's major water infrastructure projects, Binnies helps power our water-stressed nation to achieve self-sufficiency



(From left to right) Mike Collins, Head of Sustainable Infrastructure (APAC), Department for International Trade (DIT); William Yong, Managing Director, Binnies Singapore; Alan Ryder, CEO and Founder, RSK Group; Dr Amy Khor, Senior Minister of State for Sustainability and the Environment; Her Excellency Kara Owen, British High Commissioner to Singapore; Goh Si Hou, Chief Executive, PUB; and Lucy Thomas, Managing Director, RSK Centre for Sustainability Excellence at the reception to celebrate Binnies' centenary in Singapore. Photo credit: Binnies Singapore

- Binnies to drive business growth and deliver sustainable water solutions in Singapore and the Asia Pacific region via wider implementation of advanced digital water technologies; and further explore novel sustainable solutions for coastal and flood protection, as well as water circularity.
- In the last century, Binnies has remained a constant in the local water scene, having worked on many landmark water projects across Singapore, including four of the five desalination plants, Tuas Nexus, the Deep Tunnel Sewerage System (DTSS) and NEWater Factories I and II at Changi Water Reclamation Plant, among others

Singapore, 6 December 2022 – Binnies, an RSK Group company providing sustainable and resilient water, wastewater and flood resilience solutions, today celebrates its 100th year of water excellence in Singapore. As they look back on a century of partnering with Singapore in securing adequate and affordable water supply for future generations, Binnies prepares for an exciting future powered by new digital water technologies, with advancements in artificial intelligence (AI), digital twins and data analytics.

As an island nation with limited land for water storage and a lack of water resources, Singapore is considered one of the most water-stressed countries in the world. Despite a challenging environment with geographical limitations, Singapore is now a global success story in water resilience via a holistic water management approach and technology-driven infrastructure encompassing water conservation and reuse, and desalination of seawater.

As Singapore strides forward with plans to achieve a water-sustainable future, the collaboration of Binnies across the RSK Group and with innovation leaders will ensure the next 100 years see as much success as the first. Having already developed an advanced digital twin platform, Binnies will look to expand into AI, augmented reality and more granular data collection for a more technologically advanced platform that will yield greater efficiencies at a lower cost.

"Celebrating the centenary of Binnies in Singapore is a momentous occasion for us to acknowledge our heritage as we look to the future. Today, we face a pressing and immediate climate emergency that requires a concerted global effort and response. Binnies is committed to drawing on our expertise and experience in solving complex global water and environmental challenges, and working with governments and stakeholders in Singapore and around the world to address constantly evolving needs as we secure and safeguard a water future for all," said William Yong, Managing Director, Binnies Singapore.

Since 1922, Binnies has been a present and supportive partner in Singapore's journey to water self-sufficiency. Building upon colonial-era water supply foundations such as the Lower Pierce and Upper Seletar reservoirs, Binnies worked alongside the Singapore government to develop the first blueprint for water supply diversification for Singapore Water Supply in the 1970s. The company also played significant roles in many major water projects across the country as it transformed from a British naval base into an Asian economic powerhouse.

In recent years, Binnies has provided engineering solutions and technology for four out of the five desalination plants in Singapore: SingSpring Desalination Plant, the first large-scale seawater desalination facility for the country located in Tuas; Tuaspring Desalination Plant, a seawater reverse osmosis desalination plant that is also the largest in Asia; Keppel Marina East Desalination Plant, the only facility capable of treating both sea and reservoir water in Singapore; and Jurong Island Desalination Plant, an innovative, energy-efficient facility.

Binnies was involved in engineering works for Tuas Nexus, the world's first fully integrated used water treatment and solid waste management facility co-located in a single greenfield site. Binnies provided engineering design for the Deep Tunnel Sewerage System Phase 2 (DTSS Phase 2), a nationwide project that completes Singapore's long-term vision of a recycled water super-highway. At the Choa Chu Kang Waterworks, Binnies applied its digital and design expertise to set the requirements for smart technology and digital solutions to improve operational efficiencies. Recently, the company also delivered a feasibility study commissioned by PUB for underground stormwater drainage and storage systems to mitigate the impact of rainfall-induced floods.

Beyond Singapore, Binnies has spearheaded the adaptation of the exemplary Singapore water infrastructure model across the Asia Pacific region at the Batamindo Industrial Park in Indonesia and Suzhou Sino-Singapore Industrial Park in China, among others. In Australia, Binnies has worked on the Queensland Western Corridor Recycled Water Scheme and the Sydney Desalination Plant – one of the largest desalination plants in the world. The Philippines, under the purview of the Manila Water Enterprise, also applies technology and expertise honed in Singapore for several conversion projects at wastewater treatment plants.

"Binnies is a name synonymous with world-class engineering and has seen great success in Singapore and the region, and it is great to see the organisation thrive further since joining the RSK Group in early 2021. With Binnies and the other businesses in the RSK Group leveraging each other's expertise, our low- and zero-carbon solutions and digital innovations are helping global governments and organisations mitigate environmental impacts. As we celebrate Binnies' 100th anniversary in Singapore, we look forward to collaborating closely with various stakeholders to advance Singapore's standing as a global hydro hub," said Alan Ryder, CEO and Founder, RSK Group.

WABAG SECURES INDUSTRIAL WASTE WATER TREATMENT ORDER IN ROMANIA WORTH ABOUT INR 260 CRORES (EUR 30 MILLION)



December 12, 2022: VA TECH WABAG ('WABAG'), a leading pure-play water technology Indian Multinational Group, further enhances its leadership in the Industrial water treatment market in Romania with WABAG Water Services S.R.L., Romania ('WABAG Romania'), its European subsidiary, securing a repeat order from Purolite S.R.L, Romania ('Purolite') worth about INR 260 Crores (EUR 30 Million) towards upgrading the Industrial Wastewater Treatment Plant ('WWTP') in Romania.

The contract will be an Engineering & Procurement ('EP') scope contract which includes design & engineering, equipment supply, installation, commissioning and start-up of the Purolite Victoria WWTP. The project is scheduled to be executed over a 24-month period.

The existing plant, located in Victoria, Brasov County, was designed to treat 5,820 m3/day of wastewater generated from resin production. Purolite has planned to increase the production and an increased wastewater flow will result from production. Thus, an upgrade of the existing WWTP has become necessary. The upgrade will include additional pre-treatment, extension of existing lamella clarifiers and new Reverse Osmosis stage, in order to treat the effluent up to national NTPA001 discharge criteria.

The key features of the WWTP upgrade includes:

- Influent pretreatment, Cooling, neutralization
- SO4 and calcium precipitation and solids separation
- Reverse osmosis treatment stage
- Brine Evaporation Crystallizations

Commenting on this order win, Mr. Erwin Moetz, CEO – Wabag Romania said, "It is a matter of extreme pride for us to have bagged this key industrial order and we thank Purolite for the confidence they have reposed in us. We have already built a waste water treatment plant for Purolite and this repeat order is indeed a great testament of the trust that the customer has, regarding our capability and competencies. Wabag Romania specializes in design and construction of industrial water plants and this project will be another marquee reference for us."

ABENGOA STARTS PRODUCING WATER IN PHASE TWO OF THE TAWEELAH DESALINATION PLANT



Evercam's 4D View allows users to easily switch between real-time footage and BIM models for better project collaboration

Evercam 4D View helps project teams leverage engineering data to communicate project plans to all stakeholders

Dublin, Ireland – December 16, 2022 – Evercam is pleased to announce the addition of Evercam 4D View to Bentley Systems' powered by iTwin program. Evercam 4D View helps project teams leverage engineering and design data to better understand the construction sequence and communicate project plans to all parties involved.
The 4D View app combines real-time, high-quality video footage throughout the jobsite with a digital twin and allows users to switch between the model and reality to track changes and communicate progress. The app addresses the challenge of the volume of data available to project teams by connecting it with 4D planning, scheduling and analysis capabilities.

It is no secret that the construction industry has famously low levels of productivity, and while BIM has significantly contributed to the improvement of communications, the industry is still hindered by the inaccessibility of project data. Often, a BIM model is only accessible to a limited amount of the project team. Evercam 4D View democratises this data by allowing all users on a project to share and interact with the model from within the Evercam platform.

Evercam 4D View allows users to easily switch between real-time footage and BIM models to make collaboration easier. Users can see any changes made to the BIM model and receive updates within the platform. 4D View provides users with a list of features from within the platform including remote measurement, navigational tools, and the ability to highlight anything from the 3D model, as the iTwin Platform recognizes each element.

Evercam offers their customers unlimited user access, allowing team members from across the globe to work virtually together, ultimately improving safety, reducing risks, and creating greater efficiencies for the entire project team.

"We are very pleased to have Evercam add their Evercam 4D View application to the powered by iTwin program," said Adam Klatzkin, Vice President, iTwin Platform, at Bentley Systems. "In doing so, Evercam joins the growing ecosystem of software developers enabling digital twin solutions with the iTwin Platform. Evercam 4D View is a great example of how real-time video from the job site can be combined with a digital twin to increase the productivity of complex construction projects."

Marco Herbst, CEO of Evercam, said, "We are excited to be building this partnership with Bentley. Their commitment to openness is important to us and our users as they use data from multiple vendors. Our long-term goal is to be able to capture and understand the entire job site. The iTwin Platform, as a live, collaborative platform, gives us access to the latest detailed digital twin, filling in a vital piece of the information gap for Evercam users."



MEMSIFT RECEIVES 37.2M₹ CONTRACT TO BUILD A FIRST-OF-ITS-KIND RESOURCE RECOVERY PLANT IN INDIA THAT MAY REDUCE 1.47 MILLION KG OF CO2 EMISSION EVERY YEAR.

Singapore, 16 December - Singapore based emerging industrial liquid-waste treatment specialist Memsift Innovations Pte Ltd received a contract to build a first of its kind resource recovery plant for the manmade fibers (MMF) industry using its proprietary Improved Membrane Distillation technology TS30™. The plant will be commissioned in the 3rd quarter of 2023 at the state of Gujarat in India. The state-of-the-art technologies from Memsift recovers more than 98% of water and up to 100% chemicals from industrial liquid-waste streams with a benefit of lower carbon footprint compared to the currently available best technologies. The 'no chemicals' 'no steam' project may achieve a negative carbon footprint by considering the manufacturing carbon footprint of the chemicals to be recovered in this project. The estimated emission reduction is about 1.47 million kg of CO2 every year which is equal to 3,356 barrels of fossil fuel. About 67% of the emission reduction is due to the direct energy savings compared to the current method in place and the remaining 33% emission reductions comes from the tons of chemicals to be recovered. Typically, it takes a mini forest of about 58,000+ trees to absorb the same amount of carbon from the atmosphere over a period of one year. Dr J. Antony Prince, Founder & CEO, Memsift Innovations said, “this project is a key stepping stone for the full-scale commercialization of Membrane Distillation technology for real-world applications. Memsift will continuously focus on the key industrial verticals (Pharma, Chemical, Pulp & Paper, Mining and Metal finishing) to achieve resource circularity by closing the liquid-waste loop and play our part in decarbonizing these industries.” With the growing demand for resource circularity and the challenges in handling toxic industrial liquid-waste due to the emerging stringent global legislation and heightened corporate environmental consciousness, Memsift opens its first round of fundraising to capture the big emerging green circular market opportunities. Memsift wants to accelerate its growth to build its first full scale membrane manufacturing and engineering hub to scale larger industrial production of its patented membranes and the modules, expand market share by opening oversea sales and aftermarket service offices and strengthen its organization capability.

ED ISSUES NOTICE TO BBMP OVER IRREGULARITIES IN INSTALLATION OF WATER TREATMENT PLANTS

The Enforcement Directorate (ED) has issued notice to the Bruhat Bengaluru Mahanagara Palike (BBMP), in connection with a case on alleged irregularities in drilling borewells and installation of water treatment plants between 2016 and 2019.
In the notice, the Central agency has sought details about the allegation on the project from the BBMP Commissioner.

N.R. Ramesh, Bengaluru South district president of the BJP, had recently alleged irregularities of 400 crore in the project.

Mr. Ramesh had alleged that the irregularities happened over the drilling of borewells and installation of water treatment plants in 2019 and he had given the complaint earlier to the Anti-Corruption Bureau (ACB).

Later the case was transferred to the ED since the alleged scam was over 400 crore, he said. “I have produced various documents before the ACB and the ED. We have found that only 25% work of installing the plants and drilling borewells was completed,” he added.

Meanwhile, the BBMP Chief Commissioner has appointed a nodal officer regarding the case and the officer will be responsible to track all the details to share with the ED.
“We have appointed the Engineer in-chief as the nodal officer and all the details are being investigated and it will be provided to the investigation agency,” BBMP Chief Commissioner Tushar Giri Nath said.

Mr. Ramesh said that the ED is investigating the case under the provisions of the Prevention of Money Laundering Act, 2002 against the Joint Commissioners, Chief Engineers, Executive Engineers, Corporators and Contractors of Dasarahalli, Mahadevapura, Rajarajeshwari Nagar, Yelahanka, Bommanahalli zones.

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Manchester City And Xylem Call On Football Fans To Vote For Young Water Heroes Tackling Global Water Issues

Xylem Water Heroes Academy Spotlighting Five Inspiring Football and Water Projects in Cities Around The World

WASHINGTON, DC, (November, 2022) – Manchester City Football Club's global community program, Cityzens Giving, and global water technology leader, Xylem (NYSE: XYL) are calling on football fans to vote for their top project as the Water Heroes Academy returns for a second year. From November 22 to December 5, fans from around the world can vote for one of five new football and water projects from young leaders working to tackle global water issues in Buenos Aires, Cape Coast, Kuala Lumpur, Melbourne, and Mexico City.

Young leaders involved in this year's program are using the power of football to provide essential education on water, sanitation, and hygiene in a bid to tackle water challenges specific to their communities. Projects include improving access to safe water in underserved communities in Buenos Aires and Cape Coast, building flood-resilient communities in Mexico City and Kuala Lumpur, and advancing water sustainability education in Melbourne.

The top-voted project will win the opportunity for young leaders to experience a once-in-a-lifetime trip to the Etihad Stadium. There, they will learn more about water challenges and solutions, and receive further training on how they can help improve the health and well-being of young people in their communities. Each of the Water Heroes Academy projects will receive funding, educational tools, training, and mentoring from Xylem and Cityzens Giving, providing young leaders the resources needed to create their own unique programs going forward.



WABAG and ADB enter into a Strategic funding tie up; ADB to invest Rs. 200 Crores in Non-Convertible Debentures

November, 2022: VA TECH WABAG LIMITED ('WABAG', 'Company'), has signed an agreement with Asian Development Bank ('ADB') towards raising Rs. 200 crores through unlisted Non-Convertible Debentures ('NCD') carrying a 5 years and 3 months tenor which will be subscribed by ADB over a 12-month period. This will be ADB's first investment in a Water sector company in India.

This is in continuation to the ongoing debt optimization efforts of the Company through long term and low cost funding sources. The capital raised through this NCD issuance will be used towards working capital requirements of the Company and this will be within the current borrowing limits, thereby not increasing the debt levels of the Company.

and Development initiatives from 3 dedicated R&D centers located in Switzerland, Austria, and India, and possesses over 125 IP Rights. WABAG's vision is aligned to the UNSDGs and ESG with special focus on conservation, optimization, recycling and reuse of resources, directed at addressing water challenges across the world. WABAG is thus one of the world's leading partners for investments in a future that is worth living.

LANXESS again ranks top in Dow Jones Sustainability Indexes

- First rank in Dow Jones Sustainability Index (DJSI) Europe; second rank in DJSI World
- Outstanding results in the areas of product stewardship, management of water related risks and human rights

Mumbai, December 12, 2022 – LANXESS once again scores highly in terms of sustainability: The specialty chemicals company ranked first in the Dow Jones Sustainability Index (DJSI) Europe in the "Chemicals" category, scoring 85 out of 100 points. In the DJSI World, LANXESS came in second as in the previous year. The Group achieved particularly good results in the areas of product stewardship, water and human rights.

"Sustainable, integrative thinking and acting supports our corporate goals and is therefore anchored at all levels of the Group," said Hubert Fink, member of the Board of Management of LANXESS AG. "We consider the renewed very good ranking in the Dow Jones Sustainability Index to be both a confirmation and encouragement of our commitment."

For the Dow Jones Sustainability Indexes, companies are evaluated in the areas of environment, social responsibility and corporate governance. The DJSI World lists the top 10 percent of assessed global companies per industry, while the DJSI Europe lists the top 20 percent of companies headquartered in Europe.

LANXESS climate strategy on 1.5-degree path

Numerous external parties have recognized LANXESS' effective commitment to climate protection, most recently the renowned Science Based Targets initiative (SBTi). The joint

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initiative of the climate protection organization CDP, the UN Global Compact, the World Resources Institute and the World Wide Fund for Nature has validated the Group's targets for reducing its emissions and confirmed that LANXESS is contributing to limiting global warming to a maximum of 1.5 degrees Celsius. This value is the target set by the Paris Agreement and is generally considered the threshold for preventing a climate catastrophe.

To this end, SBTi analyzed plans for lowering direct emissions in production (Scope 1), energy sources (Scope 2) and the upstream and downstream value chain (Scope 3). Three years ago, LANXESS had already set itself the goal of becoming climate-neutral in Scope 1 and Scope 2 emissions by 2040. In 2022, the specialty chemicals company extended its target to climate neutrality for Scope 3 emissions. It aims to achieve this by switching to sustainable raw materials, “green” logistics and a climate-neutral product portfolio.

L&T secures ‘significant’ orders for water and effluent treatment business

New Delhi: Larsen and Toubro Construction on Monday announced that its water and effluent treatment business has secured a significant order from the Tumakuru Industrial Township Limited (TITL) under the Chennai Bengaluru Industrial Corridor (CBIC). It has also bagged repeat orders from the Tamil Nadu Water Supply and Drainage Board funded by the Asian Development Bank (ADB). L&T classifies orders worth 1,000 crore to 2,500 crore as significant.

“The order from TITL is to design, construct, test, commission, operate & maintain infrastructure works at the Tumakuru Node, Karnataka on an EPC basis," the company said in a press release.

The scope of work involves design & construction of 38 km of roads along with storm water drains, cross drainage structures, potable & recycled water supply systems, sewerage & effluent collection network, power distribution system including street lighting, 7 MLD water treatment plant, 3 MLD sewerage treatment plant, 2.5 MLD common effluent treatment plant, service reservoirs and Integrated Command & Control Centre (ICCC) building including operation & maintenance of the complete system for a period of four years.

“This project is part of the Government of India’s flagship program of ‘Development of Industrial Corridors’ under the National Industrial Corridor Development and Implementation Trust (NICDIT), the apex body overseeing integrated development of all industrial corridors across the country," the company added.

The program envisages to develop land to promote industries, residential areas, commercial complexes, logistic hubs etc. covering a total area of 1750 acres. It also includes green cover development of 80 acres at Tumakuru.

“Further, the orders from TWAD Board are to provide ‘Underground Sewerage Scheme (UGSS)’ works at Coimbatore," the company said.

70% rejuvenation work of Buddha Nullah completed, Rs 405 cr spent

Over 48 per cent of the total awarded amount has been spent to achieve 70 per cent work for the rejuvenation of the highly-polluted Buddha Nullah, a seasonal tributary of the Sutlej, in Ludhiana, the government has confirmed.

Since the ambitious Rs 840-crore project had faced teething problems and had got adversely hit due to Covid restrictions during the initial months last year, the deadline to complete the capital work has been further extended from December 1 this year to June 30 next, officials have said.

A senior government functionary said that the goal of the project was to give a new lease of life to one of the most polluted nullahs, which runs almost parallel to the Sutlej through most of Ludhiana district, including 14-km in Ludhiana city, by ensuring that only treated domestic wastewater or fresh or storm water may flow in it.

She said several components of the project had already been completed while rest of them were in the advanced stage of completion and the pace of the ongoing work has been further accelerated to meet the deadline of June 2023.

According to the project progress report, a copy of which is with The Tribune, the laying of pipeline along the Buddha Nullah banks has already been completed by placing 5,810 m on the west side, 4,850 m on the east side and 650 m from Kundanpuri to Upkar Nagar.

Of the two new sewage treatment plants (STPs) being constructed, the work on the 225-MLD capacity STP at Jamalpur was 90 per cent complete with the target to install it within this week while 34 per cent work on another 60-MLD capacity STP at Balloke had been completed with the target to make it functional by June 30 next.

Under the domestic effluent management of the project, six intermediate pumping stations (IPSs) on the banks of the Buddha Nullah were being installed of which 85 per cent work had been completed on two units, 57 per cent on three units, and the work on remaining IPS near the Gau Ghat gurdwara was yet to start.

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DELHI GOVERNMENT TO SET UP ₹ 10.3 CRORE WATER RECYCLING PLANT IN BAWANA



The Delhi government has planned to set up a water recycling unit of two million gallons per day (MGD) capacity in Bawana, a census town in northwest Delhi, according to an official statement made earlier this week. This will help provide round-the-clock water supply to the residents of the city, it added.

The Delhi Jal Board (DJB) project will be developed at the 20 MGD Bawana Water Treatment Plant at a cost of Rs 10.3 crore, news agency Press Trust of India reported. The project was approved by Deputy Chief Minister Manish Sisodia.

The Bawana Water Treatment Plant started functioning in February, 2015. Water from this plant is distributed to households in Narela and Sultanpur, among other areas.

At present, the water treatment facility lacks a recycling plant, leading to acute wastage of water. "The Arvind Kejriwal government will construct a two-MGD recycling plant to curb the wastage," Sisodia said. In the official statement, he also instructed the officials to complete the construction work within the stipulated timeline.

The provision of water allocation in the national capital is still done on the basis of old rules, which have failed to keep pace with the city's growing population.

"In such a situation, the Delhi government is working with a plan of action and a system to ensure that every citizen can be provided drinking water 24 hours a day in their homes," Sisoda, who is also the DJB chairman, said. "Owing to the rising population, arrangements for future requirements are being made as well."

Along with this, the Delhi government is also working in a phased manner to upgrade the sewerage system in the capital, lay sewer lines in different areas and provide door-to-door sewer connections, he added.

Decentralised sewage treatment plants are being built by the government in various unauthorised colonies and rural areas to ensure that contaminated water does not flow into Yamuna, the minister shared.

PREPARED ACTION PLAN TO CONTROL POLLUTION IN DRAINS THAT DISCHARGE EFFLUENT IN YAMUNA: HARYANA GOVT

Chandigarh: The Haryana government has prepared an action plan to control pollution in all the 11 major drains that discharge treated or untreated effluent into the Yamuna river, the state assembly has been informed.

"*Due to the control of pollution in these drains, the polluted water will not fall into the Yamuna river, from which the Agra and Gurugram canals emerge,*" Transport Minister Mool Chand Sharma said.

He said this in response to a calling attention motion regarding polluted water in Agra and Gurugram canals.

Sharma on Wednesday informed the House that the Haryana government has constituted a committee in this regard. The MLAs of Gurugram, Mewat, Faridabad and Palwal districts were made its members and member secretary, Haryana State Pollution Control Board, as Member Convener, the house was informed. Additional Chief Secretary, Environment, and Principal Secretary, Irrigation, have also been nominated as members.

ive meetings of this committee have been held, he said.

The minister said it is being regularly reviewed at the level of Chief Minister Manohar Lal Khattar and the chief secretary.

He said the action plan involves construction, upgradation of the existing sewage treatment plants, common effluent treatment plants, laying of sewage and interception of sewage from unapproved areas, regular monitoring of water polluting



industries by Haryana State Pollution Control Board and taking strict legal actions against such industries.

He further said due to the implementation of this action plan, the water quality of Agra canal has improved in the last few years. Sharma informed that the Gurugram and Agra canals originate from Yamuna river at Okhla barrage in the Delhi region. Agra Canal reaches the border of Haryana and Uttar Pradesh near Karman village. The Gurugram Canal is the major source of irrigation water in Mewat and a large population is adversely affected due to pollution caused by Delhi and Uttar Pradesh.

He said during 2022, Bio-Chemical Oxygen Demand (BOD) in Agra canal on Badarpur border in district Faridabad, in terms of pollutants, the status is between 24 to 32 milligram per litre. This indicates that the river is getting badly polluted in the Delhi region.

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JALADHI JAL PRAKALPA: TRANSFORMS CHANDAI VILLAGE OF BANKURA DISTRICT IN WEST BENGAL

By Dr. Debasri Mukherjee[1], Dr. M.N. Roy[2] and Er. Sohini Tarafdar[3]

[1]Senior Research Officer, SIGMA Foundation; [2]President, SIGMA Foundation; [3]Research Officer, SIGMA Foundation

Background

Chandai is a medium size village in Pakhanna Gram Panchayet of Barjora Block of Bankura district in West Bengal. It is situated about 5 km. away from the Pakhanna GP Office and is along the border of Hatashuria GP. There are around 350 households in the village with a population of about 1800 at present. The people of this village are mostly engaged in cultivation, cottage industry and cattle rearing. The area has hard rock acquirer, which has low capacity to hold water. Therefore, it is difficult to access water and the area remains drought-prone.

Problem Statement

Difficulty in accessing water: With the background mentioned above, the villagers of Chandai faced huge water crisis. The community did not have access to adequate and safe drinking water sources. The only source of drinking water was two tube wells that were provided to the villagers by the Gram Panchayat. The number of households depending on each of these two tube wells was very high, which made access to water difficult and time consuming. The situation used to be worse during the summer months when the tube wells went dry. The water that was drawn during this season also very poor in quality. Difficulty in accessing water caused many other problems.

Sanitation status of the village also remained poor in spite of construction of Individual Household Latrines (IHHLs) to all the households under the Nirmal Bangla Prokolpo. However, when accessing even drinking water was difficult, the latrines had very limited use and many latrines remained unused. Fetching water for use in toilet made many family members to practice open defecation. Even keeping the toilets clean was difficult in absence of water. In many households it was the women who used the toilet and that also added their burden in fetching water. Open defecation increased substantially because ponds of the village went dry in summer and getting water for toilet use became difficult.

Immediate outcome: The Jaladhi Jal Prakalpa launched by the PHED West Bengal

The Public Health Engineering Department or the PHED started the Jaladhi Jol Prakalpa in 2014 at Dejuri in Barjora and started supplying safe drinking water in some of the GPs of the Block. However, Pakhanna GP did not get any piped water supply till 2019. In 2019 the pipe laying work in Pakhanna GP started, but only a few street stand posts were provided to the people. In April 2021, the pipe line work was completed partially and the PHED started providing Functional Household Tap Connections (FHTCs) to each and every household in some of the Mouzas of the GP. The Chandai village received the FHTCs in May 2021. Now all the households are

The Jaladhi Jal Prakalpa launched by the PHED West Bengal



FGD WITH GP PEOPLE BY SIGMA



FHTC AT HH LEVEL

fully covered by FHTC and everybody in the village is getting safe drinking water at its doorstep regularly from the Dejuri Plant. Though the supply timing at present is 2 to 3 hours in the morning and 2 to 3 hours in the evening, but the villagers are very happy to get sufficient amount of safe drinking water within their households now and for this they are thankful to the Gram Panchayat and the Jal Jeevan Mission's initiative.

The villagers are now using their toilet in their house because there is enough supply of water in the premises. Many have installed water tanks and store the required amount of water for use during any time. They have to fill it twice daily. Now, everyone in the village use toilet and the village has now become 100% Open Defecation Free. The villagers are very satisfied with the supply of safe drinking water and especially the women are very happy because they feel that their difficult days are gone and now they are concentrating more and more on their household work and paying more attention to their other responsibilities. Their physical suffering in fetching water has been totally removed. Many women are now engaged in different economic activities like weaving beautiful mats from the palm tree leaves and have also gained enough time to be engage in activities related to Self-Help Group.

Lessons Learnt and Way forward

Every household in the village now has piped water supply within their premises. Besides the households, all other institutions in the village also have piped water supply now. There are two primary schools and one High Madrasa in the village. They are now getting sufficient amount of water within the premises on a regular basis. The piped water supply in the High Madrasa and schools has improved the quality of life of students. Their attendance has improved as well as the problem of lack of toilet facilities or handwashing stations due to insufficient water supply has been addressed.

The Research Group of SIGMA Fundation also talked to the GP people of the Chandai village, Mrs. Hanufa Begam who stated, *"All the villagers are getting benefits of supply of safe drinking water now. Earlier the women and adolescent girls used to go to the pond for bathing which was very much uncomfortable for them. Now every woman in the village is using bathroom and toilet within her house and feels safe and comfortable. Menstrul hygeine management has also improved"*. An adolescent girl named Nargis Bano, a Class IX student at Chandai High Madrasa told, *" Now in our Madrasa all the toilets and bathrooms have enough water. We can use our toilets in the Madrasa anytime we require"*.The PWSS has improved the quality of life of the rural community in actual sense and the story of Chandai is an appropriate example how the rural life can change with supply of piped water in their premises and fulfil the vision of Jal Jeevan Mission's goal. The impact has been far greater on women and adolescent girls who have better access to education, productive time and also better hygiene.



ABOUT THE AUTHORS



Dr. M.N.Roy *did his M.Tech in electronics from Calcutta University and served the Government of India as a member of the Indian Engineering Services for around 2 years. Thereafter he joined the Indian Administrative Services in 1980. He studied Sustainable Development at the University of Birmingham in 1996. Thereafter, he did his Ph.D from the Tata Institute of Social Sciences, Mumbai and the research topic was Women's Empowerment. He led the largest literacy movement of the country while serving as District Magistrate of undivided Midnapur and also organized a people's movement on public health and the first community-led sanitation movement in that District in early 1990s. Subsequently he headed several departments of the Government of West Bengal including the Department of Panchayats and Rural Development and the Department of Health & Family Welfare and retired as Additional Chief Secretary of the Government of West Bengal. He is the Founder President of SIGMA Foundation, which is a not-for-profit organization. He has many National and International Publications. He is a member of the International Water Association, the Institution of Engineers, India, the Indian Statistical Institute, the Indian Science Congress Association and the Environment and Sustainable Development Association, India.*



Dr. Debasri Mukherjee *is a Senior Research Officer in SIGMA Foundation a 'Not for Profit Organization' based in Kolkata, India. Before this She was a Research Officer (WQMS) from the day of inception of the Water and Sanitation Support Organization (WSSO), Public Health Engineering Department, Govt. of West Bengal for eight years. Prior to that she was with UNICEF Kolkata office for one year, The Energy Research Institute-Delhi (teri) for two years as a WASH Officer and IIT Delhi as a Project Officer for Fluoride Mitigation Programme for one year. She did her PhD from Delhi School of Economics-Department of Geography and also having international exposure in the field of Water Quality Monitoring and Surveillance Programme. She specialized with water quality monitoring, management of water supply schemes related issues and in-depth knowledge of water safety and security plan implementation. She is well experienced for capacity building in the WASH sector including development of training module, GLP Model and IEC/SBCC module. She is having many good publications in water sector. She received many awards in water sector. She is a member of the International Water Association (IWA), the Indian Science Congress Association (ISCA) and the Environment and Sustainable Development Association, India.*



Er. Sohini Tarafdar *did her M.E by Research in Chemical Engineering from CSIR- NEERI and is specialised in water engineering and techno-socio-economic research. She works in the diversified arena of development sector with a special focus on water security and safety, water technology and circular water management for enhancement of water use efficiency. Her field of interest includes gender equality & social inclusion amalgamated with governance & policy making. She has been working in the domain of water research for more than 9 years and is experienced in providing technical solution to water and waste water management. She has worked in various organisations including CSIR-NEERI (Nagpur and Kolkata Zonal Laboratory), CMPDI (Coal India Ltd.), SOS Children's Village Kolkata, Riddhi Foundation and SIGMA Foundation. She has handled major projects of Government and international donor agencies like UNICEF, ADB, AMRUT etc. She is established author in her domain with various national, international and departmental publications. She is also involved with the development of communication materials and capacity building of various target groups related to WASH. She is a full-time member of Organisation for Women in Science for the Developing World (OWSD)- An UNESCO Unit since August, 2022.*

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

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WATER INFRASTRUCTURE DEVELOPMENT: SAUNI YOJANA GUJARAT

By Subhash Sethi, Chairman, SPML Infra Limited



Gujarat is among the fastest growing states in India with gross state domestic product (GSDP) for 2022-23 is estimated about US$ 288.73 billion compared to US$ 259.25 billion in 2021-22, an increase of 13.3% year-on-year. The growth surge happened largely due to the distinction of being one of the most industrially developed states that contributes about a quarter to India's goods exports. It is a leader in industrial sectors such as chemicals, petrochemicals, dairy, drugs and pharmaceuticals, cement and ceramics, gems and jewellery, textiles and engineering. The industrial sector comprises of over 800 large industries and over 4.5 lac micro, small and medium enterprises.

Gujarat's infrastructure sector has grown significantly in the past few years with substantial rise in the number of industrial clusters, petrochemicals, airports, ports, and has emerged as a key hub for automobile, pharmaceuticals, electronics, gems and jewelry, textiles and engineering. In June 2022, the Hon'ble Prime Minister has inaugurated and laid foundation stone of development projects worth Rs. 21,000 crore (US$ 2.63 billion) at Gujarat Gaurav Abhiyan.

Gujarat accounted for the highest share in total investment. According to the DPIIT, FDI inflows in Gujarat stood at US$ 30.38 billion between October 2019 and June 2022. As of August 31, 2022, Gujarat had a total installed power generation capacity of 44,930.44 MW, comprising 29,204.20 MW under private utilities, 8,452.61 MW (state utilities) and 7,273.63 MW (central utilities). Gujarat has over 3,300 pharmaceutical manufacturing units, which contributed 30-35% to India's pharma sector's turnover and around 28% to India's pharma export during 2018-19. Export of drug formulations from Gujarat reached US$ 2.82 billion in FY22.

Gujarat is one of the most industrially developed states in India and the world's largest producer of processed diamonds, accounting for 72% of the world's processed diamond share. The urban population in Gujarat is increasing significantly. With about 43% of population residing in the urban areas as per 2011 census, Gujarat is among the large urbanized states in the country. With faster urbanization trend, it is quite evident that the state's urban population will surpass its rural population. A report by McKinsey suggests that Gujarat will be 66% urban by the year 2030.

But the state needs to focus more on developing sustainable infrastructure for water, wastewater and irrigation infrastructure to address the water scarcity issues for drinking water, and bulk water for industrial and agriculture purposes. One of the key challenges of urbanization in Gujarat is provision of drinking water. A large part of the state is water stressed and has severe shortage of drinking water.



3000 MM Dia MS SAUNI Yojana Pipeline, Gujarat

Gujarat is one of the most industrially developed states in India and the world's largest producer of processed diamonds, accounting for 72% of the world's processed diamond share.



Among all natural resources, water is considered the most vital. In India from being infinite and renewable, it has become a finite and vulnerable natural resource. The issue is more severe in Gujarat where water availability is not very positive as state has been facing acute drinking water scarcity due to recurrent droughts, low rainfall and skewed distribution pattern.

Gujarat is characterized by variations in the topography and wide variations in annual rainfall. Three fourth of the area of the state is unsuitable for groundwater withdrawal due to rocky terrain and coastal region. The supply of surface water is also limited and the state has a long recorded history of droughts. The rainfall pattern in Gujarat is erratic and uneven which leads to imbalances in distribution of water in different regions. Gujarat at present has only 2% of the country's water resources to cater to 5% of the country's population.

The total water availability in the state is 50 BCM, of which surface water accounts for 38 BCM and ground water accounts for the balance 12 BCM. Of the 38 BCM of surface water, more than 80% is being used for irrigation purposes, leaving limited supply for drinking and industrial uses, which are therefore, largely dependent on groundwater.

Fresh water availability is an issue in almost two-third of the state population where people has been facing water availability issues or quality problems. The available quota of surface water is also not distributed properly. Gujarat, Saurashtra and Kutch regions have water resources of 89%, 9% and 2% respectively, against this; the total geographical area of these regions are 45%, 31% and 24% respectively. The underground water resources of state are 17508 million cubic meters.

With increasing population and firm economic growth, water demand will increase considerably in coming years. Per capita fresh water supply in urban areas is between 73 to 117 litres per capita daily (LPCD) is much lesser than the recommended national benchmark level of 135 LPCD.

The water pollution, in general, and degradation of groundwater quality in particular are the added dimensions of water scarcity issue. Thus, the water problem of the state involves quantitative shortages, as well as, qualitative deterioration.

Government of Gujarat has focused approach towards providing long term solutions to water challenges by investing in water supply infrastructure based on sustainable surface sources to achieve water security. The initiatives have started showing results and ground water level is up by 67% in some parts of the state. The 3 specialized agencies, viz. Gujarat Water Supply & Sewerage Board (GWSSB) established for rapid development and proper regulation of water supply and sewerage services in the state to ensure sustainable water supply and sanitation services; Gujarat Water Infrastructure Limited (GWIL) was established for bulk water supply for fulfilling water needs of the state; and Water and Sanitation Management Organization (WASMO) created for drinking water service delivery at users level in rural areas in the state.

The Project

Saurashtra Narmada Avtran Irrigation Yojana (SAUNI Yojana): The Govt. of Gujarat has



2587 MLD Pumping Station for SAUNI Yojana Phase-1, Gujarat



2587 MLD Pump House for SAUNI Yojana Phase-1, Gujarat

initiated the ambitious Saurashtra Narmada Avtran Irrigation Yojana (SAUNI Yojana) with an estimated cost of INR 108 billion to divert One Million Acre Feet (1MAF) excess overflowing flood water of Narmada Dam to Saurashtra to distribute it to 115 Reservoirs through a total of 1115 Kms to irrigate 1.8 million hectare of land, mainly in Saurashtra, Kutch and north Gujarat, benefiting millions of farmers. This project is going to resolve the water scarcity of 132 towns and 11,456 villages in the Saurashtra, Kachchh, North Gujarat, Panchmahal and Ahmedabad regions for drinking and irrigation. About 1,650 MLD of water is supplied to 39 million people across these regions and with the good crop; it is boosting the economy of the state.

SAUNI Yojana is an ambitious large water infrastructure development project aimed to resolve the water related problems in Gujarat. SPML Infra has contributed significantly in the development of water infrastructure in the state. It has executed the phase-1 and phase-2 projects under SAUNI Yojana that was inaugurated by the Hon'ble Prime Minister of India in 2017 and 2019 respectively. The company is currently executing the phase-3 of this project and it is a challenging EPC project to execute given the complexity of the project for laying large diameter pipelines in different soil and terrain and volatile weather conditions.

SAUNI Yojana is an ambitious large water infrastructure development project aimed to resolve the water related problems in Gujarat.

Scope of Work:

Phase-1: SPML Infra scope comprised construction of pumping stations with capacity of 13,475 M^3/hr with 30 meters head; supply and laying of 20.47 kms Twin MS pipeline (total pipe laying 40.95 kms) of 3000 mm diameter of 17.5 mm thickness with external 3LPE coating & internal food grade epoxy coating; 66Kv Switch Yard, SCADA system and allied works along with 10 years of operation & maintenance post commissioning.

Phase-2: Pipe laying for 36.6 kms with MS Pipeline of 3000 mm diameter of 17.5 mm thickness with external 3LPE coating & internal food grade epoxy coating under the Link 1, Package IV as part of the Phase 2.

Phase-3: Supplying and laying 139 kilometers pipeline of 1000-2700 mm diameters and construction of pumping station along with 10 years of operation & maintenance post commissioning.

Project Challenges:

EPC projects are schedule driven with intersected phases to complete the project as early as possible. Sometime these overlapped phases pose challenges that lead to cost overrun and schedule delays. Some of the key challenges faced while executing this project includes:

The existing pipe manufacturers in India were not having the installed facility to manufacture and supply 3000 mm diameter 3 layer polyethylene coated pipes. SPML Infra got them to upgrade their facilities to manufacture and supply the required pipes

in adequate quantity as per time schedules.

- The transportation of heavy pipes (each 12 mtrs pipe weighted 15.6 metric tonnes) was very challenging. SPML Infra had to develop complete logistics using specially made 18 wheel low bed trailers for transporting such high value pipes to project locations spread across towns and villages.
- After laying of such huge pipes, the enormous task of jointing, welding and coating with 3 layer polyethylene was carried out with complete precision and safety by the experienced teams using complete protection from toxic gases emanating from welding inside the pipes.
- SPML Infra specially trained the work force deployed with complete facilities for safe transportation and laying in diverse soil and climatic conditions
- The transportation and placement of heavy pumping machineries were a difficult task that was completed with proper planning and management control at site. The rotator of all pumps was imported from Germany for the quality and longevity.

Project Learning:

Each project is unique and has distinctive challenges. We have learned to consolidate our cohesive team work between different divisions responsible for the execution of a project. Since our projects are spread in geographies and locations with diverse cultural background different from each other, we have learnt to deal with situations arising out of local condition.

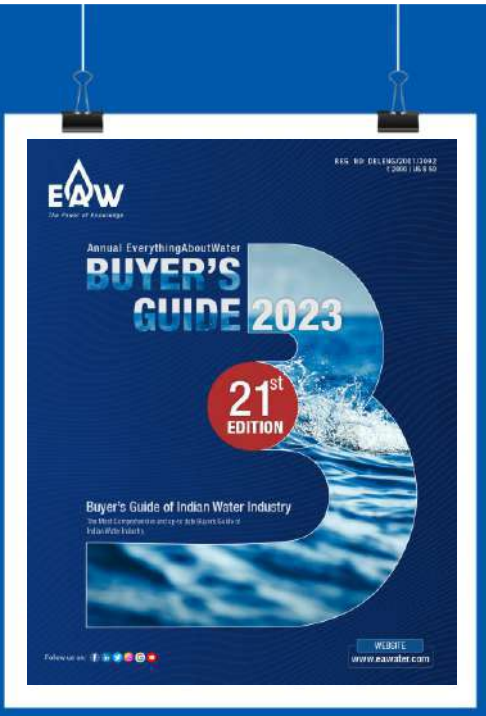
For SPML Infra, each project is unique and comes with distinctive challenges. According to our philosophy, team work and consistent performance measured approach is required for timely execution of the project. To provide impetus to work, SPML Infra believes in employee empowerment at all levels. Additionally from its past experience, the company has learnt to anticipate bottlenecks which are faced during project execution and preemptive measures are taken at every step to eliminate the delays.

ABOUT THE AUTHOR

Mr. Subhash Sethi *is Chairman of SPML Infra Limited. Under his leadership, SPML Infra went on to establish itself as a leading water infrastructure development company in India with over 650 completed projects to provide safe drinking water to over 50 million people. His valuable contributions in water and infrastructure development have been recognized widely and he has received several prestigious awards.*

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

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SOLAR POWERED WATER TREATMENT: SUSTAINABLE & ESSENTIAL

By Mohammed Naser Azeez, Managing Director, Aquality Water Solutions Pvt. Ltd.



Water is the most essential need for the survival of human, animal and ecological life. Assured availability of clean drinking water is also important for commercial activities leading to a nation's social and economic progress. There are almost 2.2 billion people, roughly around 30% of the world population having issues with access of clean water and sanitation at their premises and have no option but to drink contaminated water.

Globally, contaminated water is the second-biggest cause of premature deaths by drinking polluted water with mortalities about 1.4 million annually. The vast majority of pollution related deaths happens in developing and low-income countries. A global study found that the most fatalities due to water pollution happened in India, China, Nigeria, Pakistan, and Indonesia.

India Water Scenario

India is home to 18% of world population and 15% of global livestock population. However, the availability of freshwater is very limited, only 4% of global freshwater sources, out of which less than 1% are useable. According to a Lancet study, more than 500,000 people in India died in 2019 caused by water pollution alone.

NITI Aayog's water report has estimated that about 40% of the country's population is likely to face water stress by 2030, while over 600 million people is currently facing severe water scarcity. Its assessment points to the disturbing fact that almost 70% of the country's underground and surface fresh water could be contaminated. Water pollution is mainly caused by discharge of untreated or partially treated sewage, industrial effluents, improper management of generated sewage, and maintenance of existing infrastructure.

India ranks 120 among 122 countries in the water quality index, and 133 out of 180 nations for its water availability. It has been estimated that more than 40 billion litres of untreated wastewater enters Indian rivers and other water bodies every day. This is a serious matter that almost 70% of the generated sewage is not being treated and disposed of into water bodies every day. Water-borne diseases are common in India and have a significant economic burden, which has been estimated to be around USD 600 million per year.

Groundwater is the main source of domestic water supply for rural and urban India along with prime source for industrial production. More than 80% of the supply sourced through it, making India the largest user of groundwater in the world. Fluoride and arsenic contamination is common in groundwater that affects almost 2 million households in the country.

India is a vast country with great geographical diversity of dry deserts, green forests, snowy mountains, a long coast line and fertile plains. Certain parts in India are so fertile that they are counted amongst the most fertile regions of the world, while others are so unproductive and barren that hardly anything can be grown there. Provision of clean drinking water in areas with severe water scarcity



Aquality Water Solutions Pvt. Ltd. has developed the innovative Solar Powered Water Filtration that envisages providing safe drinking water to people in remote areas.



and high level of groundwater contamination is the biggest challenge.

A vast population in India lives in rural areas and mostly away from proper fresh water sources. The tribal population, security forces disposition and industrial clusters are facing a daunting task of making clean water available for drinking.

With the climate change and energy volatility surging, the only way of providing clean drinking water in such areas are by operating the filtration system by adopting sustainable energy management like solar power. The situation is same or may be more hazardous in African and Middle Eastern countries where electricity is not accessible to large population due to challenging geographical condition with large desert areas, hilly terrain and dense forest; main reasons people have no option but to consume unclean and contaminated water leading to severe health issues and premature deaths. They rely on water sources prone to contamination or travel long distances to collect drinking water.

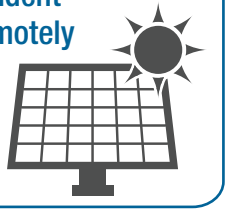
Solar Powered Water Treatment

Solar powered water treatment systems can vastly enhance the quality of water, improving the health, development, safety and livelihoods of people in such areas. Solar-powered water systems can keep feeding clean water to a community or habitation, security establishments, industrial clusters but it can also help in generating buffer electricity that could be used for lighting. They can reduce the impact of water contamination and can easily work in extreme weather events when other electrical systems are no longer operational.

Unlike traditional hand pumps, solar-powered treatment systems can be used anywhere for water storage and can supply water for multiple purposes, making water available for drinking or ultra-pure water for industrial production. This will reduce walking and waiting times, and can make water readily accessible to schools, health-care facilities, communities and security forces deployed in difficult terrains and forest areas.

With the water supply situation becoming more frightful in vast region of the world, UNICEF has been working on solar-powered water treatment systems and it has been successfully installed more than 1,200 solar-powered water treatment systems in over 40 countries, providing water to the most vulnerable people in remote areas. This is the most suitable option for making water safe for areas where groundwater or surface water sources are contaminated and access to electricity is unpredictable and challenging.

An easy-to-install solar-powered water purification unit functions independent of the grid, an ideal solution to remotely process and filter clean and safe drinking water.



The Project

Aquality Water Solutions Pvt. Ltd. has been leading the initiative in India to make drinking water clean and safe to our security forces and other establishments globally including human habitats in India, Africa and Middle Eastern Countries. I have worked in Middle Eastern countries and have witnessed the challenging situation of getting safe water for consumption. When I returned back to India, I worked with my friend Mr. B. M. Balakrishna to make a pioneering solution of Solar Powered Water Filtration System which we showcased to Ministry of Water & Sanitation in 2015. The prototype system was liked by ministry officials and delegates during the flagship event, Indovation.

We worked further on the prototype to enhance the filtration capacity and made a successful system which has the capability of producing 500 to 20,000 litres of clean water per day depending upon the requirements. It is certainly an important innovation for making provision of drinking water to those who are facing the challenges in getting it. Aquality Water Solutions Pvt. Ltd. has installed Solar Powered Water Filtration System for para-military forces deployed in the dense forest areas in different states.



The System

The new development of solar powered water filter has high speed water filtration unit that can purify water from practically any source, such as hand pumps, swamps, wells, floods, rivers, and even waste water. The technology being used applies innovative high purification techniques to make water absolutely clean destroying all containments and producing high grade water suitable for drinking at any place without the requirements of conventional electric supply. These water treatment unit needs electricity as conventional units but the best part is that it generates its own electricity for the purpose and is ideally suited for areas with non-existent or erratic and unreliable power supply.

The purification device is also compact, at around the size of a big box, has low power requirements and has no removable parts that need to be maintained or replaced, such as carbon filters or reverse osmosis membranes. The best part of the system is it can recycle used water as well for using it in toilet flush in all Swacch Bharat Mission toilets that has been constructed but not being used properly due to lack of water. Each unit has been designed as plug and function units for easy deployment at any remote site with minimal time for making it functional. The system can easily be transported to long distances by all transportation modes making it the best possible solar-powered water purification system to be installed at any place in India and globally.

The Benefits

The solar powered water treatment technology will help our defence services including Military, Navy, Air Force and paramilitary forces like Border Security Force (BSF), Central Reserve Police Force (CRPF), Central Industrial Security Force (CISF), Indo Tibetan Border Police (ITBP) and even State Police Forces posted in forest and hilly areas. The portability of the system helps it in easy to install and easy to operate and maintain that will be a great advantage.

The Slient Features

- The system is completely mobile and can be installed anywhere.
- During an emergency situation, like a disaster, it can be deployed with immediate relief efforts.
- It is available in various sizes meant for small scale use to commercial and community supply.
- These are stand-alone, user-friendly system designed to purify and disinfect water.
- These solar energy-based treatment technologies will prove to be an alternative to the current technologies in water treatment.
- It will enable our security forces to access clean, safe water out in the field, regardless of water source quality.
- It will improve forces' resilience by reducing the logistical burden of transporting and relying on water tankers or bottled water convoys.
- The system is fully scalable, with one water purification unit able to create 500 to 20,000 litres of clean water per day.
- It helps promoting sustainability by reducing the demand of electricity and bottled water.



- It will reduce the carbon footprint associated with electricity use, and sourcing, transporting and disposing of bottled water and traditional water purification filters.
- It is a portable and modular water purification unit for safe drinking water at point of use for even humanitarian missions.
- It can be mounted on a vehicle to provide clean drinking water to different locations every day without any difficulty.
- Solar energy and its utilization in the water treatment process make its way as the potential solution for the provision of safe and clean drinking water.

Way Forward

Solar energy-based water treatment technologies will prove to be an alternative to the current technologies in water treatment and disinfection. With technological improvement and compactness, it will prove to be the necessity in future for all rural settlements wherever Jal Jeevan Mission (JJM) scheme is providing functional tap water connections. The system will be immensely helpful if implemented along with JJM projects for not only providing safe water for drinking, but it will also enable recycling of wastewater and make all toilets built under the Swachh Bharat Mission properly functional with adequate supply of treated water for flushing.

Solar energy is a sustainable and greener energy source for carrying out water treatment. Solar energy for water purification has been widely explored in recent times. Another major problem with developing countries is handling water-borne diseases, which lead to major health issues and fatalities. Solar energy comes to the rescue here, and its application for the disinfection of water will cater to the need for safe water, improving community health and providing a sustainable solution.

ABOUT THE AUTHOR

Mohammed Naser Azeez *is an engineering graduate with MBA from Preston University, USA. He is the Managing Director of acclaimed Aquality Water Solutions Pvt. Ltd. that provides technologically advance and innovative solutions for water and wastewater treatment.*

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TARGETING SURFACE WATER POTENTIAL ZONES USING CRITIC WATER QUALITY INDEX, MOORA AND GIS TECHNIQUES IN MAHANADI BASIN, ODISHA, INDIA.

By Abhijeet Das, Research Scholar, Department of Civil Engineering, C.V. Raman Global University

Abstract

As one of the largest rivers in Odisha, the Mahanadi River plays an important role in local economy and ecosystem. However, rapid use of water quality leads to serious water pollution. However, the main objective of this present study is to evaluate the surface water, with an aim of collecting 20 samples from 19 monitoring sites for a period of 1-year (2021-2022) using the Critic water quality index (CWQI). The spatial distribution maps were prepared using the Inverted Distance Weighted (IDW) in ArcGIS 10.5. The concept of multi-criteria decision-making methods (MCDMs) such as MOORA was introduced which utilize weights and rough set theory to give a reliable and unbiased description of overall pollution levels of each sampling location. The physicochemical results were classified according to WHO limits values for drinking water. CWQI value of surface water quality was found to be in a range of 36-290.8, signifying excellent to extremely poor category. It reveals that 84.21% of samples fall under excellent classes for drinking categories. Based on the assessment scores prescribed by MOORA, the Paradeep (St. 9) was found to be the most polluted station in comparison with other locations, followed by 2nd (Cuttack D/s) and 3rd (Choudwar D/s). Agricultural waste runoff, untreated effluents and many other anthropogenic activities were identified as the main contributor in decreasing the water quality at St. 8, 9 and 19 respectively. The water quality methods which are discussed extensively in the paper, can also provide an overall idea about indexing for further research.

Keywords: Mahanadi River, Critic water quality index, MOORA, Inverted Distance Weighted, anthropogenic.

I. Introduction

Water is the most important natural resource for existence of lives and planets on the Earth (Yang et al. 2021). Water pollution is a major problem arising from industrial and economic growth, so geochemical studies have been done to assess the water quality of several great rivers in world (Le et al. 2022). Surface water is a precious resource that India needs to utilize sustainably to meet the growing demands in its domestic, agricultural and industrial divisions (Mahadevan et al. 2020). The quality assessment may give a clear information about the environments in which the water presents (Long-Ling et al. 2021). Over the past few decades, the wastewater generated from different sources such as mining activities, food industries, petrochemical industries, healthcare facilities, domestic sewage and others, is rich in recalcitrant toxic pollutants, has demanded a paradigm shift in wastewater treatment (Wang et al. 2020). A number of studies (Hasan et al. 2019; Sarkar et al. 2019; Parvin et al. 2022) have been conducted to measure surface water quality of the country. Those studies illustrated that the quality of this water resource is continuing to be contaminated through heavy industrialization, growing agrochemical-based cultivation, and municipal wastes (Parvin and Tareq 2021). The aptness of surface water quality depends upon amount of cleanliness and load of pollution (Steinhart et al. 1981; Lu et al. 2019). The frequent variations of WQIs were addressed in literature over the past five decades (Brown et al. 1970; Dunnette 1979; Bhargava 1985; Majeed 2018; Banda & Kumarasamy 2020a; Islam & Mostafa 2021e). One of the major limitations in this method is the assignment of equal weight to all parameters (Lumb et al. 2011). Apart from WQIs, the potential of multi-objective decision-making methods (MCDMs) in stream restoration efforts has been evaluated by researchers in modifying WQI ranking, redressing management issues such as storage system, performance assessment, demand response and renewable energy sources (Zahedi 2017; Yousefi et al. 2018). Several researchers have come up with different methods of determining the criteria weights of a multi-criteria decision-making (MCDM) problem (Ginevicius and Podvezko 2005; Aldian and Taylor 2005; Chung et al. 2012; Dragon et al. 2018). Amongst is the Criteria Importance Through Inter-Criteria Correlation (CRITIC) water quality index (CWQI) known to be the earliest and probably the most widely used method (Diakoulaki et al. 1995). To determine the weights by calculating the value is the way of defining the weights of every water quality indicator based on the interpretation of the variation degree of every evaluated indicator value. The MOORA method (Multi objective optimization on the basis of the ratio analysis) tries to provide an improved method for offering a cumulatively derived, numerical expression describing a certain level of quality of water based on critic weights (Peng et al. 2020; Khan et al. 2016). The effectiveness of such procedures depends on the conceptual framework of assessment processes and on the common language used to identify and address complex water challenges. Geographical Information System (GIS) is rapidly growing field for a variety of application from micro-level planning to macro-level planning, implementation and regular monitoring (Balamurugan et al. 2020b). Inverted Distance Weighted (IDW) classification is taken into account where the points closer to the predicted position have a greater effect on the predicted value than points far from the predicted position (Panneerselvam et al. 2021). The integration of WQIs, MCDMs and GIS provides the detailed quick and reliable information for decision makers to adopt or implement strategies related to water pollution and scarcity (Singh et al. 2019). Mahanadi River, Odisha is a major water supply source for various purposes. Since, it is devoted to agricultural uses, its quality should be assessed to safeguard public health and environment (Song et al. 2020). Number of works were carried out on the role of different urban and industrial effluents (Chakrapani and Subramanian 1990; Nanda and Tiwari 2001; Das, A 2022), but no study has been carried out using CWQI and MCDMs. As a result, the quality is in a declining trend because of over-exploitation and other anthropogenic

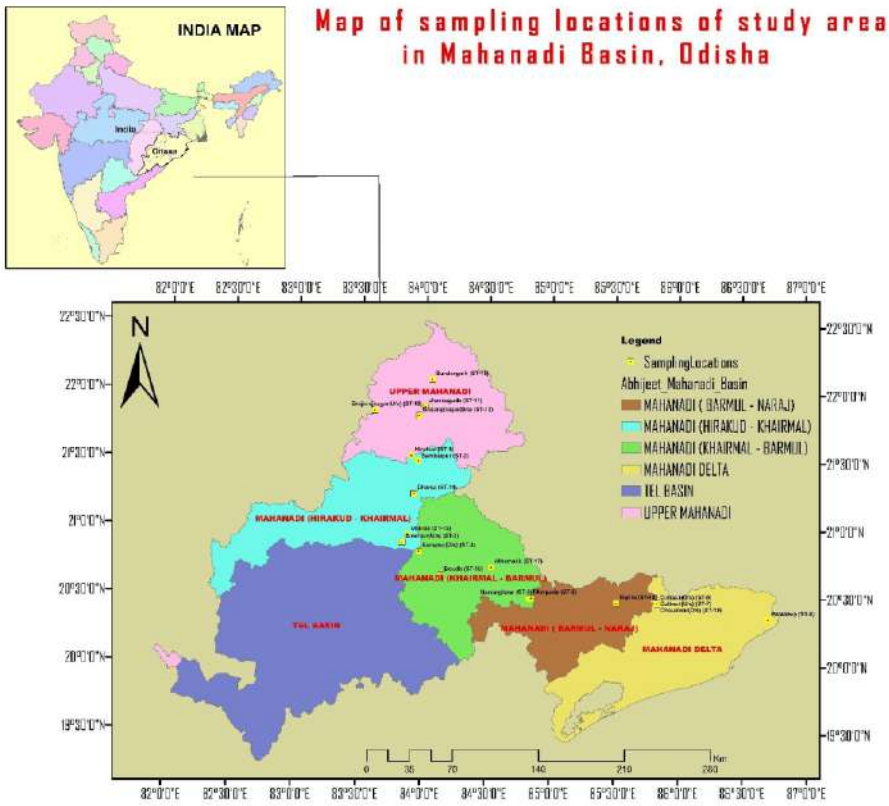


Figure 1. Location of sampling sites (delineated using ArcGIS 10.5)

activities. So, water quality assessment of the present scenario is needed. The present study aims to fill the gaps in previous studies of the area and to evaluate the surface water quality for drinking purposes by using GIS, CWQI and MCDMs such as MOORA approach.

II. Material and methods

Study area

Mahanadi River Basin (MRB) majorly drains the states of Chhattisgarh and Odisha and smaller portions of Jharkhand, Maharashtra and Madhya Pradesh. It is considered to be the third largest in the peninsula of India and the largest river of Odisha state. The basin lies between latitude 19°21'N and 23°35'N and longitudes 80°30'E and 86° 50'E. It extends over an area approximately 141,600 Km2, has a total length of 851 Km and with peak discharge of 44740 m3/sec (Chakrapani and Subramanian 1990). The average annual rainfall is about 142 cm and temperature ranging between 15.8°C to 28.7°C. Agriculture area, forest reserves, mining areas and urban centres are the major land uses. The Geo-coordinates, landmarks and demarcation of sampling sites mentioned in Figure 1.

Sampling strategies and analysis

Standard methods for examination of Water and Wastewater (APHA 2017) were used for sampling and analysis of water quality at all locations on the river. The water quality data during the year from 2021-2022 from 19 locations and 20 parameters were used for the present investigation. Considered parameters namely pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), total coliform (TC), total suspended solids (TSS), alkalinity, chemical oxygen demand (COD), ammoniacal nitrogen (NH_3-N), free ammonia (free-NH_3), total kjehdahl nitrogen (TKN), electrical conductivity (EC), sodium adsorption ratio (SAR), boron (B), total dissolved solids (TDS), total hardness (TH), chloride (Cl-), sulphate (SO_4^{2-}), nitrate (NO_3^-), fluoride (F^-) and iron (Fe^{2+}). The quality of the analysis was confirmed by standardization using blank, spike and also duplicate samples. As an additional assurance of accuracy, the chemical analysis was verified by calculating the ion balance error, which was generally within 5%. MATLAB (Mathworks R2018b) was utilized to compute the water quality indices and decision-making approaches using the function command.

CRITIC weighted water quality index (CWQI)

CRITIC (Criteria Importance Through Inter-criteria correlation) is a widely used MCDM technique that determines the objective weight for the criteria (Diakoulaki et al. 1995). It uses correlation analysis to measure the value of each criterion and helps in calculating the objective weights of each criterion by eliminating the effect of decision maker on the decision-making process. Steps involved in calculation of CWQI are as follows: (Diakoulaki et al. 1995). The Weight (W_j) is calculated using $W_i = C_j / \Sigma C_j$, where C_j is the volume of information contained in j^{th} criterion calculated as $C_j = \sigma_j * \Sigma (1-r_{ij})$, where r_{ij} is the correlation coefficient between the two criteria and Σ_j is standard deviation of the j^{th} criterion. Quality rating scale for each parameter was assigned by $Q_i = (P_j / S_i) * 100$. CWQI was calculated by $CWQI = \Sigma W_i * Q_i$. The water quality classification scale suggested by Wu et al. (2011) signifies waters with CWQI < 50 to be of excellent quality, CWQI between 50 and 100 as good, CWQI between 100-150 as medium, CWQI between 150 and 200 as poor and CWQI> 200 as extremely poor.

MOORA Method

The MOORA (Multi-objective optimization on the basis of Ratio analysis) method, first introduced by Brauers (2006, 2008), is such a multi-objective optimization technique that can be positively applied to answer numerous complex decision-making problems. It consists of two components such as ratio and reference point approach (Khan et al. 2016). A ratio system will be formed by normalizing the data of decision matrix which can be calculated by using the equation $x_{ij}^* = x_{ij} / (\Sigma\, x_{ij}^2)^{0.5}$, where x_{ij}^* represents the normalized value i^{th} alternative on j^{th} attribute. xij* is a dimensionless number which lies between o and 1. These normalized performance measures are added together in case of beneficial (larger-is-better) attributes and subtracted in case of non-beneficial attributes (lower-is-better). This provides an overall assessment value of the performance measures which can be represented by the following equation: $Yi = \Sigma^{g}_{j=1} Wi * xij * \Sigma^{g}_{j=g+1} Wi * xij *$. Finally, assign ranking to the overall assignment value Yi in descending order. The highest value of the Yi represents the best alternative, while the lowest value of Yi represents the worst.

III. Results and discussion

The physicochemical characteristics of the 20 surface water samples were statistically evaluated and the results such as minimum and maximum and their corresponding permissible limits have been shown in Table 1. The pH value varied from 7.7-7.9 showing alkaline in nature, and that the samples are under WHO permissible limits. The DO (7.3-7.8) is higher the permissible limits (WHO 2017), favouring high temperature variations and phytoplankton growth. It is noted from the present study, the BOD is under the permissible limits (5 mg/l). TC varies from 1212.4-42529.2, but the board allows a limit of 5000 MPN/100 ml or less. Higher values reported at St. 8, 9 and 19 because of factories and sewage discharge. TSS represents suspension of clay and soil particles and its concentration for all sites in the present study ranged from 28.6-74.9 mg/l, indicating well below the threshold of 100 mg/l. Alkalinity provides a thought of characteristic salts in water. The values recorded as 70.4-100.9 mg/l. COD indicates presence of biologically resistant organic substances. Its value recorded as 6.8-21.9, which are well below the standard limit of 30 mg/l. NH3-N (0.5-1.9) and free NH3 (0-0.1) is present in waste water, domestic sewage, agriculture, industry and landfills. The values are within the drinking guidelines. TKN concentration fluctuated in the range of 3.3-11.8 mg/l. The findings showed that water bodies at St. 8 and 9 are higher than WHO standards, which are contaminated with nutrients, industrial zones and fishing ports, leading to pollution of water environment. EC is an indirect measure of TDS. Observed value of 138.1-7779.4 was found in the study area and St.9 exhibits high EC because of sewage and fertilizer runoff. The current study obtained SAR values in the range of 0.4-16.6 meq/L, which are less than 10 meq/L, indicating that river water is suitable for irrigation except St.9. Presence of B in surface water is a consequence of the discharge of wastewater and in the present study, its value ranged from 0.0-0.6 mg/l. These values were allowable as per WHO (2 mg/l). The calculated TDS values fluctuated from 82.3-13230.6, signify samples are below the admissible limits (WHO) except St. 9. Higher TDS is due to enrichment of salts in water. The recorded TH values ranged from 51.2-2195.2. St. 9 has higher TH because of industrial and mining activities along the sides of river bank. Cl was higher in St. 9 due to effective leaching from upper soil layers by industrial and domestic activities and dry climates. Apart from this, all locations are within the limit of 250 mg/L. The value of SO42- ranged from 5.0-376.1 in the study area. SO42- is higher in St.9 due to release of sulphur gases from industries, which get oxidized and enter into the water during precipitation. F- influences teeth greatly by preventing and minimizing tooth-worsening hazards at low concentrations. F- in river water varies from 0.3-1.0 mg/l,

Table 1. Statistical Water-Quality Parameters in the Study Area (All units are in mg/l except pH (unitless) and EC (µS/cm))

Parameters	Range (Min-Max)	WHO (2017)
pH	7.7-7.9	8.5
DO	1,57,500	6
BOD	1.1-2.4	5
TC	1212.4-42529.2	5000
TSS	28.6-74.9	100
Alkalinity	70.4-100.9	200
COD	6.8-21.9	30
NH_3-N	0.5-1.9	2
Free NH_3	0-0.1	2
TKN	3.3-11.8	5
EC	138.1-7779.4	2250
SAR	0.4-16.6	10
B	0.0-0.6	2
TDS	82.3-13230.6	100
Cl^-	9.7-4904.9	250
So_4^{2-}	5.0-376.1	200
F^-	0.3-1.0	1
No_3-	1.3-2.7	45
Fe^{2+}	0.6-2.6	3

which suggests water is suitable for drinking as per WHO (1 mg/l). Nitrate contamination results from leaching and excess use of inorganic fertilizers and manures as well as disposal wastewater by specific industries. In the study area, the value varies from 1.3-2.7, which completely satisfies the WHO criteria of 45 mg/l. Fe2+ in the study area was predicted to be from natural sources or industrial wastewater. The level of Fe2+ was found to be 0.6-2.6, leading to give confirmation in line with WHO standards (3 mg/l). The overall findings indicate that most of the parameters in St. 8 (Cuttack D/s), 9 (Paradeep) and 19 (Choudwar D/s) eventually exceeded the permissible limits described by the WHO (2017). These observations shed significant light towards human-induced activity. CWQI has been applied to evaluate the spatial changes in water quality (Singh et al. 2019). It is a step-forward from traditional WQIs, which rely on personal judgements and expert opinion to assign weights to parameters. The overall values of CWQI of the water samples from all 19-sampling station are presented in Table 2. In the present research, the CWQI value varies from 36-290.8, signifies excellent to extremely poor category. The spatial variability of the water quality as computed by CWQI with respect to physicochemical parameters is depicted in Figure 2. Calculated CWQI values revealed that 84.21% surface water sources were of excellent quality ,10.5% had poor water quality and 5.26% exhibited extremely poor water quality. It has been noticed from the results that St. 8, 9 and 19 are identified as hot spots due to the deteriorated water quality on account of higher concentration of certain parameters such as TC, TKN, EC, SAR, TDS, TH, Cl- and SO42-. It is still observed that 15.78% samples represent poor water quality which may be due to the prolonged intensive agriculture and consumption of poor-quality water may affect human health.

However, in such a complicated scenario, the MOORA method, which is a reliable method based on critic weights and clearly identifies the relative pollution level by giving them their overall ranks such that the highest MOORA rank would indicate the most polluted sampling location. The assessment value (Yi) and MOORA ranks of the sampling locations are shown in Table 3. The evaluation of the MOORA yields significant results which have been shown in Figure 3. To create a spatial map in

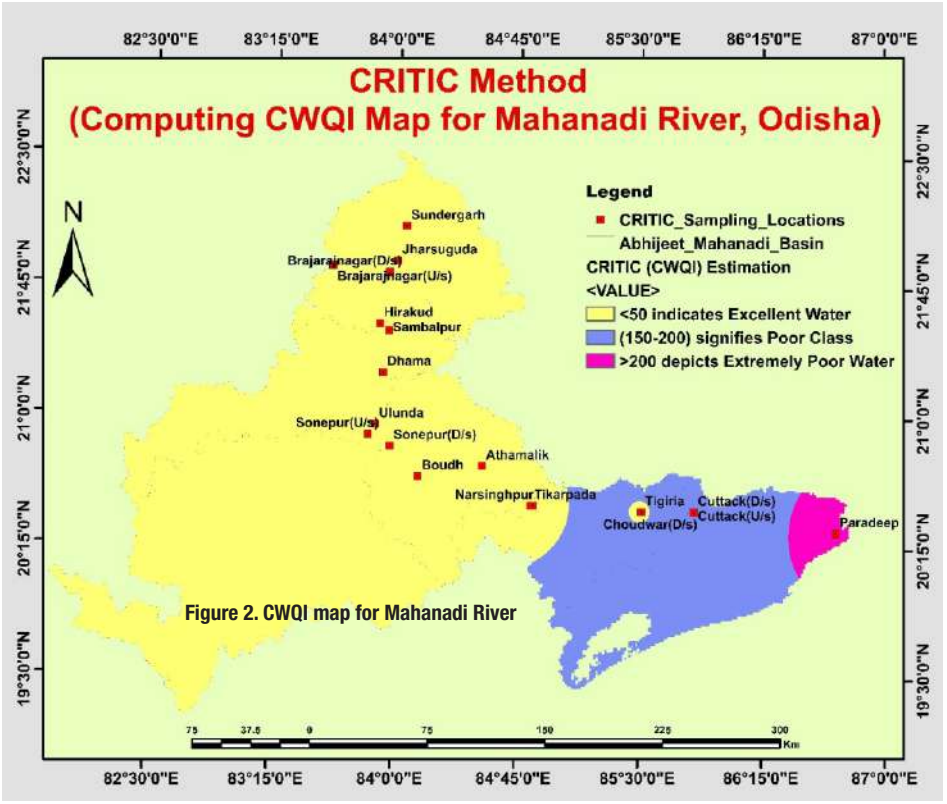


Figure 2. CWQI map for Mahanadi River

ArcGIS, MOORA values were interpolated over the entire study. The developed map can be seen in Figure 4. During the study area, it is being noticed that sampling site Paradeep (St. 9) was the most polluted in comparison with other locations. This was evident from the highest CWQI values at this location. It also accompanied with high values of TC, TKN, EC, SAR, TDS, TH, Cl- and SO42-. 2nd and 3rd polluting site were considered to be Cuttack D/s (St. 8) and Choudwar D/s (St. 19) depending upon the assessment score as specified in Table 3. Based on the results from both of the approaches (CWQI and MOORA), significant differences were found between upstream and downstream locations. The values reported to be excellent in upstream and poor/extremely poor in downstream due to urban wastewater and agricultural runoff. It can be concluded that CWQI and MOORA has been shown to be effective in investigating pollutants, and provides an overall ranking to the sampling sites as well as proved efficient in ranking the sites. In the present study, only two approaches were used to access the surface water quality evaluation. Furthermore, the current work is done for the 1-year time frame. Future work can be done for the seasonal variation to give a comparable result.

IV. Conclusion

Surface water salinization, intensive agricultural practices and associated fertilizer application are the

Table 2. Summary of CWQI of Mahanadi River along with its water quality status

Sampling Station	CWQI	CWQI status
St.1	36.52	Excellent
St.2	44.38	Excellent
St.3	36.29	Excellent
St.4	43.90	Excellent
St.5	41.72	Excellent
St.6	42.93	Excellent
St.7	41.25	Excellent
St.8	174.00	Poor
St.9	290.88	Extremely Poor
St.10	41.50	Excellent
St.11	36.43	Excellent
St.12	38.40	Excellent
St.13	42.25	Excellent
St.14	43.76	Excellent
St.15	36.07	Excellent
St.16	40.87	Excellent
St.17	42.84	Excellent
St.18	41.24	Excellent
St.19	162.00	Poor

Table 3. Assessment score and MOORA Ranks in Mahanadi River, Odisha

Locations	Y_i	Rank
St.1	0.032	16
St.2	0.039	9
St.3	0.032	18
St.4	0.040	6
St.5	0.037	11
St.6	0.037	10
St.7	0.036	12
St.8	0.093	2
St.9	0.890	1
St.10	0.033	15
St.11	0.031	19
St.12	0.032	17
St.13	0.036	13
St.14	0.039	8
St.15	0.034	14
St.16	0.040	4
St.17	0.039	7
St.18	0.040	5
St.19	0.062	3

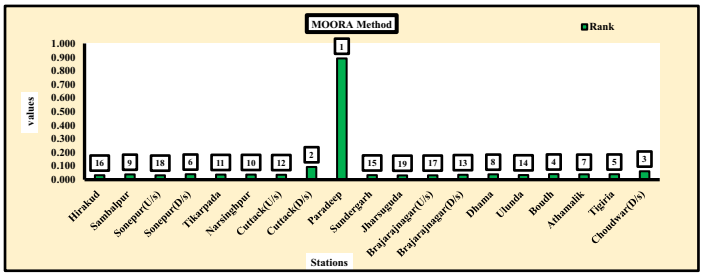


Figure 3. Rank of all sampling sites

major threats to surface water sustainability in Mahanadi Basin, Odisha. This study incorporates the governing process of hydro-chemistry, used 20 surface water samples taken during the 1-year time frame (2021-2022) from 19 locations for water quality assessment using an integrated approach of CWQI, MOORA and GIS methods. CWQI which takes into account uncertainties of occurrences of physicochemical parameters. Reliability critic-based MCDMs such as MOORA have been employed in prioritizing decision making by ranking sampling sites based on their overall pollution levels. GIS-based spatial analysis using a IDW interpolation technique was used to represent the spatial variation of CWQI and MOORA. Based on the results, the following conclusions can be drawn from the study: CWQI reveals 84.21% surface water sources were of "excellent quality", 10.5% had "poor water" and 5.26% exhibited "extremely poor water" quality domains respectively. Highest value of CWQI (poor graded) came out to be at the St. 8, 9 and 19 locations, lying in the proximity where densely population is available. In assessment of overall pollution levels of each sampling location, MOORA denoted that St. 9 was most polluted followed by St. 8 and St. 19. This present work reflects that these locations are significantly owed by anthropogenic inputs mainly from agriculture, domestic sewage, factories, industries and geogenic sources. Although structured approaches based on aggregative WQI evaluation methods have been applied in the past, this research for the first time provides an intensive surface water quality assessment by computing critic weight coefficients and rank scores for the water quality indicators. However, the method proposed an important alternative for instant universal and relative analysis for all available surface water quality data. The outcomes of the study area may help local governing bodies to identify the suitable and vulnerable sites for effective management of surface water resources in the river basin.

Acknowledgements

I sincerely acknowledge the State Pollution Control Board (SPCB), Odisha, India and C.V. Raman Global University (C.V.R.G.U), Bhubaneswar, Odisha, India, for providing valuable data regarding the water quality of River Mahanadi, Odisha, for carrying out analysis and result interpretation.

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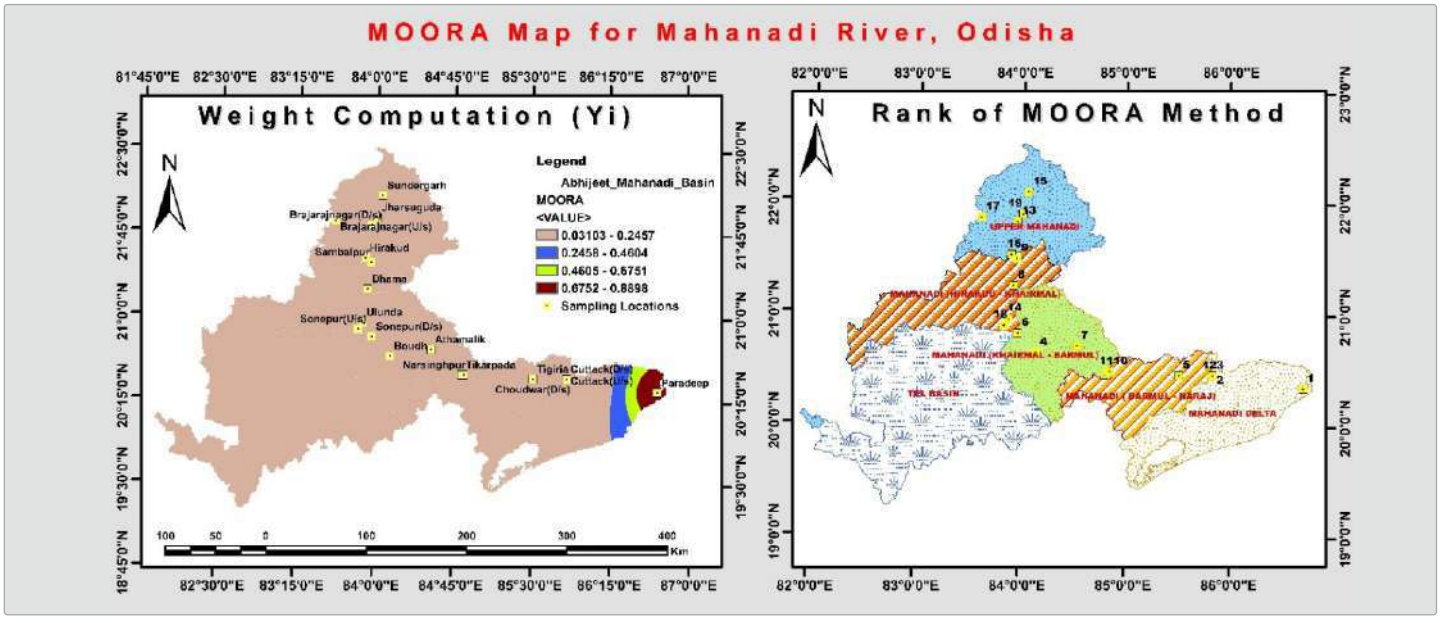


Figure 4. Spatial variation map of MOORA method

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POTS OF WATER BURDEN: A CASE STUDY ON WATER SCARCITY IN CHAKNADA VILLAGE OF PURULIYA DISTRICT IN WEST BENGAL

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Background and Introduction

Four billion people across the globe experience severe water crisis every year[1]. According to estimation by global experts, 700 million people could be displaced due to intense water scarcity by 2030[2]. Most importantly there is a ceaseless journey to access safe water by the communities in various parts of the world. Women and children are the most affected groups due to this global crisis. As per global statistics, women and girls spend around 200 million hours fetching water every day[3]. In Indian villages women spend up to four hours a day to fetch water which results to be a hindrance in their socio-economic progress[4]. Women walk miles to fetch water for their family from the nearest source and children drop out schools to collect water for their near and dear ones. A report published by Down to Earth mentions that women in India are considered as second-class citizens who is pushed at a higher risk of vulnerability due to the rising water scarcity in the country[5]. In West Bengal, the situation is no different and due to absence of preservation measures it is on the brink of becoming a parched state[6]. The Purulia district is known as the parched lands of the state as it is a drought prone (under the semi-arid climatic zone) district of West Bengal. Various villages in Purulia suffer from acute water shortage as most of the tube wells and taps are non-functional[7]. Geologically this district is under the basaltic or metamorphic condition and the water table is mostly in confined by nature. So, getting the tap connection or the withdrawal of water from the hard rock area is quite costly and the medium or low rainfall also add the cause of low recharge of the water table and depletion of groundwater on a regular basis.



COLLECTING WATER FROM SUB-SURFACE

Estimation by global experts, 700 million people could be displaced due to intense water scarcity by 2030

Chaknadais a small village in Chatumadar Gram Panchayat of Hura Block, Purulia district in West Bengal. The village has 150 families of indigenous population and the dwellers have been struggling for access to safe water for decades. Women and girls of the village face immense drudgery due to the prevailing water scarcity in the area. The population lacks awareness on their right to water and the implementation of Jal Jeevan Mission in the state. Such a case of water burden has been highlighted in the following case study.

Problem statement and challenges

The entire village of Chaknada is dependent on 3 hand pumps of which one is almost dry due to gradual depletion of ground water table. The water lifted through other two hand pumps are of very poor quality and is unfit for drinking purposes. The villagers suffer from acute water related diseases like diarrhoea and other intestinal ailments. Further, the surrounding villages of Chaknada are fed by a surface-water based pipe water supply scheme (source of water is Patlui and Kangasabati Rivers), but this particular village is out of coverage of the scheme. The villagers have very little voice and not organized or empowered to communicatewith the Public Health Engineering Department (PHED) about their crisis. There is one primary school in the village which faces similar challenges in providing access to safe water to its students. The situation has compelled the villagers to seek for an alternate source. Therefore, the villagers of Chaknada village collect the sub-surface water from the river bank of Kangsabati river for potable purposes which is at a distance of 2.5 kms from the village. The women and girls of the village travel twice a day (or thrice during summer season) to the river bank to collect water. Still, a few challenges prevail as per the community. Apart from women the water burden also has direct impact on the children and indirectly affects the socio-economic growth of the entire community. The women take their children along especially Carrying water through undulating area girls to teach them the unique art of collecting water from river banks by

[1]UNICEF, 2020.
[2]Ibid (1a)
[3]World Vision, 2018.
[4]Article by Times of India, 14th February 2020
[5]Article by Down to Earth, 16th August, 2021
[6]Article by First post, 25th July, 2018
[7]Report by ANI, 18th March, 2021.

digging pits. During the season of sowing and harvesting, when the mothers are busy with agricultural activities the young school going girls alone go for collecting the water for their entire family. The children bear the water burden which directly has an impact on their education as they fail to attend school. Carrying water from a long distance everyday also affect their health.



CARRYING WATER THROUGH UNDULATING

Due to the undulating geographical set up, the village track which is followed by the women to fetch water is not suitable for walking and causes immense physical strain. The pregnant and the menstruating women are also not exempted from the drudgery. The struggle of the villagers intensifies in the rainy seasons when river banks get flooded and identifying proper locations for digging pits becomes difficult. They are left with no choice but to walk further approximately for 5 kilometers to collect water from a tube well of a nearby village Jambad. The only water purification process practised at home is straining through clothes before consumption. The water is boiled in households before intake only if there prevails any ailment. To meet with the country's challenges, Govt. of India (GOI) initiatedJal Jeevan Mission which aims to provide Functional Household Tap Connection (FHTC) to every rural household in India by 2024.The program is based on the community approach to water which includes extensive information, education and communication to make it everyone's priority[8].

In West Bengal, 22.10 % of rural households has been provided with household tap water connection as per JJM dashboard[9]. However, majority of villages in West Bengal which are not provided with piped water supply face little problem of water scarcity because of presence of large number of hand pumps. Such villages like Chaknada are an exception and do not always draw the attention of the Gram Panchayat or the PHED to take appropriate measures. The voice of the people who are suffering also matters and indigenous people are likely to have less voice and, therefore, receive less attention.



BUSY COLLECTING WATER FROM SUB-SURFACE BED

Immediate outputs/ outcomes and possible impact

Water burden hugely affects the quality of life of the community especially women and children since they take the sole responsibility of collecting water for their family. It's a shame for the society that in the modern 21st century, the women in our rural area find the work of drudgery as normal. They are unaware of their rights to water and empowerment[10]. The children especially girls often bunk and drop out from schools as they spend most of their time in collecting water with their mother and as a result they are drained out of energy for their studies. Gender ideology has been used for decades as a social tool for the women and the indigenous population to accept the water burden as fate. The indigenous population of Chaknada village in Purulia district of West Bengal are victims of multi-dimensional poverty. From health Busy collecting water from sub-surface bedperspective, it has been reported by socio-economic researchers and gender experts that excessive physical hard work leads to musculoskeletal disorders (MSDs) in women[11]. Therefore, provision of basic amenities like water supply at doorstep is one of the primary parameters to provide relief to the population of Chaknada village who walk miles to fetch water every day and sun and rain.

Common problems faced by the villagers using the water from hand pumps:

- Bad taste
- Difficulty in boiling foods
- Hard to wash off the soap foam from the clothes after washing



[8]Official Website of Jal Jeevan Mission (JJM), as viewed on 18th April, 2022.
[9]Ibid (8a)
[10]Access to Water and Empowerment of Women: State of Drudgery Work and Relief by SUJAL, Gender and Water Alliance, 2013.
[11]"Measuring the Drudgery and time-poverty of rural women- a pilot study from Rural Rajasthan by Abhijeet V. Jadhav, Indian J Occup Environ Med, 2020

Lessons learnt and way forward

The indigenous population of the village in Chaknada are unaware of right to water and even knowing that right does not help them unless that are empowered to remain engaged with the government to redress their sufferings. Although in the village nearby the work of laying of pipeline is being carried out, this section of the community remained indifferent as they have accepted the water scarcity as their fate. The way forward to the situation is:

- Bring information on these types of water scarce tribal villages to the government for extending support under the JJM on a priority basis;
- Sensitize the GP and build their capacity to take care of the needs of the water scare villages inhabited by the tribal population on a priority basis;
- Conduct extensive IEC/SBCC in the village on water security and safety, water conservation and rain water harvesting and Jal Jeevan Mission program and its impact on health;
- Training of women and skilling them with other livelihood options involving women federations;
- The entire community should be made aware of the importance of girl's education;
- There needs to be gender sensitization in the village including men.

ABOUT THE AUTHORS



Dr. M.N.Roy *did his M.Tech in electronics from Calcutta University and served the Government of India as a member of the Indian Engineering Services for around 2 years. Thereafter he joined the Indian Administrative Services in 1980. He studied Sustainable Development at the University of Birmingham in 1996. Thereafter, he did his Ph.D from the Tata Institute of Social Sciences, Mumbai and the research topic was Women's Empowerment. He led the largest literacy movement of the country while serving as District Magistrate of undivided Midnapur and also organized a people's movement on public health and the first community-led sanitation movement in that District in early 1990s. Subsequently he headed several departments of the Government of West Bengal including the Department of Panchayats and Rural Development and the Department of Health & Family Welfare and retired as Additional Chief Secretary of the Government of West Bengal. He is the Founder President of SIGMA Foundation, which is a not-for-profit organization. He has many National and International Publications. He is a member of the International Water Association, the Institution of Engineers, India, the Indian Statistical Institute, the Indian Science Congress Association and the Environment and Sustainable Development Association, India.*



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Er. Sohini Tarafdar *did her M.E by Research in Chemical Engineering from CSIR- NEERI and is specialised in water engineering and techno-socio-economic research. She works in the diversified arena of development sector with a special focus on water security and safety, water technology and circular water management for enhancement of water use efficiency. Her field of interest includes gender equality & social inclusion amalgamated with governance & policy making. She has been working in the domain of water research for more than 9 years and is experienced in providing technical solution to water and waste water management. She has worked in various organisations including CSIR-NEERI (Nagpur and Kolkata Zonal Laboratory), CMPDI (Coal India Ltd.), SOS Children's Village Kolkata, Riddhi Foundation and SIGMA Foundation. She has handled major projects of Government and international donor agencies like UNICEF, ADB, AMRUT etc. She is established author in her domain with various national, international and departmental publications. She is also involved with the development of communication materials and capacity building of various target groups related to WASH. She is a full-time member of Organisation for Women in Science for the Developing World (OWSD)- An UNESCO Unit since August, 2022*

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WATER MANAGEMENT BY DIRECT POTABLE REUSE IN WINDHOEK, NAMIBIA

By K. Yagna Prasad, Chief Technology Officer,VA Tech Wabag Ltd.



Abstract

This case study is presented with Windhoek's water management including wastewater reclamation and direct potable reuse (DPR). This study demonstrates that with an integrated approach including proper policy, legislation, education, technical and financial measures even severe water shortages can be managed.

Key words

Direct potable reuse, wastewater reclamation, water management, Windhoek

Introduction

Namibia is the most arid country in Southern Africa. More than 80% of the country consists of desert or semi-desert. Windhoek, the capital of Namibia, is located in the Central Highlands approx. 1,600 m above sea level. The annual rainfall in Windhoek is approximately 370 mm, while the potential surface evaporation rate is in the range of 3,000 – 3,500 mm/a. The distance to the closest continuously running river, the Okavango River, is ca 700 km and the ocean ca 300 km from Windhoek. The population of Windhoek was about 240,000 in 2000 with a growth rate of approx. 3.5% per year.

The city's water supply is based on the use of surface water and groundwater. However, as the region is one of the driest in the world, all the potable water resources within a radius of 500 km have now been fully exploited. The rainfall is uncertain and long spells of severe droughts are frequently encountered. Therefore, the supply of water from the central Namibian reservoirs and wells cannot be guaranteed in the near future. In 1994, forced by this prediction the City Council of Windhoek approved an integrated Water Demand Management program including policy matters, legislation, education, technical and financial measures.

Water demand management in windhoek

Today the total water demand of Windhoek is 21 million m³ per year, i.e. an average demand of 57,500 m³/d and depending on the season a range of approx. 40,000 – 75,000 m³/d. There are four main sources of water supply to the central area of Windhoek: dam water (Von Bach Dam), groundwater (50 municipal production boreholes), reclaimed water from both the New Goreangab Water Reclamation Plant (NGWRP) and the Old Goreangab Water Reclamation Plant (OGWRP). Figure 1 shows the water supply scheme including wastewater reclamation and reuse.

The capacity of the NGWRP is approx. 7.5 m m³/a. Currently, the City uses 5.5 m m³/a of this water, i.e. almost a quarter of the total water

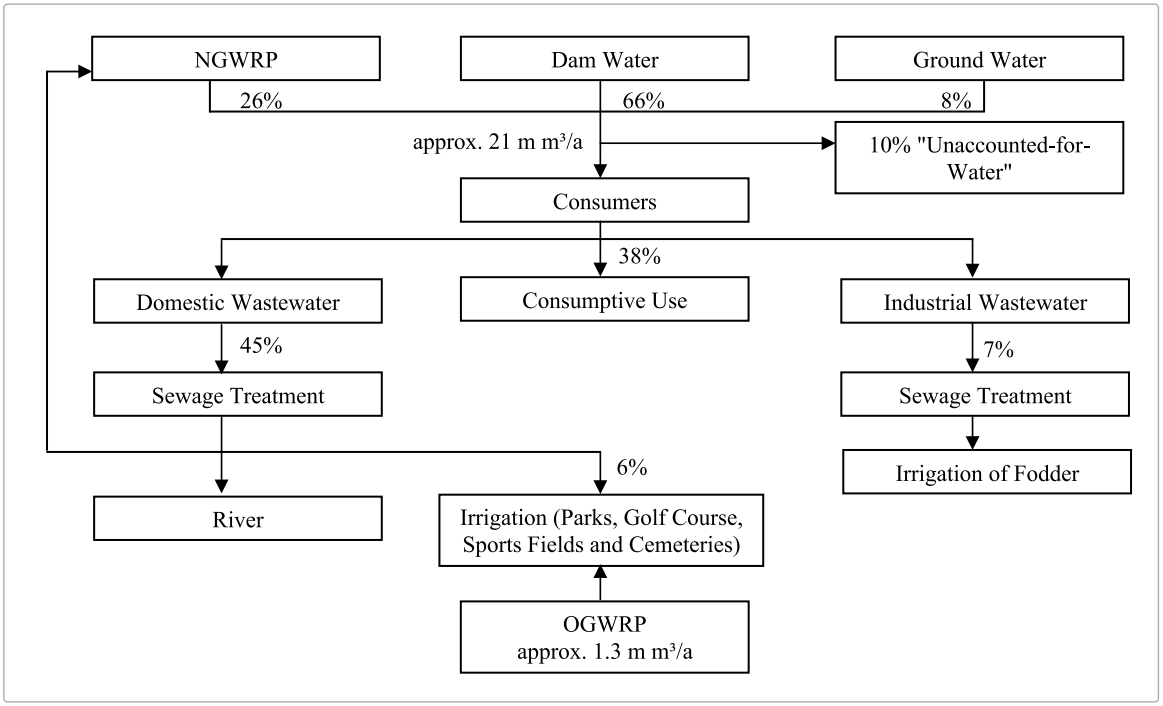


Fig. 1: Water Sources / Water Supply to Windhoek

demand is supplied by the NGWRP. The water of the OGWRP is unsuitable for human consumption and used for irrigation (5,000 m³/d mainly for sport fields and a golf course). The OGWRP is treating polluted Goreangab Dam water. The treatment process consists of flocculation, dissolved air flotation, rapid sand filtration, granular activated carbon filtration and chlorine disinfection.

Industrial wastewater (approx. 0.3 m m³/a) discharged mainly from a small food and beverage industry is treated in anaerobic followed by aerobic ponds and reused for irrigation of pastures.

Municipal wastewater is treated in the Gammams Water Care Works. This is a nutrient removal plant comprising primary treatment (fine screen, coarse screen, grit and grease removal, primary sedimentation), secondary treatment (nitrogen and biological phosphorous removal) with both an activated sludge process and with trickling filters in parallel. Additionally, the secondary effluent (COD approx. 60 mg/l) is polished in maturation ponds with retention time of approximately four days. The outlet (COD approx. 30 – 40 mg/l) of these ponds serves as raw water for the New Goreangab Water Reclamation Plant (NGWRP).

The new Goreangab Water reclamation plant (NGWRP)

In the past regular droughts in Namibia and a continuous shortage of potable water supply to Windhoek have necessitated the City of Windhoek to investigate alternative sources of raw water.

It was decided to exploit reclaimable water from the Gammams Water Care Works (Municipal Wastewater Treatment Plant) and the Goreangab Dam. This led to building of the Old Goreangab Water Reclamation Plant (OGWRP), which produced drinking water utilizing the mentioned sources as raw water. This plant, after more than 30 years of successful operation, was in the second half of the nineties of the last century at the end of its viable life span. It was therefore decided to build a new, larger reclamation plant next to the old plant.



Fig. 3 : Biologically activated carbon (BAC) filtration & Granular activated carbon (GAC)

The NGWRP produces 21,000 m³/d of drinking water safe for human consumption at all times. A "multiple barrier" approach was taken during the final selection of the process technology (Figure 2). The following unit processes have been included in the final plant: Powdered activated carbon (PAC) dosing, pre-oxidation and pre-ozonation, flash mixing, enhanced coagulation and flocculation, dissolved air flotation (DAF), dual media rapid gravity sand filtration, ozonation, biologically activated carbon (BAC) filtration& granular activated carbon (GAC) filtration (Figure 3), ultra-filtration (UF, Figure 4), disinfection and stabilization.

The treatment processes that were chosen ensure that at least two (in many cases three or more) removal processes are provided for each crucial contaminant that could be harmful to the human body or aesthetically objectionable.

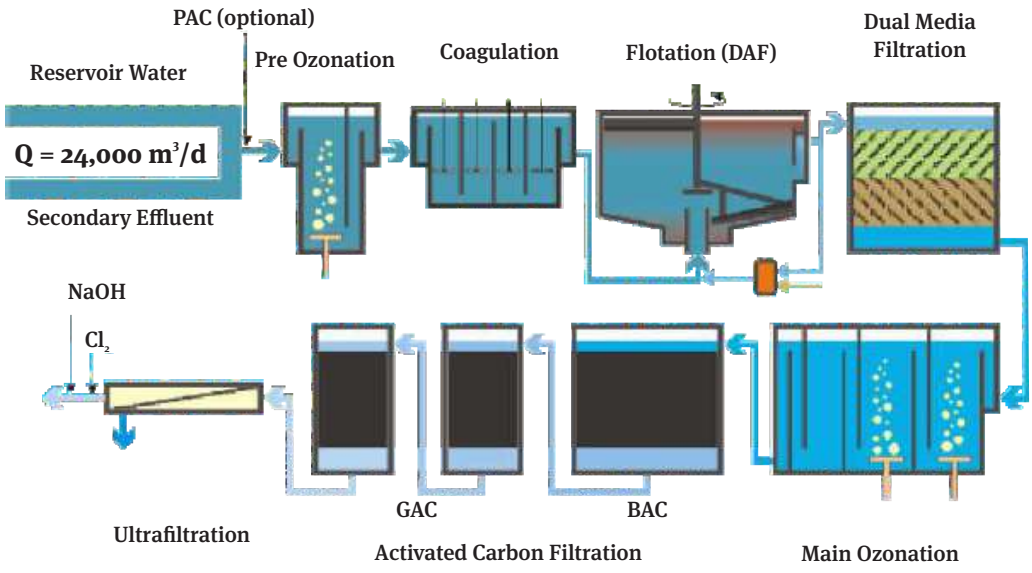


Fig. 2 : Process flow diagram

For example, complete and/or partial barriers for one of the most resistant pathogens, Cryptosporidium, include ozonation, enhanced coagulation, DAF, dual media filtration, ultrafiltration and chlorination.

Similarly, five barriers have been included for organic substances, viz. enhanced coagulation, ozonation, BAC, GAC adsorption and ultrafiltration. This ensures both micro-pollutant removal and degradation and results in a substantial reduction of the THM formation potential (Table 1).

The basis for the guarantee values is provided by the WHO Guidelines, the Rand Water Guidelines (South Africa) and the Namibian Guidelines for Group A water. Water samples are taken for analysis in the water reclamation plant laboratory every four hours. Refrigerated composite samples are taken twice per week and used for a comprehensive analysis of all the water quality constituents.

The process is automated based on a monitoring supervisory control and data acquisition (SCADA) system. The plant operation shows that the requested guarantee parameters can be easily met and a high quality drinking water is provided (Table 1). Additional safety is provided by blending the reclaimed water with treated dam water and/or groundwater. The maximum portion of reclaimed water fed into the distribution system is 50% in times of low water demand (winter season). Originally the maximum percentage of reclaimed water was limited to 35%. The basis for this limit was a DOC value of approx. 5 mg/l produced in the OGWRP and the corresponding THM formation potential in the distribution network after blending. Since the NGWRP constantly achieves DOC values of < 1 mg/l, the original limit of 35% for reclaimed water has been increased to 50%.



Fig. 4: Ultrafiltration process step

Table 1. Major Quality Parameters for NGWRP Water

PARAMETERS	UNITS	RAW WATER (design value)	TREATED WATER (guarantee value)	WHO Guidelines	EU Directive	RESULTS[1)]
PHYSICAL & CHEMICAL						
Turbidity	NTU	53	0.1	0.1[2)]	[3)]	0.08
DOC	mg/l	15	5	-	-	1.0
COD (dichromate)	mg/l	43	20	-	-	12.6
THM	µg/l	169	20	[4)]	100	11[5)]
MICROBIOLOGICAL						
Giardia	per 100 ml	214	0 or log 6 removal	-	-	0
Cryptosporidium	per 100 ml	334	0 or log 6 removal	-	-	0
E. Coli	per 100 ml	20,347	0	-	0	0
Heterotrophic Plate Count (37°C)	per 1 ml	332,150	80	-	-	8
ELEMENTS						
Iron	mg/l	2.8	0.05	-	0.2	<0.05
Manganese	mg/l	0.9	0.005	0.4	0.05	<0.005

[1)]Median at Performance Test
[2)]Recommendation for Effective Disinfection
[3)]No Abnormal Change
[4)]Guideline Values: Chloroform 0.2 mg/l, Bromoform 0.1 mg/l, Dibromochloromethane 0.1 mg/l, Bromodichloromethane 0.06 mg/l
[5)]Currently 4-6 µg/l have been accomplished

The project has been financed by the Kreditanstalt fuer Wiederaufbau (40%), the European Investment Bank (55%) and the City of Windhoek (5%). The consultants were GFJ (South Africa), Multi Consult (Namibia) and Fichtner (Germany). The contractor consisted of a consortium made up of DB Thermal (at that stage representing WABAG technology in Southern Africa) and Stocks Structures. The technology incorporated in the plant is based on WABAG technology.

The NGWRP was started up in May 2002, with final handover on August 5, 2002. The plant was officially inaugurated on December 2, 2002.Initially, raw water fed to the NGWRP consisted of 50% secondary effluent and 50% surface runoff water from the Goreangab Dam. Currently, the portion of secondary effluent feeding the plant constitutes 100% secondary effluent, because the quality and quantity of Goreangab Dam water has deteriorated to a point where it cannot be utilized anymore. As already mentioned this water is currently only abstracted for treatment in the OGWRP and used for irrigation.

A 20-year operation and maintenance (O&M) contract has been concluded between the City of Windhoek and the Windhoek Goreangab Operating Company Ltd. (WINGOC). In order to include as much specialist process and operating know-how, WINGOC is made up of three major international water treatment contractors: Berlinwasser International, VA Tech Wabag and Veolia Water.
The investment costs for the reclamation plant were approx. € 12.5 m: Electrical & mechanical equipment, € 8.3 m; civil works € 4.2 m. Total operating costs are € 0.63/m3 (capital costs € 0.33/m3, operational costs € 0.30/m3). These costs are lower than other options for importing water to Windhoek (e.g. transport from the Okavango River).

Public awareness to water saving and acceptance of direct potable reuse

In order to increase both the level of awareness to water saving and the acceptance of direct potable reuse the City of Windhoek has arranged adequate education programs in schools, radio and television as well as in printed media. The evaluation of these programs showed that the biggest benefit will be accomplished if water awareness forms part of the normal curriculum in schools.

Reclaiming drinking water from municipal secondary effluent is not generally acceptable to the public and psychological barriers have to be broken down first. However, with persistent and good marketing as done in above-mentioned education programs, this perception can be changed. The people of Windhoek have even derived some pride from the fact that they are the only ones where direct potable reuse is applied worldwide.

A prerequisite for this success was of course that since the beginning of potable reuse in 1968 no outbreak of waterborne disease has been experienced and no negative health effects have been attributed to the use of reclaimed water. An indication for the trust in potable reuse is the fact that only 5% of the population uses additional point source treatment in their homes e.g. with GAC filters (and cooling the filtrate in the fridge). Interviews with people showed that they like to drink tap water (average portion of reclaimed water approx. 25%, max. portion 50%).

Conclusion

Summarizing the experience made in Windhoek, it can be said that careful water management including direct potable reuse is required to secure the water supply of the City. With proper process design and quality management, water meeting stringent standards can be produced by reclamation and direct potable reuse can be practiced. The public will accept such schemes if properly informed, despite initial health and aesthetic concerns. The operation of the NGWRP represents a milestone for further similar projects. The Windhoek Water Management policy can be considered as a model for other arid regions.

ABOUT THE AUTHOR

Dr. Yagna Prasad *is Chief Technology Officer in the Engineering &Technology Division of VA Tech Wabag Limited, Chennai, one of the world's leading pure-play water technology multinational company in the field of Water and Wastewater treatment. WABAG offers sustained solutions for special customer needs through a comprehensive range of services and innovative technologies in turnkey execution and operation of water and wastewater treatment plants in both municipal and industrial sectors.*

Dr. Yagna Prasad having 28 years of experience in the field of Water and Wastewater treatment is associated with Wabag-India for the last 26 years and involved in design and engineering of several Municipal and Industrial wastewater treatment plants, Drinking water treatment plants as well as Pre-treatment for RO & DM plants executed by Wabag-India.He is also involved in the R&D / Technology development activities being carried out in India by the company since 2016.

He is graduated in Chemical Engineering from College of Engineering, Andhra University, Visakhapatnam, has done master's degree at AC Tech, Anna University, Chennai and Ph.D. at IIT, Madras.

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RADAR SATELLITE-BASED GROUNDWATER TARGETING AND PROSPECTING USING NOVEL NON-INVASIVE TECHNIQUE: CASE STUDY OF PABAI KHURD, KHANDWA, MADHYA PRADESH

By Riddhish Chetan Soni, Manish Kothe, Divyang Soni, Ram Singh Parihar, Ankit Singare, Anurag Wasnik, Karan Behar, Aumsat Technologies LLP

Introduction

Advancement in radar technology has opened new opportunities in the field of subsurface groundwater exploration. The satellite-based active imaging radar technique offers an opportunity to detect, isolate and target subsurface water signatures. In this study, we have evaluated the utility of satellite-based and electro-resistivity-based surveys to analyze the spatial distribution of groundwater pockets In the Pabai Khurd village of Khandwa district in Madhya Pradesh.

Khandwa is a district situated south-west in the state of Madhya Pradesh. The district is bounded to the east by the Harda & Betul districts, to the south by Burhanpur district, to the west by Khargone district and to the north by Dewas district. It receives an annual rainfall of 777.6 mm. The geological area spread across 7,52,450 Ha consists of major physiography units, including structural hills of Deccan traps, flood plains, and valley fills with intermontane pediment depressions. The rivers of Narmada, Chhota Tawa, Sukta and Bhim Nadi drain the district. Out of the 994 Ha irrigated area, there are 47224 Dug wells and 4036 Bore wells predominantly from the water-bearing rocks of the Vindhyan Sandstone formation. With increasing food consumption and changing weather patterns, the need to tap into renewable groundwater has become essential for the people of Khandwa District.



Radar Technology for Exploration of Groundwater

Using a combination of multi-frequency satellite radar and an electro-resistivity-based survey, an effort was made by Aumsat Technologies Limited Liability Partnership to detect groundwater resources in Pabai Khurd village of Khandwa District. Satellite-based Synthetic Aperture Radar (SAR) in polarimetric configuration was used to isolate groundwater signatures in subsurface fissures and cavities. Finally, an electro-resistivity-based survey was used for field validation and truthing.

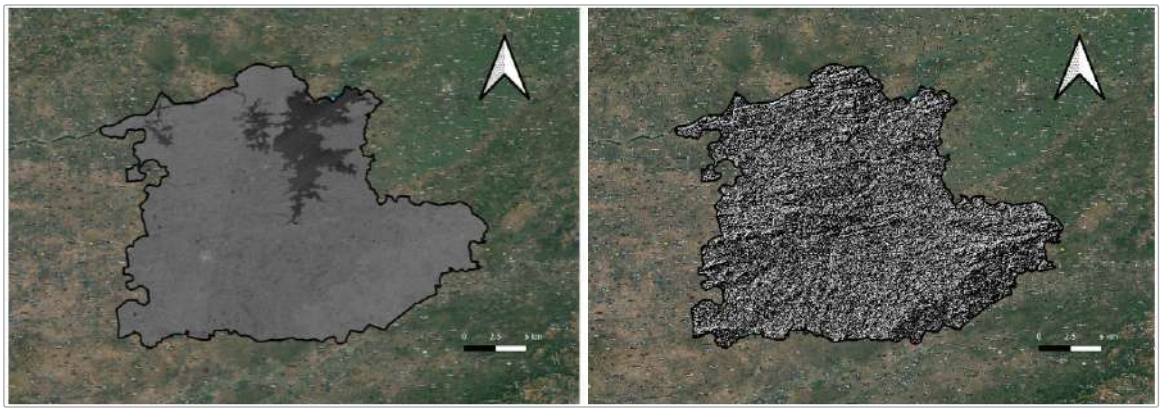


Image 1: Khandwa District map using multi-frequency Satellite Radar



Image 2 : Red bowl shale formation of Vindhyan sandstone group

Pabai Khurd village is located in Pandhana tehsil of Khandwa district in Madhya Pradesh, India. It is situated 8km away from sub-district headquarters Pandhana (tehsildar office) and 28km away from district headquarter Khandwa. The image shows the land of a farmer Shri. Dhulichand Gupta, who's land was scanned for groundwater discovery.

As the diagram in Image 4 shows, the direction and speed of groundwater movement are determined by the various characteristics of aquifers and confining layers of subsurface rocks in the ground. Water moving below ground depends on the permeability and on porosity of the subsurface rock. The regional movement of the water trend is towards the west and southwest.

Groundwater Trend using Satellite Gravimetry

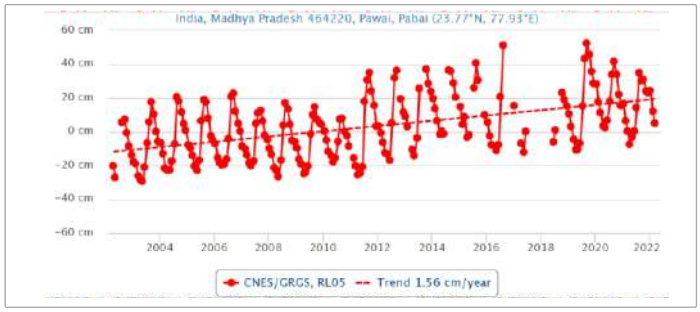


Image 4 : Groundwater Trend Direction

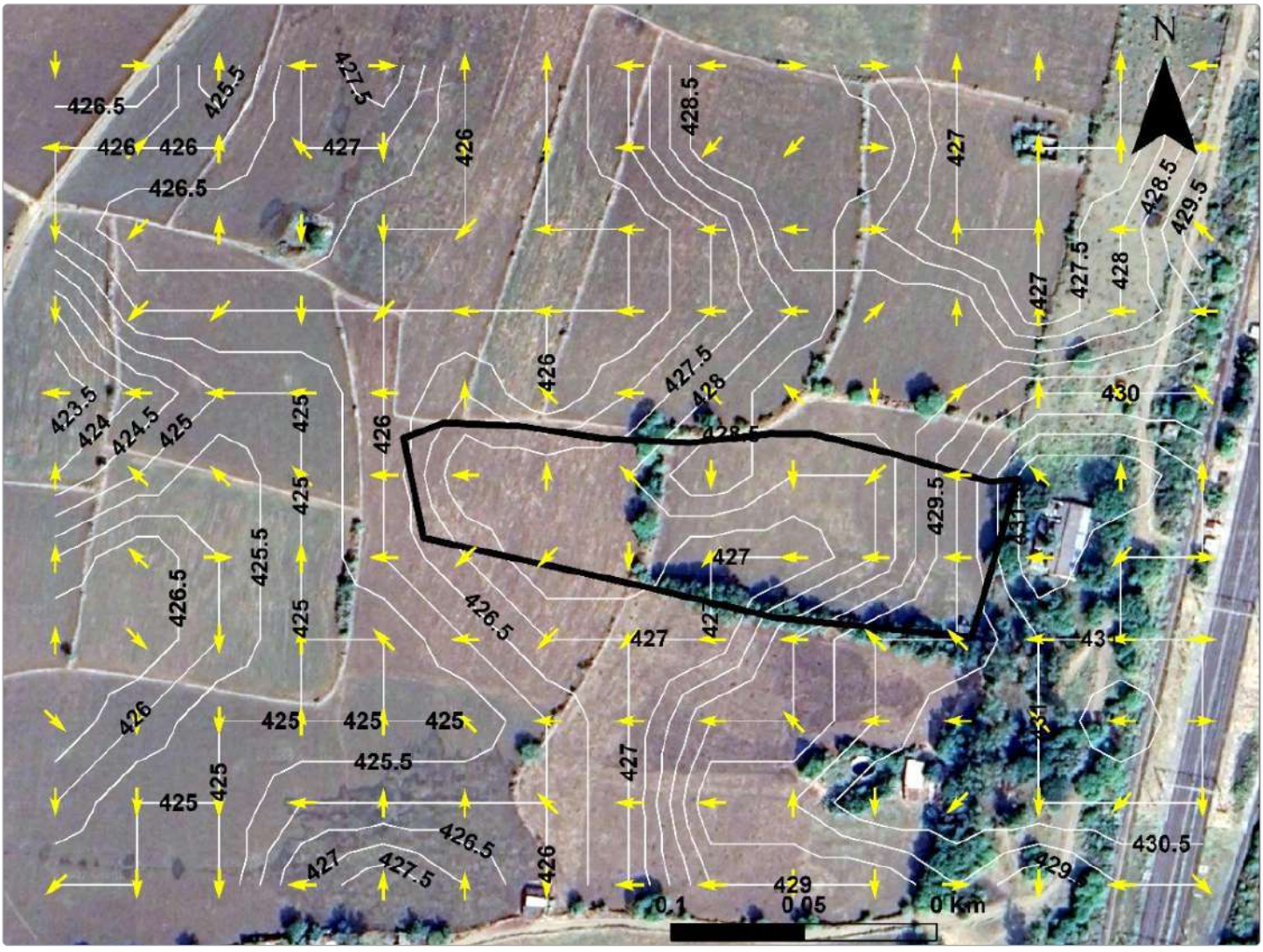


Image 3 : Groundwater Flow Direction

The groundwater level trend has also been observed using Mann–Kendall test statistics where 25% of the total area shows an increasing trend in the monsoon period, 45% area shows a slight increasing trend in the pre-monsoon period, and 30% area shows a slight declining trend in the post-monsoon period. Overall groundwater trend is increasing by 1.56 cm per year.

Climate Variables

The maximum temperature was recorded on 13th May 2022 about 46 degrees Celsius.

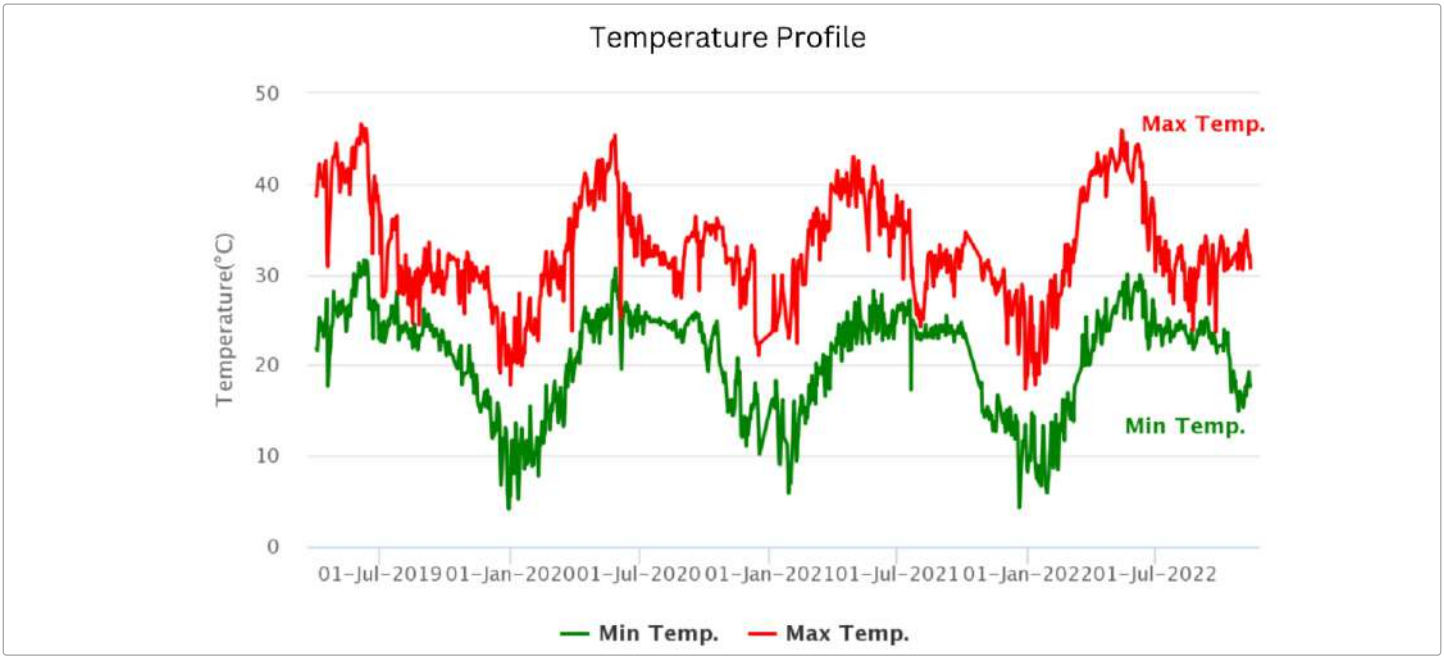


Image 5 : Satellite Temperature Measurement

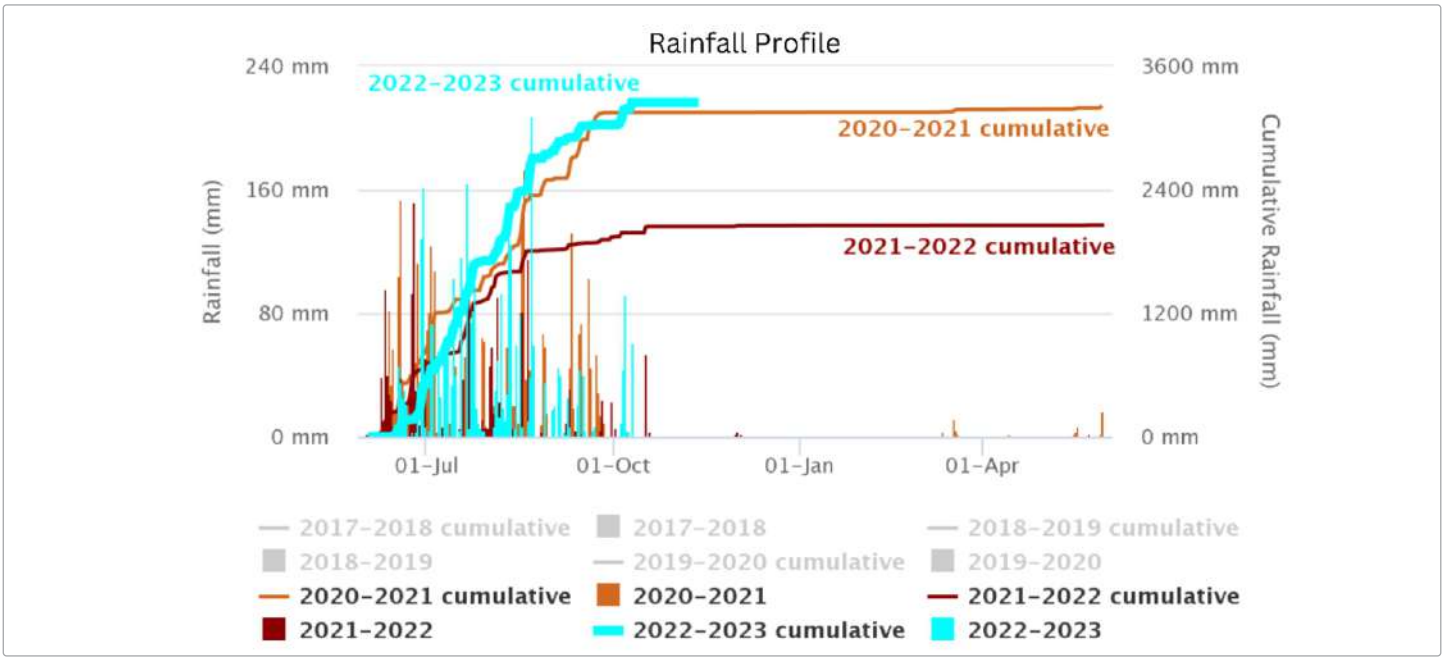


Image 6 : Satellite Rainfall Measurement

The area received maximum rainfall on 21st August 2022 amounting to 208mm. Comparatively, it received less rainfall than the year 2020.

Groundwater Targeting

The groundwater feature of any terrain depends on several factors, such as subsurface lithological structure, geomorphological features, the drainage network, lineament, and slope. The aquifer zones in the given site are mentioned in dark blue. In this field, groundwater was discovered at a depth of 42m using the electrical-resistivity method in Schlumberger configuration mode.

Epilogue

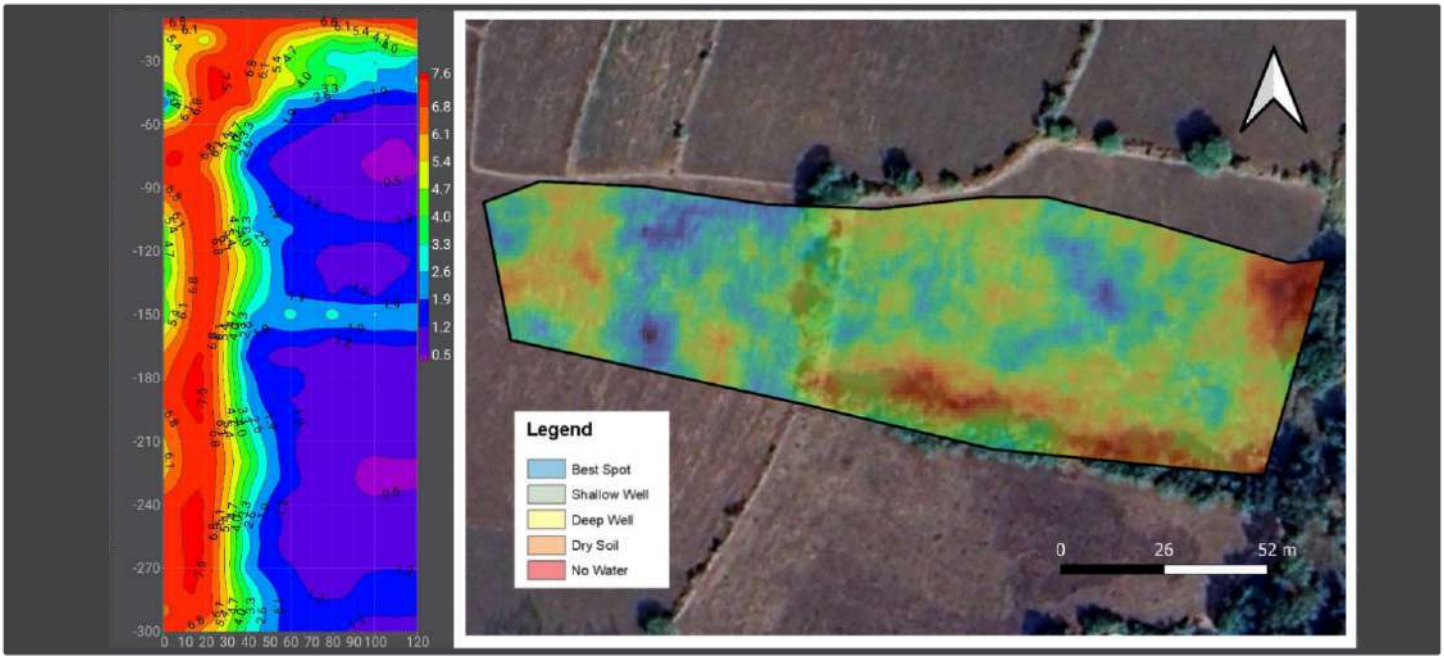


Image 7 : Groundwater availability and depth



Image 8 : Groundwater availability after drilling and borewell

Groundwater targeting is an essential public service. The resulting hydrological information enables evidence-based decisions about water. Public safety, food supply, energy

production, social justice, the environment, health, and prosperity depend on groundwater availability within any watershed. Policies, planning, adaptive management, and engineering decisions need reliable information about the variability of groundwater quantity and groundwater quality over time and in space. The role of groundwater in the context of the sum of the impacts of human activities must be understood to learn from the past, manage the present, and create a secure water future. Providing a safe and secure water source to support all requirements is expensive. Developing the sufficient capacity to survive periods of drought is costly. Making wrongful assumptions about the quality and/or the quantity of water in providing these essential public services is expensive. Given the high cost of hydrological ignorance, a sustainable supply of relevant, reliable, and trustworthy integrated groundwater management is necessary.

Aumsat envisions helping farmers with its services providing exceptional value propositions backed by cutting-edge technology. Unlike conventional costly, time-consuming methods used in groundwater exploration, such as acoustic, resistivity, and transient electromagnetic surveys, Aumsat's services can help detect groundwater zones at a high rate of precision with high precision, and 75% reduced cost. Together we plan to make the groundwater infrastructure of India resilient and sustainable.

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Introduction:

Refineries generate a significant amount of waste duri g the pro es es. Effluent treatment tech ologies followed in the Refineries will differ from site to site based on the site requirement, raw effluent char cteristics and treatment level required by the regulatory authorities.

Refinery ET treats wastewater from various streams, such as OWS (Oil water sewer), Sour water, Spent Caustic, Regeneration effluent, backwashes, leachate, etc. Pretreatment of effluent in some streams are carried out before discharging to ETP. Desalter effluent consist of significant amount S of benzene and VOC (volatile organic carbon) which tends to vaporize in the sewer system leads to excessive emission and odor issues. And it leads to discharge of oil, emulsion, solids to the surface of the

Secondary Treatment

- DAF to remove further oil and solids from t e primary treated effluent. By coagulation and floc ulation, the dispersed oil and solid particles removed from the wastewater prior to discharge to biological treatment.
- In a DAF system, effluent is recycled partially, pressurized, saturated with air and mixed with the incoming feed, which consists of coagulants, flocculants, DOPE added in the flash mixer.
- When the recycle stream is depressurized it releases the air bubbles which attach themselves to any free solids contained in the feed

Sand Filter (PSF)

ressure Sand Filter of a multiple layer of h a variety in size and gravity. These Filters designed to remove turbidity nd suspended particles present in the feed water with minimum pressure drop.

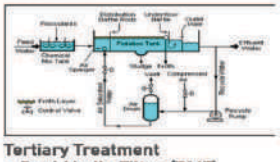
- Activated Carbon Filter (ACF)

Activated carbon filter is used to remove organic Compounds, Taste, Odour and Free Chlorine from the raw water. Activated carbon works via a process called Adsorption, where pollutant molecules in the fluid (water) are trapped inside the pore structure of the carbon substrate.

materials. The material as a carbon and energy for the microbial growth, and convert the food into cell tissue, water and oxidized products (mainly CO2).

A sequencing batch reactor (SBR) is a fill-and-draw semi-batch biological treatment that employs aeration, sedimentation and clarification in a single reactor.

Membrane bioreactor' (MBR) is generally a term used to define wastewater treatment processes where a perm-selective membrane, eg microfiltration or ultrafiltration, is integrated with a biological process – specifically a suspended growth bioreactor.



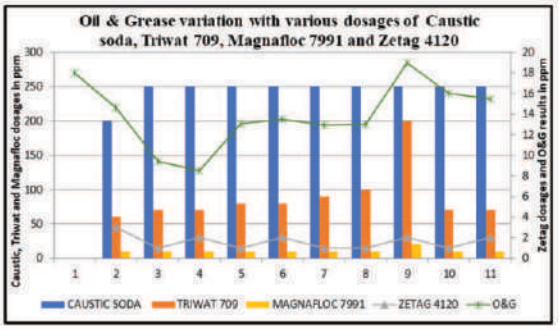
Tertiary Treatment

- Dual Media Filter (DMF)

A Dual Media Filter is primarily used for the removal of turbidity and suspended solids as low as 20 microns. Dual Media Filter very efficient particle

Case 2:

Currently, the effluent to TPI containing traces of free oil, bulk of emulsified oil and sulphide is routed to flash mixer-I provided with an agitator where the pH maintained with the addition of H2SO4/Caustic. Then the effluent passed to the flash mixer-II and treated with FeCl2 which reacts with Na2S, excess suphide treated with H2O2 and De Oiling Poly Electrolyte (DOPE) solution dosed in the Flash mixer-III to enhance the agglomeration of emulsified oil. At present, the suspended solids removal and the oil removal needs to be fine-tuned



RO Treatment

- RO DM Plant

Demineralisation Plant will remove the entire minerals from the water, by passing the treated RO water through Anion and Cation bed.

- RO Plant

Reverse Osmosis (RO) is a water treatment process that removes contaminants from water by using pressure to force water molecules through a semipermeable membrane. During this process, the

to get the required efficiency from the subsequent treatment systems. If the oil not removed completely from the TPI & DAF, it would affect the biological systems and the required output parameter will be a challenge.

Currently, The effluent from the TPI containing traces of free oil and sulphide is routed to flash mixer tank provided with an agitator where the pH maintained with the addition of HCl/Caustic, along with the addition of PAC which reacts with Na2S, excess

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DECENTRALIZED MBR SOLUTIONS FOR A RESIDENTIAL COMPLEX – HYDERABAD, INDIA

By Smit Nimbarte, Commercial Development Manager, DuPont India



The background

Hyderabad is one of the top eight cities in India, which has recently undergone rapid industrialization and urbanization that has impacted the supply of clean water in many parts of the city. This has resulted in urban water insecurity with insufficient and unreliable water supply.

While Hyderabad experiences semi-arid tropical climatic conditions, with an average annual rainfall of 810 mm, several areas in the city are facing potable water shortage due to irregular supply. Most of the water supply in the city depends on the surface water received through river Musi and several natural and manmade lakes around the city.

The local government has mandated for companies as well as residential and commercial properties to set up decentralized STPs on their premises and to use the treated water for secondary applications like gardening, flushing, car washing, etc.

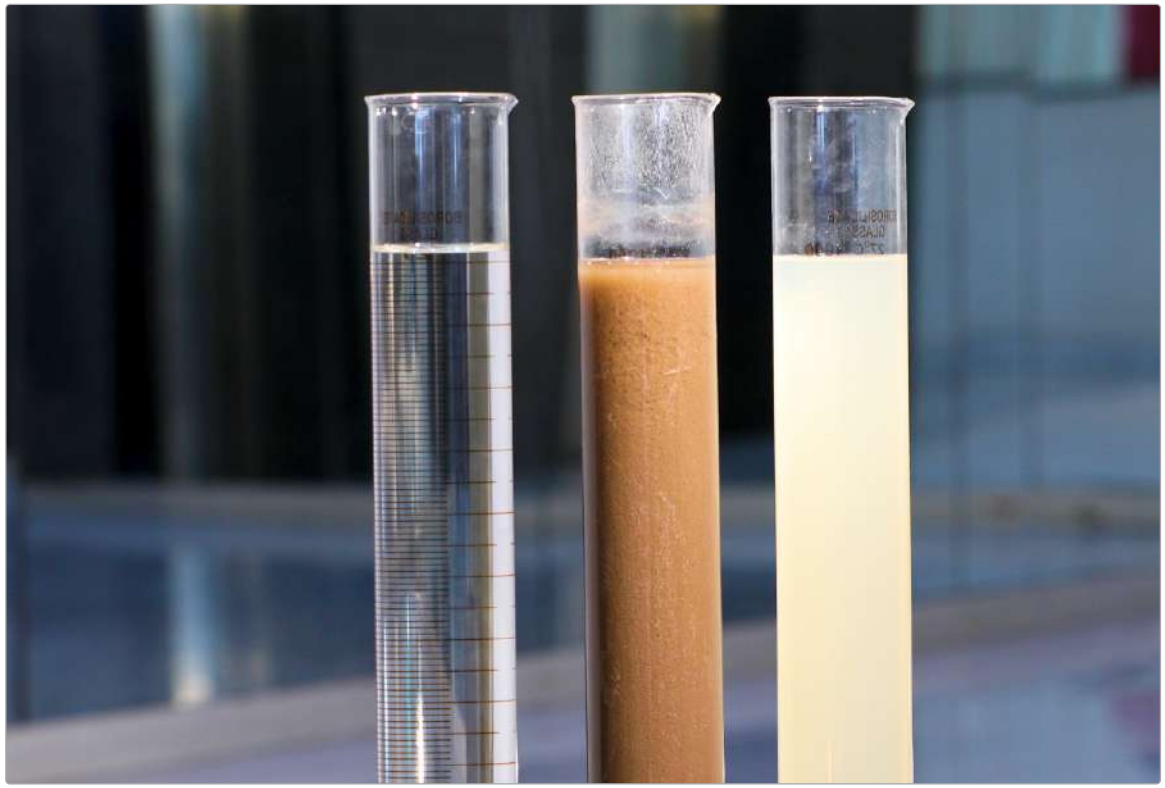
To upgrade and operate existing plants in the city, DuPont Water Solutions joined hands with Banka Bio Limited. Banka Bio is a pioneer in Water, Sanitation, and Hygiene (WaSH) infrastructure. Under this arrangement, DuPont is responsible for the technical design and supply of MEMCOR® MBR membranes, whereas Banka Bio supplies, installs, tests, and commissions (SITC) for the balance of the plant.

What is MBR?

Membrane Bioreactor (MBR) is an advanced wastewater treatment technology used to extract liquid from a suspended growth activated sludge system The MemPulse® MBR process replaces the secondary clarifiers typically used in conventional waste treatment methods for solid/liquid separation. Unlike secondary clarifiers, however, the treated water quality is not dependent on the mixed liquor suspended solids concentration or the settling characteristics of those solids.

In fact, MemPulse® MBR systems can operate at much higher biological mixed liquor suspended solids (MLSS) concentrations than conventional activated sludge systems. Typically from 8,000 mg/l to 12,000 mg/l or 3 to 6 times the solids concentration in conventional systems. In addition, the retention of all biomass allows greater control of Solids Retention Time (SRT).

High-quality treated water is common to MBR systems, where longer SRT and greater MLSS concentration promotes oxidation,





complete nitrification, and reduced biosolids production. Filtrate has low Biological Oxygen Demand (BOD) (< 5 mg/l), is virtually free of suspended solids, and can have very low concentrations of nutrient nitrogen and phosphorus.

MemPulse® B40N Membrane Filtration Module

MemPulse® Membrane Bioreactor (MBR) System uses a unique pulsed, plug flow aeration to greatly increase process efficiency and reduce energy usage.

- The MemPulse® B40N membranes are bound together in modules using a unique dual-potting system and submerged within a compact modular rack located in a separate membrane tank.
- A continuous air flow is evenly distributed to each aeration device where it is accumulated and then released as a pulse of large bubbles that increase in size as they move up the membrane fibers.
- DuPont's membrane system leads the industry in energy consumption with specific energy usage as low as 0.08 kWh/m³ and delivers superior filtration performance while reducing aeration energy up to 60%.

Benefits of upgrading to MemPulse® MBR:

- High-quality effluent
- Drastically reduced system footprint
- Fewer process steps
- Eliminates sludge settle ability issues
- Modular expansion capacity

The challenges of the existing STP

The implementation of decentralized STPs was well understood, but this project faced several challenges, not least of which is the operation of the existing STP and maintenance of treatment services. Some of the challenges that Banka Bio had initially faced were:

1. Raw water availability: Sourcing of raw water for all primary as well as secondary applications through tankers was one of biggest challenge faced by residential clients of Banka Bio.

2. Cost of raw water: Because tankers are the only source of raw water, the cost of water is significantly high.

3. Odor issues: The existing STP was undersized and giving 500-600KLD of treated sewage, whereas, actual requirement was for 1200KLD, which left a huge amount of sewage partially treated, resulting in foul odor affecting the habitants in that area.

4. Height issues: The height available to install STP

The Solution

With consideration of the challenges faced by Banka Bio, DuPont offered its

> ***Customer quote:***
> *When we meet our end user expectations by delivering 100% recycled water to meet their environmental social goals, it gives us biggest joy as a service provider*
> ***– Vishal Murarka CEO, Banka Bio***



MemPulse® AMB40N modules for setting up the plant. MemPulse® MBR, with its unique design and flexibility, helped Banka Bio get tertiary treated water directly at the outlet of the MBR tank, eliminating the need of clarifier, sand filter, and carbon filters. This not only enabled the client to upgrade the existing treatment system to MBR, but also led to capacity augmentation while delivering ultrafiltration (UF) grade treated water at the outlet. In addition, the newly developed Header plate assembly for the AMB40N Modules enabled the client to install the plants in low height areas where maximum heights are 4 meters.



The benefits

With the help of DuPont's MemPulse® MBR, the client has been able to achieve log 3 reduction in bacteria, log 2 reduction in virus, attained Turbidity less than 1 and TSS less than 2. Some other benefits for clients include:

1. Shorter lead times as the local stock is maintained by DuPont.
2. Strong technical support by the DuPont team.
3. Lower energy consumption for MBR membrane air scouring.

DuPont's MemPulse® MBR is thus proved to be a cost-effective, reliable solution to the clients.

ABOUT THE AUTHOR

Smit Nimbarte *is a Commercial Development Manager for India Sub Region and supports regional growth programs with a focus on end-user engagement and new business & application development for the entire product portfolio. Smit is based out of Mumbai, India and has 10+ years of work experience in technical services and Sales for water and wastewater treatment industry.*

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

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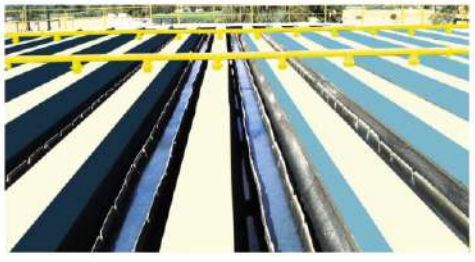
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THE CASE STUDY OF INDIA'S AGEING SEWER MANHOLES AND THEIR MIMIC OF THE "DANCING DAFFODILS"

By Dr S Sundaramoorthy, Dr S Saktheeswaran

Daffodils are unique flowers at about 60–90 degrees to the stem rotating away from the wind and the petals cup and give a streamlined shape to the wind passage and is poetically called "Dancing Daffodils". Paradoxically, our ageing sewer manholes also "Dance" as in Figs 1 and 2.



Fig.1. Dancing Daffodils-Note opposite Directions



Fig.2. Dance of Sewer Manholes, Left- Dancing in monsoon floods, Right-Sinking down in soil erosion after floods both at Chennai.

There are still parts of the "trunk sewers" of the British period and vulnerable as in Fig. 2. Chennai has done rehabilitation as early as 1994 as in Fig.3 for British masonry arch sewers and manholes. Similar rehabilitations are needed in other older and heavily built up areas in the country but is a Herculean Task like Kolkata for example. The crucial issue is the GOI Sewerage Manual of 2013 itself has specified the guidelines as (a) Instituting an ultrasonic survey of the structural integrity of all manholes over 30 years, (b) Isolate the manhole by plugs & transfer pumping and (c) internal polymeric/elastomer lining as in Fig. 4. But not much has been heard since. The need is priority budgetary allocations or "a stitch in time saves nine". Even then, venting of corrosive Sulphide gas at frequent manholes by vent stacks is needed which house owners reject. This is offset by natural air draft by following the GOI dictum of sewers flowing only 80% depth which in turn is easily achievable by immersible pumps in pump pits which can not only pump, but also sweep the pump floor dry something which is a norm abroad but India is yet to make a head start. ??? It is time the submersibles introduced in India by the lead author in 1980's move over to immersibles



Fig.3. Left-Author & M D at Chennai's oldest arch sewer in 1994 and another in 2020.
Right, 26 km X 2.3 m Kolkata Brick Sewer of 1886 with 50,000 cum silt, cleaned & lined

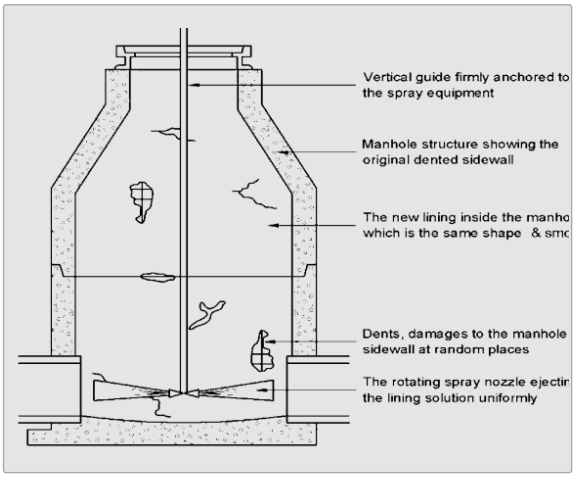


Fig.4. In Situ Manhole lining by pumped slurry and rotary riser nozzles to effect a monolith and resurrect the manholes and protect them from failing again

ABOUT THE AUTHOR

Dr S Sundaramoorthy *is former Chief Engineer (O&M) of Chennai Metro Water and Sewerage Board and* ***Dr S Saktheeswaran*** *is the copy editor for JICA for the GOI Manual of Sewerage in 2013.*

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

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LIFT STATION REPAIRS DEMONSTRATE EFFICACY OF NEW CHEMICAL GROUT INJECTION TECHNOLOGY

By Suzan Chin-Taylor, CEO / President, Creative Raven & The TUIT Group



Injecting chemicals to stabilize, lift, seal or compact weak soils and rocks is not new. Polyurethane grout material has been used for this purpose since the 1960s. However, the limitations of this process have often been frustrating, not only for asset owners but installers, as well. Historically, material injection has been limited to shallow depths of twenty feet or less, due to the technology, means, and methods of application.

As the material is injected, it begins to synthesize (cure) inside the injection tube. While the synthesis rate can be accelerated or retarded by controlling the chemical temperature, that control is short-lived. The deeper or longer the injection tube, the longer time the chemical has to cure before exiting the tube. While this is happening, the diameter of the injection tube effectively shrinks in diameter as the cured material bonds to the tube wall. This limits the depth at which successful injection can occur, using the old technology. Another side effect is that the chemical being injected can lose its desired effect the deeper it is injected, as it cools once leaving the tube.

This frustration is being abated by Deep Horizons Injection Grouting (DHIG), a process developed by Polymer Technologies Worldwide, Inc (PTW). Their innovative method of injecting chemical grout allows the ability to inject at depths far exceeding previous limits. The following case studies describe how Polymer Technologies WW successfully injected their product to seal a leaking effluent line, with an invert depth of approximately 35 feet and an injection depth of 45 feet, at two Florida sanitary lift stations.

Multiple Repair Attempts

Lift Station 87 was under construction to replace existing Lift Station 7 on the wastewater collections system of the City of Sarasota, Florida. It would eventually forward about a third of the City's wastewater flows to its WWTP. While testing the 36-inch influent line, which crosses Hudson Bayou, City crews discovered significant groundwater intrusion through several holes, breaks, and joint failures. This infiltration would cause the sanitary system to unnecessarily work harder, putting more stress on the system. That would not only waste capacity but also shorten the life of WWTP equipment over time, so it had to be eliminated.

The first repair effort was a trenchless epoxy-impregnated liner installation (CIPP). While this type of largely non-disruptive repair has worked in similar circumstances, it failed to stop this water intrusion. A second effort to repair the pipe involved injection of a two-component, fast-reacting chemical grout, intended to seal the pipe from the exterior, in-situ. This historic method failed for reasons previously described, as the pipe is situated deeper than 20 feet.

Third Time's the Charm

The method considered for a third try was traditional dig-and-replace, but that would have caused extensive disruptions to



Sealing the buried line while construction continues uninterrupted on the remainder of the lift station infrastructure by the prime contractor.



Lift Station 87 subject pipe during original installation

surrounding infrastructure and the local population, which was why previous attempts had been trenchless. This more traditional option was estimated to add an additional $9-12 million to an already-over-budget project, along with extending completion time approximately another year for the already severely delayed project. Highly motivated to avoid these major issues, the City took a chance on engaging the patented new DHIG process. Not only did this effort seal the pipe leaks, it also enhanced and further stabilized the foundation of the lift station structure. Best of all, because the process is trenchless and requires a small physical footprint, it not only didn't disrupt the surrounding area, but was actually accomplished while the facility construction continued.

Another nearby lift station project at Symmes Rd. in Hillsborough County, Florida, also proved out other advantages of this new injection method. Station well inlet pipe cracks and some other damage was found to be caused by approximately 4 inches of settling of the cover slab. Using the standard testing procedure, soils in proximity to the station—ten feet between 18.5-28.5 feet below ground surface— were found to be very loose, displaying weight-of-rod conditions, in which the boring tube drops under its own weight, without any force applied.

The wet well for the station measures 8 feet in diameter and 30 feet in depth. To excavate and repair the station would again result in a large area of disturbance that could have possibly affected an adjacent residential community, underground utilities (electric, cable, etc.), and possibly Symmes Road itself. Again, the decision was made to take a chance on the still-new DHIG technique.

Post-Injection Testing

Standard ground borings (STP data) demonstrated that injected material did not expand beyond the lift station property. Injecting 2,623 gallons of polymer through four injection points, with injection depths between 1-45 feet below grade, yielded the following results:

- Soils around the wet well were strengthened to the point where weight-of-rod conditions no longer exist.
- Soils outside the lift station footprint were shown to have insignificant change in soil stiffness. This indicated no adverse effects to surrounding properties or structures from the injection.
- The grout filled voids, stopping leaks from eroding the area around the system, and water intrusion into that system that had also caused erosion.

A post-injection analysis and report was rendered on the Symmes Rd. project by Integrity Drilling & Geophysical Services, LLC, of Groveland, Florida. During the project covered here, testing showed good control of the material, in that none of it encroached on neighboring properties. Also revealed was that soil adjacent to the grout was compacted and stabilized, despite no presence of material in those sampled soils.

Rig Operation

The DHIG rig is used, in part, to advance injection casing to the desired depth. The three-inch diameter steel casing, threaded on each end, is advanced, with new sections threaded on as needed. While skin friction is considered negligible, it takes increasing power to turn the casing as it advances more deeply. Turning power is also affected by the strength and adhesive properties of the material being advanced through the casing.

Upon reaching the desired injection depth, the rig withdraws the casing as the polymer is injected. Care must be used to advance at an appropriate rate that avoids fouling the casing with the polymer; but not so fast that the polymer is under-injected. To inject the polymer, a special nozzle is advanced through the casing and attached to the drilling head at the tip of the casing. This is the third use of the rig, to lower the casing head and attached chemical feed lines in a careful manner, to avoid fouling the lines or damaging the injection nozzle. Upon carefully lowering the equipment by attaching a lowering/turning bar, that bar is then rotated to lock the equipment to the head. As the casing is withdrawn, the lowering bar is removed in sections, just as the casing is removed.





How It Works

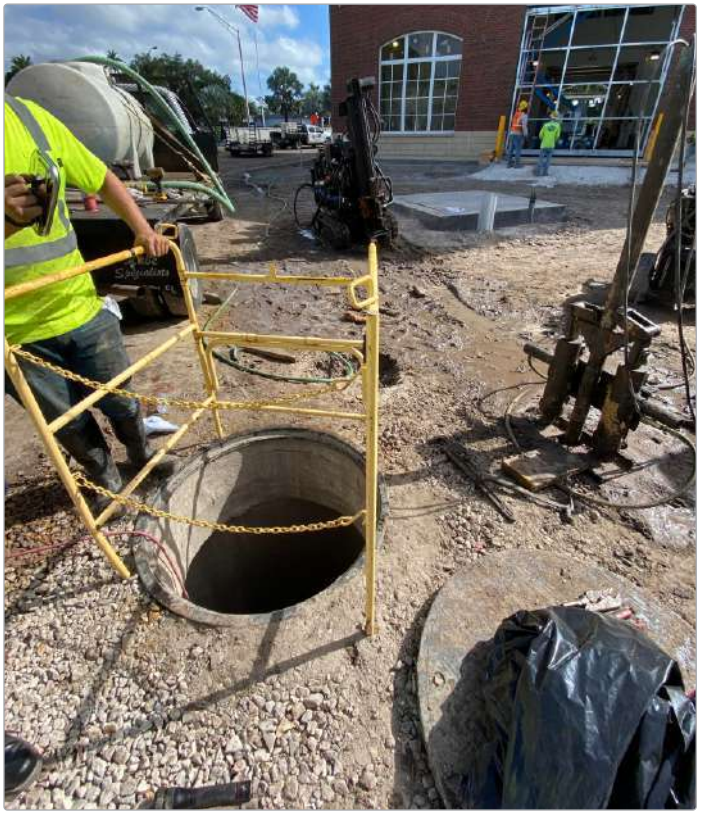
The injection method of the DHIG chemical is like any other. Pumps that feed the chemical must be powerful enough overcome the strength of the soil materials, as well as the line friction. Line friction will most likely be the controlling factor relating to possible depth efficacy. This limiting factor can be overcome by increasing the pumping power, feed line and casing diameter, and subsequently the rig size and associated power, so it's adaptable to the needs of many applications.

The significant advantage of the DHIG process is that, theoretically, there is no limit to the depth at which the material can be successfully injected. This is due to the material being combined at the tip of the casing—which allows for full material strength to occur where needed at the tip—as opposed to inside the feed line, which is standard practice using most existing systems.

Another benefit is that the material can be injected from a lateral point, to avoid interference with nearby surrounding project activity. This results in reduced time, cost and impacts to the public and the environment. For example:

- A leaking cross drain can be sealed without closing down a busy highway or interstate system.
- A sanitary lift station can remain in operation while a leaking influent line is sealed.
- A building can remain in operation while a basement wall is sealed.
- A leaking earthen dam can be sealed without lowering water levels.
- Retaining walls can be sealed at depth, without excavation or injection from the face, which can further weaken the wall.
- Stabilizing embankments—bridges, railroads, roadways, canal banks, etc.
- EPA-related concerns such as underground oil, frack well, hazmat or radioactive leaks at any depth can be sealed, preventing catastrophic contamination of surrounding freshwater aquifers or ecosystems.
- Sealing abandoned wells and mine shafts, while allowing for future material removal so that the well or shaft can be put back into service.

The suitability of this process and material has been successfully applied up to 100 feet below ground surface without unforeseeable limitation.



ABOUT THE AUTHOR

Suzan Chin-Taylor, *MSc is an international entrepreneur, published author, course creator, podcast host and speaker who helps businesses in the wastewater infrastructure, treatment and related civil infrastructure sectors take the mystery out of digital marketing and PR in order thrive in the new online selling environment. She is CEO / President, Creative Raven & The TUIT Group.*

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

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SANITATION IN RURAL INDIA – A CASE STUDY IN PARODY, MALADY AND REMEDY

By Dr S Sundaramoorthy, Dr S Saktheeswaran

Abstract

The historical open defecation in rural India has been abolished 100 % by a rapid project from 2014 to 2020 by providing Individual Household Latrines (IHHL) which was only 38.7 % in 2014. However, the disposal of faeces has been provided by what is called on-site sanitation with mostly twin pits dug into the ground by taking alibi from the United Nations and World Bank guidelines. The parody is these are for only households in isolation but not a whole habitation. Consequently, this has resulted in the invasion of faecal and pathogenic organisms spatially into the hitherto pristine soil environment, which is a malady. It is high time to contain these because, the infested pathogenic organisms may well mutate and mimic a Covid like challenge. The typical remedy is the centralized underground sewerage system but this appears a distant mirage as even the relatively cash-rich urban sector could achieve only 32.7 % coverage as recent as 2011. The compounding challenge is the rural does not have the required human and financial resources to maintain such a system. Paradoxically, a simpler locally developed system as "twin-drain" demonstrated even in 2007 in two Tsunami resettlements right here in India at a cost of only 15 % of the underground sewerage system and functioning successfully has not been emulated.

1 The Guidelines Used for the IHHLs

This is depicted in Fig.1 as a combination of safe distance of the pit from a water source and other technologies as modified twin-pit toilets or "Ecosan toilet, biogas linked toilet, vermiculture based toilet and septic tank with proper treatment system" in specific cases such as impermeable soil, hard strata before 0.75 m depth and water logged condition. The moot question is the "Ecosan----- system" cannot be provided for the IHHL and it can only be for a community toilet complex. This defeats the objective in a different sense in that the female gender walking up to these in the after dusk hours and in deep nights is an impossibility for safety and security reasons and also their day to day operation and maintenance (O&M) involves electrical machinery and more so, the funds to support such O&M may never ever be generated in the rural sector leave alone the shift operators not willing to do service in such demanding conditions and may be a case of "remedy worse than the disease"

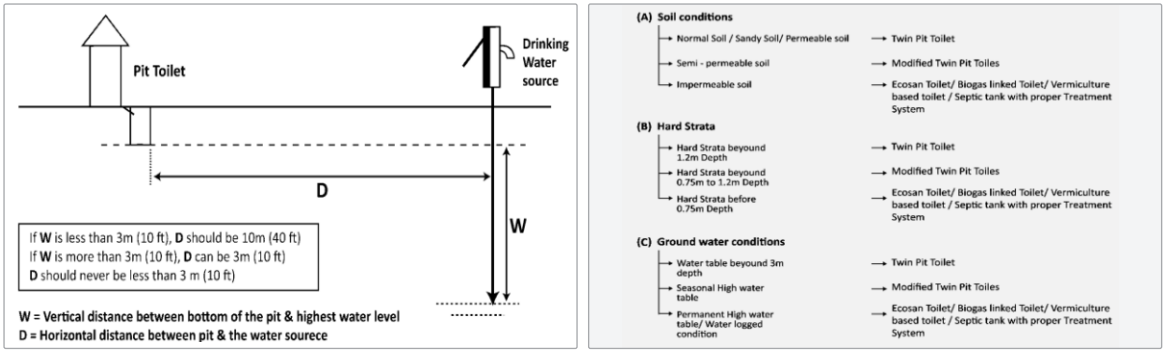


Fig. 1. The guidelines Evolved and Used for the IHHL and Disposal Options

2 The Colachel and Kodimunai Tsunami of December 2014.

These coastal fisherman habitations of Colachel with 340 families and Kodimunai with 160 families in south coastal Tamilnadu were wiped out in the 2004 Tsunami and the tragedy is shown in Fig.2.



Fig.2. Destroyed hamlets, Mass burial/cremation, Annual homage in beach with milk & bouquet

3 The Rehabilitation of Colachel and Kodimunai

The rehabilitated Colachel setting is 32 concrete roads of 4.5 km, 340 individual houses with 3 m open space all-round. The foundation was designed to withstand one more floor in future. Within, each house, there was an IHHL connected to a septic tank and upflow filter and the effluent from the upflow filter and the other wastewaters were led to the house side of the twin drain in the road. The rainwater from the houses was led to the road-side of the twin drain which was the storm drain and all drains with removable cover slabs. Ground water recharge is negated as the rehabilitation site was an erstwhile salt pan and hence dense clay. The twin drain was provided on both sides of the road. The sewage drains alone were networked into an interceptor drain and stabilization pond followed by maturation pond entirely by gravity as in Figs.3 and 4



Fig.3. Colachel- Septic tank & Upflow filter, twin drains layout, typical road and stabilization ponds.



Fig.4. Kodimunai-Twin drains, houses and ponds, authors with Heini Muellar of Caritas Swiss

Compared to underground sewerage system the twin drain system cost was only 15 % and covers the habitation seamlessly in day and night without the nuisance of digging up roads or sewer cleaning machines, reason being, the liquefied faeces and other wastewater flow easily. When drain network defies complete gravity, solar driven on-line low lift pumps can be used. Right from 2007, the system is in use. The layout of the new habitation of Colachel (Kodimunai was smilar), typical of Septic Tank & Upflow filter and household sewerage to twin drain are shown in Fig 5.

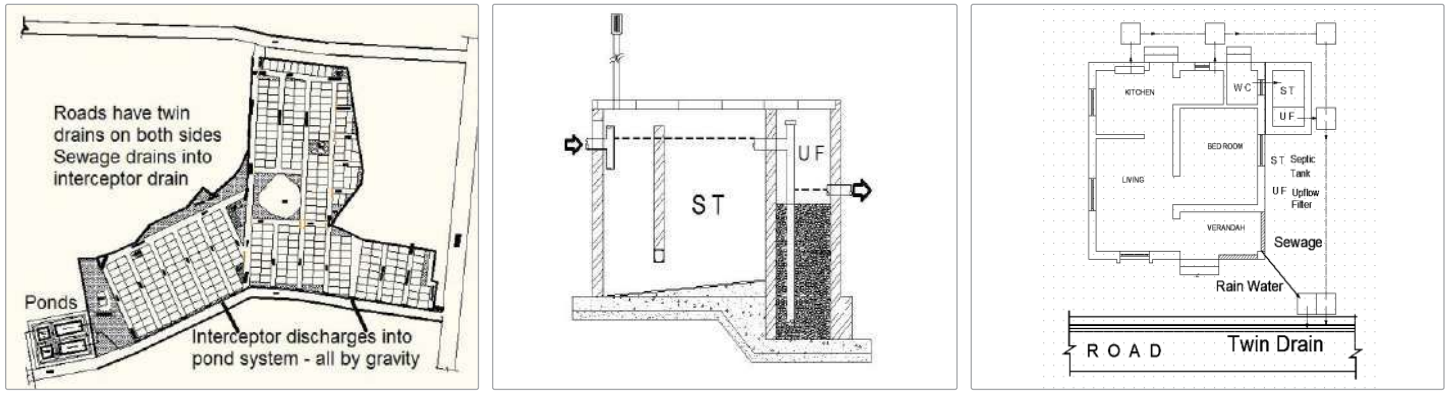


Fig.5. The Layout of Colachel, Typical sewerage of house and Septic Tank (ST) Upflow Filter (UF).

The septic tank was designed to handle the slurry of faeces and ablution water and the downstream Upflow filter had half-broken bricks from the rejects of the brick kiln. A generous fall of 45 cm was allowed for the friction loss in the filter. The toilet of the house had a floor level 45 cm above that of the house floor and this helped in achieving the seamless hydraulics right up to the twin drain. The Rehabilitation of Kodimunai was almost the same except that it was smaller for 160 families.

4 The Twin Drain Saga Then (2007) and Now (2022)-Self Servicing by Itself !!!

The works were completed in two years and commissioned in 2007. Some allotees have built one more floor also. One of the roads in Colachel with the twin drains intact after 15 years is shown in Fig. 6.



Fig. 6. Typical road in Colachel with Innocuous Twin Drain intact from 2007 (left) and 2022 (right).

The twin drain system is intact even after 15 years, the roads were never dug up, no house sewer connections blockages overflowing on the roads, no need for manholes, no need for "sewer divers", no need for sewer cleaning machines and above all, no breeding of mosquitoes from overflowing sewage and above all at only 15 % of cost of underground sewerage. This mimics the parody of having followed the overseas guidelines and ended up as a vast soil pollution by pathogenic sewage organisms. After all, the habitations covered by the IHHL project must have had roads anyway and the Indian Road Congress specifies the drains as part of a road. Thus, twin drains should have been possible.

5 The Stabilization Pond System-the undoing over the years.

The success of the twin drain system is rather disappointed in the stabilization ponds as in Fig. 7.



Fig.7. Left & Middle. The Ponds then and now. Right. A pond from a public STP earlier at Chennai

While the ponds were a natural system of choice as of 2007, the problem in recent times is the inability to daily deploy workers to skim water edges free from leaves of crouching trees. This cuts off the heat energy from solar incidence and the symbiosis activity is curtailed. It is basically a question of funds.

6 The Lessons of it all

6-1. While the open defecation has been 100 % eradicated, it is a matter of introspection about the resulting infestation of the soil mass with the pathogenic faecal organisms compounded by the possibility of the daily repetition mutating these to a Covid like challenge of dermatitis.

6-2. The so-called second phase of connecting the IHHLs to an underground sewerage is a distant mirage in rural setting mainly due to generating a tariff revenue break-even and hence, the pragmatic remedy is the twin drain system at only some 15 % of the cost.
6-3. The stabilization pond technology of 2007 has to give way to the small foot print of the Defense Research Development Organization (DRDO) Bio-Digester.
6-4. The sooner the twin drain is attempted, the better-before it all becomes "one big soil borne mess" and dermatitis complexities in the feet of the users of the system with no immediate cure.
6-5. In a lighter vein, we might have though inadvertently, caught the tiger by the tail.

Acknowledgements

To all the officers of Caritas India, Catholic Relief Services, Caritas Swiss, Kottar Social Service Society, the architect Mr David Sundar Singh, the contractor Mr Cleatus and profoundly to Mr Sunil Paliwal, the collector who readily gave clearances at all times and USAID in enveloping the project.

ABOUT THE AUTHORS

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Dr S Saktheeswaran *is the former Urban Sanitation Expert of World Bank in India and former Waste Management Expert Swatch Bharat Mission in Ministry of Housing & Urban Affairs and the designer of the twin drain and stabilization ponds system of Colachel and Kodimunai.*

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SUSTAINABLE WASTEWATER MANAGEMENT FOR URBAN INFRASRTUCRE – A CASE STUDY

By Santosh Hedge, Transwater System Pvt. Ltd



In a continuous quest to change water scarcity to water abundance and make the safest water available for the population through sustainable means of resource management, we at Transwater System Pvt. Ltd. have derived an optimum solution of

BOSON® Whitewater – The "3rd source of water"

The following case study is a classic example showcasing the sustainable way of saving enormous quantity of fresh water consumption in the cities. Before we get into the case reference, let us understand the set up and scenario of existing water and wastewater network.

Freshwater scenario

India as a country is blessed with enormous resources and all the problems related to water can technically be solved by better management of water and better use of known and proven technologies to increase the water availability.
Mostly urban water infrastructure in majority of the cities in our country is dependent on Surface water source nearby which is usually pumped from far away places with huge losses in the form of NRW (Non-Revenue Water). Additionally, this is subjected to seasonal fluctuations as these sources are typically rain fed. Further, considerable portion of fresh water requirement is also met by Ground water (direct borewell or through tankers)

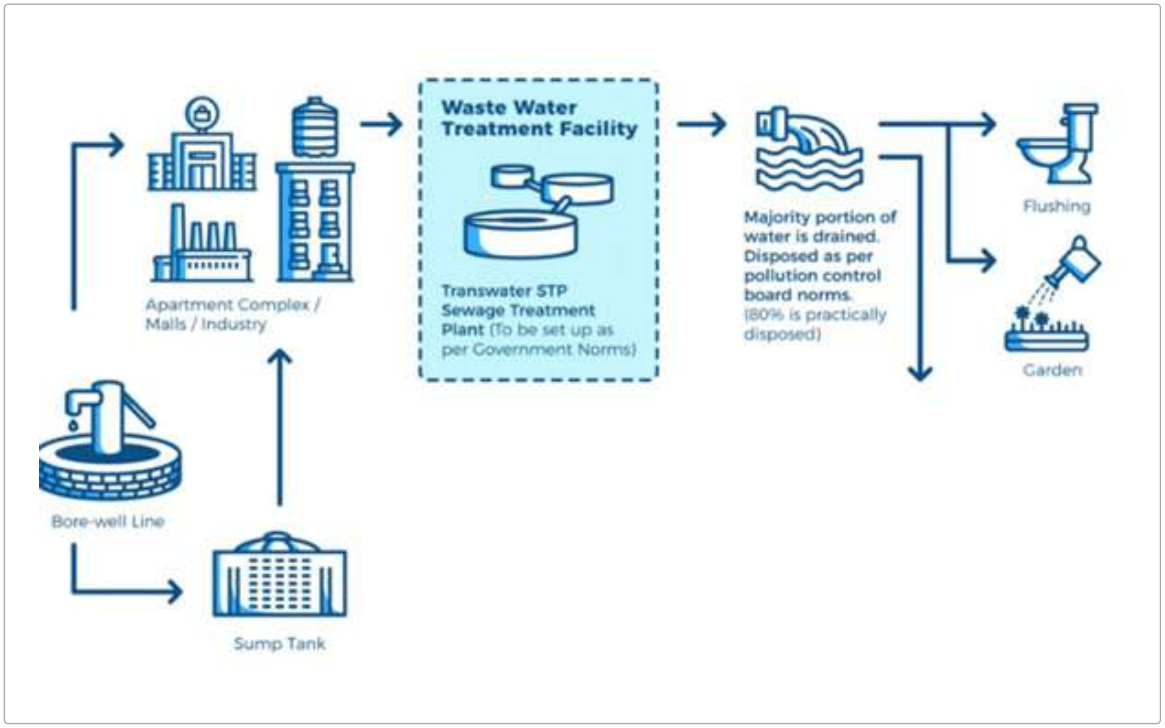
The usages / applications can be broadly classified into

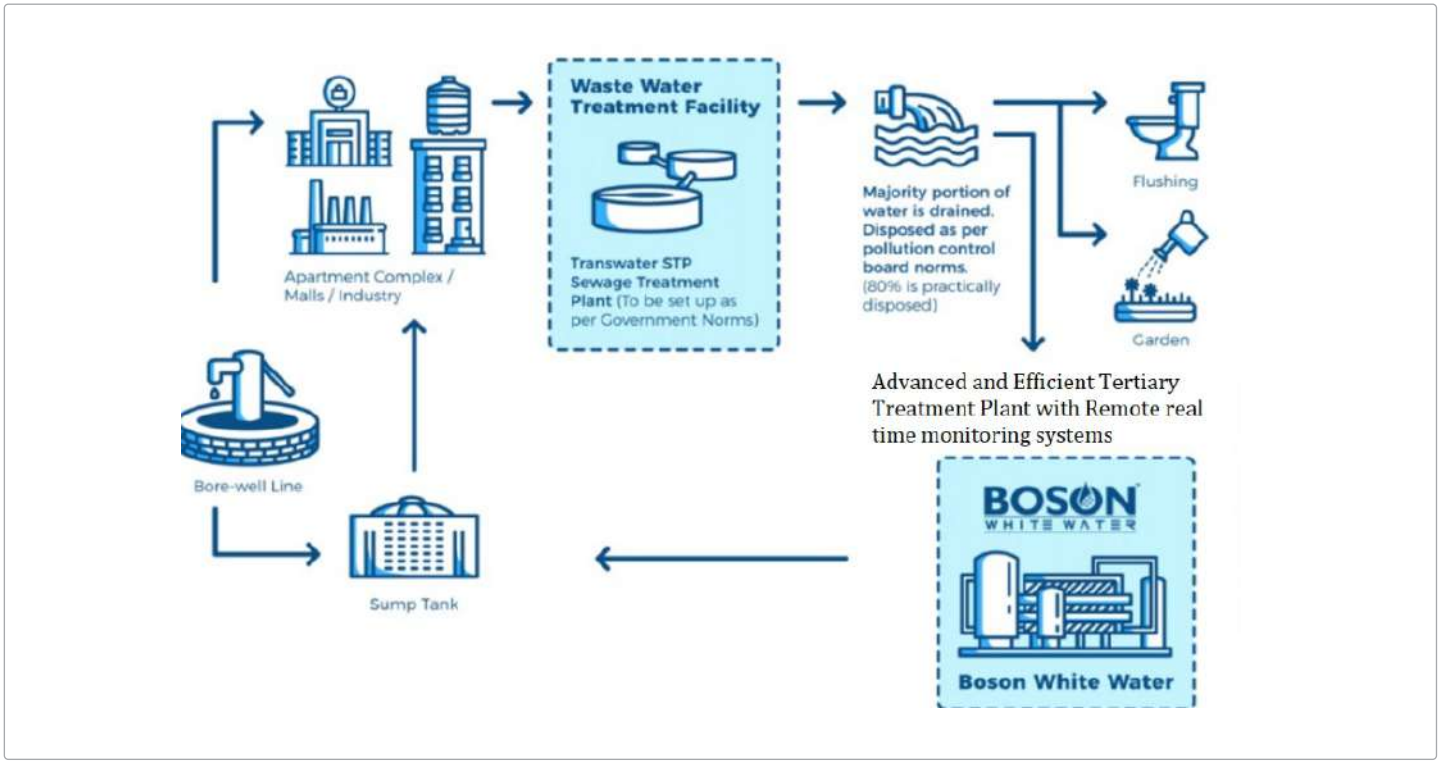
a) Drinking & cooking (direct potable)
b) Domestic usage – bathing and washing
c) Toilet flushing
d) Cooling tower for commercial establishments
e) Industrial supplies (manufacturing & process industries)

Wastewater scenario

User population generates equal amount of wastewater in the form of domestic sewage and industrial effluents.
Most of the industries have been mandated for recycling and systems have been implemented. Many of the industries are dependent on recycled water and also have achieved Zero Liquid Discharge with 100% recycling.
Zeroing on the sewage and its treatment infrastructure and summarizing the current set up below representative image provides a gist of the network for apartments and commercials establishments.

Additionally large municipal sewage treatment systems are put in place for treating the untreated sewage from independent residential establishments. The treated sewage is eventually let out into the water bodies flowing out of the cities.
In the current scenario, the many of the municipal sewage treatment





Treatment network set up with BOSON® Whitewater in place

systems are not functional to the expected levels due to Overload on STPs from unused/excess treated sewage from decentralized STPs or storm water flooding

Treated sewage in the apartments & commercial spaces is supposed to be utilized for

1. Gardening & irrigation
2. Toilet flushing
3. Cooling tower make up (wherever applicable)

In reality the usage is restricted only to gardening due to under performance of STPs or faulty operations or inconsistent quality of STP treated water. This in turn leads to usage of fresh water for toilet flushing and cooling tower make up in spite of having abundant treated STP water.

Unused excess treated STP water is sent to the nearest drain and the same gets mixed with untreated raw sewage which gets into a municipal centralized STP for treatment. This increases the hydraulic load onto the municipal STPs resulting in under performance which leads to poor treated water quality which eventually gets into the water bodies.

BOSON® Whitewater - "3rd SOURCE OF WATER"

Case reference:

Client	: Large residential apartment association
Location	: Peenya, Bangalore
Capacity of the STP	: 240 KLD
STP technology	: Sequencing Batch Reactor
Capacity of BOSON® Whitewater	: 200 KLD
Captive consumption	: 120 KLD
Excess recovered water	: 80 KLD

Background:

The residential complex has more than 450 apartments. Fresh water source is borewell and multisource tanker. Association/residents faced acute water crisis periodically and struggled to manage the water requirements.

STP is installed of 240 KLD capacity based on Sequencing Batch Reactor technology and was operational for > 02 years. Residents tried to use the treated STP water as a substitute for fresh water for toilet flush but they were not successful in this direction as the quality of the treated STP water was inconsistent.

Approach:

After a detailed discussion and evaluation of the site conditions and set up and feasibility check, BOSON® Whitewater system is installed for the premises. The system is a combination of multiple stages (11 stages) of treatment and occupied only 02 car parking spaces.

This unit recovers high quality potable grade water (complying the water quality as per IS 10500 standards). This water is supplied to the apartment as a replacement of freshwater which was being used for toilet flush and other utility requirements. Additionally, after fulfilling the requirements of the apartment the excess water is being sold to nearby industries through tankers who were dependent on inconsistent quality of tanker water

Key Advantages:

- No capital investment for association
- Large quantity of Fresh water savings
- Freedom for water scarcity and shortage in supply from external sources.
- Consistent quality

- Benefit for industries with supply of high-quality water for process (cooling, boiler and manufacturing)
- Reduction in cost associated with excess water discharge/handling
- Peace of mind and 100% compliance requirements met
- Water scarcity to water abundance
- Cost savings for industries in terms of OPEX of their WTPs
- Product quality enhancement due to higher quality of water
- No hassle of wastewater generation and handling



Our Focus:

If cities move towards Indirect Potable Reuse (IPR) / Direct Potable Reuse (DPR) norms by using advance technologies to recover potable water from the waste water. Developed Cities have already adopted such more predictable methods in their water management to become sustainable.

Of course, when such technologies are employed, they should have the capability to be digitally measured, monitored and controlled to ensure best quality of water. In the similar lines our multi stage, IOT enabled, fully automatic BOSON® Whitewater systems are developed and implemented generating 64+ crore litres/anum of high-quality potable grade water which is being used by residential complexes, industries, commercial complexes for various applications.

Challenges:

Direct/Indirect Potable reuse of treated water comes with a huge MINDSET barrier to handle. As a society we are still gripping to understand and come to terms in reuse of secondary treated water for Gardening and flushing. Looking at reuse of STP treated water for potable reuse looks like impossible task in hand for government and private players trying to solve the impending water crisis.





How can we overcome Challenges?

Few key market factors which can help overcome MINDSET barrier to reuse STP water for potable reuse.–

A. FIRST of all, we need to understand the fact that Total water available on our planet is fixed.
B. The source of water which is supplying the water to our apartments / complexes through tankers is unknown. There are more than few instances when these unknown waters have showed substantial Fecal coliform counts, pesticides, carcinogenic contaminants etc.
C. The Water pricing is a critical area which directly depends on unstable supply and demand and varying at different seasons. Reference: PWC report – Closing the Water loop.

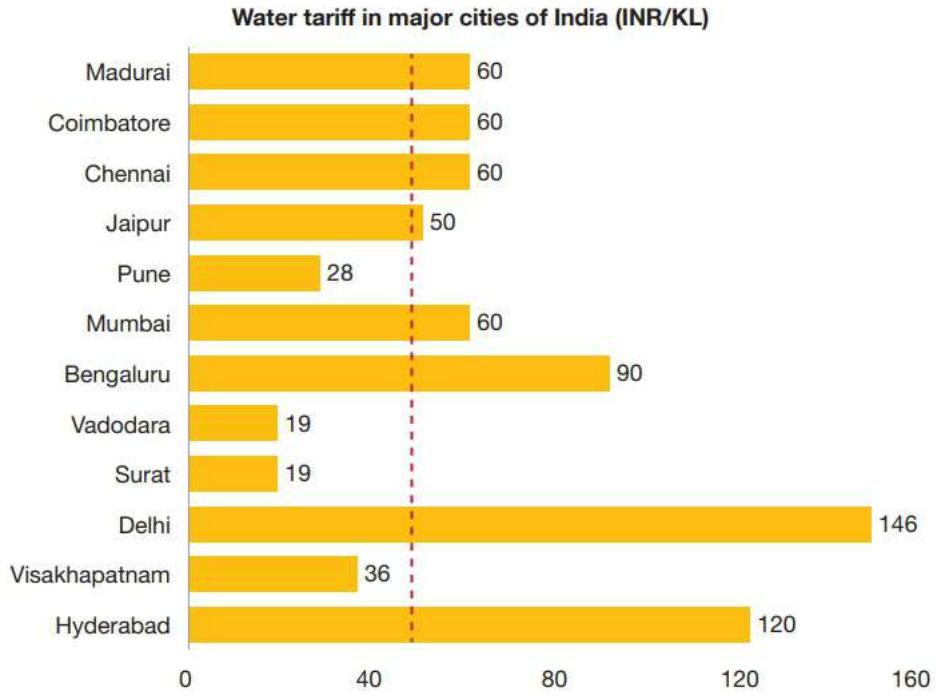
Logical thinking and assessing technology benefits begins only when the other sources of water is costlier. Imagine the "WHITEWATER – Potable water recovered from STP water" is almost the cost of tanker water people buy and Whitewater comes with the benefit of each batch Water Report (A small slip which indicates the water quality for the water in the tanker) also periodic detailed test reports by NABL Accredited Laboratories in line with the WHO/BIS standards for drinking water quality with a

D. Natural doomsday case when water availability becomes real challenge.

This should never happen; however, few regions have faced this for short periods. However, this cannot be actionable item to implement. Government sectors, NGO, Social Organization can have more measurement and can create awareness campaigns to prevent such disasters happen. Planning for doomsday of not having water for supply can still be beneficial than be completely clueless on what to do on such massive natural scenario's occur and implement necessary regulation to maximize recovery, reuse and Zero Discharge policies.

Summary:

The only way forward for cities of India to become sustainable in terms of water is



recovery of potable quality water from waste water. This would make our country water abundant. We are used to hearing the word water scarcity and if our mindset changes from scarcity to "abundance" we have better infrastructure for the city.

We at BOSON® strongly believe that WATER is a GOD particle.

We working aligning ourselves towards UN's SDG goals creating "The Third Source" of water and manage this precious resource sustainably. Consistent access to safe water and making it viable for the population.

Adopting Circular Economy in its true sense and implementing it efficiently.
Our goal is to prevent our societies from seeing the "DAY ZERO"

About the organization – **Transwater System Pvt. Ltd. – BOSON® Whitewater**

Recently won the **MISSION PAANI** award by CNBC TV18 (Top 4 in India) and have also been called Water Warriors by publication like Times of India, HAR EK BOOND (Republic TV), Better India.

Winners of India-Pitch-Pilot-Scale-Start-up Challenge 2022 under **Amruth 2.0**

Providing solutions for water/wastewater treatment from 2008.

We are convinced and strongly believe that the only way for cities of India to sustain in terms of water is to reuse every drop of waste water generated from the city and create a **"Third Source" of Safe Water for all.**

ABOUT THE AUTHOR

Santosh Hegde *– A Water/wastewater professional with a great passion for Environment. True believer of Circular Economy and working towards Reduce-Recycle-Reuse. Chemical engineer with a specialization in environmental engineering with more than 16 years of experience in Water / Wastewater management. Worked on various "Tough to Treat" complex wastewaters with best-in-class technologies and solutions and provided optimum & sustainable solutions to the clients.*

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

IDEAL IFAS™ CASE STUDY CITY OF EMPORIA WWTP, EMPORIA, KS USA

By World Water Works

QUICK FACTS

- **INDUSTRY:** Municipal
- **PROCESS TYPE:** Activated Sludge
- **TECHNOLOGY:** Ideal IFAS™
- **DESIGN:** 3.8 MGD; 10,063 lb/day BOD
  1,650 lb/day TN
- **STARTUP DATE:** AUGUST 2018

Background

The City of Emporia, in East Central Kansas, recently experienced an increase in population and more stringent effluent permit requirements resulting in a strained wastewater treatment plant. Emporia retained the services of a local engineering firm to evaluate the current and future needs of the system and recommend an economical, sustainable, and effective solution.

Like many other WWTPs nationwide, Emporia was tasked with new effluent permit requirements relating to Total Nitrogen (TN) and Total Phosphorous, (TP). Due to both space and budget restrictions, engineers focused on treatment solutions that could be retrofitted into existing tanks. After evaluating several options, World Water Works' Integrated Fixed Film Activated Sludge (IFAS) conformed to all the requirements and was selected.

Solution

IFAS incorporates specialized bio-media into portions of the existing aerobic zones to cultivate the slower growing nitrifying bacteria to aid in the reduction of ammonia thus allowing the MLSS bacteria to perform the bio-P and denitrification. The addition of IFAS equips Emporia with reliable and stable operations under varying loads.





Conclusion

Over six months, starting in late 2018, the IFAS system was introduced at Emporia and became fully operational. The first process train treated 100% of the flow while the second process train was under construction and commissioning. As expected, the biomass developed quickly on the media and immediately aided in the nitrification.



The figures below indicate influent loadings and effluent quality. Outside of a couple of unexpected and atypical peak loads in early 2020, the IFAS system has been operating successfully and produced high quality effluent meeting all the permitted requirements.

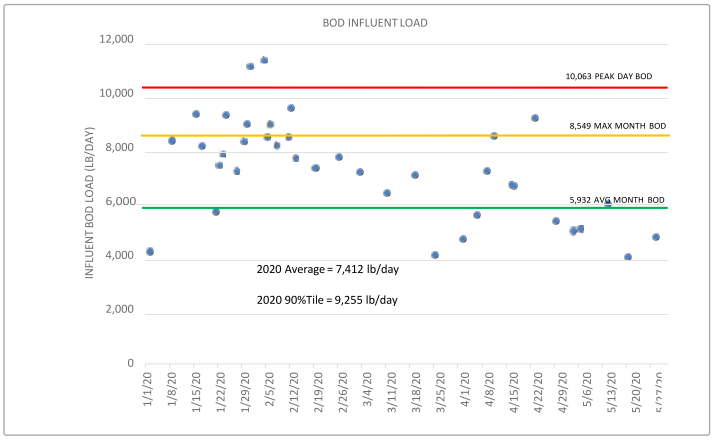


Figure 1 – Influent BOD Load for 2020

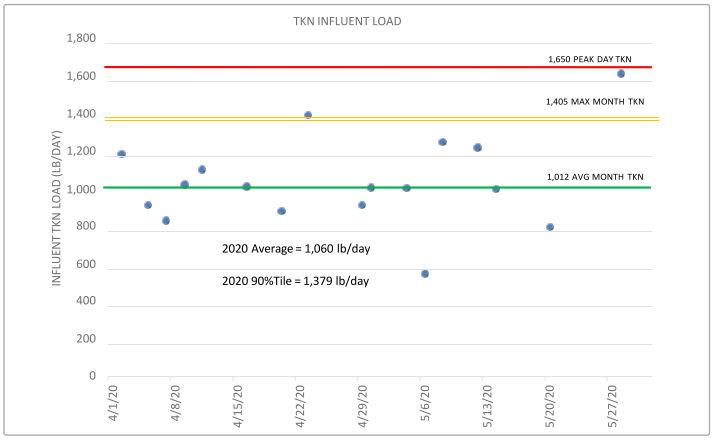


Figure 2 – Influent TKN Load for 2020

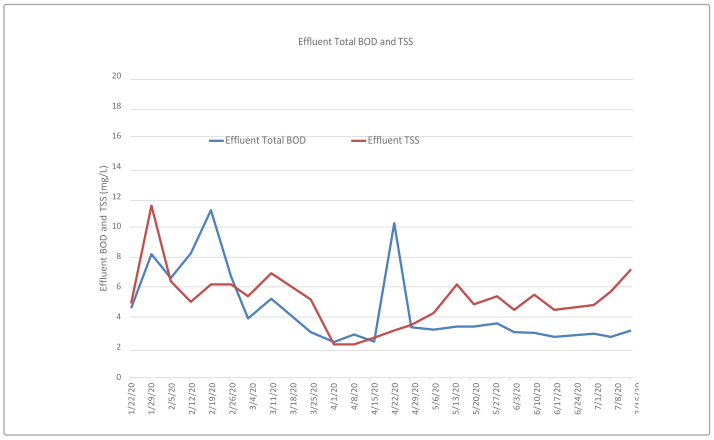


Figure 3 – Effluent BOD and TSS for 2020

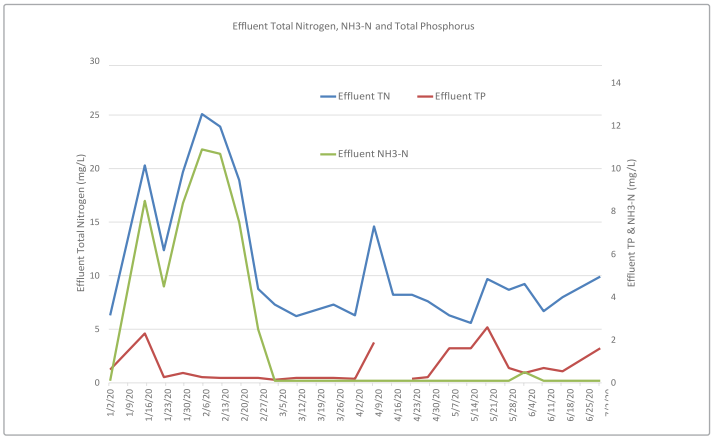


Figure 4 – Effluent Total Nitrogen, Total Phosphorus and NH3-N for 2020

ABOUT THE AUTHOR

World Water Works International Inc *and its affiliated companies ("World Water Works" or "WWW") is an innovator in the wastewater treatment industry, driven to help industrial and municipal customers find wastewater treatment solutions that deliver clean water, perform better, recover resources and save money. The company was founded in 1998 in USA, with a strong focus on innovation, quality and customer satisfaction. For over 20 years, executing these goals have enabled WWW to establish a leading reputation and meaningful relationships with over 700 customers including Nestle, Easen Unilever, Coca-Cola, Hindustan Unilever Limited, JSW, Toshiba Water Solutions, Danone, Disney, Hormel Foods, Sharjah Municipality, Proctor & Gamble, Wipro, National Peroxide Ltd. and several of the leading municipalities. WWW have installations in more than 29 countries across the world.*

WWW is a global leader in Biological nutrient removal and solid-liquid separation technology and our core technologies comprise of Ideal DAF, Ideal MBBR / Ideal IFAS, BIOCOS, DEMON and InDense.

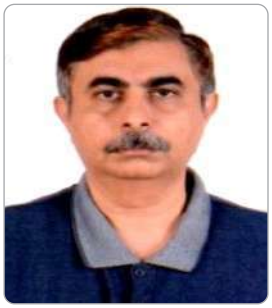
At WWW, we have a diverse international design team consisting of engineers, operators, mechanics, electricians and managers that lead and supports World Water Works' innovative approach. Combining this expert team with a strong commitment to Research & Development and Customer Commitment yields some of the most robust, yet cost-effective high-performance products for our Clients.

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

REGULAR, TIME BOUND & OPTIMIZED WATER QUALITY MONITORING ENSURES NO PROCESS INTERRUPTIONS AT GNFC

By Dr. Rakesh Farasram, Chief Manager & Dr. Mayur J. Kapadia, former Additional General Manager & Head, Quality Control Division, GNFC Ltd., Bharuch, Gujarat.





Water is perhaps the most precious natural resource after air. It is required for recreation, drinking, fisheries, agriculture and industry. Each of these designated uses has different defined chemical, physical and biological standards necessary to fulfil the respective purpose.

There are multiple requirements of water in every chemical industry:

- Process
- Steam
- Washing
- Sanitation
- Drinking
- Cooling
- Scrubbing
- Pollutants disposal

The quality of water for defined purpose of use plays a crucial role as it is directly related to the production processes. The contaminated water or improper water quality badly affect the production process through variety of undesirable phenomena like chocking, corrosion, reduced heat transfer, scale / slime formation etc. It also adversely affects the performance as well as the life of equipment. Hence, water quality testing assumes prime importance in chemical industry. Each user has a concentration threshold for the different contaminants in water, beyond which it can cause adverse effects. Water quality analysis helps industry in mainly following ways:

- To check whether the water quality is in compliance with the standards, and hence, suitable or not for the designated use.
- To monitor the efficiency of a water treatment plant.
- To check whether upgradation / change in an existing system is required and to decide what changes should take place.
- To monitor whether water quality is in compliance with Government rules and regulations.

Three types of parameters of water quality are measured in general - Physical, Chemical, and Biological / Microbiological :

- Physical parameters are those that are determined by the senses of sight, smell, taste, and touch and include temperature, colour, taste and odour, turbidity, and content of dissolved solids.
- Chemical parameters are measures of those characteristics which reflect the environment with which water has contact. These include pH, hardness, dissolved oxygen, COD, BOD, chloride, residual chlorine, sulphate, nitrogen, fluoride, iron, manganese, copper and zinc, toxic organic and inorganic substances, as well as radioactive substances.
- Biological parameters reflect the number of bacteria, algae, viruses, and protozoa present in water.

Owning to the crucial and direct role of water quality in manufacturing processes of chemical and other products, characterisation and monitoring of the quality of various water streams on regular, continuous and consistent basis become highly significant, particularly for large scale industrial complexes. Bearing this in mind, water quality monitoring practices have been comprehensively planned and executed at M/s Gujarat Narmada Valley Fertilizers & Chemicals Ltd. (GNFC). Moreover, the analytical frequencies in various plants are balanced and optimized over approx. 40 years to achieve dual purposes of cost reduction and meaningful insight about abnormalities. It is the aim of this paper to appraise reader about the practices followed at GNFC which have aided in continuing manufacturing operations uninterruptedly and at the same time, deriving maximum possible efficiency of the equipment and thereby raising productivity at a bare minimum cost towards analytical jobs. Sharing of such experience towards water testing could prove to be vital and handy for industries desiring to achieve higher productivity.

About GNFC & its Laboratory activities :

- Having started with Ammonia & Urea complex in1981, GNFC has added various fertilizer and chemical plants over last >40 years as shown in Table-1.
- Since very beginning, ample attention is paid to testing of all streams of water of all these plants.
- In view of enormous uses of water within the industrial complex, a considerable amount of time and expense is incurred to monitor and test water quality across all the operations of the plants.
- For this purpose, GNFC has setup fully equipped laboratory dept. with >250 employees & complete infrastructure with a host of many sophisticated laboratory instruments.
- 11 Laboratories are operated on round-the-clock basis in the vicinity of manufacturing plants.
- Professionally qualified man power possessing qualification of either B. Sc. or M. Sc. or Ph.D. is deployed for analytical job.
- The analytical techniques prescribed under universally accepted references like APHA (American Public Health Association) or IS (Indian Standards) or ASTM (American Standards for Testing & Materials) are employed for quality monitoring.
- The monitoring of various constituents / parameters is carried out using duly calibrated sophisticated laboratory instruments.
- More than 6000 samples of water streams are monitored for various parameters every month.
- Based on the analytical findings Vs specifications / limits / norms, corrective actions are taken at plant scale to bring the parameters

within normal range of plant operation.

Monitoring of Raw Water & Demineralization Plant streams:

The raw water is drawn from Narmada River, its Sardar Sarovar Dam and Ukai Dam on Tapi river. This water undergoes steps of sedimentation in lagoons, organic matter removal by chlorination, turbidity removal by alum treatment, sand filtration and post-chlorination. The resulting 'Filtered Water' is used for variety of purposes like Cooling Tower Make Up, Process, DM plant feed, Drinking, Sanitation, Floor washing etc. The DM water is generated using Ion Exchange Resin Bed process. The specifications of raw water, filtered water, DM water are shown in Table 2.

Monitoring of quality of different streams is done on continuous basis as shown in Table 3. The parameters for analysis of each sample are selected on the basis of criticality and significance of respective parameter for plant operation. The regular and time bound analysis helps GNFC in optimizing chemical consumption for water treatment, deriving maximum possible Output Between Regeneration (OBR) of resin beds,diagnosing water quality issues and water treatment plant's operational problems.

Monitoring of Condensate Water Quality:

Condensate water, essentially condensed water vapours, gets generated in almost all the process plants. Since condensate quality is as equivalent as DM water, it is the endeavour of every industry to reuse it in place of DM water. However, contamination, if any, coming from the process plant can severely deteriorate condensate quality. Therefore, GNFC has been regularly and periodically carrying out monitoring of condensate quality of various process plants for important parameters such as pH, Conductivity, Silica, Chloride and Hardness. Whenever any deviation is found in quality, the condensate of respective plant is cut off for recycling.

Moreover, the condensate is passed through polishing unit before being reused. The streams of cation exchange and mixed bed resins as well as charcoal filter beds are also regularly monitored to check effectiveness of the polishing process. The polished condensate is then mixed with DM water and used as Boiler Feed Water.

Monitoring frequency of condensate is given in Table 4. The regular and time bound analysis helps in reducing water consumption, improving energy efficiency, and reducing water treatment chemical cost.

Monitoring of water samples from Steam & Power Generation Plants:

GNFC has been operating 3 coal fired and 1 gas fired high pressure boilers. In addition to this, there are 2 Captive Power Plants and 1 Co-gen plant. To prevent problems of scale formation, corrosion, reduced heat transfer, tube failure, restrictions in water flow, higher pressure drop, turbine blade failure, erosion of blade, higher turbine vibrations etc., water quality at different stages is monitored at relatively high frequency as depicted in Table 5. Thrust is particularly given on maintenance of alkaline pH and hydrazine in Boiler Feed Water to avoid corrosion and ensure oxygen scavenging. Point worth noting towards phosphate dosing mechanism is that parameter like Silica is also checked along with phosphate in mother solution of Tri Sodium Phosphate. Ingress of external silica through such solution provides proper insight into real water chemistry of boiler samples.

Moreover, the small capacity boilers, being operated in different process plants to recover heat from the gases and other hot streams, are given the same importance as far as monitoring of water chemistry is concerned. Strict vigilance over water chemistry helps GNFC in taking appropriate actions in cases of deviations from norms.

Cooling Water Monitoring:

For its manufacturing plants in fertilizer / chemical / power sectors, GNFC has been operating total 16 open recirculating cooling towers having recirculation rates of 300-500 M^3/Hr to 40,000 M^3/Hr and 3 to 14 CT cells. Due attention towards periodical water quality monitoring, corrosion-control, scale-control and biocidal treatment, maintenance of adequate cycle of concentration (CoC) have helped in operating all these systems at highest possible efficiency and minimal issues of corrosion, scale and bio-fouling.

Table 6 shows the monitoring frequency of different streams of Cooling Water and Chilled Water systems. The limits fixed for various parameters are shown in Table 7. Free chlorine monitoring at 4 hours interval ensures minimal biogrowth. Levels of treatment chemicals are determined every day so as to maintain adequate levels so that corrosion and scaling are kept at minimum. Side stream filters' cleaning and analysis of inlet & outlet samples speak about efficiency of filtering mechanism. All these analytical costs go a long way in keeping CW problems far away.

Effluent Water Monitoring:

Based on pollutants to be treated and site of manufacturing plants, GNFC has been operating 5 different Effluent Treatment Plants Viz. Central Plant (taking care of Fertilizers / Chemicals plants), Nitrophosphate complex, Ethyl Acetate, Nitrobenzene and TDI. Inlet and Outlet samples of each unit operations are regularly monitored for key parameters (Table 8) to check effectiveness of the treatment step. Moreover, monitoring of effluent quality is also undertaken at battery limit of each manufacturing plant to know the actual pollutant load contributed by each plant and to undertake efforts to restrict the load. The final discharged effluent is comprehensively monitored for all the parameters prescribed in Consent Order of Pollution Control Authority. Further, third party analysis certificate is also obtained once in a month for discharged effluent. All these steps help the Environment Monitoring Unit achieve 100% compliance of the norms.

Similarly, the gaseous and solid wastes are also monitored to improve compliance and recover maximum possible amounts from wastes. Samples of effluent receiving natural water bodies like Nalas, Culverts, River and Sea are also monitored once in each season to learn about environmental impact of the discharged effluent on nature. It is pertinent to note here that industries conscious towards environment conservation should follow approach followed by GNFC.

Investigative analysis :

In case of troubles in manufacturing operations or suspicion about material loss, investigative analysis is carried out at various intermediate points to exactly pin point the area from where material is getting lost. In cases of loss of organic chemicals at very low levels or increased biofouling, indirect approaches are explored. COD comparison of Cooling Water and Make Up Water is one such example. To diagnose exchanger tube leakage, inlet and outlet samples of every exchanger are analysed for parameters like pH and Chloride, which gives idea about mixing of Cooling Water with Process Stream.

Cost effective & timely monitoring :

Due attention is always given towards cost incurred towards analytical requirements at GNFC. The costs may be in terms of manpower cost, analytical infrastructure, calibration of instruments, chemical & utility cost. The analytical requirements of plant operation groups are optimized by constant interactions between Lab & Operation groups. Parameters are optimized for each sample stream in view of criticality of parameter. Simpler and low-cost analytical methods are chosen.

Reagents are prepared in-house to bring in accuracy at a lower cost. It is always endeavoured to deliver analysis results before next scheduled analysis is taken up. This allows operator to take action which could reflect in subsequent analysis. Thus, time required for analysis is also an important variable for selection of analysis method. The method chosen should also provide ample time for repetition of the analysis before next analysis frequency.

Conclusion :

In order to operate industries without impediments caused by off-spec water, the qualitative and quantitative measurements are needed from time to time to constantly monitor the quality of water from various sources of supply, internal water circuits and finally discharged or recycled streams.Water data and analytics have become increasingly available and relevant, but the insights themselves are not generally actionable.

GNFC has succeeded in integrating water quality data and analytics into an actionable water quality monitoring strategy across the entire organization through implementation of following key criteria:

- The measurement / monitored parameters are carefully chosen with respect to process and envisaged troubles in plant operation.
- It is not always possible to monitor every variable, but parameter/s of core importance are measured.
- Cost of measurements are kept at bare minimum level for long-term sustainability of the monitoring program.
- Sample collection is rigorous and repeatable.
- Universally acceptable analysis methods are selected with great caution. Any change in methodology is well recorded and accompanied by an extended period in which both old and new methods are used in parallel.
- Results are delivered to internal customers before next scheduled sampling is performed.
- Consistency, periodicity and quality of work are critically maintained through interactive supervision. The data are well documented in computer programs. The analysis data are well presented and interpreted in consultation of plant operation groups.

Acknowledgement :

The motivation and permission provided by the management of GNFC Ltd for publishing the case study is gratefully acknowledged.

Table 1. Manufacturing plants being operated by GNFC

YEAR	PRODUCT	TECHNOLOGY PROVIDER
December,1981	Ammonia	M/s Linde AG, Germany M/s GE Energy, USA M/s BASF, Germany M/s Halder Topsoe, Denmark
December, 1981	Urea	M/s Saipem, Italy
August, 1985	Methanol-1	M/s ICI, UK
July, 1987	Power Plant -1	M/s BHEL, India
February, 1989	Power Plant -2	M/s BHEL, India
February, 1989	Methyl Formate	M/s Kemira OY, Finland
February, 1989	Formic Acid	M/s Kemira OY, Finland
October, 1989	Concentrated Nitric Acid -1	M/sPlinke, Germany
March, 1990	Weak Nitric Acid -1 (61.5%)	M/s UHDE, Germany
December, 1990	Methanol -2	M/sICI, UK
July, 1990	Ammonium Nitrate(Melt)	M/s UHDE, Germany
August, 1990	Calcium Ammonium Nitrate	M/s UHDE, Germany
September, 1990	Ammonium Nitro Phosphate	M/s BASF, Germany
December, 1994	Nitro Benzene	M/sChematurEnggAB, Sweden
September,1995	Acetic Acid (Glacial)	M/sBPChemicals, UK
February, 1995	Aniline	M/s Chematur Engg AB, Sweden
March, 1998	Synthesis Gas Generation Unit (SGGU)	M/s Linde AG, Germany
July, 1998	ToluneneDi-isocyanate(TDI)	M/s Chematur Engg AB, Sweden
January, 1999	Concentrated NitricAcid -2	M/s Plinke, Germany
May, 2011	Concentrated NitricAcid -3	M/s Plinke, Germany
July, 2011	Weak Nitric Acid-2 (61.5%)	M/s UHDE, Germany
March, 2012	Cogeneration Power & Steam Unit(CPSU)	M/s BHEL, India
October, 2012	EthylAcetate	M/s KBKChem.Engg., India
January, 2013	Ammonia Synthesis Gas Generation Plant (ASGP)	M/s Halder Topsoe, Denmark
July, 2014	ToluneneDi-isocyanate(TDI- II), Dahej complex	M/s Chematur Engg AB, Sweden
Dec, 2021	Formic Acid Revamp	M/s GNFC In-house team

Table 2. Typical Quality / Specifications of Raw Water, Filtered Water and DM Water

PARAMETER	UNIT	RAW WATER	FILTERED WATER	DM WATER
pH	-	7 - 8	7 - 8	6.5 – 7.0
Conductivity	Micro siemens	250 – 350	250 – 350	< 2
Free Chlorine	ppm	-	0.5 – 1.0	Nil
Total Hardness as $CaCO_3$	ppm	90 – 140	90 – 140	Nil
Calcium hardness as $CaCO_3$	ppm	50 - 80	50 - 80	-
Magnesium hardness as $CaCO_3$	ppm	40 - 60	40 - 60	-
Turbidity	NTU	15 - 500	1 - 2	-
Total Solids	ppm	200 – 250	-	-
Total Dissolved Solids	ppm	150 – 230	200 – 250	-
Chlorides as Cl	ppm	15 - 30	15 - 30	< 0.05
Soluble Silica as SiO_2	ppm	12 - 22	12 - 22	< 0.02
Iron as Fe	ppm	0.1 – 1.0	< 0.1	-
Total Alkalinity as $CaCO_3$	ppm	90 - 130	90 - 130	-
Sulphate as So_4	ppm	15 - 40	15 - 40	-
Sodium as Na	ppm	25 - 40	25 - 40	<0.02
Potassium as K	ppm	5 - 10	5 - 10	-
$KMnO_4$consumption	ppm	5 - 20	1 - 2	-

Table 3. Monitoring of Raw Water Treatment & DM plant samples

SAMPLE STREAM	PARAMETERS MONITORED	FREQUENCY OF ANALYSIS
Raw Water Treatment Plant		
River water (3 sources)	pH, Cond, Turbidity, Solids (total, dissolved, suspended), Alkalinity, Hardness, Ca, Mg, Cl, SO4, Silica, Na, K, Fe, KMnO4 consumption	1/week
Measuring Flume (2 streams)	Free Chlorine	3/week
Clarifier (2 streams) O/L	pH, Turbidity, Cl, Free Chlorine	3/day
Sand Filter O/L (8 streams)	Turbidity	3/week
Activated Charcoal Bed feed	KMnO4 consumption	3/week
Activated Charcoal Bed O/L (4 streams)		
Deoiling unit I/L & O/L	Oil	1/week
Filtered water (CW make up, Process, Drinking)	pH, Cond, Turbidity, TDS, Alkalinity, Hardness, Ca, Mg, Cl, SO4, Silica	1/week
Tap water	Free Chlorine	6/day
Cation feed water		3/day
Demineralization (DM) Plant		
Cation feed water	Free Chlorine	3/day
Cation O/L (5 streams)	pH, FMA, Hardness	2/day
Degasser O/L (3 streams)	Co_2	3/day
Weak Base Anion O/L (5 streams)	pH, Cond, Cl	1/day
Strong Base Anion O/L (5 streams)	pH, Cond, Silica	1/day
Mixed Bed Resin Bed O/L (5 streams)	pH, Cond, Silica	3/day
DM Tank (3 tanks)	pH, Cond, Silica, Hardness	4/week
DM water supply header	pH, Silica	2/day

Table 4. Condensate Water Quality Monitoring

SAMPLE STREAM	PARAMETERS MONITORED	FREQUENCY OF ANALYSIS
Ammonia plant Condensate (AC) I/L	pH, Cond, Silica	2/day
Nitro Plant condensates	Silica	1/day
Heating condensate	pH, Cond, Cl, Silica	1/day
AC Pump Discharge	pH	2/day
Turbine condensate (6 streams)	pH, Cond, Silica, TH as $CaCO_3$, Sodium as Na, NH_3, Iron	1/day
ASGP Condensate (4 sources)	pH, Cond, Silica	1/day
Nitric Acid Plant Heating Condensate	Cond	1/day
AC Cation O/L (3 streams)	pH, Cond	3/week
UC Cation O/L		3/week
AC Mixed bed O/L (3 streams)	pH, Cond, Silica	3/day
UC Mixed bed O/L		3/day
AC Tank	pH, Cond, Silica, Hardness, Cl	4/week
UC Tank		4/week
Condensate Polishing Unit	pH, Cond, Silica	1/shift

Table 5. Monitoring of Steam & Power Generation Plant Samples

SAMPLE STREAM	PARAMETERS MONITORED	FREQUENCY OF ANALYSIS
Feed Water to Boilers, Power plant, Turbine and Co-gen Plant (5 sources)	pH, Cond, Silica, N2H4, Alkalinity	1/day
Super-Heated Steam (3 sources)	pH, Cond, Silica, Fe	3/day
Super Saturated Steam (3 sources)		1/day
Imported steam		1/day
High Pressure Superheated Steam		3/day
Low Pressure Steam		3/day
High Pressure Drum blow down	pH, Cond, Silica, PO_4	3/day
Low Pressure Drum blow down		3/day
Mother solution of Tri Sodium Phosphate (4 tanks)	Silica, PO_4	2/week
Boiler Blow Down (3 boilers)	pH, Cond, Silica, PO_4	3/day
Waste Heat Boilers		
Feed Water	pH, N2H4	2/Shift
	Cond, Silica, Fe, Hardness	1/day
Bleed off Water	pH, Silica, Cl,	2/Shift
	Cond, Cl	1/day
Steam samples	pH, Cond, Silica, PO4, Fe, Cl	1/day

Table 6. Cooling Water Quality Monitoring

SAMPLE STREAM	PARAMETERS MONITORED	FREQUENCY OF ANALYSIS
Sand filter O/L	Turbidity	1/day
Supply Header	pH, Free chlorine	1/shift
Return Header	pH, Free chlorine	2/shift
	Nitrate	1/week
Cooling Water	As shown in Table 7	3/week
	Phosphate (Ortho & Organo), Zinc	1/day
	Oxidation Reduction Potential (ORP)	As necessary
	Total Viable Bacterial count	1/week
	Sulphate Reducing Bacteria	2/month
Cooling Tower	Corrosion Rate	1/month
Chilled Water system	Inhibitor	1/week
	pH	1/shift

Table 7. Cooling Water Specifications

PARAMETER	UNIT	DESIRED VALUE
pH	-	6.8 – 7.5
Conductivity	Micro mhos / cm	2000 max
Free Chlorine	ppm	0.2 – 1.0
Total Hardness as $CaCO_3$	ppm	800 max
Calcium hardness as $CaCO_3$	ppm	–
Magnesium hardness as $CaCO_3$	ppm	–
Turbidity	NTU	15 max
Total Solids	ppm	–
Total Dissolved Solids	ppm	–
Chlorides as Cl	ppm	250 max
Soluble Silica as SiO_2	ppm	125 max
Ortho Phosphate as Po_4	ppm	5 - 6
Organo Phosphate as Po_4	ppm	0.3–0.8
Zinc as Zn	ppm	0.5 – 1.0
Iron as Fe	ppm	1 max
Ammonia as Nh_3	ppm	ND
Total Alkalinity as $CaCO_3$	ppm	–
Nitrate as No_3	ppm	10 max
Total Viable Bacterial count	per ml	10^5 max
Sulphate Reducing Bacteria	MPN / 100 ml	100 max
Corrosion rate	mpy	3 max

Table 8. Monitoring of Effluent Streams

SAMPLE STREAM	PARAMETERS MONITORED	FREQUENCY OF ANALYSIS
Sump Reservoir -16	pH, Amm N_2	2/day
Sump Reservoir -17		2/day
Sump Reservoir -18	pH, Cond, Amm N_2	3/day
Sump Reservoir -3	pH, Amm N_2	1/day
Cooling Tower 1		2/day
I/LCooling Tower 4 O/L		1/day
Main drain	pH, Cond, Amm N_2	3/day
Plant drain recycle	pH, Amm N2, Free NH_3	6/day
Plant Drain effluent	pH, Temp, TDS, SS, COD, BOD, Oil, Cl, CN, SO_4,FCl2, F, Amm N_2, F-NH_3, NO_3, Zn, PO4, TKN, S	3/week
	pH, Amm N_2,Free NH_3	1/day
Rly nala effluent	pH, Amm N_2	1/day
Storm water (8 storms)	pH, NO_3	1/day
Equalization Tank 1 O/L	pH, NO_3, Fluoride, P_2O_5	1/day
Equalization Tank 2 O/L	NO_3	3/day
Equalization Tank 3 O/L	Lime concentration	1/day
Lime slurry	pH, Amm N_2	3/day
Stripping Tower 1 I/L		3/day
Stripping Tower 1 O/L		3/day

Table 8. Monitoring of Effluent Streams

SAMPLE STREAM	PARAMETERS MONITORED	FREQUENCY OF ANALYSIS
Alum slurry	Al_2O_3	2/day
pH adjustment tank 1,2,3	pH	1/day
Act Charcoal 1 I/L	pH	1/day
Act Charcoal 1 O/L	pH	3/day
Denitrification Reactor I/L	pH, NO_3, F, P_2O_5, Ca, SO_4, Amm N_2	3/day
Denitrification Reactor O/L	pH, NO_3	3/day
Treated effluent	pH, Amm N_2, NO_3, F	3/day
ANP Discontinuous effluent	pH, Amm N_2, NO_3, F, P_2O_5	1/day
Sand wash effluent	pH	1/day
NOx wash effluent	pH, Amm N_2, NO_3, F, P_2O_5	1/day
Nitro Treated Effluent	pH, Temp, SS, COD, SO_4, F, Amm N_2, F-NH_3, NO_3, PO_4, Colour	1/week
Equalization Tank 1 O/L	pH, NO_3	1/day
Equalization Tank 2 O/L	pH, Amm N_2, NO_3, F, P_2O_5	1/day
Equalization Tank 3 O/L	pH, No_3	3/day
Waste Water – Nitric acid Plant (2 streams)	H_2SO_4, HNO_3	3/Shift
Sewage Treatment Plant water	pH, TS, TDS, SS, COD, BOD, Cl, SO_4, FCl_2, Amm N_2	1/week
Culvert Sample	pH, Amm N_2, F, NO_3, PO_4	1/month
Kantharia nala		1/ 2 month
Bhukhi river water - 3 samples	pH, Cond, Turb, TH, Cl, F, NO_3, PO_4, Na, COD, Amm N_2, Free-NH_3	Once in four months
Well water- 6 samples	Appearance, Colour, Odour, pH, Cond, Turb, TH, Cl, F, NO_3, PO_4, Na,	Once in four months
Nala water-4 samples	COD, Amm N_2, Free-NH_3	Once in four months
Yellow water	H_2SO_4% & HNO_3%	On request
Red water	pH, Nitro Phenol, Nitro cresol	On request
Mixed waste water	pH, Benzene, Nitrobenzene, Nitro Phenol, Nitro cresol	1 / Day
	H_2SO_4%, HNO_3%	2/ Day
Washer	pH, Benzene, Nitrobenzene, Dinitrobenzene	1 / Shift
Acidic Water	H_2SO_4% & HNO_3%	1 / Shift

ABOUT THE AUTHORS

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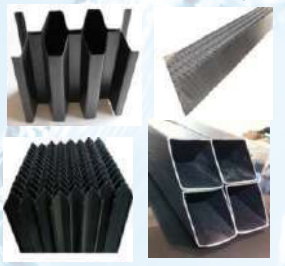
Dr. Rakesh P. Farasram *has been working in Quality Control Dept. of M/s Gujarat Narmada Valley Fertilizers & Chemicals Ltd (GNFC) since 1990. He obtained his Ph.D degree in Organic Chemistry in 1998 from South Gujarat University. He is having industrial QC experience of > 32 years. His research work has helped GNFC in curtailing costs at several stages of process. He has won several awards for implementing ideas for technological improvements. He has published various research papers in various journals. Presently, he is discharging his duty as Chief manager in Quality Control Dept of GNFC Ltd.*

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

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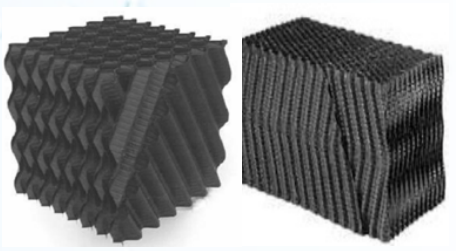
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USE OF EMICROBES (READYMADE CULTURE) IN STP: A CASE STUDY

By Mangesh Dashrath, Founder, Envicare



The stringent norms laid down by the PCB (Pollution Control Board) in India have created the challenges for the STP and ETP manufacturers and for the Industry itself. The use of specially developed microbial culture in wastewater treatment plants (STP and ETP) is gaining the great advantages like:

1. To reduce the BOD level <10 ppm
2. To provide the nutrients to the culture
3. To maintain the MLSS inside the Aeration Tank
4. To achieve the compact design in wastewater treatment.

The specially developed EMicrobes has been used for the STP- 150 KLD at one of the Industrial sewage containing wastewater from toilets, washrooms and canteen the results has been outstanding.

The application of EMicrobes with the technology like MBBR (Moving Bed Bio Reactor) based STP has impacted the overall result to reduce the input BOD level from 218 ppm to lower down to less than <3.0 ppm.

The plant is running successfully from last 1 year with the online monitoring system installed to monitor the the treated water quality.

Of course, the direct use of EMicrobes doesn't provide you theresults as listed above.It requiredthorough and in-depth analysis, technologies upgradation, on-site studies and right applications and monitoring to achieve the desired results. Below are the onsite pictures of for better understanding.



Online Results @ Site

SR #	PARAMETERS	STP INLET	STP OUTLET	KSPCB LIMITS
1	pH	6.38	7.78	6.50 to 9.0
2	BOD (Bio Chemical Oxygen Demand) 3 days @ 27 Deg C	218 ppm	2.96 ppm	< 10 ppm
3	COD (Chemical Oxygen Demand)	382 ppm	16.95 ppm	< 50.0 ppm
4	TSS (Total Suspended Solids	128 ppm	9.68 ppm	< 20 ppm



STP @ Site



Treated Water& Sewage

ABOUT THE AUTHOR

Mangesh Surve *is a Chemical Engineer and has been leading ENVICARE for the last 22 years as its MD. With corporate offices in Pune, Dubai & Malaysia, he uses his knowledge to navigate the company in various related offerings. The innumerable awards in his kitty speak for his work. Envicare's team of committed engineers, managers, consultants & technicians are sought-after in India & internationally for their resourcefully sustainable technological & after-sales know-how. Their devoted R&D laboratory, AQUA Laboratories, runs actively on the ISO guidelines for water, wastewater & effluent testing.*

In ENVICARE kitty, they have 750+ distinguished clientele, 1500+ installations, international business experience and successful recycling of over 5000+ million litres of wastewater from industrial & domestic activities. The ISO 9001: 2015 certification marks their commitment to quality consciousness and management.

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

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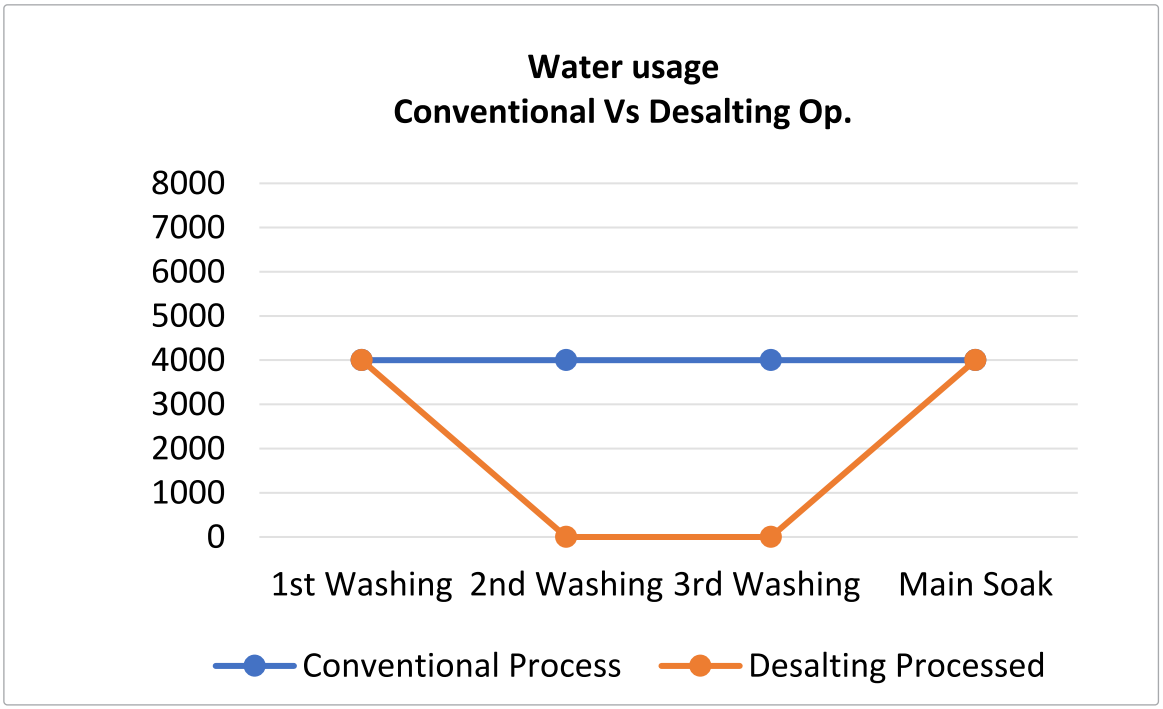
WATER OPTIMIZING MECHANISM IN LEATHER TANNERY – INTERVENED THROUGH DESALTING MACHINE AND SOLENOID VALVE WITH LIMIT SWITCH, TO TACKLE THE WATER WASTAGE AND INCREASING CARBON FOOTPRINT

By Dipayan Adhikary, Solidaridad



Kolkata is the second most important tanning and leather goods manufacturing center in the country. Approximately a quarter of India's tanning is done in Kolkata. It produces leather goods and accessories, such as shoes, gloves, wallets and belts for the domestic and international markets. Despite the sector's huge growth potential, it is plagued with several pollution issues due to lack of clean and green technologies. To facilitate the further economic growth of the tanning and leather cluster in line with national and global market demand, it is important that environmental issues and waste management are addressed and overall efficiency and quality of the tanning processes are improved. Therefore, Solidaridad's project "Effective waste management and sustainable development of the MSME tanning companies in the Kolkata Leather Cluster (Bantala)" is in line with the larger objectives of Solid waste management of Bantala Leather Cluster and the Memorandum of Understand between the Governments of West Bengal and the Netherlands, on implementing sustainable practices and waste management of Kolkata Leather Cluster, Bantala. The project aims to establish a sustainable partnership between tanners and pollution control authorities which will effectively take charge of the main challenges related to overall water use, organic and chemical waste levels in the effluent water and also utilization of solid wastes to a value-added product. The key objectives of this project are to optimize the water usage in 100 tanneries in Bantala leather cluster and to qualitative reduction of the final effluent discharge by 50%. Under the ambit of this project, Solidaridad has introduced eco-friendly and techno-commercially viable solutions to enhance the industrial wateruse efficiency in tanning industry and reduce the overall effluent load in the CETP regulated by CLCTA (Central Effluent Treatment Plant).

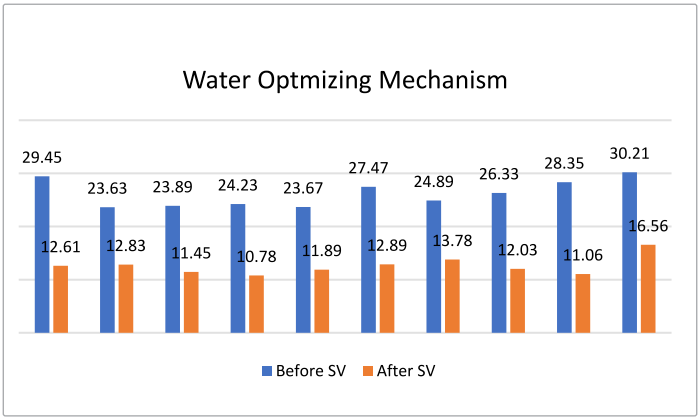
One of them is retrofitting of a water optimizing mechanism in the fleshing operation through installation of Solenoid valve & Heavy-duty limit switch that helps to reduce the water use by around 50%. Another intervention, Desalting mechanism that helps to recover the cured salt and as a result it reduces the water usage of washing operation by 66%. Washing of the cured hides/skins to remove salt is important for the process. It involves washing of hides/skins 3 to 4 times leading to TDS load in the wastewater. Desalting machine will help to remove the salt from cured hides/skins and also reduce the



water involves in washing operation by 66%.Fleshing operation is essential for any tannery and its process even though it is very water intensive. Replacing the machine with the advanced one is extremely costly initiative. So, by retrofitting with Solenoid valve in the machine can optimize the water usage by 50%.

In the conventional system, tannery needs to wash the cured hides/skins three times in paddle for 30 minutes each and it will take 4000 liters of water each washing, means 12,000 liters of water for three washing for one paddle, to remove all the salts that was applied at the time of curing operation (temporary preservation). Solidaridad intervened with Desalting machine, which will help to remove the salt in the preliminary stage before going for washing. Therefore, one wash is enough to serve the purpose properly. After desalting operation, the water consumption for one paddle will be 4000 liters. So, the reduction of water consumption is [{(12000-4000)/12000} *100] = 66.6%. This intervention also saves running time of the paddle and the recovered salt.

During fleshing operation, water flows over the rollers to clean the blades, maintain constant temperature and lubrication of the hides to avoid any damage. There is a considerable wastage of water as water keeps on flowing even when the paddle is not pressed by operator. The water gives a smoothness to the fleshing operation. The water flows regularly even at the start of the fleshing operation and flows continuously without break till the operation is completed. In the conventional process, for fleshing of one hide takes approximately 35 seconds to complete the process, starting from taking the pelt for fleshing to piling the pelt after the operation and the flow rate of the pipeline is 1.300 liters of water / second. So, one piece of hide is consuming 45.500 liters of water. In the other hand, after installing the Water optimizing mechanism (Solenoid Valve & Limit switch), flow of water starts as soon as paddle is pressed by foot of operator and flow stops when foot is taken off from paddle. In this way solenoid will allow the water to flow through the machine only when the pelt touches the feed roller. And this technological alteration is very smooth, therefore, has been largely accepted. The following are the results of the trials on cow skins Before SV Installation Average water consumption in liters for 10 Pelts (53+46+49+47+46+44+49+46+47+48)/10 = 475/10 =47.5 liters After SV Installation Average water consumptionin liters for 10 Pelts (26+22+21+22+23+21+25+21+20+21) /10 =222/10 = 22.2 liters So, the reduction of WaterConsumption is [{(47.5 – 22.2)/47.5}*100] =53.3%



Total Dissolved Solids (TDS) is one of the most challenging pollutants in the effluent coming out of industry. Tannery effluents carry heavy TDS loads due to a massive presence of salts on the raw hides applied for curing purposes. Hence, there is a need to revamp leather processing methods for the sustainability of leather industry. In the traditional leather processing, the cured hides/skins are taken for washing process to remove the excess salt from the hides/skins. During these washings, ample amount of water is being used for it and mixed with the final effluent. This highly saline water



increases the TDS (Total Dissolved Solids) of the effluent and CLC's CETP (Central Effluent Treatment Plant) system struggles to reduce this pollution load. Conventional treatment systems such as the chemical and biological treatment stages are unable to remove the TDS. The removal of salinity or TDS in the effluent requires expensive and very sensitive processes such as reverse osmosis (RO) and the evaporation of RO reject in multiple effect evaporators. Solidaridad came up with a solution which can recover the salt and also saved the ground water. Desalting machine, can easily recovered the maximum salt form the hides/skins before going to the washing stage. This mechanism will reduce the salt load in the washing float as well as will reduce the water usage by 66%. We have also calculated the GHG analysis and saving from both time and water reduction.

Solidaridad observed and analyzed the data of excess water consumption in Fleshing operation. Strategically selected the first 10 pilot trials. The strategic factors for selecting the tanneries were 1. Varied scale of operations production capacity 2. Kind of raw materials used cow, buff calf, goat etc. 3.Product line of tanneries. Solidaridad introduced Solenoid Valve as a solution of using water accurately thereby reducing excess water use during fleshing operation. During fleshing operation, water continuously flows over the rollers to clean the blades and maintain constant temperature on the hides to avoid any damage. There is a considerable wastage of water as water keeps on flowing even when the paddle is not pressed by operator. T o control continuous flow of water during fleshing operation, a switch which is connected to Solenoid Valve is placed near to the feed roller and roller connected to the paddle. Flow of water starts as soon as paddle is pressed by foot of operator and flow stops when foot is taken off from paddle. It has been observed that by installing Solenoid Valve on Fleshing Machine, it is possible to reduce water use by more than 50%, thus saving huge quantity of water which would have otherwise increased the volume of effluent. Solenoid valve's work is controlling the flow of water. The valve function involves either opening or closing of an orifice in a valve body, which either allows or prevents flow through the valve. A plunger opens or closes the orifice by raising or lowering within a sleeve tube by energizing the coil.

Conventionally, in a tannery at Kolkata leather cluster, they are doing 3 lots each day in paddle. Each lot contains 100 hides for the operation. Water capacity of each paddle considerably 4,000 liters and for washing operation they used to perform 3 times for each paddle / lot. Traditional way, one paddle for one lot uses 4000 liters of fresh water. Then for a day in a tannery they are using 36,000 liters of fresh water during 3 paddles washing operation. After desalting operation this washing cut down to one time from 3 times. Therefore, the water savings each paddle is 8,000 liters and for a day in a tannery the amount is 24,000 liters of fresh water saving. In the 50 tanneries, the total fresh water savings per day is 12,00,000 liters. Yearly the amount is coming out 34,56,00,000 liters of fresh water, yearly saved water = 1,24,416 no. of people can ne hydrated for 1 year [25 million liters of water annually - enough water

to keep more than 9,000 people hydrated for 1 year according to WHO figures].

This intervention saves around 55%-66% of fresh water and helps to reduce the load of the CETP. The scientific calculations and water mapping studies on the field determines that the fresh water requirement during fleshing operation is only for 15 seconds while there was no operation on the machinef or remaining 20 seconds. Following is the calculation of water saving through retrofitting of fleshing machines for a tannery processing 300 hides/day, time taken for fleshing one hide is 35 seconds. We calculated the flow rate in the tanneries generally 1.3 liters / seconds. So, for fleshing one hide, water consumption is 45.500 liter and after installing the solenoid, the water consumption is 19.500 liters (only operational time). Water savings amount will be 26 liters / hide, for 300 hides the amount of water saving each day is 7800 liters / day. Then for 100 tanneries the total water savings per day is 7,80,000 liters of fresh water extraction. Yearly amount of the saved water is 22,46,40,800 liters, yearly saved water = 80,870 no. of people can be hydrated for1 year[25 million liters of water annually - enough water to keep more than 9,000 people hydrated for 1 year according to WHO figures].

The intervention saves around 50% -55% of fresh ground water in the Kolkata leather cluster and helps to reduce the volume of wastewater discharge from the tannery. The reduction in water extraction will have a positive impact on the ground water level and also in the downstream area.

Water Optimizing Mechanism through retrofitting of Solenoid Valves & Limit Switch

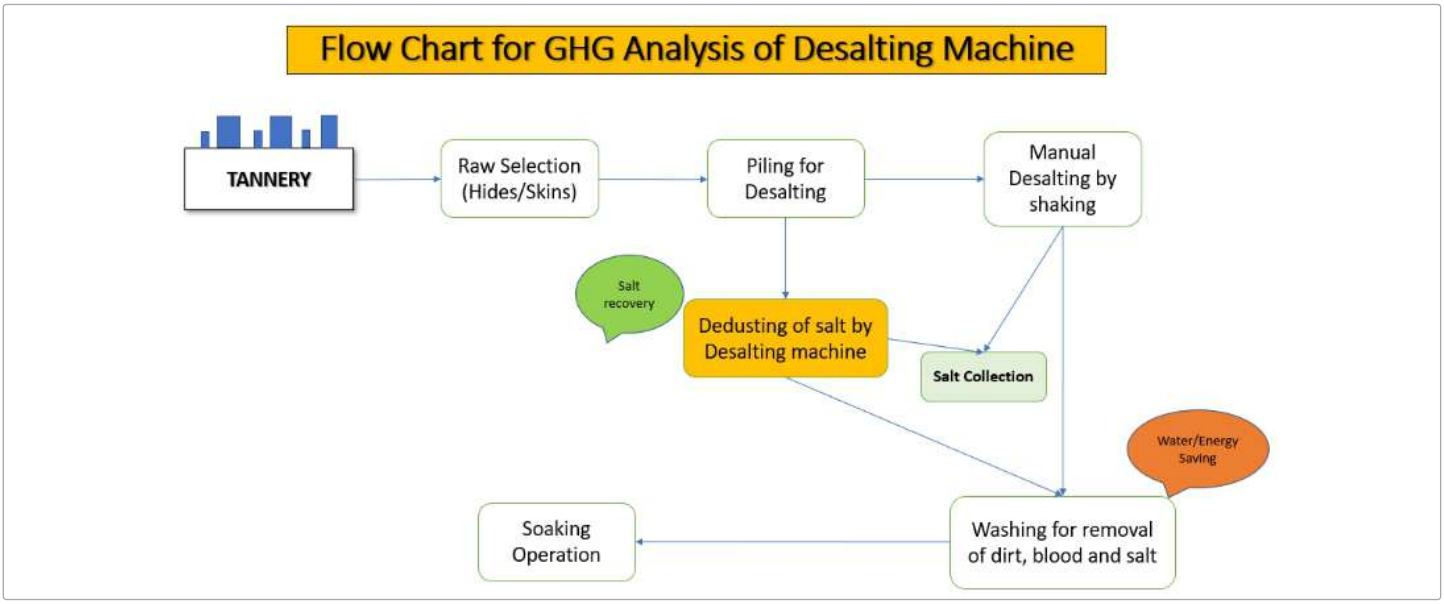
Desalting machine is a comparatively low-cost intervention with respect to other machineries in a general tannery. This system is user friendly and doesn't require much of space in the tannery. Cost of the machine including all the charges is INR 1,20,000 or USD 1500. This machine supports to reduce the water consumption and optimize the running time of paddle (Conserve electricity). The business case of this intervention is calculated in terms of the total water saving cost, that determines the payback period of the investment in 6 months. This intervention has significant effect on carbon footprint reduction. This intervention supports in creating green jobs in the leather supply chain by creating a scope for the local fabricators and manufacturers to develop such machines for water and salt savings.

It is a low-cost intervention and does not have any major investments on maintenance and operations.This system is easy to install on any kind of fleshing machine without significant changes made to the beam house operations. Cost of the valve including installation charges is INR 8500 or USD 107. This isa one-time investment cost for the tannery which helps them to reduce their water consumption around50% of their per day water utilization. The business case of this intervention is calculated in terms of the total water saving cost, that determines the payback period of the investment in 02 months. This intervention will also increase the shelf life of the boring pump installed in the tannery. This intervention supports in creating green jobs in the leather supply chain by creating a scope for the local fabricators and manufacturers to develop such valves for water saving.

Desalting machines can be utilized in other industries like separating rice from paddy, dust remover / cleaning of cars etc. In the leather industry, Solidaridad piloted in only 5 tanneries in Kolkata which scaled up and 50 tanneries are now operating this mechanism regularly and actually observing the benefits coming out of it. In Kanpur -Unnao already 30 tanneries are doing this intervention. Solidaridad is disseminating the results of this activity in the Tamil Nadu leather cluster through consultations, communication material and also demonstrated in few tanneries. Through our programs, we intend to scale up this intervention at pan-India level and bring a sector-wide significant difference in the water consumption of leather industry in dedusting process.

This simple yet effective retrofitting of the fleshing machines by installing solenoid valves is a veryeasily replicable solution. It finds its application in multiple sectors. It





has a large-scale applicability and can be used in industrial, agriculture or domestic sectors. Some of the examples are automatic sprinkler irrigation system, in automated car washing systems, in floor washing machines, in water meters,automated coffee dispenser machines and a lot more. This system can be very effectively used to regulatethe flow of fluids thereby creating wide-scale scope in enhancing water use efficiency. In the leatherindustry itself, Solidaridad piloted this intervention in only 10 tanneries in Kolkata leather cluster which scaledup in a huge manner and 100 tanneries adopted it. In the Kanpur-Unnao, already morethan 120 tanneries have retrofitted their fleshing machines through this intervention. Also, Solidaridad is already disseminating the results of this activity in the Tamil Nadu leather cluster through consultations, communication material, etc. Through our programs, we intend to scale up this intervention at pan-Indialevel and bring a sector-wide significant difference in the water consumption of leather industry infleshing process.

This unique intervention creates a win- win situation for the tanners by enhancing their market competitiveness and also having a positive impact of the environment sustainability by reducing the withdrawal of fresh water. This water optimizing mechanized intervention creates a potential to save 7,80,000 liters if fresh water and desalting machine intervention saves 12,00,000 liters if fresh water withdrawal each day from the ground water. Solenoid valve can contribute to reduce the carbon footprint (Scope 2) by utilizing less water and desalting machine also contributes to reduce carbon footprint (scope 2 + scope 3) effectively.

Contribution towards Sustainable Development Goals Sustainable Development Goals 6 – Increasewater-use efficiency and ensure freshwater supplies - this water optimizing intervention and desalting machine helps to reduce 7,80,000 liters& 12,00,000 liters of fresh water withdrawal every day from the ground water thereby, enhancing the availability of freshwater for other water users in the landscape. Sustainable Development Goals 8 - Enhanced scope of green jobs- our interventions will add to decent work and economic growth. This is done by enhancing a scope for the local fabricators to develop such cost-effective machines that reduces water consumption. Sustainable Development Goals 12 - Sustainable consumption and production process. Through pilot demonstrations of such green technologies and processes, the project has contributed to sustainable management of water resource and responsible management of chemicals and waste. Sustainable Development Goals 13 – Take urgent action to combat climate change and its impacts. Both solenoid and desalting machine reduces the water usage > reduces the running time of the boring pump > minimizes the energy consumes by the pumps > as a result reduces the carbon footprint. Only desalting machine directly cut down the running time of paddle machine by more than 65%.

Desalting mechanism supports to reduce the carbon footprint in both ways – Scope 2 & scope 3. An example of the procedure of capturing the reduction of carbon footprint given below;

In a tannery "A",
They used to process 600 pieces of Jhutia hides every day. In conventional washing/soaking/liming process, they are using 4 no. of paddles for process the whole 600 pieces (150 pieces each) every day.

Conventional process, they are using 3 times of washing to remove the salt/dirt/blood and other unfixed proteinous / non-proteinous matter from the hides/skins.
Paddle capacity of the tannery "A" is 4000 liters (volume).

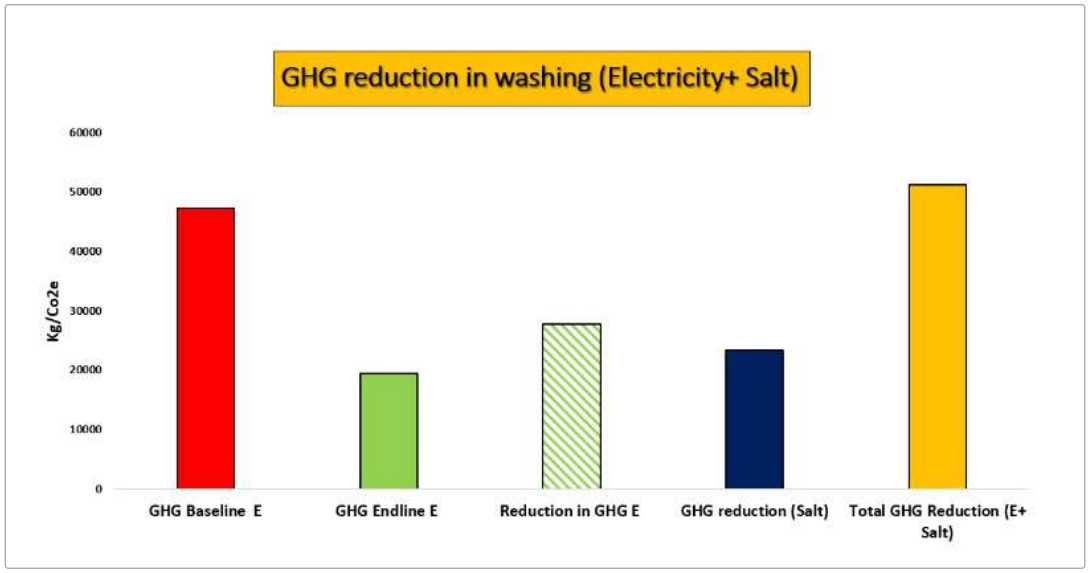
Conventionally to complete the washing for 1 paddle (150 pieces of jhutia hides) it takes (4000 × 3) = 12,000 liters of water.

To complete the washing for 4 lots (600 pieces of jhutia hides), it takes (12,000 × 4) = 36,000 liters / day
To complete the full washing, it takes to run the paddle for 90 minutes for 1 paddle. For 4 paddles, the cumulative running time will be 360 minutes or 6 hours for each day.

For, Kolkata leather complex, working days depend tannery to tannery (20 days to 24 days). Tannery "A"s works 20 days in every month.

In conventional washing process for tannery "A",
Monthly water consumption for washing = (36,000 × 20) = 7,20,000 liters of water,
Yearly the amount will be = (7,20,000 × 12) = 86,40,000 liters of water
Consumption of electrical energy through paddle motor (running time);
In tannery "A", the capacity of the paddle's motor is 10 hp.

The amount of consumed electricity every day by 4 paddles for washing operation is



= [(10 × 6 × 0.746)] = 44.76 kWh,
Monthly the amount will be = 44.76 × 20 = 895.2 kWh
Yearly, it will be = (895.2 × 12) = 10,742.4 kWh
Consumption of electrical energy through the water extraction pump;
In tannery "A", there is 1 pump of 5 hp capacity which helps to extract the water from ground storage to 10,000 liters capacity of an overhead tank in 1 hour time.
So, yearly the pump takes (86,40,000 / 10,000) = 864 hours to extract the required water from ground to overhead tank.

The amount of consumed electricity yearly for extracting water through pump is
= [(5 × 864 × 0.746)] = 3,222.7 kWh
Yearly for tannery "A",
the total electrical consumption for washing operation is
= (10,742.4 kWh + 3,222.7 kWh) = 13,965.1 kWh
In conventional system of washing,
The total amount of carbon footprint produced;
=Input value (in kWh/Year) × 0.91 (Emission Factor)
= (13,965.1 × 0.91) = 12,708.2 Kg / CO2e.

After installing brush type semi-automatic Desalting mechanism, the total washing process reduced to 1 time only for each paddle.

1. **No. of washing cut down to 1 time from 3 times,**
2. **Washing time also reduced to 30 minutes only.**

After Solidaridad intervention, to complete the washing for 1 paddle (150 pieces of jhutia hides) it takes 4000 liters of water.

To complete the washing for 4 lots (600 pieces of jhutia hides), it takes (4,000 × 4) = 16,000 liters / day

To complete the full washing, it takes to run the paddle for 30 minutes for 1 paddle. For 4 paddles, the cumulative running time will be 120 minutes or 2 hours for each day.

After Solidaridad intervention, washing process for tannery "A",
Monthly water consumption for washing = (16,000 × 20) = 3,20,000 liters of water,
Yearly the amount will be = (3,20,000 × 12) = 38,40,000 liters of water
Consumption of electrical energy through paddle motor (running time);
In tannery "A", the capacity of the paddle's motor is 10 hp.
The amount of consumed electricity every day by 4 paddles for washing operation is
= [(10 × 2 × 0.746)] = 14.92 kWh
Monthly the amount will be = 14.92 × 20 = 298.4 kWh
Yearly, it will be = (298.4 × 12) = 3,580.8 kWh
Consumption of electrical energy through the water extraction pump;

In tannery "A", there is 1 pump of 5 hp capacity which helps to extract the water from ground storage to 10,000 liters capacity of an overhead tank in 1 hour time.
So, yearly the pump takes (38,40,000 / 10,000) = 384 hours to extract the required water from ground to overhead tank.
The amount of consumed electricity yearly for extracting water through pump is
= [(5 × 384 × 0.746)] = 1,432.32 kWh
Yearly for tannery "A",
the total electrical consumption for washing operation is
= (3,580.8 kWh + 1,432.32 kWh) = 5,013.12 kWh
In conventional system of washing,
The total amount of carbon footprint produced;
=Input value (in kWh/Year) × 0.91 (Emission Factor)
= (5,013.12 × 0.91) = 4,561.93 Kg / CO_2e
After Solidaridad's intervention in washing operation, the overall reduction of carbon footprint is
= (12,708.2 Kg / CO_2e - 4,561.93 Kg / CO_2e)
= 8,146.27 Kg / CO_2e

ABOUT THE AUTHOR

Dipayan Adhikary *is currently working with Solidaridad. He is B.Tech in Leather Technology from GCELT. He has done MBA in Supply Chain Management from NMIMS. He has previously worked as Assistant Manager, Buckman, Thailand. Over all he has 6 years of experience in leather research and development.*

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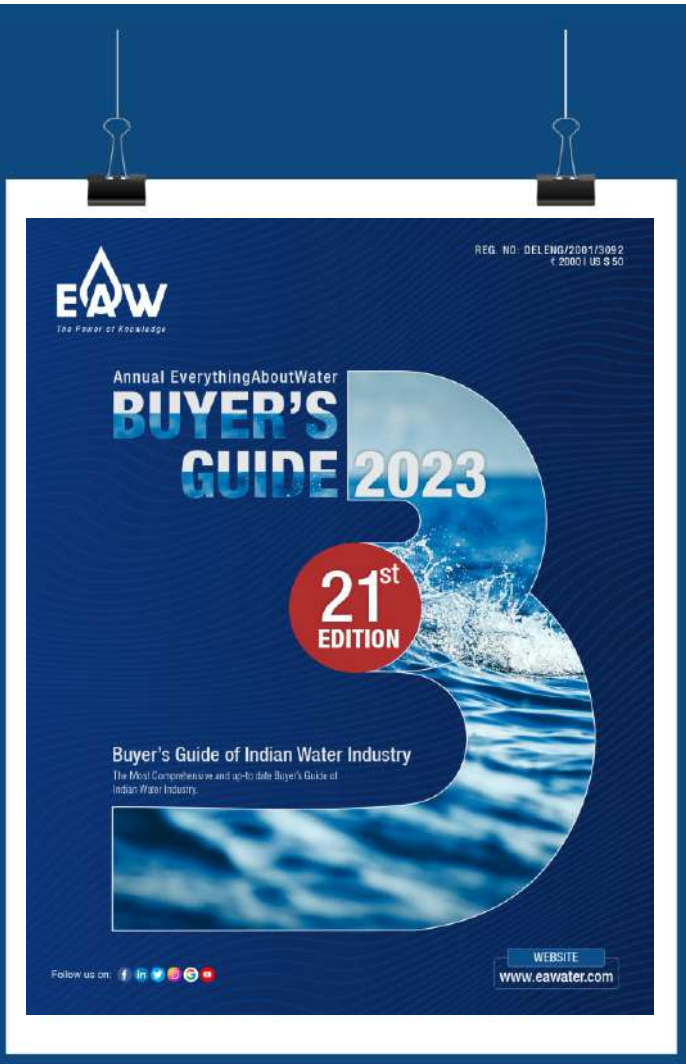
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HOW PAPER MILLS ARE IMPROVING THEIR EFFLUENT TREATMENT BY FOCUSING ON BIOLOGY

By Sanjay Bahl, General Manager, Superweld Ecosolutions



This case study details how India's leading Paper mills are improving their effluent treatment by focusing on biological wastewater treatment, despite having supporting infrastructure.

What Were the Original Conditions?

1. Low dissolved oxygen in aeration tanks: Surface aerators installed were unable to improve D.O. Demand for dissolved oxygen was high due to high BOD, and COD load. Dissolved oxygen would range from 0. 6-to 0.9ppm in the aeration tank and a lot of odours were getting generated.

2. Poor Settleability: Activated sludge in aeration tanks was bulking, very little settle ability was observed, and frequent foaming was being observed.

3. High-Temperature Shocks: Due to the high temperature of wastewater from the paper machine, the existing biology was stressed. microbes need a narrow temperature range of 31-38 deg Celsius to work optimally.

4. Lesser MLVSS: Indicating low microbial growth, due to the above factors microbial washout was certain and there were just not enough biomass to degrade the COD and BOD.

What Steps Were Taken to Improve the Biology?

1. For low Dissolved oxygen: Regular dosing of specialized bio inputs was done to improve dissolved oxygen levels, these bio inputs are formulated from perborates and peroxides.

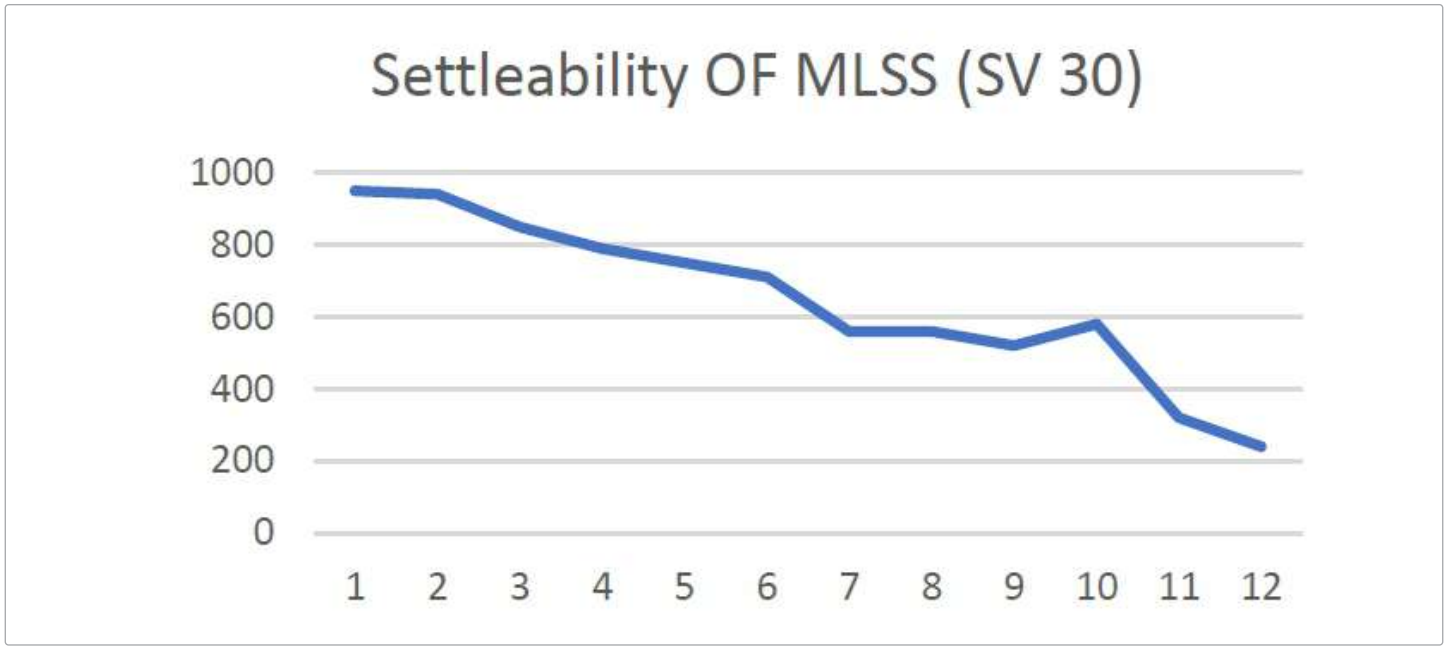
2. For High-Temperature: Adjustment of water flow and operations under expert guidance ensured inlet water temperature not go beyond 35 Deg Celsius.

3. For improving settle ability:
A) Low DO and well settling floc forming microbes were regularly administered in the aeration inlet.
B) Micronutrient addition was also done to improve biomass growth under the high-stress conditions.

What Benefits Were Achieved?

1. Increase in D.O. level by 25%
From the very first day of dosing oxygen-releasing bio inputs, D.O. levels jumped up. This one factor alone becomes a critical improvement because higher DO develops more forms of higher bacteria that digest COD and settle well.
2. Increase in Sludge settle ability





Sludge settle ability improved from 900ml/L to 550ml/L within a matter of 10 days.

3. Improve the ETP outlet effluent TSS
COD levels below 250mg/L and TSS below 40mg/L were observed at the secondary outlet.

4. Colour Reduction in ETP outlet effluent.

5. Increase MLVSS by 15%

Conclusion

The biology of any wastewater plant is one of the most economical tools available to treat wastewater. But given the delicate Microbial Chemistry Expert Guidance in Operations and Nutritional Support for Microbes becomes important. The Use of Oxygen-Releasing Nano Inputs has many benefits in wastewater like an increase in bioactivity, suppression of unproductive filamentous microbes, odour control, and keeping sludge settled for a longer time in clarifiers/ tube settlers.



ABOUT THE AUTHOR

Sanjay Bahl *helps businesses and their leaders by providing eco-logical solutions for pollution control and waste management problems. At Superweld Eco-Solutions, they create innovative products to treat wastewater, malodours, solid waste, algae treatment, and lake and pond remediation. Sanjay has helped clients like Paper Mills, Pharma Companies, Hospitality Industry, and Food and Beverage Industries to Meet Stringent Wastewater Discharge Parameters.*

A Post Graduate of Symbiosis College, Sanjay, and his team act as technical advisors and trouble shooters to 900+ clients. They help companies like CETPS, Dairy, companies improve their biological wastewater treatment, and he strongly believes Indian biotechnology is among the best in the world. Along With His Passion for Transforming the Course of Companies, He Likes to Read About the Latest Technologies and Does Social Work in His Free Time.

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**

POND LINER OF HDPE GEOMEMBRANE FOR INDUSTRIAL WATER RESERVOIR

By Kantappa Halake; Sr. Manager – R&D, Sanjay Sharma; Director Operation and Gaurav Jain; Director, Megaplast India Pvt Ltd



Key words: Geomembranes, barrier, pond liner, polyethylene, blown extrusion

Abstract

The barrier liners for gas and fluid impounding from various applications are made from polyolefins. The polymer includes polyethylene (PE), polypropylene (PP), polyvinyl chlorides (PVC) and their derivatives are commonly used worldwide. The PE materials of different types based on density are selected to change the properties of geomembrane. Being a mechanically tough material, the High-density polyethylene (HDPE) geomembranes are often preferred for hazardous waste landfills, water conservation, waste ponds, etc. The thermal and oxidative degradation of the base polymer changing the morphological structure and service life of the polymer. This case study analysed the final condition of an exhumed HDPE geomembrane sample that was 1.5 mm thick for industrial water storage in Bal Krishna Industries, Bhuj, Gujarat. The sample was collected after 7 years of service in the slope area of water pond. The sample was continuing in field exposure of stored water. The laboratory evaluation was performed based on physical and thermo analytical performances according to global standard of GRI-GM13. GRI standards are mainly based on the ASTM specifications. The reduced minutes of OIT demonstrated that the depletion of antioxidants has been occured. Still major amounts of antioxidants are remained to depletion during its service life. The carbon black is in the range of required standard.

1. Introduction and Sampling of Exhumed Membrane

The geomembranes are very low permeable liners used to control the liquid or gas migration in human made projects. For many decades, it has been envisaged that petrochemical based material typically PE of different grades are major starting materials to manufacture geomembrane (1,2). Due to the low cost, the uses of geomembrane(PE-liners) for storage of liquid and industrial residues is wide spread relative to other liner materials. The typical geomembranes are manufactured through blown-film extrusion process with standard comply of geosynthetic institutes, GRI-GM13 and GRI-GM17 for HDPE and LDPE polymers respectively. The Geosynthetic Research Institute (GRI) specifications constitute the world's most stringent set of minimum technical requirements. The technical standards are completely based on the standard specifications from ASTM certifications (1,2,3).

The various types of PE liners for demanding applications in the areas includes, mining, any landfill to petrochemical, agricultures, aquaculture, oil, and gas industries, etc are available in the global market. A state-of-the-art multilayer blown extrusion process has accommodated to produce the liner with maximum 8-meterwide in the roll form. The geomembrane product categories have variations such as in thickness, colour, surface textures and flexibility. The final products are globally recognised through as standard specification from GRI. The specifications are measured with well calibrated equipment and testing conditions provided in ASTM standards. The high barrier film of seven layered liner have its barrier properties is in very lower limit called ultra-barrier films. The barrier limitations can be controlled varying the proper layer percentages and materials compositions and types. These are basically depending on what kind of barrier requirement for commercial applications (3,4).

The present case study focused on the exhumed HDPE geomembrane liner from industrial water reservoir. The 40KL water reservoir was installed at Balkrishna Tyre Industries (BKT) Bhuj, Gujarat for industrial applications. This membrane is utilised as flow barrier of reserved water and the actual picture of pond is shown in Fig. 1.

The pond was installed in June 2016 with seeking the advantages of HDPE liners such as zero water exchange, erosion control of earth and controlled loss of stored water from the reservoir. The sample is collected from the slope area and which was continuous in contact



Fig. 1 : 40KL industrial water reservoirs pond using HDPE liner

with stored water for the time span of 7 years.

Usually, the exposure of HDPE membrane causes thermal and oxidative-degradation which may initiate further and propagates the deterioration process with respect to the time. Many active additives are playing superior role to overcome deterioration of properties. The active additives are mixed during extrusion process in the form of master batches. The additives usually delayed and inhibits the process of deteriorations and benefits to increase the service life for geomembrane.

The thermo analytical and physical analyses were used to understand the conditions of exhumed sample. The physical and other thermoanalytical tested parameters are shown in Table 1.

Table 2. Physical and Thermo analytical test of Exhumed sample with minimum required standard GRI-GM13

PARAMETERS	UoM	GRI-GM13	EXHUMED SAMPLE, 7YRS
PHYSICAL PROPERTIES			
Thickness	mm	1.5	1.518
Density	g/cc	≤ 0.940	0.952
CBC	%	2.0-3.0	2.47
MFI	g/10 min	-	0.1434
THERMAL PROPERTIES			
Tm	°C	-	128
Tc	°C	-	114
Std-OIT	min	100	87
HP-OIT	min	400	245

2. Results and conclusions

2.1 Physical evaluations

The Table 1 shows the physical test results of exhumed sample and the American standard's minimum required values for the reference. The standard GRI-GM13 is a global standard for HDPE geomembrane minimum specification for the manufacturing and quality assurance. The sample analyzed presented an average thickness and calculated density value higher than the nominal thickness and density. The calculated carbon black content (CBC) is in the rage of required minimum standard. This indicates the improving in density of HDPE. The similar results also obtained in literature with lower in MFI (4). The MFI of exhumed sample is 0.14 g/10 min.

2.2 Thermoanalytical evaluations

The DSC evaluation as standard-OIT and HP-OIT demonstrated that the depletion of antioxidant in test temperature of 200°C. The resulted values of 87 mins and 245 mins for Std-OIT and HP-OIT respectively are lower than required values which indicates the depletion of antioxidants. These lower numbers of OIT 87 min and 245 mins also indicated the added antioxidants still remained in the sample to deplete further. The thermal behavior of exhumed sample is illustration in Fig. 2 shows the heating and cooling curves.

The thermogram indicates the gradual heating and cooling profiles. The melting curve shows board peak which starts from temperature 87.49 °C to for melting phenomenon. The baseline change of the curve indicates a tendency of soften the materials due to the continuous increase in temperature until it reaches the melting point of 128.38 °C. Then after, the sample was cooled with temperature rate (shows in cooling curve), materials start crystallization at 118.12 °C and complete the crystallization occurred at 114.39 °C. In both melting and crystallization points, its

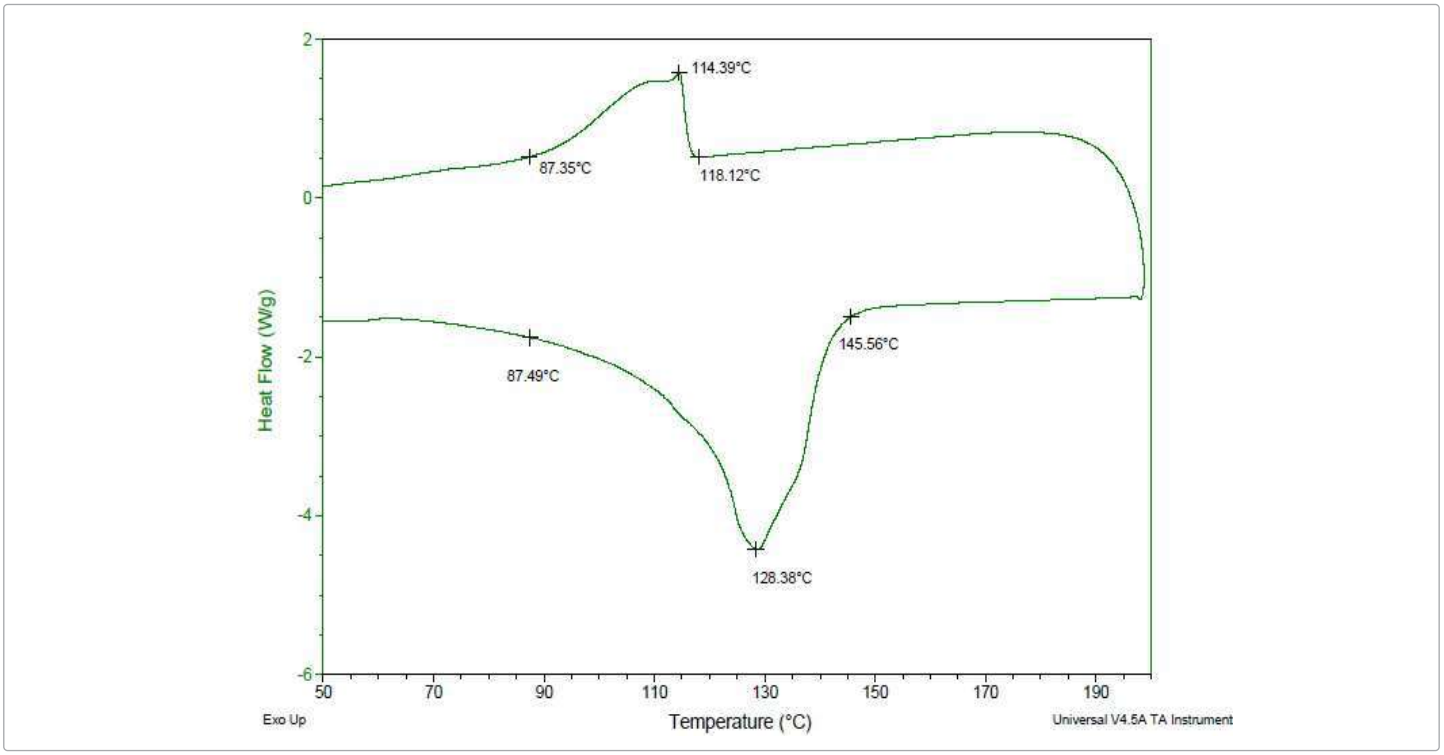


Fig. 2 : DSC melting and crystallization curves of exhumed liner sample

observed that there is an indication of overlapped reactions which is attributed to the presence of foreign impurities in the material.

3. Conclusions

The higher value of sample density and thickens for exhumed sample is related to the crystallinity. During the aging and service time molecular chains were relaxed and aligned more properly. The reduction in number of minutes for OIT study (std-OIT value of 87 min and HP-OIT values 245 min) indicates the antioxidant depletions. This indicated still enough amounts of antioxidants are available for duplication. The standard evaluation as per the GRI-GRM13 this material is qualified for further services. Therefore, the analyzed HDPE exhumed geomembrane showed changes in its properties due to aging mechanisms and the waste contact at the site. For future studies, its recommended to obtain and characterize liner exhumed sample with time and compare with virgin sample with predetermined times. Always the multiple test reading with time will give clear understanding with proper quantification of properties.

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ABOUT THE AUTHOR

Dr. Kantappa Halake is the Sr. Manager- R&D, Megaplast India Pvt. Ltd.

Mr. Kantappa Halake has completed his M.Sc. degree in polymer chemistry and has worked in National Chemical Laboratory as Project Assistant between Nov.2006 and Aug.2010. Here he supported the projects sponsored by multinational companies. Then-after, he joined in Chung-Ang University, Seoul, South Korea for PhD in polymer engineering and materials science and earned PhD degree 2015. Subsequently, he continued to work in there as non-tenure track assistant professor (4 years) and was promoted to associated professor (6 months). In 2019, he shifted to Cosmo Films Ltd (Now renamed to Cosmo First Ltd) to start his carrier in industry and he is looking after new product development towards sustainable solutions for environment.

*Presently, Mr. Kantappa working in Megaplast India Pvt Ltd, and looking new development in multi-layered film manufactured by blow process technology. Multi-layered products of geomembrane include the barrier, high barrier for various gasses, agri-films, etc are developing based on polyolefins for various applications from agriculture, construction, mining and many more applications. Overall Mr. Kantappa is looking for all the technical aspects of materials science for future developments in geomembranes. His overall research experiences are highlighted in 11 peer reviewed articles published in international journals in the area of polymers and polymer-structure property relationship. He has also presented his work in 20 national/international conferences from India, south Korea, and USA and two of them are honoured as, "**Best Paper Presentations.**"*

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4 DECADES' EXPERIENCE OF M/s GNFC TOWARDS COOLING WATER TREATMENT & MANAGEMENT

By Dr. Rakesh Farasram, Chief Manager & Jaysukh Sardhara, Manager, GNFC Ltd.

Recirculating cooling water (CW) systems in industries are meant to dissipate heat from industrial process systems with Water as a heat transfer medium. During the course of heat exchange, the ions of cooling water concentrate into many folds. The concentration of ions in water often lead to problems like corrosion, scale, microbiological fouling, foam etc.

Corrosion Control: Corrosion is controlled by maintaining pH of cooling water on slightly alkaline side and ensuring thorough passivation layer of corrosion inhibitors on the metallurgy of equipments.

Scale Control: Scale formation can be controlled by one or more of the following strategies :

1. Limit the concentration of critical ions
2. Dosing of acid to remove carbonates and bicarbonates through their conversion into CO_2. Carbonate level control restricts water's potential for calcium carbonate formation.
3. Alter system design or operation - increase water velocity, air rumbling in heat exchanger inlet water to dislodge and remove scales and deposits, modify design of exchangers, metallurgical change etc.
4. Apply chemical deposit inhibitors.

Medium and large cooling towers (CT) are treated with both scale inhibitors and corrosion inhibitors. Additionally, oxidizing and non-oxidizing biocides are dozed for microbiological control.

This paper aims to appraise reader about operating experience of M/s Gujarat Narmada Valley Fertilizers & Chemicals Ltd (GNFC), Bharuch, Gujarat, India towards operation and management of many Cooling Water Systems during last >40 years. The case study also presents various problems, difficulties, remedies as well as technological developments in the light of CW analytical data of last 5 years.

COOLING WATER SYSTEMS AT GNFC :

The fertilizer plants were commissioned in year 1981 for which there were 2 open recirculating cooling water systems. (Figure)

Subsequently, GNFC expanded in the fields of fertilizers and chemicals by putting new manufacturing plants for which new CW systems were added. During the course of this journey, capacity of many cooling towers has been enhanced for increased production of on-going products. Presently, GNFC has been operating 14 CW systems at its Bharuch location and 2 at its Dahej location. The operating criteria of CW systems at Bharuch is given in below Table 1.

The raw water for industrial use is drawn from Narmada and Tapi rivers. After treatment for removal of turbidity, organic matter and microbial load, the resulting water is used for make-up requirements. Typical quality of make up water is given in Table 2.

Cooling Water Treatment adopted at GNFC :

In the very initial years of GNFC's start-up, there was very limited knowledge about the severity of the problems and remedial measures. Therefore, CW treatment at GNFC began with package

Table 1. Design / Operating data of 14 CW systems at Bharuch

COOLING TOWER	RECIRCULATION RATE (M^3/hr)	SUMP VOLUME (M^3)	NO OF CELLS	MAKE UP RATE (M^3/hr)	BLOW DOWN RATE (M^3/hr)
CT-1	35,000	12,000	12	650	130
CT-2	9,300	2,500	5	172	34
CT-3	10,500	2,500	4	213	43
CT-4	500	40	2	8	1.5
CT-5	4,000	1,200	3	71	14
CT-6	2,500	1,000	2	45	9
CT-7	2,500	580	2	42	8.5
CT-8	860	225	3	13	2.5
CT-9	7,000	2,000	5	96	15
CT-10	1,800	400	4	18	3
CT-11	3,300	600	5	50	10
CT-12	2,500	530	3	36	7
CT-13	7,000	1,850	4	182	36
CT-14	5,400	1,000	5	51	7

treatment program provided by an overseas water treatment expert company. During these initial years, GNFC faced some glitches in performance of CW systems. With establishment of GNFC's manufacturing plants, there was thrust on increasing knowledge base among GNFC people for cooling water treatment. Many books were referred for the subject by young people backed by top management team. Also, during period of 1982 – 87, many Indian water treatment companies developed themselves. With acquired knowledge base and support of Indian water treatment companies, GNFC switched to in-house CW treatment program based on Poly Phosphate, Organo Phosphonate, Zinc, Polymeric Dispersant, Sulfuric acid and Chlorine gas. These chemicals were dosed individually and their levels in recirculating water were checked on a daily basis. For effective administration of dosing, GNFC formulated its own single liquid formulation after a few years. The monitoring of dosing became an easier task with single formulation.

GNFC continued in-house treatment for almost 15 years. By that time, there was flooding of specialized water treatment expert companies in India. They not only provided treatment programs but also took care of monitoring with guaranteed performance at a lower cost than in-house treatment. In view of techno-economic advantages, GNFC took a step-wise leap towards handing over CW treatment to third party expert companies one system after the another. Presently, 14 CW systems at Bharuch complex are handled by third party with GNFC's own supervision and control on dosing of chemicals for more than last 2 decades.

During > 40 years of operation of various CW systems for fertilizer, power, chemical and petrochemical plants, GNFC has never faced major down-time on account of problem in CW system. By keeping a close eye on maintenance of desired water chemistry, levels of inhibitors and bio growth through own Laboratory and Independent Cooling Tower Cell, GNFC has sustained highest possible production levels without hurdles on cooling tower side. It is the purpose of this article to appraise reader about the long-standing operating experience of GNFC in this field.

Overall treatment philosophy :

All throughout these years, GNFC has continued with conventional treatment



program based on Phosphates – Zinc – Polymer in conjugation with Chlorine as oxidizing biocide and a few non-oxidizing biocides. The treatment chemicals are selected by Cooling Water Cell, Technical Services and Laboratory Depts. CW cell takes care on inventory of the treatment chemicals. On the recommendation of CW cell, the chemicals are procured by Material Management Dept. Upon receipt of supply at Stores Dept, all products undergo quality control tests at GNFC's own laboratory. If a chemical is found to meet with agreed specifications, it is cleared by Laboratory and issued to Plants for use by Stores Dept. The chemicals not meeting PO specifications stand rejected.

Corrosion & Scale Control :

The chemicals used are sources of following ingredients :

- Blend of zinc and ortho phosphate

Table 2. Make Up Water Quality

PARAMETER	UNIT	VALUE
pH	-	7.0 – 7.5
Conductivity	Micro mhos / cm	250 - 300
Alkalinity as $CaCO_3$	ppm	100 - 120
Total Hardness as $CaCO_3$	ppm	90 - 130
Turbidity	NTU	1 - 2
Total Dissolved Solids	ppm	150 - 200
Chlorides as Cl	ppm	15 - 25
Soluble Silica as SiO_2	ppm	15 – 20
Aluminium as Al	ppm	0.1 – 0.2
Viable Bacterial Count	Number / ml	< 100
Sulphate Reducing Bacteria	MPN / 100 ml	< 10
Sulphate as SO_4	ppm	15 - 20
Calcium as $CaCO_3$	ppm	50 - 70
Organo phosphate as PO_4	ppm	40 - 60
Magnesium as $CaCO_3$	ppm	0.1 – 0.2
Ortho Phosphate as PO_4	ppm	BDL
Zinc as Zn	ppm	< 0.1



- Polymeric dispersant
- Organo phosphonate
- Sulfuric acid

Microbial Control :

Oxidizing biocides :
- Chlorine gas
- Chlorine dioxide
- Bromine release compound (for specific CT)

Non-Oxidizing biocides : To avoid immunity development, following 3 types of non-oxidizing biocides are dosed as a shock treatment, when Chlorine and Chlorine Dioxide are not found effective.
- Quaternary Ammonium compound
- Dichlorophene
- Thiocarbamate

A bio-dispersant is continuously maintained in CW to prevent colonization of the microbes.

Monitoring of cooling water chemistry and key indicators :

GNFC has cautiously fixed desired levels of various ions in consultation with experts (Table 3) so as to minimize chances of corrosion and scale formation.

For appropriate monitoring of CW chemistry, GNFC Lab carries out exhaustive analysis of all the cooling waters at a frequency given below :

- pH and residual chlorine analysis on 2 or 4 hourly bases
- Daily analysis of inhibitor concentration
- Complete analysis of all cooling waters twice or thrice in a week
- Total viable bacterial count once every week
- Sulphate reducing bacteria count once in a fortnight
- Corrosion rate measurement through placement of Mild Steel & Stainless-Steel coupons once every month at CW supply header, CW return header and CT basin. (Figure)
- Calculation of Cycles of Concentration on weekly and monthly basis to check adherence to desired COC.

Experience vis a vis CW analytical data of last 5 years :

The yearly average analytical data of last 5 years (2017 – 2021) are presented in Tables 4(a), 4(b) and 5. Parameter-wise discussion along with difficulties & challenges faced during operation are discussed hereunder along with remedial actions taken.

pH : Data show that pH of all 14 CTs have been maintained well within limits. Periodical monitoring by Laboratory and online pH meters combined with timely actions pertaining to start & stop of sulfuric acid dosing are being done well. Maintenance of adequate pH has helped GNFC in avoiding CW to be either corrosive or scale-forming.

Chloride : Against desired level of 250 ppm, Chloride levels in all CTs during last 4 of total 5 years were maintained < 275-280 ppm, which indicates that due attention is given for avoiding chances of stress corrosion caused by chlorides. For restricting chloride levels, chlorination is reduced at occasion and non-oxidizing biocides are

Table 3. Desired water chemistry of CW

PARAMETER	UNIT	VALUE
pH	-	6.8 – 7.5
Conductivity	Micro mhos / cm	2,000 max
Total Hardness as $CaCO_3$	ppm	800 max
Turbidity	NTU	15 max
Chlorides as Cl	ppm	250 max
Soluble Silica as SiO_2	ppm	125 max
Residual chlorine	ppm	0.2 – 0.5
Ortho Phosphate as PO_4	ppm	5 - 6
Total Phosphate as PO_4	ppm	10 - 12
Zinc as Zn	ppm	0.5 – 1.0
Iron as Fe	ppm	1 max
Organo phosphate as PO_4	ppm	0.3 – 0.6
Corrosion rate	mpy	3 max
Organo phosphate as PO_4	Number / ml	< 1,00,000
Corrosion rate	MPN / 100 ml	< 150

dosed. Enough blow down of CW is also done to attain chloride level <250 ppm.

In year 2018, yearly average chloride level in all CTs is found around 500 ppm. The reason towards this continuous abnormality was contamination of river water source by sea water. Due to low flow in river on account of a dam constructed in its up-stream, there were occasions of heavy ingress of sea water due to high tide of sea, which is 40 km far from water source. This tidal effect had contributed chloride levels of upto 200–250 ppm from usual value of 15-20 ppm in the river water. The impact of tidal effect was so high that heavy blow down of CW, bringing COC down from 5-6 to 1-2, was also not sufficient to achieve chloride level of <250 ppm.

To combat the situation, Molybdate and Pyro Phosphate inhibitors along with high-power stress polymeric dispersant were additionally dosed in CTs to operate CTs at elevated chloride level. With continuous watch on the performance of heat exchangers, the limit of Chloride was raised up to 500 ppm. Subsequent plant shut down did not show signs of much deterioration on heat exchanger surface, which indicated that modified treatment program had performed well. It also provided boost to combat tidal effect in future using enhanced CW treatment program. Fortunately, GNFC did not have to face issue of high chloride in make-up water thereafter due to several other actions towards drawl of river water.

Ortho Phosphate : Data indicate that adequate levels of treatment chemicals were maintained all throughout in all CTs. Laboratory monitoring of CW chemistry followed by appropriate dosing actions have been key factors in proper management of treatment program at GNFC.

It is noticed for CT-10 in year 2019 that average ortho phosphate level was only 0.3 ppm against desired level of 5-6 ppm. This is due to adoption of a non-chemical treatment program based on ultra-low frequency electromagnetic waves. This program energises water molecules and other constituents in such a way that hard scales do not form. Due to process leaks and other typical observations in cooling towers of process plants, these treatments were supplemented with chemicals for some period of time. Long standing experience for these novel treatment programs could not be built due to other process related reasons.

Residual Chlorine : The average residual chlorine levels in various CWs are around 0.5-0.7 ppm. The dosing of chlorine gas is done intermittently in such a way that residual of around 0.5 ppm is maintained. Usually, there are some occasions of around 1.0-1.5 ppm level and some occasions of NIL level. Overall, desired level is maintained.

In CT-12, the level is found below 0.1 ppm in few years. This is due to small size CT and inconsistency in dosing, when chlorine gas was directly fed from chlorine tonner into CT basin. There were incidences of either no residual chlorine or very high level of residual chlorine. Such inconsistencies are addressed by installing a system to generate chlorine-rich water and its charging at low rate into CTs.

Hardness : The concentration of hardness causing cations like Calcium and Magnesium is required to be restricted as Calcium can precipitate in the system as $CaCO_3$ and Magnesium can lead to hard magnesium silicate scales. GNFC has, therefore, allowed CT operation at maximum total hardness level of 800 ppm. Whenever this level crosses much beyond 850 ppm, adequate bleed off is done from CT basin till total hardness falls below 800 ppm. Data in Table 4(a) indicate that GNFC has hardly faced any challenge in maintenance of hardness level.

Other important parameters : GNFC has fixed upper limit of 12 ppm for total phosphate level to restrict phosphate sludge in heat exchangers. Zinc levels are adequately maintained at 0.3-0.5 ppm. Iron pick up is continuously watched and it is seen that it has remained 0.1-0.2 ppm in almost all CTs during the 5 years period. Little high Fe level in CT-14 is on account of metallurgy of equipments. GNFC's constant vigilance towards maintaining adequate levels of treatment chemicals and restricting trouble causing ions below specified limits is visualized in the annual analytical data of 5 years.

Bio growth : As presented in Table 5, the bio growth is monitored by 2 means, Total Viable Bacterial Count (TVC) and Sulphate Reducing Bacteria (SRB) count. Fairly low level of TVC than specified level is by virtue of constant vigilance on residual chlorine level, physical inspection of CT wooden parts and regular dosing of non-oxidizing biocides. As a result of vigilance, the SRB counts are also remaining <100 in yearly average figures. SRBs, at occasions in some CTs, are found in thousands, but immediate actions of increasing chlorine dosing or biocide dosing help GNFC in keeping annual average below 100.

Table 4 (a). Yearly average analytical data of concentrations of ions in 14 CTs during years 2017 – 2021

COOLING TOWER	pH (7.0 - 7.5)					Total Hardness as $CaCO_3$ (800 ppm max)					Chloride as Cl (250 ppm max)					Iron as Fe (1 ppm max)				
YEAR →	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
CT-1	7.20	7.30	7.22	7.23	7.20	725	568	730	547	638	282	483	179	174	226	0.13	0.13	0.15	0.15	0.13
CT-2	7.05	7.08	7.07	7.05	7.07	642	667	682	591	624	271	456	205	214	253	0.17	0.13	0.15	0.18	0.14
CT-3	7.25	7.32	7.38	7.36	7.28	720	689	735	784	740	227	398	197	202	202	0.11	0.16	0.19	0.22	0.14
CT-4	7.37	7.47	7.55	7.44	7.58	650	557	627	575	609	202	402	133	131	133	0.10	0.17	0.12	0.14	0.19
CT-5	7.17	7.17	7.21	7.12	7.56	707	578	668	778	762	256	441	206	236	211	0.11	0.34	0.11	0.10	0.16
CT-6	7.16	7.18	7.19	7.17	7.56	729	610	695	790	782	267	442	215	236	215	0.11	0.12	0.10	0.11	0.11
CT-7	7.29	7.30	7.23	7.12	7.17	737	603	446	663	754	231	532	91	224	212	0.11	0.14	0.10	0.12	0.14
CT-8	7.24	8.14	7.29	7.31	7.41	733	594	692	699	740	267	455	195	238	242	0.11	0.11	0.10	0.10	0.11
CT-9	7.32	7.39	7.28	7.29	7.29	741	631	758	772	656	255	487	245	256	196	0.15	0.17	0.17	0.14	0.13
CT-10	7.35	7.51	7.42	7.30	7.38	722	556	724	642	689	263	402	194	273	226	0.11	0.11	0.10	0.11	0.12
CT-11	7.27	7.32	7.16	7.27	7.25	720	621	741	858	821	277	470	212	232	234	0.13	0.19	0.14	0.14	0.13
CT-12	7.18	7.78	7.22	7.14	7.18	746	628	739	824	782	280	544	206	221	213	0.15	0.23	0.18	0.17	0.17
CT-13	7.13	7.37	7.19	7.36	7.25	763	612	773	793	738	269	456	172	209	186	0.16	0.15	0.14	0.11	0.13
CT-14	7.09	7.20	7.12	7.04	7.27	665	555	699	802	771	205	458	240	260	251	0.31	0.28	0.31	0.22	0.39

Corrosion Rate : As described above, the corrosion rate is measured by placing MS corrosion coupons in various headers of CT every month. The data presented in Table 5 are annual average of the monthly corrosion rate. Against desired limit of 3 mpy, it can be seen that corrosion rate has remained <1 mpy in all CTs except a few exceptions.

In CT-8, CT-10 and CT-12, the corrosion rate in years 2018 and 2019 is found high than desired limit. This is due to adoption of non-chemical water treatment program in these 3 CTs. The philosophy of non-chemical treatment is based on electromagnetic waves to alter ionic structure that prevents hard scale formation. This philosophy does not permit cleaning of metal surface on monthly basis. Therefore, the technology supplier had desired discontinuation of corrosion rate measurement, but GNFC had continued its practice of corrosion monitoring to build its own experience. After 2019, GNFC switched back to chemical treatment due to its own factors. After switching over, the corrosion rate in these CTs has come down to <1 mpy.

Physical observation of heat exchangers

Apart from close monitoring of CW chemistry on regular basis, GNFC has also adopted a practice of observing physical condition of the heat exchangers in presence of water treatment expert company, respective plant in-charge, Maintenance dept, CT cell and Laboratory during each annual turn-around of plants. Photographs are taken for future comparison and observations are recorded. Samples of scale, sludge, fouling material are collected and analysed by Laboratory. Water jet cleaning of exchanger tubes and sulfamic acid cleaning, when necessary, is done till iron pick up comes to a stable level. Detailed analysis of collected samples is done to investigate performance of the treatment program.

Scale / sludge analysis

The collected samples from CT basins, exchanger tube surfaces, exchanger domes etc are thoroughly analysed for various metal oxides in Laboratory. To identify the organic or inorganic nature of sludge, Loss on Ignition at different elevated temperatures is determined. The detailed analysis helps in deriving clues about corrosion, scale formation, metal pick up, phosphate deposition etc. Required changes in chemical treatment are done based on chemical analysis and physical observation of exchangers.

Cycles of concentration (coc)

Very high emphasis is given on conservation of water as it is a precious and scarce natural resource. To save as much water as possible, GNFC has been operating cooling towers at higher COC. High COC operation serves dual purposes of (i) water conservation and (ii) lowering down treatment cost. Commencing with 3-4 cycles of concentration in initial years, GNFC has reached to 5-6 cycles of concentration without much adverse effects. Due to constant vigilance by various departments, all CTs are successfully operated at 5-7 COC. In view of limited economic benefit Vs risks involved in operating CTs at >7 COC, GNFC has targeted operation at 6 COC.

Conclusion

Though CW treatment and management is a complex subject which needs to be tactfully handled, GNFC has been successfully handling all aspects of CT operation, due to which there has not been any down-time of the manufacturing plants on account of CW. GNFC is conscious about adequate attention towards CW management because the best available treatment program is also likely to fail in fulfilling the expectations, if proper and timely actions are not taken. Close coordination among Process Plant, CT cell and Laboratory on day-to-day basis has proven effective in deriving optimum efficiency of CW systems in GNFC.

Acknowledgement :

The motivation and permission provided by the management of GNFC Ltd for publishing the case study is gratefully acknowledged. The authors are also indebted to Dr Mayur J Kapadia, ex-AGM, GNFC for inspiration, guidance and critical review of the case-study.

Table 4 (b). Yearly average analytical data of concentrations of ions in 14 CTs during years 2017 - 2021

COOLING TOWER	Ortho Phosphate as PO4 (5-6 ppm)					Total Phosphate as PO4 (10-12 ppm)					Zinc as Zn (0.5-1.0 ppm)					Residual Chlorine (0.2-0.5 ppm)				
YEAR →	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
CT-1	5.3	4.9	4.6	3.9	3.9	6.0	5.5	5.9	4.2	4.6	0.66	0.39	0.64	0.52	0.49	0.32	0.32	0.42	0.39	0.41
CT-2	5.2	5.5	5.1	5.7	4.3	5.7	6.0	6.3	6.9	5.5	0.58	0.41	0.66	0.72	0.54	0.46	0.44	0.49	0.46	0.45
CT-3	6.5	6.5	6.0	6.5	6.0	7.2	8.3	7.2	7.1	7.7	0.79	0.66	0.64	0.61	0.49	0.42	0.47	0.40	0.41	0.41
CT-4	7.8	5.8	6.0	6.7	7.1	8.1	7.7	7.2	7.1	8.2	0.78	0.59	0.53	0.59	0.42	0.47	0.27	0.40	0.36	0.25
CT-5	5.6	4.9	5.5	7.2	5.6	6.3	5.8	6.6	8.0	7.3	0.49	0.34	0.25	0.30	0.25	0.27	0.19	0.29	0.18	0.23
CT-6	5.9	5.2	5.9	7.3	5.7	6.6	6.1	6.9	8.2	7.3	0.51	0.37	0.28	0.30	0.25	0.19	0.17	0.23	0.16	0.25
CT-7	6.1	4.8	4.5	5.9	5.3	7.0	6.0	5.8	6.5	6.8	0.39	0.32	0.32	0.33	0.30	0.28	0.28	0.29	0.43	0.52
CT-8	6.7	3.2	5.5	6.6	6.6	7.1	6.6	5.6	7.0	8.3	0.58	0.35	0.16	0.25	0.29	0.33	0.15	0.31	0.37	0.45
CT-9	5.8	5.1	5.5	5.8	4.4	6.4	6.5	6.2	6.7	6.1	0.47	0.37	0.40	0.44	0.42	0.11	0.24	0.42	0.42	0.38
CT-10	5.4	2.5	0.3	5.0	3.9	6.1	5.2	2.2	4.4	5.5	0.34	0.28	0.30	037	0.25	0.30	0.35	0.30	0.30	0.43
CT-11	5.7	5.3	6.0	7.8	6.5	6.3	6.7	6.6	7.7	8.4	0.65	0.48	0.47	0.51	0.47	0.24	0.11	0.17	0.26	0.26
CT-12	6.9	4.6	6.7	8.5	7.1	7.2	6.5	7.0	8.9	9.6	0.52	0.34	0.24	0.41	0.53	0.05	0.32	0.08	0.07	0.02
CT-13	6.6	5.7	5.9	7.0	5.2	7.4	6.7	6.8	7.2	6.6	0.71	0.62	0.84	0.64	0.57	0.46	0.39	0.39	0.47	0.48
CT-14	6.1	5.6	5.8	6.6	6.0	6.1	5.6	5.8	6.6	6.0	0.35	0.42	0.56	0.39	0.32	0.41	0.44	0.47	0.45	0.45

Table 5. Yearly average analytical data of microbial growth and corrosion rate in 14 CTs during years 2017 - 2021

COOLING TOWER	Total viable count (per ml)					Sulphate Reducing Bacterial count (per 100 ml)					Corrosion rate in Return Header – MS (mpy)				
YEAR →	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
CT-1	13,000	9,100	2,900	2,700	11,500	<100	<100	<100	<100	<100	0.85	0.81	0.52	0.51	0.44
CT-2	12,300	7,200	2,400	4,000	16,000	<100	<100	<100	<100	<100	0.97	0.74	0.61	0.48	0.47
CT-3	10,600	6,500	2,800	3,900	12,000	<100	<100	<100	<100	<100	0.83	0.96	0.41	0.43	0.39
CT-4	10,000	7,000	2,400	4,200	14,200	<100	<100	<100	<100	<100	0.79	0.83	0.40	0.50	0.38
CT-5	11,000	6,800	2,400	3,600	15,100	<100	<100	<100	<100	<100	0.78	0.77	0.61	0.35	0.33
CT-6	12,800	7,700	3,000	4,900	12,200	<100	<100	<100	790	<100	0.88	0.82	0.58	0.36	0.33
CT-7	9,600	7,000	2,500	2,800	20,500	<100	<100	<100	<100	<100	0.84	0.76	1.07	0.42	0.41
CT-8	12,800	6,200	4,200	4,700	15,200	<100	<100	<100	<100	<100	0.93	4.25	1.26	0.41	0.34
CT-9	10,600	7,700	2,900	8,900	10,900	<100	<100	<100	<100	<100	0.95	0.82	0.51	0.38	0.12
CT-10	9,600	7,400	5,110	4,500	8,700	<100	<100	<100	<100	<100	0.92	1.79	6.97	0.71	0.62
CT-11	11,300	6,800	4,800	8,000	6,200	<100	<100	<100	<100	<100	0.88	0.70	0.41	0.38	0.38
CT-12	10,000	11,400	30,900	7,200	8,800	<100	<100	<100	<100	<100	0.88	1.71	0.66	0.42	0.38
CT-13	10,800	7,300	2,400	3,600	8,700	<100	<100	<100	<100	<100	0.85	0.71	0.50	0.36	0.39
CT-14	1,000	1,000	100	1,000	10,000	<100	<100	<100	<100	<100	0.91	0.67	0.53	0.39	0.39

ABOUT THE AUTHORS



Dr. Rakesh P. Farasram *has been working in Quality Control Dept. of M/s Gujarat Narmada Valley Fertilizers & Chemicals Ltd (GNFC) since 1990. He obtained his Ph.D degree in Organic Chemistry in 1998 from South Gujarat University. He is having industrial QC experience of > 32 years. His research work has helped GNFC in curtailing costs at several stages of process. He has won several awards for implementing ideas for technological improvements. He has published various research papers in various journals. Presently, he is discharging his duty as Chief manager in Quality Control Dept of GNFC Ltd.*



Mr. Jaysukh Sardhara, M. Sc. (Chemistry) *has been working with M/s Gujarat Narmada Valley Fertilizers & Chemicals Ltd (GNFC) since 1988. He has discharged his duties in various capacities in Quality Control Dept. His 32 years' experience in QC dept involves water & effluent analysis, fertilizer & chemical products analysis and many other raw materials. He also has contributed in effectively managing inventory of Lab essential items. He is currently discharging his duty as Manager in Quality Control Dept of GNFC Ltd taking care of cooling tower aspects along with several other quality control functions.*

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WATER TREATMENT SYSTEM: PRODUCTIVE & SUSTAINABLE

By Abdul Rahman Mohammed, CEO, Sahara Industry



Since the human inception, water has always been the lifeblood of all human activities. With rising population and demands for more resources, water supply has been challenged and unsustainable practices for ages have caused severe water scarcity. The lack of access to clean drinking water leads to millions of deaths every year and ever rising demand for clean water is outstripping supply.

It has been estimated that 80% of India's surface water is polluted which results in India losing $6 billion every year due to waterborne diseases. Water cycle imbalances, increasing water consumption and wastage in urban areas, political and regulatory disputes, increasing irrigation and agricultural demand, industrial growth, lack of optimal water resource management technologies and water-borne diseases pose major challenges to the Indian water sector. According to estimates, India's water sector requires investment worth billions of dollars. Development of new and sustainable means to supply, recycle and reuse of precious water resources is the most significant challenge. We need to get serious about water to avert a major future global economic and humanitarian crisis.

A sustainable approach for provision of clean water is essential to control the precarious tilt in the water balance.

The Project

In-Effects Marketing is an authorized distributor for international acclaimed brands of furniture and hardware for southern states in India. Started with a modest beginning in 2006, it currently deals in brands like Ebco, Zipco, and European brand Peka, Salice and Yale by Assa Abloy with distribution network in all major states with over 600 variations. It has established its leadership as a competitor to Ikea brands with technology driven and innovative approach of integrated supply chain management. They provide environment friendly workplace to their employees and sales force at all locations with full liberty to innovate and craft excellence in all their products and services. They have created a niche of their products and have a captive market across all southern states in India.
As part of their sustainability goals, a better water treatment plant was needed that could reduce the water usage and energy costs associated with its operations.

Challenges

A major distribution chain of international brands of wide range of furniture and hardware solutions in Andhra Pradesh was looking to reduce the impact of its operations on the environment while



meeting the water treatment challenges at its facility. Until recently, the company was using municipal water supply and groundwater for its operation and personnel. The company was looking to make water drinkable from the ground water sources which have the turbidity of over 1400 PPM and TDS of 2300 PPM and reduce the use of more expensive municipal water supply.

Project Implementation

Sahara Industry is a leader in water treatment plant and machineries in south India and has executed a large number of projects for making water clean and safe for domestic and industrial purposes. The Engineers of the company surveyed the facility, obtained a series of water samples, reviewed water usage pattern and water source plans and investigated associated energy and water costs.
Sahara Industry's field sales team and product engineer performed water input and output projections, evaluated water quality at receiving end and calculated resulting energy and water savings to determine a viable approach for the plant.

A completely new and fully automatic water treatment system with agitator having the capacity of 400 litres per minute was installed. The installed water softener has the capability of making water ultra-pure reducing the turbidity level to more than acceptable level. The USP of this particular model of water softener is that it has reduced the TDS of 2300 PPM and hardness from 1400 PPM to less than 25 PPM where conventional water softeners work upto 800 PPM hardness only, thus reducing the load of water contamination to advanced purity level.

Solution

The customised and innovative solution placed by Sahara Industry as per detailed analysis resulted in a significant return on investment to the client. After research and consulting with the end user, the final solution included a high grade water softener, top opening 36" diameter pressure vessel that could withstand 250,000 times of cycle test from 10 psi to 150 psi withstanding pressure having a one piece, seamless high density polyethylene liner and an encapsulated, leak free engineered polymer inlet which are 100% corrosion resistant and low maintenance requirement. A Droplet 7x32 FRP Bag Filter Housing with 5 Micron Filter bag is provided to stop suspended solids entering into the system. By this system both Softener life is enhanced and also improves water quality.

The storage tanks for raw and treated water separately along with level controls and re-pressurization system and retrofit kit to realize the savings of softener salt. All system being fully automatic, there was no need for softener sequence controller for proper valve sequencing and timing.



Demonstrating its commitment to continuous product improvement and post purchase efficient services, Sahara Industry has been working in the field of water and wastewater treatment solutions for a long time now. The ISO 9001:2015 certified company has executed projects in almost all industry verticals and its innovative and customised designed solutions have been well appreciated by its client and customers resulting in improved reliability. Its premier membranes, vessels, deionizer system and other products command a leadership position in the market.

Being market oriented and with modern system and processes, Sahara Industry has a client-centric approach to provide high quality products with excellent service standards. The technical expertise and in-depth understanding of the water sector has enabled it to offer the best integrated and strategic approach to industrial and municipal water and wastewater treatment systems. The Company provides multi-disciplinary water and wastewater treatment and engineering services and delivering ideal solutions based on the experience of implementing hundreds of plants and projects with integrated project approach.

ABOUT THE AUTHOR

Abdul Rahman Mohammed *is a young entrepreneur with an MBA in marketing & finance, he is the Founder & CEO of Sahara Industry, providing technologically advanced, economical yet best quality water and wastewater treatment solutions. His success lies in his dynamic leadership and his group company has achieved turnover of over INR 1000 million.*

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DISSOLVED AIR FLOATATION (DAF) TECHNOLOGY AND SLUDGE DE-WATERING BELT FILTER PRESS (BFP)

By Prateek Vashistha, Assistant General Manager (Process, Proposals & Marketing), Krofta Engineering Limited



Description of the Problem:

Water used in industrial applications, is often regarded as waste after it has served its purpose and is discarded in nearby fields or in drains leading to nearby rivers and lakes. This waste water, depending on the industry, can contain suspended solids (sand, silt, biological matter or sewage), oil and grease, COD (chemical oxygen demand) and BOD (biological oxygen demand), indicating that the water has low levels of dissolved oxygen. The water may even contain dissolved solids such as salts, metals and minerals. Typically, paper, pharmaceuticals and textile industries can contain high COD levels, while food processing, pulp and paper and distilleries can contain high levels of BOD. When this waste water is dispersed in nearby land and sources of water, it degrades the soil by seeping underground, making it impossible for plant life to grow. Similarly, in sources of water, it kills marine life and stops algae growth. Sludge generation is another one of the problems which requires to be treated. Sludge handling is not an easy task since it is primarily in liquid form, with consistency levels remaining low in majority of the cases. Based on the nature of the sludge, it can contain many nutrients, organic and inorganic material and other minerals in dissolved form.

Solution:

Machines running on Dissolved Air Floatation (DAF) technology are an excellent solution for primary treatment of waste water. This is not a new technology, but the efficiency is constantly being upgraded to remove greater percentages of total suspended solids, COD and BOD. Today, up to 95% of TSS and oil and grease can be removed from waste water after DAF treatment. In this process, chemicals which lead to coagulation and flocculation of lighter particles are dosed in the wastewater, these flocs rise to the surface by the upward movements of bubbles released from a highly pressurised air dissolving tube. These particles are removed by the help of surface skimmers or scoops, this is called floated sludge. The heavier particles will naturally settle at the bottom of the DAF tank and are collected in the sludge collection tank with the help of bottom scrappers. The treated water in the middle of the two layers of sludge moves out via the outlet nozzle. Below shown are the results of a rectangular type DAF installed in a paper mill in Ludhiana, India having an inlet flow of 700 m^3/hr:

	Inlet Parameters	Outlet Parameters	Reduction
TSS	350 mg/L	28 mg/L	92%
COD	1052 mg/L	282 mg/L	73%



The above results show reduction in TSS and COD which is consistent among other KROFTA installations in paper mills across the world.

Since, in many cases a DAF machine is used for primary treatment, a portion of the treated water is fit to be re-used in the process which enables industries to reduce operating costs, while a certain portion can be sent for further treatment to the effluent treatment plant which has biological treatment options to remove COD and BOD as well as tertiary treatment to remove dissolved solids, this water can be used for other operations which require fresh water, or it can be discarded since it is now within legal limits of TSS, COD and BOD.

The floated and settled sludge generated after DAF treatment often has water consistency between 93-98% which makes it difficult to handle. The sludge can be treated by squeezing out the excess water. Two new products used by several industries include Screw or Volute press and Belt Filter Press (BFP). A new version of the filter press, the triple wire belt filter press is the latest technological offering by KROFTA. Below shown are the results of a triple wire belt filter press installed in a paper mill in Punjab, India for sludge treatment with inlet flow 32 m^3/hr:



Inlet Sludge Consistency	Minimum Outlet Sludge Consistency
2.5%	25%

Takeaway and some instrumentation information:

DAF products are integrated with the accessories of pumps and chemical dosing using PLC panels. Timers ensure that the right amount of chemical dosing is taking place at the correct time intervals so that the machine can function at its most efficient level.

The Triple Wire BFP has wash water spray nozzles above the top belt which ensure the sludge does not stick to the belt. These nozzles turn on at given intervals since it is integrated with a timer. The machine also has sensors on either side which keep the tension and centring of the belt in check. Such instrumentation ensures smooth running of our machines.

Further, the Triple wire BFP has proven to consume less power than a more conventional sludge de-watering a decanter centrifuge. A study conducted in a paper mill shows savings in power of almost Rs. 30,00,000 per year. This is attributed to the drive motor being only 2.6 kW per hour as compared to a 30kW per hour drive motor being used in a centrifuge.

The combination of a DAF installation followed by a sludge-dewatering unit can help in waste water treatment and then sludge handling. The treated water can be re-used and the nutrient rich sludge can be used as manure, or can be sold in some cases. DAF installations are running successfully in a range of industries such as tanneries, textile, seawater, oil refineries, pulp and paper, food and beverage, pharmaceuticals, dairy, municipal sewage, automobile and even laundry.

ABOUT THE AUTHOR

Prateek Vashistha *is Assistant General Manager (Process, Proposals & Marketing) at Krofta Engineering Limited. He is a Engineer (B. Tech) who is responsible for the preparation of Proposals, Process & Equipment Design, Hydraulic design, Engineering functions, Feasibility Study, Tender specification, Technical Bid evaluation & Detailed project and Concept report.*

He is subject matter expert who has expertise in primary treatment of wastewater. He has more than 5 years of experience in designing water and wastewater treatment equipment and also is a marketing professional having experience in the field of Water & wastewater treatment, turnkey projects etc specialized in Project Management, Planning, Controls and Performance Measurement.

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RIGHT OPERATION & MAINTENANCE OF WASTEWATER TREATMENT PLANT AT THE MANUFACTURING INDUSTRIES IN THE PRESENT ERA (MAINLY ACTIVATED SLUDGE PROCESS- ASP BASED WWTP)

By Satish Panchal, Founder, Satsang Enviro Advisor

Water is one of the most precious resources of this earth and without the water we can't expect anything move as we wish. We all taken granted that water is free and we can do whatever we would like with the available water.

In spite of high level of awareness, various quality and environmental standards, stringent environmental laws, frequent intervention and hefty penalties from the tribunal and federal courts, number of experts available surrounding to all of us, the situation of water pollution at our rivers, ponds, ground water are alarming and we are not at all serious about the basic problems for the right O & M of our WWTP, CETPs, ETPs as well as STPs.

Considering more than three decades of rich and practical experience for the proper and Ethical Environmental Management of the Manufacturing Industries, covering Chemicals. Petrochemicals, Refinery, Distillery, Fertilizers, Soda Ash, Pulp and Papers, Steel & Mining, Engineering Thermo-plastic, Thermal Power Plant, Agrochemicals as well as Enviro-Infrastructure Projects, the basic for the right O & M have to consider as under:

A. The layout of the entire manufacturing facilities has to be re-look for the proper storm water management. Number of Incidence observed that during heavy rain the generated wastewater mix with the storm water and that mix water reach in to the nearby water bodies as well as entering in to the ground and nearby agricultural field creating series problems for the water pollution, as well as ground water contamination.

B. Proper evolution of real water consumption at the Manufacturing industries at the different areas inside the premises are the need of the hours. For that a proper and right water balance diagram has to be prepared by installing a dedicated, calibrated standard flow meter - Refer Exhibit A. Now a days good quality of Online water Flow meter also available and its record also maintained for the proper understanding the consumption. If industry doesn't have an online recording system for the flow data, then a dedicated log sheet has to be maintained attached Refer Exhibit A & B as an example of water consumption data for single area.

C. For the generation of wastewater from the different activities of Manufacturing process and plants, the following points has to be considered before going for the Right O & M of WWTP.

- **Manpower for the Right O & M of WWTP:**

WWTP Section / Dept. of the Manufacturing Plant must be headed by the qualified Environmental Engineer / Scientist having an adequate experience for the concerned O & M of WWTP, supporting by a qualified trained operators {instead of casual labours} as well as qualified and trained Laboratory Analyst and supporting staff for the civil, mechanical, electrical, instrumentation technicians are utmost

WATER BALANCE DIAGRAM- EXHIBIT -A

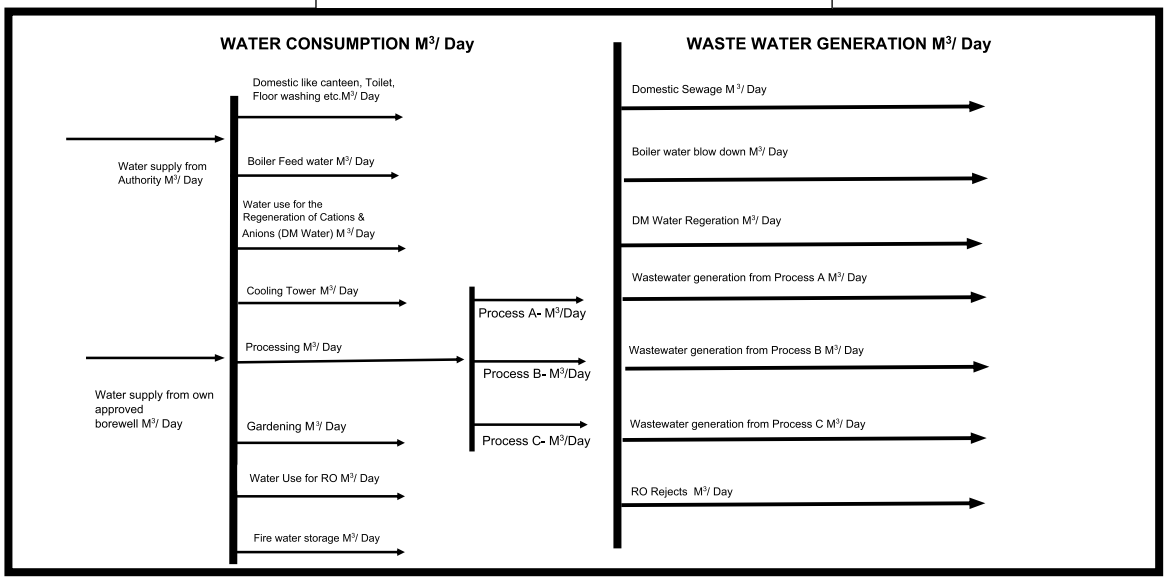


EXHIBIT – B

Log book for maintaing water consumption data for Area				
Date	Intial flow meter reading	Final flow meter reading	Factor	Water Consumption M^3/day
1				
2				
3				
4				
5				
6				
7				

required to achieve the right O & M of WWTP.

- **Identification of each wastewater generation streams:**

The wastewater generation steam from the following area has to be properly quantified:

1. Domestic wastewater generation from the domestic activities, covering toilets, urinals, canteen, floor washing etc.
2. Utilities like generation of wastewater from the regeneration of cations and anions for the DM water plant, RO Rejects, Cooling tower blow down, boiler flow down etc.
3. Wastewater generation from the different process, like polymerization, coal washing, paper machines, etc.
4. Wastewater generation from the reactor cleaning it may be a batch process or continuous process (after certain period of time) etc.

- **Segregation of the wastewater generation stream:**

Segregation of different wastewater generation stream is utmost important before entering these streams into the WWTP / ETP, to avoid more complication for the right treatment.

Experience clearly shows that is has been a general practice to mix all the different wastewater stream and make the wastewater as a cocktail and then the treatment plant is not at all capable to treat all these wastewaters.

Most of the CETPs are facing the problems of the cocktail phenomena and not at all able to meets all the statutory norms of the Authorities.

Even our cities STPs are not only receive the sewage, but it contains various wastewater like industrial runoff particularly during the rainy periods, industrial wastewater directly connected with the STPs, {legally or illegally} Hotel, Restaurant, Hospital, commercial establishment, Malls, multiplexes, Party plots etc discharge / disposed substantial quantity of non-sewage wastewater into the STPs and that's why most of the STPs are fail to achieve the statutory norms.

It has been also a general practice in the Manufacturing industries that all the domestic wastewater adds into the Bio-Rector of ASP- Activated Sludge Process which can now treat separately in a modular STP or small capacity and that treated sewage may be utilised for the gardening purpose or after disinfection may be utilised for other off-grade requirements also.

- **Regular analysis:**

Regular analysis of different steams for the various pollutants like pH, Suspended Solids, Chemical Oxygen Demand, COD, BOD, Ammoniacal Nitrogen, Phenols, Heavy Metals, Pesticides through the standard Methods are very important to evaluate the strength as well as its treatment mechanism. Now a days Real Time Online Monitoring System (RTOMS) also available, which also provide the data for right treatment process, its operation etc.

D. Treatment process and its O & M:

- **Neutralization:**

Acidic wastewater generated from the Process can be neutralised with right quantity and quality of alkaline solution. General Practices in the Industries is just adding the Lime in the acidic wastewater stream. The lime may be a cheap as compared to other alkyl but it created another problem of sludge generation and its safe disposal, which ultimately a costly affair and now a liability issue also.

Instead of Lime right percentage of Caustic solution, neutralize the acidic stream. Here few of the industries have an issue for the higher amount of TDS developed due to caustic addition. For that a process study is required and if necessary alternate alkyl may be used for the neutralization.

Instead of direct dumping a caustic soda of flake into the acidic steams it is required to have a proper percentage of Caustic solution optimize the resources and also enhance the efficiency

For the alkaline steams proper and systematic addition of acid is required. The selection of acid is based on the nature of the alkaline streams.

- **Equalization:**

After the Neutralization the wastewater steam along with other wastewater stream, which are more or less on the same characteristic transferred to the Equalization area. If all these wastewater stream transferred through the pump, then all these pumping machineries must be energy efficient as well as its regular maintenance are utmost important. The bearing, gasket etc, has to be replaced on regular basis as well as oiling & greasing of the rotating machineries helps to overcome the frequent problems on the pumping machineries.

If Industry have two equalization sumps, then it has to be use in a series mode rather than the parallel mode, which helps to the forward systems of WWTP.

Purging of Air from the bottom helps to equalized all the received wastewater stream. Here the retaining time is also very important. Experience shows that due to frequent problems in the blower from which air purging applied to the equalization created anaerobic condition which creates a serious problem at the forward system of WWTP. Some of the Industries have a separate stream containing with very high Solid and another low Solids, that has to be mix proportionally to get the effects of the equalization.

- **Coagulation and Flocculation:**

The equalized wastewater from the equalization zone has to be transferred to the Coagulation and Flocculation area. Here considering the nature of the equalized wastewater a specific dose of Coagulant and Flocculants has to be added through a dosing pump, to get the better results in the Primary Clarifier.



The dose of the coagulants and flocculant has to be decided on the basis of the Jar Test results, that can be carry out at the Environmental Laboratory at the plant itself, rather than just to add into the system. The RPM of the coagulation and flocculation chambers also have to check for the proper coagulation and flocculation process.

The bottom sludge from the coagulation and flocculation chambers has to be remove regularly and may be discharge into the Sludge Drying Bed area or dewater through the mechanized dewatering system

- **Primary Treatment / Clarifier & its Sludge:**

The wastewater from coagulation and flocculation chambers now transferred to the Primary Clarifier. This clarifier has a retention time about 4 to 5 hrs and it may have a scrapping mechanism to remove the floating particle on continuous basis. The supernatant directly transfers to the Bio- Reactor of the Activated Sludge Process. The bottom slurry of the primary clarifier has to be removed on regular basis and dewater through mechanized dewatering system. The dry sludge has to be disposed as per the directives from the Statutory Authorities.

Experienced showed that there has been a general practice in few of the industries to discharged Primary clarifier bottom slurry into the sludge drying beds along with the secondary clarifier sludge. The mixing of Primary and secondary clarifier sludge into the Sludge Drying Beds creates serious problems.

The characteristic of Primary Clarifier and secondary Clarifier bottom slurry are totally different, so to mix both the slurry not at all helps for the right O & M of the WWTP.

The mechanized dewatering system for the primary clarifier is also an important part of the WWTP, so its regular maintenance helps for the smooth functioning of the forwarding system.

- **Bio- Reactor – Activated Sludge Process**

Bio-Reactor / Aeration Zone of WWTP is the heart of the system and its operation as per the standard practices are utmost important.

Primary clarifier supernatant directly enters in to the Bio- Reactor and it mix with already have an active biomass in the same.

The important Parameters to be check on the regular basis are as under:

a. Dissolve Oxygen
b. Mixed Liquor suspended Solids- MLSS
c. Mixed Liquor volatile suspended Solids- MLVSS
d. Mean Cell Residence Time - MCRT
e. Sludge Volume Index-SVI
f. Food to Microorganism (F/M) Ratio.
g. Sludge Age
h. Nutrient Balance- N:P: K
I. Sludge Return rate as well as excess sludge wasting
j. Oxygen Uptake Rate

Oxygen has to be supplied through the dedicated Aerator or Diffused Aeration system and its routine Mechanical, Electrical and Instrumentation maintenance are utmost important. Dissolved Oxygen measured through the standard online calibrated instrument help to check the real requirement of the Oxygen.

Nutrient dosing on the basis of the N: P : K has to be added through a dedicated dosing pump only.

The activities at the Bio-Reactor are totally depends of the Microorganism and it also have an effects of the climatic conditions like temperature etc.

Microbes are also very sensitive, very short life and to maintain healthiness of the Bio-Reactor microbial activity has to be maintained as per the standard parameters as mentioned above.

Experience shows that sometimes industries add jaggery, cow dung, mehnda, Gud, etc. at the Bio-reactor as a food for the Microorganism. The additions all these totally disturb the Microorganism health and it have a reverse impact on the performance on the WWTP.

Even addition of Domestic sewage is not at all advisable, considering the different microbe present in the sewage as compared to the Bio-reactor.

Frequent checking of the Microbial strength as well as its healthiness through the Microscope help to maintain the good condition at Bio-Rector.

Now a days readymade culture is also available. This culture have is own advantage and disadvantage. The industry can develop a culture of microbes at the site itself by Soil Enrichment concept and that culture has to be maintained under the proper condition and also multiplied and enhance in a larger quantity as and when required.

- **Secondary Treatment / Clarifier & its Sludge**

Wastewater from Bio-reactor enter in to the Secondary Clarifier for further treatment. The retention time at Secondary clarifier is also in the range of 3 to 4 hours. If microbes work perfectly at the Bio-reactor than there is no issues of Nitrification or Denitrification.

To remove the floating sludge and particles from the Secondary Clarifier scrapping mechanism help. The regular cleaning of floating sludge is utmost important for the forward treatment.

The ratio for the return sludge v/s wastage of sludge from the Secondary Clarifier depends on the treatment at the Bio-Rector as well as proper O & M of the same.

The wastage sludge shall be drain in to the Sludge Drying Beds. Few of the Industries applied the mechanical drying system for the same.

Sludge Drying Beds has to be designed in such a way that all water from the drain slurry / sludge of the Secondary filter and remaining solid retain on the Sludge Drying beds, which shall be dry over a period of time due to natural condition.

Frequent cleaning of the filter media as well as topping of the sand at the Sludge Drying Beds are utmost important to get the proper results of the same.

The filtrate of the Sludge Drying Beds has to check for the different parameter and it meets the norms than may be reuse for any purpose at the WWTP or Gardening or direct mixing with the final disposal.

The dried sludge has to be disposed properly at the approved Landfill site by applying all the regulatory requirements.

PSF – Pressure Sand Filer / Activated Charcoal Filter
Pressure Sand Filter and Activated Charcoal filter further help to remove all the remaining floating particles / impurities to meet the treated wastewater disposal norms.

Regular cleaning of the filter media, through back washing as well as topping are required to get the proper efficiency of the system.

- **Disinfection:**

Disinfection is the part of the tertiary treatment and its requirements are based on the statuary norms as well as reuse of treated wastewater inside the industries. There are different methodology and system are being available in the market but and is has to be selected considering the requirements and it's easy to operate concept.

Use of chlorine for the removal of colour as well as a disinfectant must be carefully study considering the characteristic of chlorine gas and safety aspects.

The efficiency of all the above units of WWTP has to be regularly monitoring / checked to get the proper functioning of the entire WWTP.

Dedicated Log sheets / Log books for the entire O & M of the WWTP & Energy Consumption for the hourly basis as well as daily wastewater samples analysis of the different stream and different units of WWTP are most important activities for the Right O & M of WWTP. The log sheets / Log books may be designed based on the site condition.

If WWTP designed as per the actual raw wastewater characteristic of different streams and also maintain as per the standard operating procedure as mentioned above there are more chances to reuse the treated wastewater as maximum as possible inside the premise to achieve the ZLD concept and industry become a water positive company.

As a responsible business person, good citizen of this great Country and for the future generation it is utmost important to protect every single drop of water so that our natural water bodies not become a dumping ground of all the wastewater generated by the industries and organization.

ABOUT THE AUTHOR

Mr. Satish Panchal *pure environmental engineer, having more than three decades of rich and practical experience for the proper and ethical environmental management of the manufacturing industries, covering Chemicals. Petrochemicals, Refinery, Distillery, Fertilizers, Soda Ash, Pulp and Papers, Steel & Mining, Engineering Thermo-plastic, Thermal Power Plant, Agrochemicals as well as Enviro-Infrastructure Projects. He has worked at world Largest Refinery at Kuwait as an Environmental Expert. Recently supersaturated {after working more than 12 years} from the Vadodara Enviro Channel Limited as Managing Director, encouraged to start something, which help to the society in a larger perspective. Thus Mr. Satish Panchal started an Advisory / Independent Consultancy named as SATSANG ENVIRO ADVOSROS based at Vadodara.*

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SHANGHAI ACRYLONITRILE PLANT USING BDP ACHIEVES TOTAL REUSE GOAL

By Eric Li, Co-Founder, CEO and Dr Ben Chow, Associate BDP EnviroTech



SECCO's water reclamation facility at an acrylonitrile production plant in Shanghai, China, **recycles 100 percent of wastewater influent and saves US$4.5 million annually from water supply, energy, and wastewater discharge costs.** Authors CEO, Eric Li and Dr Ben Chow, Ph.D. of BDP EnviroTech LLC explain how the Biological Double-Efficiency Process (BDP®) helps the facility achieve these results.

Acrylonitrile is widely used in Asia and many other countries to manufacture products such as acrylonitrile butadiene styrene (ABS) plastic, nitrile rubber (Buna-N), acrylic fiber, and synthetic resin. However, the process used to produce acrylonitrile – catalytic ammoxidation of propylene, also known as the SOHIO process – also produces one of the most difficult-to-treat industrial wastewaters. This process involves the catalytic reactions of propylene, ammonia, and air (oxidizer), forming by-products such as acetonitrile and hydrogen cyanide. It typically has high chemical oxygen demand (COD), total nitrogen (TN), and the extremely toxic compound cyanide (CN-). TN removal is one of the major challenges for treating acrylonitrile wastewater. There is no specific discharge standard for TN, and its removal is not typically monitored in other acrylonitrile wastewater treatment plants in China. Therefore, the removal efficiency of conventional wastewater treatment process for TN in acrylonitrile wastewater is not well established.

In 2011, the Shanghai SECCO Petrochemical Company's acrylonitrile manufacturing plant set a goal to reuse 100 percent of its wastewater as a supplementary production water source in order to address growing concerns of the massive industrial water demand and high costs associated with water purchase and wastewater discharge. The company is a joint venture of British Petroleum, China Petroleum and Chemical Corporation, Shanghai Petro-chemical Company, and East China Investment Company. It is also the largest petrochemical joint venture in China and one of the biggest acrylonitrile production plants in the world. To achieve this goal, the Biological Double-Efficiency Process (BDP®) was chosen as the secondary biological treatment process based on the results of pilot tests conducted from 2011 to 2012 at SECCO's acrylonitrile water reclamation plant.

BDP removes TN. It is common practice in the activated sludge process to remove nitrogen by ammonia oxidation followed by nitrate/nitrite reduction to nitrogen gas. The autotrophic organisms use oxygen as the electron acceptor to oxidize the ammonia in the aerobic environment. The heterotrophic organisms using nitrate/nitrite as the electron and carbon from organic compounds, prefer low to zero dissolved oxygen (DO) levels, and are responsible for de-nitrification.



Shanghai SECCO (BP & SINOPEC joint venture)
Zero discharge wastewater and zero discharge of waste gas.

The conventional secondary wastewater treatment process for nitrogen removal consists of separated basins for the aerobic process (nitrification) and anoxic process (de-nitrification). In contrast, the BDP process is a continuous and mainstream simultaneous nitrification and denitrification (SND) process, involving both nitrification and de-nitrification reactions occurring in a single bioreactor. The BDP process also eliminates the secondary clarifier by including a fast-clarification zone into a unique all-in-one integrated structure. The process generates significant savings by eliminating the need to separate treatment processes into anaerobic and aerobic tanks and secondary clarifier. Figure 1 shows the flow chart comparison between the BDP process and conventional activated sludge process.

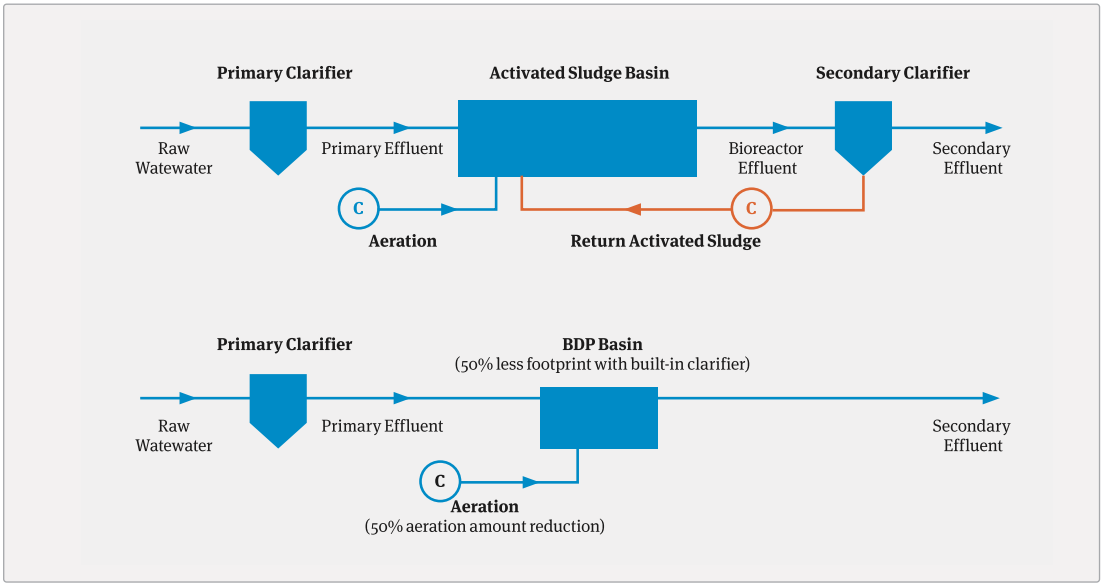


Fig.1. Flow chart comparison between conventional wastewater treatment process and the Biological Double-Efficiency Process.

In the BDP process, the dissolved oxygen level is kept low at approximately 0.3 milligrams per liter (mg/L), creating an oxygen concentration gradient across the granular sludge flocs, with denitrification occurring at anoxic zones within the core of floc particles and nitrification occurring near the surface of floc. Short-cut nitrification/denitrification is observed in the BDP process, making TN removal more efficient. Compared with full chemical reactions for nitrogen removal, shortcut nitrification/denitrification refers to reactions in which ammonia is oxidized directly to nitrite (NO2-) without nitrate (NO3-) as the intermediate, followed by reducing it to nitrogen gas (N2) and into to the atmosphere directly. The mixed liquor suspended solid (MLSS) is kept high at approximately 8,000 mg/L; therefore, a high sludge concentration with a low food/microorganisms ratio helps to maintain smaller sludge flocs that can sustain just enough aerobic activity in the low dissolved oxygen environment. The high MLSS also enables the BDP process to double its treatment capacity with the same footprint when compared to the conventional process.

Facility process design for the process design of the SECCO water reclamation facility in Shanghai, the domestic wastewater and the acrylonitrile wastewater are first conveyed into separate regulating basins and then pumped into a mixing basin for blending. The alkalinity of the mixed wastewater is adjusted by adding caustic. The mixed wastewater stream is then introduced to the BDP system and immediately diluted by recirculated MLSS and lifted by an airlift device into the aeration zone for treatment. The concentration of dissolved oxygen (DO) in the aeration zone is automatically regulated to facilitate the removal of chemical oxygen demand (CODCr), ammonia nitrogen (NH3-N), TN, and CN-components by microorganisms. Wastewater leaving the aeration zone flows into the fast clarification zone by gravity, where effluent exits the BDP basin, and mixed liquor is returned to aeration zone. Excess waste activated sludge (WAS) is collected by the sludge scrapper and then pumped to a solids handling facility for further treatment and disposal.

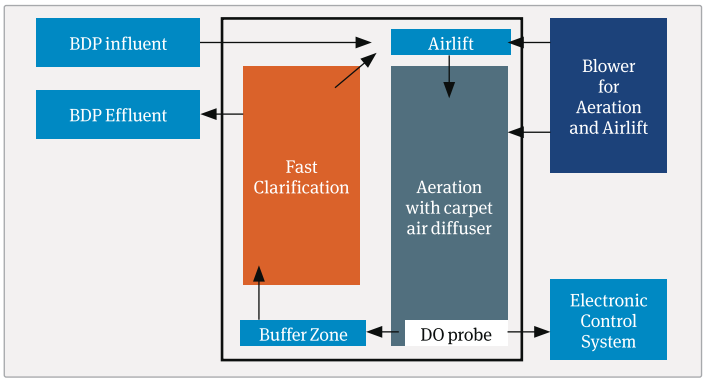


Figure 2. BDP System Treatment Flow Diagrams

Table 1

Parameter	Units	Values
Flow Rate	million liters per day	360
Annual Treatment Capacity	million liters per year	1,317
Annual Operation Time	hours/year	8,760

Treatment Capacity of BDP® Biological Treatment System in SECCO project

Table 2

Parameters (mg/L)	CODCr	TN	NH3-N	CN-
Influent after Mixing	≤ 1,500	≤ 250	≤ 50	≤ 5
BDP Effluent (6 months average)	93	18	2.5	0.3
BDP Effluent Requirement	≤ 150	≤ 25	≤ 10	-
Removal Rate	94%	93%	95%	94%

Note: The data represents the performance of the BDP secondary treatment process only.

A flowchart of the BDP process is provided in Figure 2. This shows the entire secondary treatment process flow of this facility, using BDP as the main biological treatment process for enhancing suspended solids, COD, and TN removal. SECCO's full-scale design treatment capacity of BDP is 150 cubic meters per hour (m3/hr), including 60 m3/hr of acrylonitrile wastewater and 90 m3/hr of domestic wastewater, respectively. Table 1 shows the daily average and annual treatment flows. Operating since November 2014, the full-scale BDP system has a treatment capacity of 3,600 cubic meters per day (m3/d) and meets discharge requirements while significantly reducing estimated operation and maintenance costs. Table 2 shows the consistently high removal rates achieved by the BDP process for COD, NH3-N, TN, and CN-.

Conclusion

SECCO's Shanghai water reclamation facility has become a flagship model for the petrochemical industry worldwide. The BDP system reduces 50 percent of the volume of air necessary for aeration compared to conventional technologies; it eliminates separated secondary clarifier structure and substantial energy required for onsite pumping in conventional RAS process; and it combines anaerobic and aerobic process into one bioreactor to achieve an excellent nutrients removal rate.

The plant recycles 100 percent of the wastewater and saves approximately US$4.5 million dollars annually from industrial water supply purchasing, energy consumption, and wastewater discharge.

Table 3

- Main Pollutant: High COD, NH3-N, TN & CN-
- Capacity: 3,600 m³/d (951,000 GPD)
- Process: Mixing Tank+ BDP ® Basin + Tertiary Treatment

Table 3

Water Quality	*Influent mg/L*	*Effluent mg/L*
COD_{Cr}	3000	110
BOD_5	1500	5
NH_3-N	40 ~ 80	5
TN	500 ~ 600 (90)	30 (4)
CN	CN	0.1

ABOUT THE AUTHORS

Eric Li *is the key inventor and CEO of BDP (Biological Double-efficiency Process). He has 21 years of experience in charge of research and development of wastewater treatment and recycling water technology. He has managed over 60 full-scale applications of BDP technology in the US, Europe, China and Taiwan. He is recognized as a world authority in wastewater treatment and mainstream simultaneous nitrification and denitrification (SND) process.* ***Eric Li, works at BDP EnviroTech LLC, based in Irvine, California, USA.***

Dr Ben Chow, Ph.D. was previously a project manager at BDP EnviroTech, now assists BDP in an associate role.

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UNIQUE & ROBUST NEXT GEN SOLUTION TO TREAT BIO -METHANTED EVAPORTOR CONDESATE PLANT IN DISTILLERIES TO ACHIEVE ZERO LIQUID DISCHARGE AND MAKING TREATED WATER AS INTEGRAL PART OF THE PROCESS

By Abhishek Tripathi, Business Head – Ethanol & New Business Initiatives and Parineeta Deka, Assistant Manager – Marketing, Paques Environmental Technology India Pvt Ltd.

Rampur Distillery:

1st and only sucessfull Plant in India to treat evaporator condensate generated from 3 different feedstocks - Sugarcane molasses, BMSW and Grain

Radico Khaitan is the largest manufacturer of Indian Made Foreign Liquor (IMFL) in India. In March 2019, Paques India has successfully commissioned CPU (Condensate Polishing Unit) with NEXT GEN ANAEROBIC BIOPAQ®ICX reactor at their Rampur Distillery Plant, Uttar Pradesh.

The Challenge

Rampur Distillery is among the largest distilleries in India and has been a key player in the Indian Distillery Industry since 1943. The distillery produces high-grade Extra Neutral Alcohol ("ENA") from molasses, grains and Scottish design malt spirit from barley malt.
Since Radico was a brownfield project with limited space, organic pollutants were an issue, and available technologies were not viable on a technical or commercial level.
Water reuse is becoming more and more important in order to reduce the environmental footprint and to solve the water scarcity problem. To deal with this problem, Rampur Distillery was looking for a reliable and robust system to treat condensate and to achieve ZLD in their production process.

Major Challenges faced prior to commissioning -

- Condensate from 3 different streams mixed together
- High Ammonical Nitrogen at the inlet
- Strict timelines
- Space constraint

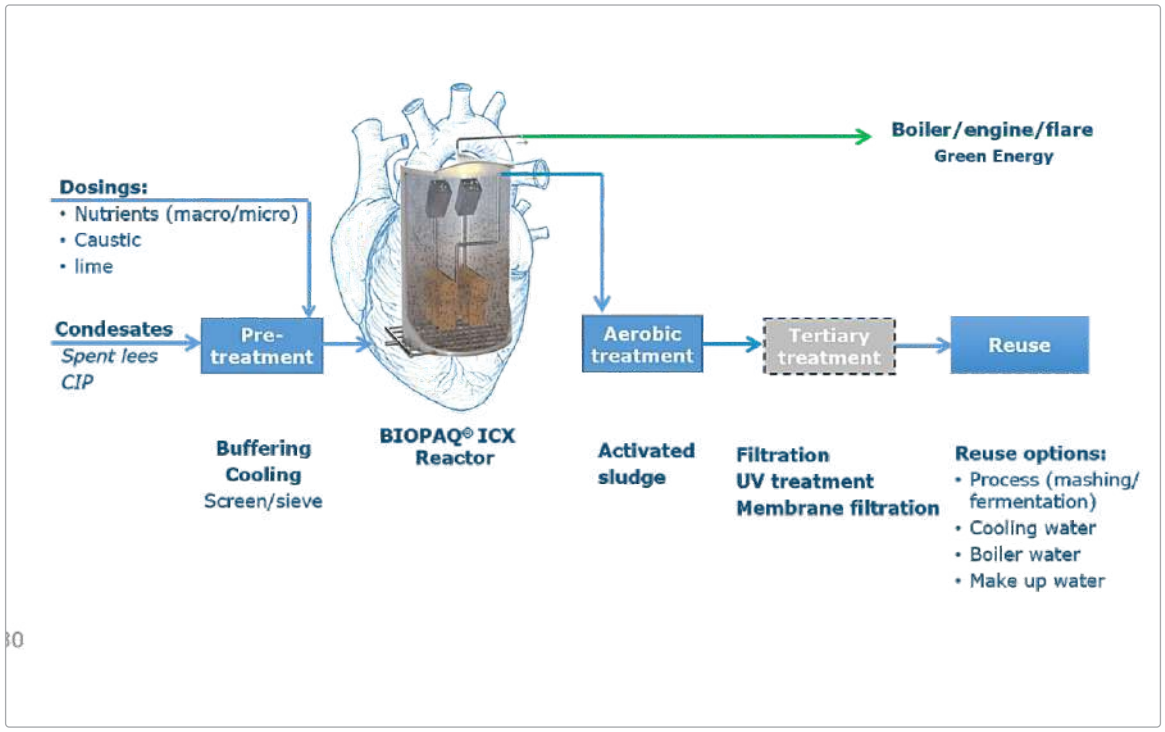


Figure 1. Location of sampling sites (delineated using ArcGIS 10.5)

The Solution

For treating wastewater to be reused in the distillery fermentation process, a Condensate Polishing Unit powered by Biopaq® ICX appeared to be the best solution. The modular design of the reactor also required a minimal space, best suitable for urban areas for saving on land and costs. Paques therefore commissioned a BIOPAQ® ICX High rate reactor with granular Biomass to treat their effluent from 3 different condensate streams.

The BIOPAQ®ICX (Internal CirculationX Advance reactor) is a cost-effective high rate anaerobic effluent treatment for industrial wastewater. The condensate effluent enters the ICX reactor where it is mixed with granular anaerobic biomass in the distribution system. A part of the effluent is recycled to the factory as process water in the fermentation stage. Good granular biomass from the production process is harvested from the reactor to seed other reactors.

Technical Benefits of BIOPAQ®ICX

- Excellent Granular biomass retention (2-stage separators)
- High biomass level in reactor: high COD capacity (VLR)
- Robust, proven influent distribution system designed to also extract biomass from the reactor
- Smart Reactor design and automated control
- No clogging issues and CIP of all internals is possible
- Closed reactor, no odour and no vent air needed
- Listed by GWI as best emerging technology in Anaerobic field
- Could be easily fit for a retrofit job
- Quick Start Up time



Fig. 2. BIOPAQ®ICX



Fig. 4. Granular Biomass

The Execution

Within a short period of 4 months, CPU was erected, and within 4 hours of commissioning, biogas could be flared out, while full load was taken in a few days afterwards. This was made possible by the Granular Biomass inside the BIOPAQ®ICX.







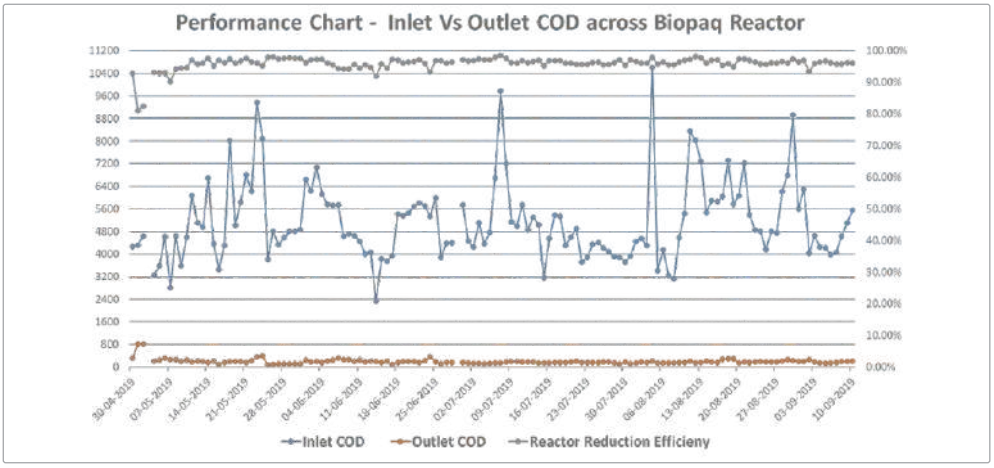
Fig. 3. Condensate Polishung Unit at RADICO KHAITAN

The Performance

Compared to what was promised to the client, the Condensate Polishing Unit delivered much higher efficiency results. Even though there was high NH4N present, the results have been consistent in almost 2 years of installation.

Highlights

- Treated wastewater is utilized for fermentation in alcohol production
- Despite of high Ammonical Nitrogen in waste water the COD reduction efficiency across the reactor is 95% - 97% on a consistent basis
- Since major organic load is reduced by BIOPAQ®ICX the downstream operating

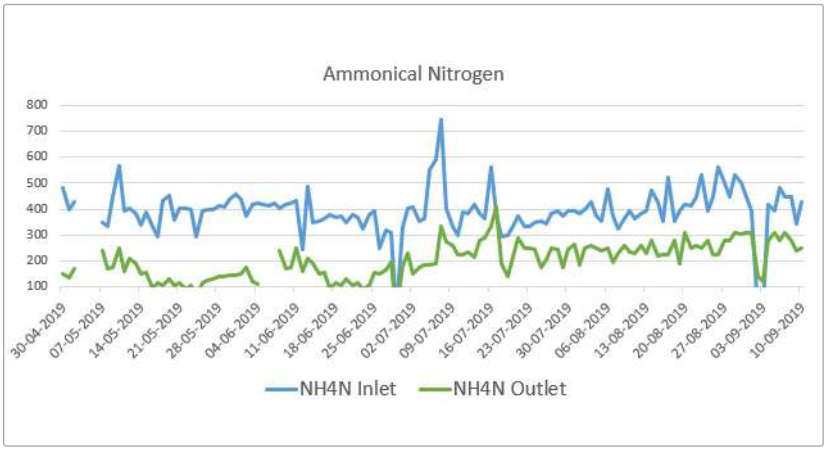


expenses for post-treatment has been significantly optimized

- Despite frequent shockloads, both in flow & COD, the ICX system has been giving a consistent output efficiency
- Although a brownfield project with limited space, CPU has been successfully installed & commissioned. And since April 2019, the plant has been running consistently

Biogas Utilised as Green Energy

The Methane purity in the Biogas generated is around 80% which has never been possible or seen in any of conventional reactors and is utilized for green energy generation as they take the same to Biogas engine.
The Ammonical Nitrogen is acts as a nutrient, because of this there is Biomass Development, and post anaerobic the Ammonical Nitrogen is controlled via Anoxic Zone..



Conclusion

High-rate anaerobic reactors are an excellent treatment option for wastewater from molasses distilleries and sugar mills. An ICX bioreactor converts organic compounds to biogas and granular biomass in the absence of air. This reduces effluent discharge costs and produces green energy at the same time. Further, the biogas generated can be used to fuel the boiler.

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DIRECT SEEDED RICE: BOON TO TAIL-END FARMERS OF TBP COMMAND AREA

By R. H. Rajkumar., S. R. Anand., J. Vishwanatha and A.V. Karegoudar, AICRP on Management of Salt Affected Soils, ARS, Gangavathi (UAS-Raichur)



1. Brief details about success story including details of initial locations trials :

Farmer Name: Mr. Sharanappa Kulkarni

Name of the village: Thimmapur, Gangavathi Taluka, Dstrict Koppal, Karnataka

2. Input Required:

- Seeds, Seed cum fertilizer machine, pre and post-emergent herbicide
- Recommended dose of fertilizer as prescribed in package of practice
- Irrigation as and when hair cracks appear on soil
- Pesticides and insecticides as and when required

3. Impact of technology involved on soil, water & crop yield:

Soil: Reduction in soil compaction, reduced wheel tracks (small trenches) during machine harvesting which in turn help easy land preparation and sowing operations in the next season.

Water: Water saving up to 15-20 % during land preparation (puddling) as compared to PTR thus also help to minimize/avoid development of water logging and secondary salinization especially at the tail-end of the command.

Savings in water:

	PTR (control)	DSR
Irrigation applied (m3/ha) (without RF)	11315.0	9010.0
Effective RF (m3/ha)	1407.0	1407.0
Total irrigation applied (m3/ha)	12722.0	10417.0
Less irrigation applied than control (m3/ha)	-	2315.0
Percent less irrigation than control (%)	-	18.11
Net saving from irrigation (Rs./ha)	-	90.28

Note: Water charges for TBP area- Rs. 200 / acre (Rs. 0.039/ m3)-(CADA 2012)

Yield: Higher paddy yield (70.0 q/ha) was recorded in PTR (control) compared to DSR (68.0 q/ha) method but it was on par with PTR

Table 1. Water production efficiency as influenced by DSR

Sl. No.	Treatments	Yield (q/ha)	WPE (kg/m3)
1	PTR (control)	70.0	0.55
2	DSR	68.0	0.65



Happy DSR farmer at Thimmapur, Gangawati



Scientists farmers interaction about DSR at farmer field at Thimmapur, Gangawati

	PTR	DSR
Cost (Rs. ha^{-1})	49,100	37,850
Gross Returns (Rs. ha^{-1})	1,33,000	1,29,200
Net Returns (Rs. ha^{-1})	83,900	91,350
BC ratio	2.71	3.41

Note: Paddy @ Rs. 18 per kg, Straw @ Rs. 1 per kg, Urea, DAP and MoP @ Rs. 5, 24 and 16 per kg respectively

4. Cost per unit or cost per ha and Benefit Cost Ratio:

Benefits:

1. Saves cost of production as raising of nursery and transplanting

is not required
2. Saves water as DSR do not require standing water
3. In time sowing is possible in DSR
4. Saves time and energy by reduction in the fuel cost for puddling
5. Increases yield and profitability

5. Reactions by farmers about technology:

- Savings in time and labor – as there is no time spent on land preparation (cultivator, rotavator and puddling), raising nursery and transplanting. Since seeds were sown directly during the early onset of monsoon (June) which not only help to minimize pest and disease incidence but also increase crop yield and fair price for the crop. In addition, it also help the farmer to take up the second crop and meet its water requirement well prior to the withdrawal of canal water which is not possible in case of PTR. In the overall field operations, labour requirement is also reduced under DSR.
- Savings in water: As there is no need of puddling, water requirement is reduced by 25-30% under DSR which could be made use for cultivating an additional 50 per cent land.
- Savings in seed rate: Seed requirement for DSR is much less than (nearly 65 percent) quantity of seed required under PTR.
- As no intense cultivation (puddling) is required under DSR, an old and low Hp (30-35 Hp) tractor can be put in to use for DSR.
- Grain filling percentages under DSR was higher (88-92) compared to PTR (81-85%).
- Compared to PTR the cost of cultivation is reduced under DSR to the extent of Rs. 8000-10,000 per acre.

6. Adoption by farmers or government agencies:

Year	2009	2010	2011	2012	2013	2014*	2015*
Area under DSR (acre)	50	200	1500	25000	50000	1500	250

Note: During 2014 and 2015, monsoon delayed hence, the area under DSR reduced drastically compared to previous years.

Total area under DSR under TBP command

7. Radio/ TV talks/ Field days organized for extension of technology Radio programmes:

- Interview on Conservation Agriculture on 26-07-2012 telecast by All India Radio, Hospet.
- Interview on Technical aspects of aerobic paddy cultivation on 22-07-2013 telecast by All India Radio, Hospet.
- Interview on DSR Technology on 22-07-2013 telecast by All India Radio, Hospet.

TV programmes:

- Interview on direct seeded rice on 10-08-2013, telecast by Doordarshan, Bangalore.

Field Days organized:

- "Koorge Bhattada kchetrotsava (Field Day on DSR)" organized on 12-12-2012 at Kasabe camp, tail end of the command area (Near Raichur).
- Koorge Bhattada kchetrotsava (Field Day on DSR)" organized on 28-12-2012 at Virupapura village, Shindhanur taluka
- Koorge Bhattada kchetrotsava (Field Day on DSR)" organized on 03-09-2013 at Yaradona village, Gangavathi taluka
- Koorge Bhattada kchetrotsava (Field Day on DSR)" organized on 28-11-2013 at Virupapura village, Gangavathi taluka
- Field day on Direct Seeded Rice at Hitnal, Aadur, Gangavati Taluka on 19-11-2014 (Head reach farmers of the command).

8. Potential areas where success story can be replicated:

This technology is very much needed and can be replicated at the tail end of the command where there is acute shortage of water for the cultivation of paddy and no scope for taking up of two crops as is the case with the head reach of the command. This technology can also be adopted by head reach command area farmers' which not only ensure proper distribution of irrigation water in the entire command and also help to take care of the problems of waterlogging and secondary salinization especially at the tail end of the command.

9. Constraints/ limitations with technology:

- Weed management: Though pre- and post-emergent herbicides are available for DSR, more trainings and knowledge to be imparted to the farmers for their efficient utilization.
- Iron deficiency: Iron deficiency under DSR especially in calcareous Vertisols is observed but the farmers are aware of managing Fe deficiency through sprays.
- Land leveling is essential: With non-uniform land surface, depth of seed placement appears to be uneven leading to improper germination and crop stand. Apart from that, water and nutrient efficiency would be less under undulating fields. Therefore, land leveling is essential especially for DSR.
- Non availability of seed drill machines: As the number of DSR farmers has slowly increased over the years, there is requirement of more number of seed drill machines in the command.
- Mixing of seed from the earlier crop: There is scope for mixing up with previous crop/variety unless pre-sowing irrigation is given and application of herbicide prior to going for DSR. Total area under DSR under TBP command

10. Constraints/ limitations with technology:

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He has multi experience in teaching, research and extension. He has handled 11 courses for diploma graduates, 7 UG degree courses, 1 PG and 1 Ph.D degrees courses. He has published 13 research papers in international journal as name within first three authors and as above three authors, he published 5 papers. In national journals, he has published 12 papers as name within first three authors and 10 as name above three authors. He has presented 4 full length papers in international conferences and 6 full length papers in national conferences. He has also published 12 abstract papers as first author in international conferences and 34 abstract papers as first author and 19 abstract as above three authors in national conferences. He has published 7 handbooks, 16 research bulletins, 11 chapters in books, 15 laboratory manuals, 1 training manual, 12 leaflets/folders and 13 popular articles. He has participated in 22 International and National Conferences and attended 15 online training programmes. He has successfully completed one ICAR 21 days winter school training programme and two 10 days ICAR short courses. He got second best poster presentation Award by FAO, Rome, Italy during 2021 for his Sugarcane Research on subsurface drip irrigation in saline soils. He has second got best oral presentation and Excellence in Research Award in ICAAAS conference held at, Bangkok, Thailand during 2019.

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FURROW IRRIGATED POTATO UNDER NORTH EASTERN REGION OF INDIA-A CASE STUDY

By Th. I. Devi, Lala I.P. Ray, V. Ram, S. Swami, S. Jyothi, K. Swetha and D.J. Das, College of Postgraduate Studies in Agricultural Sciences, (CAU- Imphal), Meghalaya

Introduction

Potato (Solanum tuberosum L.) is an important food crop of the world and is ranked fourth in production volume after wheat, rice and corn. The North Eastern Hilly (NEH regions) contributes about 10% of the total production of potato in the country. The productivity of potato in the NEH region is around 8.16 t ha^{-1} as compared to the national average of 22 t ha^{-1}. Potato is grown during winter season either based on residual in-situ soil moisture or with assured irrigation supply. Crops grown during winter season experience moisture stress which is one of the reasons for low productivity. Traditionally farmers of NEH regions practice ridge and furrow method of surface irrigation to provide water to the crops. So, suitable furrow irrigation method need to be adopted to help the farmers to have a judicious usage of irrigation water for potato, which will not only save a good amount of water but also enhance increase water use efficiency (WUE). Resource conservation techniques like mulching will also help to conserve in-situ moisture during winter seasons. Mulching can also affect the temperature and provide better edaphic environment for root growth and yield of crops.

A field trial was conducted during the year 2021-22 (November-March) at the experimental field of College of Post Graduate Studies in Agricultural Sciences, Umiam, (Central Agricultural University – Imphal) Ri-bhoi district, Meghalaya. Some of the field photos during the experimental period is shown below (Fig.1-4).

Results

The data obtained from the main plot treatments shown that highest no. of tuber per plant was observed in normal furrow irrigated plot with highest yield of 17.2 t ha^{-1}. Similarly, potato plot with paddy straw treated as mulch also performed better with 17.7 t ha^{-1}. Apart from yield, other biometric parameters also gave better results for furrow irrigated potato. However, water use efficiency (WUE) was found to be more for alternate furrow irrigated potato. WUE is an indicator which signifies how best water is judiciously utilised for giving a productive output and is measured by the ratio of potato productivity with unit depth of water used. The water use efficiency was found highest for alternate furrow irrigation with a value of 46.23 kg ha^{-1} mm^{-1}. Similarly, the cost of cultivating one hectare of potato was estimated using standard protocols and prevailing market price. It was estimated that Rs.1, 05, 000 (Rupees one lakh five thousand only) is used for cultivating one hectare of potato land. The benefit cost ratio was found highest for potato cultivated under paddy straw mulch with a value of 2.50.

Conclusion

North eastern region of India enjoys salubrious climate with cold winter and high rainfall during rainy seasons. During winter period, mulching can be used as a resource conservation tool to minimize water losses and providing a better soil environment for crop growth. Potato is being a root crop, soil environment monitoring with adequate soil moisture and soil temperature helps in boosting productivity, which can well be managed through paddy straw mulching. The farmers of this region can adopt the furrow method of irrigation with paddy straw mulch for getting benefit within a span of 130 days during winter seasons. The benefit cost ratio was estimated to be around 2.5 with a cost of cultivation of Rs.1.0 lakh only. Alternate furrow irrigation technique is an improvisation of normal furrow method where irrigation water is allowed alternatively, by adhering to this technique, significant water can be saved for potato cultivation.

Acknowledgments

The authors would like to extend their thanks to the Dean, College of



Fig. 1 Crop performance when irrigated with every furrow and weed mulch treatments



Fig.2 Full furrow irrigation

Postgraduate Studies in Agricultural Sciences, Umiam, for providing all logistic supports during tenure of the experiment. The financial assistance received from CAU-Imphal is also acknowledged.



Fig.3 Crop performance when irrigated with skip furrow and paddy straw mulch treatments



Fig.4 Skip furrow irrigation



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TWW USED TO GROW WHEAT SUCCESSFULLY: A CASE STUDY

By Dilip Yewalekar and Manisha Kinge, Jain Irrigation

Preface

Ministry of Jal Shakti (Department of Water Resource), Government of India, formulated National Frame Work on Safe Reuse of Treated Water (SRTW) with the vision, of 'widespread and safe reuse of treated used water in India that reduces the pressure on scarce freshwater resources, reduces pollution of the environment and risks to public health, and achieves socio-economic benefits by adopting a sustainable circular economy approach. It heralds a shift from existing perspectives on waste to a new understanding of Our Water (Apna Jal)'. This policy is complementary to previous & current policies of State Governments, CPCB (Central Pollution Control Board), SPCB (State Pollution Control Board), and Water Supply Department also interrelated to National Water Policy (NWP2020), National Urban Sanitation Policy (NSUP2008), National Environmental Policy (NEP 2006), National Faecal Sludge and Septate Management Policy (FSSM, 2017). These policies are complementary to Goal 3 of the National Water Mission (NWM) which emphasizes promoting the recycling of used water for meeting the water needs of urban areas.

Under the framework of the Ministry of Jal Shakti, Haryana State Government has taken an initiative and implemented 'the use of TWW (Treated Waste Water) for agriculture via Drip & Sprinkler Irrigation'. The concerned article describes the methodology& a case studywhere TWW was practically used for growing Wheat & other crops successfully,Validating water quality norms specified by various governmentsand minimum residual level (MRL). It also indicates the pros-cons, hurdles & acceptance level of the public. It helps to clear doubts among the society and encourages State/Central Government, Private companies, and Growers to adopt the model to overcome water scarcity and address the environmental & water pollution issues.

Forward

Because of the lack of a political will, technical know-how, R & D data base and mindset, this subject is least highlighted at a national–international forum this is the time to formulate the policy to implement a proper TWW project at Government, Private levels & PPP throughout the countries.Some of the metro cities, airports, corporates & hotels started implementing the use of TWW for the irrigation of landscapes, gardens, and crops. Haryana & Punjab State have gone ahead in using TWW for agriculture on large scale and growers also coming forward to use TWW for growing various crops. To encourage other state governments, corporates, hotels & growers, to use TWW for agriculture,a representative case study in Table 3 with the photos of wheat grown by using TWW is highlighted in this article and so that they can follow without any doubts orhesitation.

Recently, many countries have also taken the initiative on water treatment and reuse for agriculturalpurposes. Glasgow, 10th Nov 2021-The UNEP, and India signed an agreement on climate change and committed to achieving the target of SDG 6.3. In India, parallel State/Central Governmentsare coming forward & start to implement Waste Water Treatment and reuse for agriculture, some of the results are shown in Table 1.

Agriculture water pollution

Agriculture is the world's largest consumer of water. Over thehalf-century, agriculture has expanded and intensified in order to meet the increasing food demand triggered mainly by population growth and changes in diet. The area equipped for irrigation has more than doubled, from circa 1.4 million km2 in 1961 to circa 3.2 million km2 in 2012 (ref-Aquastat, 2014). Agriculture intensification has frequently come with increased soil erosion, higher sediment loads in water, and excessive use (or misuse) of agricultural inputs (e.g. pesticides and fertilizers) to increase productivity. When the use of such products exceeds the assimilation capacity of agricultural systems, it results in higher pollution loads to the environment. The excess use of irrigation water also enhances the agricultural wastewater flows back into water bodies in the form of deep percolation to aquifers and runoff to surface waters.

Table 1. Major TWW Irrigation project. (Ref: International Water Management Institute (IWMI), Resource Recovery & Reuse Series 8)

CITY	CROP CULTIVATED	INCREASE IN YIELD (%)	SAVINGS IN FERTILIZER (%)
Indore	Wheat (Rabi)/ vegetables (summer)	30-40%	50%
Nagpur	Wheat (Rabi)/ vegetables (summer)	30-40%	33%
Jaipur	Wheat (Rabi)/ vegetables (summer)	30-40%	50%
Bangalore	Rice (Rabi), Sapota, and flowers (summer)	30-40%	100%
Delhi	Okra	67%	60%

Principle Stages of Waste Water Treatment

There are three levels of wastewater treatment: primary, secondary, and tertiary (or advanced).

Primary treatment

Primary treatment removes physical debris through the process of screening. Suspended particles that pass through screens and grit chambers are removed from the sewage in sedimentation tanks, called primary clarifiers.

- Collection tank: To collect raw water /wastewater.
- Bar Screen /Grit: To separate solid matters, and debris.
- Trap: To separate solid matters.
- Primary clarifier

Secondary treatment

Secondary treatment removes the soluble organic matter and suspended solids that escape primary treatment. Removal is usually accomplished by biological processes with microbes.

- Aeration tank
- Nutrient removal (if)
- Secondary clarifier

Disinfection

Disinfection is the last step prior to discharge of the sewage effluent into a water body which destroys any remaining pathogens in the effluent & protects public health, is usually done by injection of chlorine-based chemicals.

- Disinfection
- Final produce.
- Sludge holding tank.
- Sludge Treatment.

TWW Quality norms for agriculture

The success of (TWW) Treated Waste Water use for crop production largely depends on adopting appropriate strategies aimed at optimizing crop yields and quality, maintaining soil productivity, and safeguarding the environment. Several alternatives are available to use TWW for agriculture via various irrigation methods. The user should have prior information on TWW supply and its quality as per Table 2 for reference to ensure the formulation and adoption of an appropriate on-farm management strategy.

Table 2. TWW Quality Norms (Ref-PPCB)

SR	PARAMETERS	TWW STANDARD NORMS
1	Temperature	Not more than 50C.
2	pH	5 - 9
3	BoD	<= 10 ppm
4	COD	<= 50 ppm
5	TSS	<= 20 ppm
6	Sulfates	<= 200 ppm
7	TKN	<= 50 ppm
8	Faecal coliform	<= 100 MPN/100 ml
9	Total Phosphorus	<= 2 ppm
10	Ammonical Nitrogen	<= 20 ppm
11	SAR	<=3.5 ppm
12	EC	<=2000 micro siemens/cm
13	RSC	<= 2.5 meq/l

Advantages of the use of TWW for agriculture.

- Higher crop yield, year-round agriculture production.
- Various crops can be grown.
- Recycles organic matter and other nutrients used in soil.
- Reduces the use of fertilizer.
- Avoids discharging pollutants to surface water bodies and Increases the economic efficiency of investments in wastewater disposal and irrigation.
- Conserves freshwater sources and reduces negative impacts on surface water bodies.
- Can recharge aquifers through infiltration without adding pollution to groundwater.
- Improve soil properties –soil fertility and texture.
- The cost of pumping wastewater from nearby channels is lower than the cost of pumping groundwater.
- If offers additional benefits such as greater income generation from cultivation and marketing of high-value crops which contributes to improved nutrition and better education opportunities for children.

Limitations of using TWW for agriculture irrigation

- Because the impact of pollution is generally less and takes longer in soils (and aquifers) than in surface water, some governments may delay the construction of necessary wastewater treatment facilities.
- Water salinity and metal content in soils are increased in the long term.
- Storage capacity is needed to adapt/reconcile continuous wastewater production with crop water demand and water supplied by precipitation.
- Under non-controlled conditions

a. Pathogens contained in wastewater can cause health problems for humans and cattle.
b. Some substances that may be present in wastewater can be toxic to plants, cattle, or human-consuming crops.
c. Some substances that may be present in wastewater can reduce soil productivity and
d. Infiltration of wastewater to aquifers may cause aquifer pollution with pathogens and organic matter.

Also for proper use of water for irrigation micro irrigation technology is rapidly expanding all over the world, especially in the water scare areas of developed countries.

Agriculture Key Principles

Following key principles should be paid attention to before deciding the use of treated sewage for agriculture

a. The use of untreated sewage for whatever form of agriculture leads to a situation where the TWW entering another basin from its parental basin creates issues of water rights and as far as possible, inter-basin transfer of such reuse is not to be encouraged.
b. Agricultural use being more pertinent in rural settings, local sewage is best treated with stabilization ponds followed by maturation ponds.
c. Rotational crop pattern shall be investigated for an all the year round utilization and designed such that the runoff of treated sewage in summer is minimized.

d. As far as possible manual direct handling shall be avoided and field channels are better suited as compared to sophisticated drip irrigation etc.
e. Specific limitations on individual parameters when the treated sewage is to be considered for irrigation are addressed herein.

Irrigation – Furrow/Drip/SprinklerIrrigation System

The different types of irrigation method shave to be selected based on available water, climate, soil type, crop to be grown, and the ability of the farmer to manage the crop & irrigation system. However, when using TWW as a source of irrigation other factors, such as contamination of plants and harvested product, farm workers, the environment, and salinity and toxicity hazards, will need to be assessed. The following basic parameters should be accounted for while using TWW for agriculture for successful farming:

- Required amount of water should be applied.
- Water quality should be acceptable.
- Water application should be properly scheduled.
- Appropriate irrigation methods should be used;
- Salt accumulation in the root zone should be prevented by means of leaching;
- Rise of the water table should be controlled by means of appropriate drainage;
- Plant nutrients should be managed in an optimal way.
- Selection of salt-tolerant crops.
- Proper wetting of root zone.
- Higher application efficiency and minimum wastage of water
- Potential to contaminate farm workers and the environment.

Types of Irrigation Systems

a. Furrow irrigation

Water is applied between ridges (e.g. level and graded furrows, contour furrows, corrugations, etc.). The water reaches the ridge, where the plant roots are concentrated, by capillary action. This method can reduce crop contamination since plants are grown on the ridges, but complete health protection cannot be guaranteed. Contamination of farm workers is potentially medium to high.

b. Drip Irrigation

Water is applied around each plant or a group of plants so as to wet locally and the root zone only (e.g. drip irrigation, bubblers, micro-sprinklers, etc.). The application rate is adjusted to meet evapotranspiration needs so that percolation losses are minimized.

c. Sprinkler irrigation

Water is applied in the form of a spray and reaches the soil very much like rain (e.g. portable and solid set sprinklers, traveling sprinklers, spray guns, center-pivot systems, etc.). The rate of application is adjusted so that it does not create ponding of water on the surface.

Components of Micro Irrigation System

The type and sequence of components, in irrigation, are typically the same for all field sizes as indicated in figure 1. Yet, based on field size (and water need), component sizes (diameter) may vary. The actual selection of a specific component generally



Fig 1. Architect of Micro Irrigation System

needs to be made on a case-by-case basis. The following is a brief description of the main components of a typical Micro-irrigation system.

I. Pumping system

The role of the pumping system is to transport water from the water source to the field through the distribution system. Pumping systems may be classified as electric powered systems, gas/diesel powered systems and solar powered systems.

ii. Piping Network

The role of the distribution system is to convey the water from the source to the field. Distribution systems may be above ground (easily movable) or underground (less likely to be damaged). Pipes are most commonly made of PVC or HDPE. The size and shape of the distribution system may vary widely from field to field.

iii. Polytube

Laterals are made up of LLDPE material which is quite flexible and strong. It conveys water from sub-main lines to the root zone via Emitters/Sprinklers. Laterals are spread in entire field at a spacing that depends on the row to row distance of the crop.

iv. Emitters /Sprinklers

Emitters/Sprinklers are the main component of the Micro Irrigation system as it supplies water from laterals to the plant root zone. Type of soil, type of crop, its spacing, age and water requirement are the deciding factors for Emitters/Sprinklers

v. Filtration system

The filtration system removes physical particles present water. Different types of filters are used based on the type of particles in the water. Media (Sand) filters are used with surface water when large amounts of organic matter need to be filtered out. Screen filters or disc filters may be used to filter water from balance physical impurities present after Sand filter and 100 micron stainless steel screens are used for this purpose. When the water contains sand, a sand separators are used.

vi. Fertilizer Injectors

Injectors allow to injection of fertilizer& chemicals as per crop demand.

Government Policy

Government policy on TWW available to farmers for unrestricted irrigation or to irrigate public parks and urban green areas is a deciding factor to promote the use of TWW at a large scale and to minimize the water stress and pollution of the environment.

Instead of using TWW 100%, the option of blending TWW with other water supplies –canal water, groundwater etc. It is possible that a farmer may have saline groundwater and, if he has non-saline treated wastewater, could blend the two sources to obtain a blended water of acceptable salinity level.

Another strategy is to use the TWW alternately with the canal water or groundwater, instead of blending.

Adopting a blending strategies of TWW is normally advantageous in respect of allowing greater flexibility, increased financial security and more efficient use of the wastewater throughout the year, whereas a single-use strategy will give rise to seasonal surpluses of effluent for unproductive disposal.

Table 3. Case study:Use of TWW for Agriculture- Irrigation, STP-CADA, Shahabad, Haryana.

SR	PARAMETERS	VALUE
1	Grower	Mr Chaddha.
2	Project (*)	TWW for Agriculture –Irrigation, STP CADA Shahabad, Haryana.
3	Capacity of STP	8-13 MLD
4	Command Area	151 ha (373 ac)
5	Design Discharge	2.4-3.6 cusec per 1000 ac.
6	Crop	Wheat
7	Irrigation time	8 to 14 hours depending on crop water requirement and agro-climatic conditions.
8	Irrigation type	Micro Irrigation & Furrow Irrigation System.
9	Area	5 acre
10	Yield	18 Quintal per acre
11	Total yield	90 Quintal.
12	MSP (Govt Price).	Rs.1900 per Quintal. (year 2018-19)
13	Total Income	Rs. 171,000.00
14	Farm Expenses	Rs 91,200.00 (estimated).
15	Net Income	Rs.79,800.00
16	BC Ratio	1.87
17	Smell of wheat	No bad smell was found.
18	Taste of wheat	No bad taste was found.
19	Quality of wheat	The quality of wheat is same as market wheat no difference was found.
20	Flour Quality & Taste	Wheat Flour Quality & Taste is same as market wheat flour, no difference was found.

(*Because of Covid19 pandemic & Lockdown, could collect limited information, presented after interpretation & interaction with various farmers).

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Photo 1. TWW tank, Irrigation Control Head Unit



Photo 2. Drip Irrigation Wheat



Photo 3. Furrow Irrigation Onion



Photo 4.Sprinkler Irrigation -Germination

ABOUT THE AUTHORS



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LASER LAND LEVELLING: ENHANCING WATER PRODUCTIVITY IN TUNGABHADRA COMMAND AREA

By R. H. Rajkumar, J. Vishwanatha, S. R. Anand, M.J.Kaledhonkar and A.V.Karegoudar, AICRP on Management of Salt Affected Soils, ARS, Gangavathi (UAS-Raichur)



BRIEF DETAILS ABOUT SUCCESS STORY INCLUDING DETAILS OF INITIAL LOCATIONS TRIALS :

Farmer Name: Mr. Ramakrishna

Name of the village: Devicamp, Taluka Gangawati, District Koppal, Karnataka.

Input Required:

- Laser guided leveling machine with accessories
- Tractor with 45-50 Hp power
- Seeds
- Seed cum fertilizer machine
- Pre-emergent herbicide
- Post-emergent herbicide
- Recommended dose of fertilizer as prescribed in package of practice
- Irrigation as and when hair cracks appear on soil
- Pesticides and insecticides as and when required

Method adopted:

- Puddled Transplanted Rice (PTR) in normal leveled land and laser leveled land
- Direct Seeded Rice (DSR) in laser leveled land

1. Impact of technology involved on soil, water & crop yield:

Soil: Soil erosion was reduced and soil moisture distributed uniformly over entire DSR laser leveled land.

Water: 20-25 % water saved in DSR laser leveled land compared to PTR in traditionally leveled land. 10-15 % water saved in PTR in laser leveled land compared to PTR in traditionally leveled land. This savings in water could be attributed to uniform distribution/standing of water under laser leveled land which also helps to minimize/avoid development of water logging and secondary salinization. Consequently, weed infestation minimized in laser leveled land compared to traditionally leveled land in both DSR and PTR systems.

Yield: Higher Paddy yield (87.5 q/ha) was recorded under PTR in laser leveled land (Significantly higher compared with PTR in traditionally leveled land) and followed by laser leveled DSR land (78.75 q/ha) and least in case of PTR in traditionally leveled land (75.10 q/ha).

Savings in water:

	PTR in normal leveled land (control)	PTR in laser leveled land	DSR in laser leveled land
Irrigation applied (m^3/ha) (without RF)	11315.0	9925.0	8365.0
Effective RF (m^3/ha)	1407.0	1407.0	1407.0
Total irrigation applied (m^3/ha)	12722.0	11332.0	9772.0
Less irrigation applied than control (m^3/ha)	-	1390.0	2950.0
Percent less irrigation than control (%)	-	10.92	23.18
Net saving from irrigation (Rs./ha)	-	54.21	115.05

Note: Water charges for TBP area- Rs. 200 / acre (Rs. 0.039/ m3)-(CADA 2012)

Table. Water production efficiency as influenced by laser land leveling and DSR

Sl. No.	Treatments	Yield (q/ha)	WPE (kg/m³)
1	PTR in normal leveled land (control)	75.1	0.59
2	PTR in laser leveled land	87.5	0.77
3	DSR in laser leveled land	78.8	0.81



Plate. View of laser leveling operation at farmer's field



Demonstration and training of laser leveling organized at Sri Ramakrishna field at Devicamp.





Happy laser leveled DSR farmer at Devicamp, Gangawati.



View of machine harvesting laser leveled DSR plot, farmer to farmer interaction



Field day organized on laser leveling at Devicamp, Ganagavathi.

2. Cost per unit or cost per ha and Benefit Cost Ratio:

	PTR in normal leveled land (control)	PTR in laser leveled land	DSR in laser leveled land
Cost (Rs. ha-¹)	49,100	51,500	40,350
Gross Returns (Rs. ha-¹)	1,35,180	1,57,500	1,41,750
Net Returns (Rs. ha-¹)	86,080	1,06,000	1,01,400
BC ratio	2.75	3.05	3.51

Note: Paddy @ Rs. 17 per kg, Straw @ Rs. 1 per kg, Urea, DAP and MoP @ Rs. 5, 24 and 16 per kg respectively

Benefits:

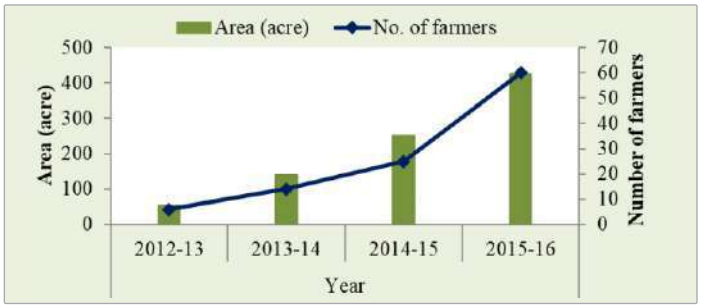
1. Saves irrigation time and energy by uniform distribution of water
2. Saves irrigation water as it increases the irrigation use efficiency
3. Increases the fertilizer use efficiency as uniform distribution of fertilizer is possible
4. Increases yield and profitability
5. Avoids waterlogging and further degradation of soil health

3. Reactions by farmers about technology:

Farmers are satisfied with this technology and adopting the technology of reclamation

4. Adoption by farmers or government agencies:

Yes, this technology was adopted by farmers and Laser guided leveling equipment got registered under the state subsidy scheme list during 2015-16. Area under laser land leveling from 2012-13 are mentioned in figure below.



5. Radio/ TV talks/ Field days organized for extension of technology

Radio programmes:

- Interview on Laser leveling technology on 29-10-2012 telecast by All India Radio, Hospet.

TV programmes:

- Interview on Laser guided leveling of land on 17-06-2013, telecast by Doordarshan, Bangalore.

Field Days organized:

- Laser leveling pratekshyate" (Live demonstration of laser leveling at farmer's field) organized on 20-06-2015 at Deveicamp, tail end of the command area (Near Karatagi).
- Laser leveling and Koorge Bhattada kchetrotsava (Field Day on laser leveling and DSR)" organized on 12-12-2015 at Deveicamp village, Gangawati taluka.

6. Potential areas where success story can be replicated:

This technology is very much needed and can be replicated at the tail end of the command where there is acute shortage of water for the cultivation of paddy and no scope for taking up of two crops as is the case with the head reach of the command. This technology can also be adopted by head reach command area farmers' which not only ensure proper distribution of irrigation water and fertilizer in the entire command and also help to take care of the problems of waterlogging and secondary salinization especially at the tail end of the command. This technology can also be replicated in dry (Semi arid) regions for withholding of moisture where there is acute shortage of rainfall and for controlling soil erosion during high intensity rainfall.

7. Constraints/ limitations with technology:

- Lack of knowledge: Though this technology is very simple but it is very new to the farmers of the Karnataka, trainings and field level demonstrations are required.
- Trained/ Skilled person is required for easy and smooth operations.
- High cost of the equipment hence farmers are unable to purchase land leveler
- Non availability of laser guided leveling equipments
- Less Custom hiring centers: A.R.S Gangavathi center is operating one custom hiring service center for entire TBP command area. Need is felt for more custom hiring centers for easy availability of laser guided leveler for small and marginal farmers on rental basis.

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LA SOCIÉTÉ WALLONNE DES EAUX CREATES DIGITAL 3D DATABASE OF COMPANY ASSETS

By Aude Camus, Senior Solution Marketer, Bentley Systems



Bentley Applications Enable Long-term Planning and Preventative Intervention by Automating Crack Detection

Optimizing Management of Water Assets for Reliable Water Supply

La Société Wallonne des Eaux (SWDE) is a regional water corporation that owns and maintains a series of water towers throughout Belgium. The organization is the dominant producer of drinking water the in Wallonne region, supplying almost 2.5 million people with 1,317 water tanks and towers. The overall goal of SWDE is to provide reliable access to water for individuals and businesses as the population and economy of the region grow.

Some of the structures that SWDE utilizes are very old, so the data on those structures was no longer accurate or, in some cases, available at all. To improve and streamline the management of all SWDE infrastructure, SWDE needed a database to increase the accessibility and accuracy of information about the company's assets. This goal would lead to more reliable water, higher quality food safety, prevention of structural defects, and a lower cost of structural interventions.

SWDE tower, built in 1981 in Juprelle, Belgium, was deteriorating and in need of support. The tower has a storage capacity of 500 cubic meters, and is supported by eight columns and beams. The tower's exterior features siding brick connected by galvanized metal anchors to a supporting wall constructed from terracotta. The concrete helped to reduce the amount of stress put on the brick and to link the exterior and inner structure; however, it also caused some challenges. The concrete caused condensation on the interior walls, which led to significant degradation over time. The degradation included burst joints, cracks, and the separation of edifice bricks. Operating inspectors have also seen superficial cracking on the brick siding. To ensure safe and reliable water service to the area, SWDE needed to repair the tower.

“Water towers are generally tall, imposing structures. A manual inspection from the ground does not allow proper diagnosis, and a complete inspection takes a long time,” said Christophe Taelman, engineer at SWDE. Typically, SWDE would conduct a survey of the damage using traditional manual surveying methods, including taking photographs from the ground or using elevators to lift workers up onto the tank. Given the challenges presented by the tower's size, SWDE quickly realized that their traditional approach did not provide a complete or efficient solution.

Manually Analyzing Drone Footage

SWDE decided to use drones to survey the damage, as that would allow them to provide a more complete picture of the damage without asking workers to spend as much time. They began to apply photogrammetry by using a Blade Chroma drone to take videos of the tower. Over 3,000 images were extracted from the drone video. However, they faced another roadblock while using drones: the vantage points gathered by the drones still required human interpretation, which came with a significant risk of error, as workers looking at drone footage could easily overlook small cracks. SWDE needed to find a way to ensure that cracks of all sizes could be identified efficiently so that necessary intervention could be taken early on to mitigate long-term deterioration and maintain a reliable and safe water network.

Applying Texture Skin Images to Develop Automated Crack Detection Software

SWDE discussed their options with Bentley Systems representatives, who worked with SWDE to develop technology specifically to meet their need for automated crack detection. SWDE determined they could create a 3D plan for the structure of the water tower in MicroStation. Once this model was complete, the next step was to refine a deep learning approach to analyze images and automate crack detection. They used Pointools to clean up and export the plan as a model in ContextCapture. While ContextCapture does not have crack detecting capabilities, Bentley developers worked with SWDE to refine an artificial intelligence (AI) capability for that purpose.

“With this new analysis using artificial intelligence on the 3D photo



reconstruction in ContextCapture, we were able to detect cracks faster and more accurately in both masonry cladding and concrete," said Taelman. The 3D visualization allowed them to see all angles clearly and analyzed cracks precisely in real time. The precise and efficient crack detection system allowed SWDE to automatically identify cracks with diameters as small as 0.1 millimeters, and the software helps to predict further development of these small cracks. An algorithm quantified the length, width, and depth of each crack and categorized them by their size and trace patterns. The resulting statistics contributed to an analysis of the overall condition of the water tower.

SWDE tested the module on the damaged water tower, by capturing 3,000 images with drone surveys and then using ContextCapture to create a reality mesh of the tower. They then used the AI capability to scan the reality mesh and detect cracks. The scan detected 1,704 cracks in the tower, 520 of which were less than 2 millimeters and, therefore, could not easily be detected by the human eye. The AI also detected that the façade had detached more than 10 centimeters from its original placement, which the human eye also would have overlooked.

Sustainability through Prevention and Savings

This project was a pilot for SWDE, resulting in a new method to efficiently, accurately, and safely detect cracks in infrastructure. The technology used on the project allows for faster and better-informed decision-making on renovation plans and techniques, ultimately saving costs. The solution reduces the time needed for surveys by 66% and saves significant costs by helping SWDE identify and plan for any necessary renovation work. "The collaborative work with Zheng Wu has allowed us to go beyond our intended aim and be able to calculate the lengths of cracks and classify them by width," said Taelman.

The accurate digital renderings have also established a baseline that SWDE can compare to future surveys to identify any degradation, helping them be proactive about preventing any risks of interruption to the water supply. In a comparison of the ContextCapture AI technique and on-site measurements using an electron microscope, SWDE found that Bentley's software was twice as effective and reliable. They determined that the automated crack detection sped up the diagnostic process by more than 600% and increased detection reliability by 100%.

The organization also estimates that the automated approach saved more than EUR 2 million in initial costs. The software works for damage prediction, decision-making, and cost reduction. The solution contributes greatly to SWDE's broader goal of secure, efficient, and reliable management and provision of water resources. By saving time and costs, the automatic crack detection software helps SWDE sustainably maintain millions of households' access to clean drinking water.

PROJECT SUMMARY

Organization: La Société Wallonne des Eaux
Solution: Water and Wastewater
Location: Juprelle, Belgium
Project Objectives:

- To create a database of water asset models for future analysis of degradation.
- To sustainably ensure an accessible water supply throughout the region by identifying cracks in the infrastructure early.

Project Playbook: ContextCapture, ContextCapture Insights, MicroStation, Pointools

Fast Facts:

- La Société Wallonne des Eaux (SWDE) is a regional water corporation that owns and maintains a series of water towers throughout Belgium.
- While an unmanned aerial vehicle gathered high resolution images of the tower, manual analysis of the images failed to detect small cracks.
- The automatic crack detection technology in ContextCapture helped quickly find cracks as small as 0.1 millimeters.

ROI:

- The automatic crack detection technology created using Bentley applications resulted in a 600% faster process of crack detection and analysis.
- SWDE's solution was twice as reliable as manual surveying methods.
- Using Bentley's software, SWDE saved more than EUR 2 million on this complex project.

> *Thanks to our experience and the use of Bentley tools, we can state that this solution is part of a preventative maintenance strategy of our infrastructure and anticipation of risks in our operation processes."* – **Christophe Taelman, Design Engineer, La Société Wallonne des Eaux**

ABOUT THE AUTHOR

Aude Camus *is a senior solution marketer with Bentley Systems, responsible for ContextCapture, Orbit 3DM, OpenCities Planner, Descartes, and Pointools. She is part of Bentley's digital cities business unit and focuses on Bentley's reality modeling products. Graduated from SKEMA Business School in France, Camus has nearly 15 years of experience in selling and marketing engineering and geospatial software.*

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NEW MOBILE ENVIRONMENTAL SAMPLER FROM HEXSOR SCIENTIFIC: A CASE STUDY

By Dr David Smith, Ms. Nisha Ravindran and Dr Jeyan Sreekumar, Hexsor Scientific

Keywords: harmful algae, Europe, Mediterranean, emergent marine toxins, filtration, sample preparation, oceantech, blue economy, sustainability.

Warming global climate and associated higher marine water temperatures are having a significant effect on the frequency and distribution of pathogenic marine organisms. As conditions become milder, harmful algae species previously confined to tropical waters are migrating further north into sub-tropical and temperate zones, becoming increasingly frequent in the waters around Europe and the Mediterranean. These species are responsible for the production of a range of emergent toxin types, including Cinguatoxin, Tetrodotoxin (TTX), and Palytoxin (PTX). Cinguatoxin and Tetrodotoxin are both potent neurotoxins, derived from Dinoflagellates, exposure to which can induce symptoms including vomiting and paralysis; Palytoxin (PTX), derived from another dinoflagellate genus, Ostreopsis, as well as red algae, can cause spasms, skeletal muscle breakdown, and kidney and cardiac failure. In rare cases, all can be lethal. Because of their increasing number and their geographical dispersal, these toxins are considered to represent an emergent threat in European waters. In addition, Dinoflagellates, diatoms, and cyanobacteria (blue-green algae) are also responsible for the production of other toxic metabolites which have been long-recognised to pose a risk in more temperate marine environments. Included within this group is Saxitoxin, also a neurotoxin and the most well-known of a group known as paralytic shellfish toxin (PST) which, again, represents a serious risk to health if ingested.

In addition to climate-induced change, and other top-down and bottom-up processes, the introduction into estuarine, riverine, and coastal marine systems of industrial, commercial and agricultural discharge rich in nitrogen and phosphorus is changing the nutrient loads available to these organisms, resulting in the increased growth of harmful algal blooms (HABs), their greater proliferation and, in some cases, new adaptations which help certain species to exploit this new reality and thrive. This, in turn, has a significant impact on biodiversity, the structure and function of marine food webs, and marine ecosystem dynamics, as well as on related marine and coastal industries. With these changes come a significantly increased risk of human and animal poisoning, which can occur either through environmental exposure, e.g. as a result of contact during swimming and other recreational activities, or through ingestion, via the introduction of contaminated stock into local bluefood networks or as a result of the irrigation of food crops with contaminated surface water.

Emergent marine toxins like Palytoxin, Ciguatoxin and Tetrodotoxin, are not currently subject to regular monitoring, or to regulation, in European waters. This is despite the huge potential economic risk that they pose to the region's fisheries and aquaculture sectors. Aquaculture – the farming of fish, crustacea, molluscs, seaweed and



Figure 1 - FLT-100

other aquatic plants and animals -, particularly, is experiencing a period of unprecedented growth, and is expected to form a key global food source in the medium- to long-term. In the UK alone, fisheries and aquaculture were worth a combined total of more than £2bn in 2021. With a predicted global contribution of more than 70% to seafood consumption by 2050, finding new ways to ensure safe, sustainable, aquacultural output, and preserve marine-oriented livelihoods and communities, into the future is becoming increasingly critical, particularly in those low- and middle-income countries which rely heavily upon it.

The scale and rapidity of marine ecosystem change has meant that historical data is no longer sufficient to allow accurate forecasting of biodiversity behaviour or ecosystem function. Technological innovation has the potential to transform marine asset management, and novel monitoring tools have already been recognised as a key tool for those working to ensure marine ecological and economic sustainability in at-risk areas.

The team at Liverpool (UK) – based SME Hexsor Scientific has been working to tackle the problems posed by HAB growth, and the damage done by marine toxins, since 2018. In 2019, Hexsor successfully completed field trials of a mobile analyser, Algae-600P, capable of detecting and quantifying chlorophyll and pheophytin, in the Republic of Cape Verde. Located in the central Atlantic, some 500km off the West African coast, the small island nation of Cape Verde is home to around 500,000 people, and ranks amongst those most at risk from climate change. The marine environment is the nation's greatest natural and economic resource, though ensuring that marine assets are protected and preserved for future generations represents just one of a number of environmental and ecological challenges faced by those living in the archipelago.

Now, Hexsor has developed a novel automated environmental sampler, the FLT-100, that allows researchers, and other marine stakeholders, to collect and prepare water samples in the field. It has been designed to overcome some of the significant obstacles to meaningful field data collection that currently make accurate mapping, measurement and modelling of biotoxic marine compounds, and marine biogeochemistry more widely, so problematic, including high rates of cell lysis and sample failure, cross-contamination between sampling events, and limited capacity for data collection at large spatial scales.

The FLT-100 was subject to its first field test in early 2022, where it was deployed off the Atlantic coast of Portugal as part of the Horizon 2020 project Emergent Marine Toxins in the North Atlantic and Mediterranean: New Approaches to Assess their Occurrence and Future Scenarios in the Framework of Global Environmental Changes (EMERTOX). This five-year project, due to conclude in 2023, was established by a consortium of 14 international research organisations to deliver a robust picture of harmful algae and bacterial emergent toxin dispersion and



Figure 2 - Field trials at Porto, Portugal

dispersion routes, the risks that they pose, to enable predictive modelling based on molecular data in the context of climate change and develop strategies to protect public and environmental health, and to develop new ways to sample and analyse these toxins and the organisms responsible for their production, particularly dinoflagellates and cyanobacteria. Portugal's coastline is home to a thriving aquacultural sector producing and harvesting wild and farmed shellfish and finfish species which are highly susceptible to algae-derived, and other, marine toxins, particularly during the spring and summer months, and so represents a key target for novel monitoring technology.

Designed using next-generation hollow fibre filtration technology, Hexsor's new automated sampler enabled EMERTOX scientists to increase both the number, and quality, of marine samples retrieved during in situ field observation, delivering target analyte retrieval rates of up to 100%, down to 70 kDA, in very samples of up to 50 litres. Similar results were achieved during a subsequent trial in Spain, and, next spring, the unit is set to be deployed in Cape Verde to support marine water monitoring efforts there. The ability to prepare and analyse potentially hundreds of samples per day in situ, and in real time, represents an important step toward achieving comprehensive assessment capabilities around spatio-temporal variability in toxin concentrations, as well as analysis of biotic and abiotic Essential Biodiversity Variables at the species and ecosystem level, and ensuring data-led marine asset management long into the future.

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SUCCESS STORY ON IVF SAMPLES.

By Preeti Shinde, Application Specialist, Hanna Equipments India

Description

One of the manufacturers of IVF media approached us for pH measurement in IVF media samples for continuous measurement in an incubator for 4-5 Hrs. Earlier they were using an ISFET pH probe, which was not giving any stability in the readings after once or twice being used in the samples. The electrode was very much suitable for their tabletop incubator flat wire was flexible and could easily pass through the incubator without hampering the internal conditions, also to their small sample size. They have to replace the electrode after every 3-4 uses the management was very furious about this continuous change as the probe was very expensive.

When they approached us they explained to us all the scenarios of the electrode, taking into consideration the sample size, we gave the Demonstration of the HI1083B electrode along with the benchtop meter. Later client asked us if Hanna has a standalone meter-like tester that can withstand the temperature of 37Deg C and can also give repeatable readings when in the incubator. After discussion, Hanna's team has given the demo of HALO HI10832 electrode, on the first instance the customer was very influenced by the Bluetooth compatibility of the electrode but the issue was with the electrode fitting in the incubator. We helped them with size and other possibilities and changes that can be done in the incubator to fit the electrode.

After a successful attempt, Hanna won the order of 2 electrodes. The customer is very happy with the results and repeatability of the readings. Soon we will be supplying more electrodes in other units, the user was so happy that he is now recommending the electrode to many fellow IVF media manufacturers.

Application

IVF or In-vitro Fertilization is the process of external fertilization of extracted eggs, retrieving a sperm sample, and then manually combining an egg and sperm in a laboratory dish. Then implanting into the human body, for this process there should be a media similar to the human body conditions and the pH should be maintained between pH range of between 7.2 and 7.4. This media is developed in laboratories.

An important parameter of IVF culture is medium pH; pH controls several intracellular processes that can impact embryo development. A Complex function is dependent on the presence of buffers in solution interacting with CO2 in the gas phase. Even a minor rise in pH can also dramatically impact embryo metabolism through the regulation of various enzymes.

We helped the client with a comparison of the ISFET pH probe and potentiometric pH probe; to convince their higher authority on why



the potentiometric pH probe is better than the ISFET probe.

Because of the satisfactory results and performance of our HALO HI10832 electrode, we have received many more enquiries from customers in similar industry.

	ISFET pH probe	Glass pH probe
Sensing surface	Hydrogen Ion-selective FET	Glass membrane
Offset/ Iso-potential Point	pH 7 is not at 0mV but can be 100mV or more	pH 7 have 0mV within acceptable range of ±15mV
Working	Based on control of current flowing between 2 Points of a junction	Based on exchange of H+ Ions that reside at the surface of chemical layer on glass membrane in proportion to pH of solution
Design	ISFET - Chip is sealed in an airtight enclosure, mounted on the tip of the sensor	The sensing membrane is doped in such a way as to generate mV only as a response to Hydrogen ions which is in a bulb shape
Body	Plastic Body sensor	Glass body sensor
Temperature dependency	Highly temperature dependent, with high risk of damage by rapid cycling temperature changes	Temperature dependent but can withstand in high temperature
Stability and accuracy	Do not offer stability and accuracy	Offer high stability due to stability of reference electrode
Observed Drift	have known for drifting problem due to low area of contact with sample and dependency on current flow between 2 points	Comparatively low drift due to large area of contact with sample and working dependency on voltage
Sensitivity to light	ISFET Chip is sensitive to light, can cause fluctuations in measurement due to light	No/less senility to light
Chemical resistant	cannot be used in combination with chlorine or other chemicals that can damage the ISFET chip	Glass being resistive to maximum chemicals can be used in any chemicals except samples that contain fluoride and HF
Cost	Fairly expensive	Affordable

ABOUT THE AUTHOR

Preeti Shinde *is an Application Specialist with Hanna Equipments India Pvt. Ltd. She has been with Hanna for more than 4 years. She supports Pan India technical issues and queries.*

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INDISCRIMINATE OZONE DOSING – DANGERS OF BROMATE FORMATION

Bromates are disinfection by products that have been well documented to be carcinogen in humans Presence of bromates in potable water has been in discussions for more than 15 years now, with limits being prescribed by many regulating authorities all over the world, in drinking water. However, the surprising fact in India is we have not even reached standards to control DBP due to chlorination and not much is being done to enforce at least to begin with whatever limits have been prescribed. World standards are far away when compared to Indian standards today and lots need to be addressed and done.

Bromates as DBP:

Bromates are not naturally present in waters. These are caused by oxidation of bromide ion containing water. In most parts of the world ozonation is a major disinfection step, normally replacing pre chlorination step. Bromide containing waters, when ozonated, can result in bromate formation, when the ozone converts the bromide ions to bromate during ozonation. The acceptable bromate ion levels in water all over the world is less than 10 micro grams/liter. These norms are strictly followed not only in the US, but also in EU, Japan and China.

Bromides are also introduced into the water as impurities and Sodium Hypochlorite is used for disinfections. Contaminations can sometimes exceed 2 mg/liter!!!

How is Bromate formed during ozonation?

The bromate formation has two kinds of path ways. These have been well documented by scientists

Pathway 1 consists of oxidation of bromide ion to hypo-bromous ion by ozone and this hypo-bromous ion being further oxidized by ozone to Bromate ions.

Pathway 2 is more complicated and involves OH radicals. When ozone is dissolved in water, it forms both molecular ozone as well as OH free radicals. These OH free radicals, oxidize bromide ions to oxy bromide radicals which is further converted to bromite ions and subsequently to Bromate ions by both molecular ozone and OH free radicals

Factors that influence bromate formation during ozonation:
Many factors need to be considered if Bromate formation is to be minimized.

1. pH of the water: pH influences bromate formation. It has been found that the formation of bromates are high when the pH is alkaline rather than an acidic pH. This is because at alkaline pH, there is a high concentration of OH free radicals during ozonation. Ozonation under acidic/neutral pH is the first priority

2. **Ozone dose:** The formation of bromate ions is directly proportional to the ozone dose. The ozone dose needs to be decided upon a thorough study of the raw water analysis so that you dose only what ozone is required. The ozone dose is normally decided based on the action required. During pre-ozonation (1ppm ozone dose), the formation of bromates are insignificant when compared to the formation of THMs when pre chlorination is used. However, because of strict cryptosporidium and giardia standards often multiple location ozonation is suggested (inter-ozonation) where the ozone dose is around 2-4 ppm. This could be a contributory factor. But water treatment authorities tend to weigh the health benefits and balance the risks and benefits of drinking water disinfection. Studies have shown that prevention of cryptosporidiosis and acute gastro enteritis outweighs human loss due to premature death due to renal failure due to Bromate ions

3. **Natural Organic Matter and Inorganic carbon content of the water:** This is very important factor as it has been found that Natural organic Matter (NOM) such as humic acid etc. and inorganic carbon have direct bearing on the formation of bromate ion from bromides. Organic radical generation by decomposition of NOM appears to enhance bromate formation. These are most often difficult to keep track during ozonation

4. Temperature of water: Often determines amount of ozone required. Studies have revealed that bromate formation has found to increase during summer when the ozone doses are increased

How can Bromate ions be removed from water?

Bromates once formed are very difficult to remove. Many technologies have been unsuccessfully tried. Like THMs they are best prevented from forming by taking precautions while disinfecting

1) BAC (Bacteriologically Activated Carbon filters)
2) Reaction of water with high doses of ferrous iron (above 10 ppm)
3) UV lamps (dose required can exceed 100 times that required for disinfection)
4) Ion exchange resins, RO and UF technology

Care during ozonation: Avoid indiscriminate ozone dosing in water. Know the right dose and ensure water parameters are within control

Conclusions

Irrespective of what is being discussed on Bromate toxicity, it is undoubtedly clear that using ozone and chlorine combinations in drinking water disinfections is a safe method to reduce the THMs formed and thereby reduces the toxicity of THMs and millions of people have been benefited by this technology. Fire is very helpful to us. We use it in our everyday lives. But fire also hurts, destroys, and kills. But aren't we still using fire? The same analogy should also be applied to ozone. Designed and used well, ozone is still a very safe and useful substance.

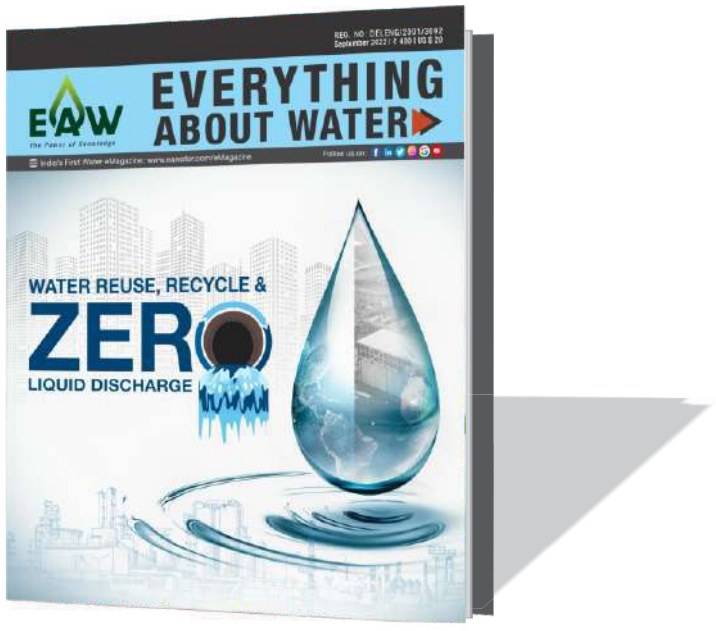
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SUSTAINABLE WATER MANAGEMENT THROUGH SPIRITUALITY AND RELIGION

By R K Khanna, Former Chief Engineer, Central Water Commission, New Delhi, India

Introduction:

Water is a basic necessity of life. It is one of the Panchmahabhutas viz earth, sky, fire, air and water. Life starts with water, with the child being given a bath, and it ends with water. So, water accompanies us throughout the journey of life.

Consumption of water has increased manifold, not only due to rise in population but also due to the so called 'improvement in lifestyle'. However, with the water scarcity increasing around the world, and water quality deteriorating fast, one wonders if the so called 'improvement in lifestyles' is actually a 'deterioration in lifestyle'.

Enough has been discussed about the conventional approach to water resources management viz technical, economic and policy related issues. A need is, therefore, felt for a different approach, comprising of spiritual and religious aspects.

Disclaimer:

The objective of the author is not to prove the superiority (or otherwise) of any religion. The idea is only to present the information regarding the water use, different practices and water management measures available/practiced in different religions.

Difference Between Spirituality And Religion:

Religion means a group of people believing in a particular faith, diktat, teacher (guru) etc. On the other hand, a spiritual person would not follow a particular religion; rather he would follow all religions viz try to adopt whatever good he finds in any religion. He would be in the quest for truth, wherever he finds it.

A religious person may have a materialistic approach to life, encouraging consumerism. Consequently, he may not be interested in conserving the natural resources, including water.

A spiritual person's approach to life would not be materialistic; it would be rather spiritual. His needs would be limited. So, he would believe in conserving the natural resources.

A spiritual person's "ecological conscience" would be awakened, but not necessarily that of a religious person.

Water Usage, Practices And Conservation Across Religions (in Alphabetical Order):

Christianity

Water is used widely in various rituals in Christianity such as Baptism. Baptism is performed by an ordained priest, by pouring water over the head of the to-be-initiated, while reciting prayers. A new borne is generally brought to church for his/her baptism, along with the parents and spiritual persons, who on behalf of the child undertakes the oath of faith. Every church has a 'baptism tank'. It is an integral part of the 10 identified areas in the church. Baptism initiates one into the Christian faith.

Holy water: Ordinary water blessed by the priest. The blessing ritual is done chanting prayers invoking events in Jesus' life. Ordinarily, the blessed holy water is kept at the doorsteps of each entry doors of the Church, and by Christians in their homes at the prayer cubicle. The faith has it that marking the doorstep with holy water keeps the evil from entering the home.

Water use and conservation:

Water bodies: Water bodies i.e., ponds attached with a temple, mosque or church used to be the traditional way of life in India. These waterbodies provided sufficient water for the religious activities and for personal hygiene. Temples and Mosques invariably need them for meeting the dictates of the religion on personal hygiene before visiting the deity. Since most Christian traditions are adapted from local dominant culture's practices, many of the old churches also had similar ponds in their compounds. One such pond that needs mention is at Palayoor Shrine in Thrissur District, Kerala, believed to have been one of the few churches set up by early Christianity of the 1st Century AD.

Hinduism (Sanatan Dharm)

Water has been treated as God in the Hindu religion and rivers revered as mother. This was to create awareness among the people regarding water conservation. Water is invariably used in almost all rituals in Hinduism. There is a vast description of water management in various scriptures.

Water management in Ramayana (Sri Ramcharitmanas, a holy book of Hindus)
When Shri Ramji (Lord Rama) visits the Pushp Vatika (a flower garden) in Janakpuri to gather flowers for his Guru (Teacher), he describes how the importance of water was recognised even in those ancient times and well-planned water management was taken up. It is described in the chapter '*Baal kaand*':

1. Nice ponds have been constructed outside Janakpuri, although a river is also flowing there. This is an example of expert water management.
2. A nice pond has been constructed inside the Pushp Vatika too.
3. When Shri Ram, Sitaji and Laxman ji depart to the forests as per the orders of their father and when the father expires, then Bharat ji is called. He goes to Ayodhya and finds that the Saryu river and the ponds are looking lifeless. It is obvious from all this that though the city of Ayodhya was established on the banks of the Saryu river, yet the ponds were also constructed. This demonstrates the importance given to water management.
4. Another example of special arrangements made for various uses of water during Ram Rajya (the times of Lord Rama) is found in the chapter 'Uttar kaand':
   Drinking water is drawn directly from the river from upper reaches, downstream of this is the place for taking bath by people of all castes and the animals drink water from the lowermost reaches.
5. When Shri Hanumanji goes to Srilanka, searching for Sitaji, he climbs on a hilltop and finds that there are many ponds and wells in the city. This is a very good example of adequate water management in Srilanka.

Water management in Shiv Puraan (a holy book of Hindus)

Gautam rishi was staying in his ashram (a place of abode of saints), doing spiritual practices along with other saints, when the rains failed for a few years and water sources dried up. Dejected, all the saints left the ashram, but Gautam rishi continued his spiritual pursuits along with his wife Ahilya. When the water in his kamandal (a

small pot of water carried by the saints), also dried up, he made special prayers to Shivji (lord Shiva). Consequently, there were good rains and all water sources filled up. Observing this, all saints who had left his ashram returned and resumed their spiritual pursuits. Even other saints also who were not getting enough water elsewhere, started staying in Gautam rishi's ashram. This resulted in water shortage and subsequently, quarrels between Rishi Gautan's wife and those of other saints. Inference is that water shortage can lead to unrest even among the saints. The lesson learnt is that adequate water resources assessment should be done while planning a habitat.

Islam

Significance of Water

It is obligatory for all concerned to distribute surplus water free of charge. Providing water is considered as sadaqah, a good deed. Some ecological hadith, or traditions attributed to Prophet Muhammad, relate to the obligation to assist the thirsty ones, whether humans or animals.

And we send water down from the sky, and allocate it on Earth, and lo! We are also able to withdraw it."

– The Holy Qur'an (23:18)

A lot of stress has been laid on preventing wastage of water such as washing cars, unnecessarily running the tap or flush toilets, taking long shower baths, excessively wash dishes. We forget about those who are in desperate need for something we often waste.

Water is a valuable resource and it is considered a great charitable act in Islam to give water to another living thing viz another human being, an animal or even a plant; these are all Allah's creations. Such act is greatly rewarded and brings us closer to Allah.

The Holy Prophet once narrated: "The best form of charity is to give someone water." Water is sometimes wasted in performing Wudu (Islamic procedure for cleansing parts of the body, a type of ritual purification, or ablution); water used should be just adequate to complete the necessary ghusl (ritual washing of the whole body).This can be done by using a small bucket of limited water to perform ablution.

"And waste not by excess, for Allah loves not the wasters."

– The Holy Qur'an (7:31)

Jainism

Lot of stress has been laid in Jainism on water conservation. The central point of Jainism is Ahinsa (non-violence). Jainism believes that there is life in water. Quoting the famous scientist Dr J C Bose, Jain scriptures say that one drop of water contains 39450 bacteria. It, therefore, preaches limited use of water for the survival of humans viz for drinking, cooking, bathing etc.

Some Jain shravaks (householders who have taken minor vows) take bath with just around 650 grams (56 Tolas) of water, by immersing a piece of cloth in water and rubbing the body with it. On the other hand, Jain munis (homeless ascetics with major vows) are not supposed to take bath at all. They just sponge their body with the minimum amount of water. To explain the concept further, Ascetics who establish themselves in pure and absolute consciousness observe complete abstinence. Those who practice the path of partial abstinence are called Shravaks.

However, no paap (sin) or himsa (violence) is considered in consuming water if it is Prasuk (pure). Several types/categories of water are described as Prasuk. Many methods are given for making the water Prasuk .This process is called Jal Gaalan.

Rainwater is supposed to be Prasuk. Warm water is also Prasuk. Fresh warm water from ponds and hilly streams is Prasuk for the purpose of toilet and bath.
Filtered water and that which is boiled and then cooled for consumption is Prasuk. In fact, Jainism advocates filtering of all fluids viz oil, milk, water etc before consumption.

Jainism also prohibits consumption of food and water after the sunset, in order to prevent killing of any life (bacteria) by oversight. Probably this rule must have been formulated long ago when electricity and artificial lights did not exist, and houses were dimly lit after the sunset. However, medical science has also found that it is a very good practice to consume food before the sunset i.e. very early to facilitate proper digestion.

Sikhism

Water is an integral part of Sikhism. A sarovar (pond) is commonly built in most of the Gurudwaras (the place of worship of Sikhs). Some of the sarovars are highly sacred like the one in Swarn Mandir, Amritsar (a highly revered Gurudwara).

Some of the sarovars have unique natural properties. For instance, water of the sarovar in Gurudwara Manikaran (in Himachal Pradesh) is so hot that if a small bag of rice is immersed in it, the same will start boiling.

Gurbaani (the sacred book of Sikhism) says
In the first place, there is life in water, by which, everything is made green. So it implies that we should conserve water, in order to save the life in it. This concept is, incidentally, same as Jainism.

Keep your mind unattached from lust, anger, greed, insistence and infatuation. This means that we should be unattached and limit our needs, thus leading to conservation of natural resources, including water.

Earning a thousand, man runs after a lakh. Satisfaction he attains not in his pursuit of wealth. Man indulges in the enjoyment of many evil passions, but he is not satiated, and kills himself by hankering after them. Without contentment, no one is sated. This also implies / advocates /stresses contentment, abhorring materialism and simplifying the lifestyle. All this would again lead to conservation of natural resources, including water.

Thus, a lot of stress is laid on water conservation in Sikhism.

Awareness Generation:

There was tremendous awareness in various religions regarding the importance of water and various rules and traditions were made so that the followers take care of the quantity and quality aspects of water. However, this wisdom was lost over time. In fact, now there is all the more need to follow those traditions, in view of the serious issues faced regarding water management.

Awareness needs to be generated among various sections of the society viz policy makers, domestic users, farmers, women (even house maids), children to take care of water related issues. Religious bodies can play an important role as people are generally God fearing and follow the dictates of religious organisations.

ABOUT THE AUTHOR

Er. R.K. Khanna, *Chief Engineer (Retd), Central Water Commission is an officer of Central Water Engineering services. He possesses 32 years of experience in various aspects of water resources development viz; Structural Design of Dams, Project Appraisal, Flood Management, Command Area Development and Environmental Management. He has worked as Member-Secretary of a number of committees on Environmental Management and Flood Management. Possessing excellent communication and editorial skills, he has contributed about two dozen technical papers in various national and international seminars. He has brought out several publications including "Guidelines for Environmental Monitoring of Water Resources Projects", commended by Chairman, Central Water Commission as a land mark publication. Er. Khanna has delivered several lectures including radio talks. He has represented CWC in several national and international seminars. He has traveled to USA, UK, Bhutan, Burma, Nepal and Iran on training and other assignments.*

Er. R.K. Khanna was the Convenor of the Workshop on "Flood Management in U.P.", the All-India Seminar on "Environmental and Social Issues in Water Resources Development" held at Lucknow during 2000 and on "Integrated Water Resources Management' at New Delhi during Dec, 2009. He co-authored and presented the theme papers in these seminars. Er. Khanna retired as Chief Engineer, Environmental Management Organisation, Central Water Commission, New Delhi in Feb 2008 and dealt with various environmental & social issues of water resources development, including environmental clearance to river valley and hydro-power projects. He contributed a paper on "Role of women in water sector", also commended by Chairman, Central Water Commission as a land mark publication.

Er. R.K. Khanna continues to be associated with various professional activities related to Water Resources and Environment. He is member, Governing Council of New Delhi Centre of World Water Council.

Er Khanna is an accredited EIA (Environmental Impact Assessment) Co-ordinator by NABET/QCI for River Valley and Hydroelectric projects.

To share your feedback or enquire about the author, write to us at **deepak.chaudhary@eawater.com**



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- Regulatory changes and new guidelines being planned / notified contact details of relevant decision - makers and project incharges.

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Authority : Chennai Metropolitan Water Supply And Sewerage Board
Address : 3rd Floor, Commissionerate Of Municipal Administration, Urban Administrative Building, Santhome High Road, Mrc Nagar, Raja Annamalaipuram , Chennai-600 028, Pincode 600028
City : Chennai
Location : Chennai | Tamil Nadu | India
Bid Open Date : 25 Jan 2023
Doc Collection Date : 24 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 2212274136020
Supplying, Laying, Jointing, Testing And Commissioning Of Second Row Of 2000mm Nominal Diameter Mild Steel Spirally Welded Pipes For Balance Portions (Gap To 7) At Different Locations Between Chembarambakkam Water Treatment Plant And Poonamallee

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Authority : Chennai Metropolitan Water Supply And Sewerage Board
Address : Office Of Superintending Engineer, Cmwssb 3rd Floor, Commissionerate Of Municipal Administration, Raja Annamalaipuram, Chennai-600 028, Pincode 600028
City : Chennai
Location : Chennai | Tamil Nadu | India
Bid Open Date : 25 Jan 2023
Doc Collection Date : 24 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 2212274137350
Supplying, Laying, Jointing, Testing And Commissioning Of Second Row Of 2000mm Nominal Diameter Mild Steel Spirally Welded Pipes For Balance Portions (Gap To 4) At Different Locations Between Chembarambakkam Water Treatment Plant And Poonamallee

OWNERSHIP:
Name : Executive Engineer
Authority : Municipal Corporation
Address : Nmc Water Works
City : Chennai
Location : Nagpur | Maharashtra | India
Bid Open Date : 09 Jan 2023
Tender Value : ₹ 34.92 Crores
Doc Collection Date : 09 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 22122727700
Development Of Infrastructure For Lifting Water From Kanhan River At Village Rohana And Conveyance To Water Treatment Plant At Godhani And Gorewada

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Authority : Chennai Metropolitan Water Supply And Sewerage Board
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City : Chennai
Location : Chennai | Tamil Nadu | India
Bid Open Date : 07 Jan 2023
Tender Value : ₹ 2.03 Crore
Doc Collection Date : 07 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 221227242420
Operation And Maintenance Of 1.60 Mld Capacity Nayan Multi Village Piped Water Supply Scheme For 31 Villages 40 Habitations Block Bajna Of District Ratlam Comprising Of Raw Water And Clear Water Pumping Stations, Water Treatment Plant ,

OWNERSHIP:
Authority : Madhya Pradesh Power Generating Company Limited
Address : O/O Se(Purchase) Sstpp, Mppgcl, Dongalia., Pincode 450112
City : Khandwa
Location : Khandwa | Madhya Pradesh | India
Bid Open Date : 13 Jan 2023
Doc Collection Date : 13 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 221227242420
Procurement Of Cctv Cameras At Main Gate, 500kld And 90kld Stp (Sewage Treatment Plant) In Mppgcl Residential Township, Sivaria.

OWNERSHIP:
Authority : Damodar Valley Corporation
Name : Se© And M), Dvc, Btps
Address : Office Of Se© And M), Btps,Dvc
Location : Bokaro | Jharkhand | India
Bid Open Date : 09 Jan 2023
Tender Value : ₹ 2.38 Lac
Doc Collection Date : 09 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 221227232630
Supply, Installation And Commissioning Of Effluent Treatment Plant (Etp) Of 3 Kld Capacity At Dvc Hospital, Btps, Bokaro, Jharkhand

OWNERSHIP:
Authority : Bharat Earth Movers Limited
Address :**********, Pincode 560001
City : Bangalore
Location : Bangalore | Karnataka | India
Bid Open Date : 07 Jan 2023
Doc Collection Date : 07 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 221227441310
Custom Bid For Services - Annual Maintenance Contract For 100kld Sewage Treatment Plant In Helicopter Mro Division

OWNERSHIP:
Authority : Zilla Parishad
Name: Prodhan Faridpur Gp
Address : Faridpur
City : Bangalore
Location : Nadia | West Bengal | India
Bid Open Date : 09 Jan 2023
Tender Value : ₹ 10.04 Lac
Doc Collection Date : 09 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 22122722360
Water Treatment Plant At Faridpur Gp Premises(15th Tied 2020 21

OWNERSHIP:
Authority : Member Secretary(Wssd),Mumbai
Name: Executive Engineer , Mjp Division , Panvel
Address : Executive Engineer , Mjp Division , Panvel
Location : Raigarh | Maharashtra | India
Bid Open Date : 09 Jan 2023
Tender Value : ₹ 1.00 Crore
Doc Collection Date : 09 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 22122727630
Operation And Maintenance Of Water Treatment Plant , Providing Pump Operators At Charlotte Lake And Providing Labours For Maintenance Of Distribution System, Recovery And Disconnection Squad And Other Allied Works At Matheran

OWNERSHIP:
Authority : National Institute Of Technology Karnataka
Name: Registrar Nitk Surathkal
Address : Nitk, Srinivasnagar Post,Mangalore - 575025
Location : Dakshina Kannada | Karnataka | India
Bid Open Date : 09 Jan 2023
Tender Value : ₹ 3.78 Lac
Doc Collection Date : 09 Jan 2023
Competition: Domestic Competitive Bidding
FTID : 221227221180
Providing Civil Repair Works At Sewage Treatment Plant S 2 Nos Of 500 Kld And 1 No. Of 220 Kld, At Nitk, Surathkal.



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EVENT CALENDAR



DECEMBER 2022

Storm Expo Asia
Wed, 07 - Thu, 08 Dec 2022
Singapore
https://www.thestormexpocalifornia.com/index.asp

E-Waste World Conference & Expo
Wed, 30 Nov - Thu, 01 Dec 2022
Germany
https://ewaste-expo.com/

KISAN Agri Show
Wed, 14 - Sun, 18 Dec 2022
Pune, India
https://krishijagran.com/events/kisan-agri-show-2022/

Hydrology & Water Resources Symposium
Wed, 30 Nov - Thu, 01 Dec 2022
Australia • Online
https://hwrs.com.au/

Digital Water Summit
29 November to 2 December
Bilbao, Spain
https://digitalwatersummit.org/

Groundwater Week 2022
6 December to 8 December
Las Vegas, Nevada, USA
https://groundwaterweek.com/

AsiaWater 2022
7 December to 9 December
Kuala Lumpur Convention Centre
Malaysia
https://www.asiawater.org/

International Water & Waste Water Exhibition (WATEX)
Fri, 30 Dec 2022 - Mon, 02 Jan 2023
Tehran, Iran
http://watex.ir/en

JANUARY 2023

Water Expo & Forum
Mon, 16 - Wed, 18 Jan 2023
Abu Dhabi, UAE
https://www.worldfutureenergysummit.com/en-gb/water.html

NEWEA Annual Technical Exhibition & Conference
Mon, 23 - Wed, 25 Jan 2023
Boston, USA
https://annualconference.newea.org/

13th IWA International Conference on Water Reclamation and Reuse
15 January, 2023 to 19 January, 2023
Chennai, India
https://iwareuse2023.com/

World Future Energy Summit
16 January, 2023 to 18 January, 2023
ADNEC, Abu Dhabi, United Arab Emirates
https://www.worldfutureenergysummit.com/en-gb/water.html

Michigan Onsite Wastewater Conference
Tue, 10 - Wed, 11 Jan 2023
Lansing, USA
https://www.canr.msu.edu/events/michigan-onsite-wastewater-conference

WWT Wastewater Conference and Exhibition
Wed, 25 - Thu, 26 Jan 2023
Solihull, UK
https://ukwir.org/wwt-wastewater-conference-exhibition-2022-25012022-birmingham

NDRWSA Water Systems EXPO
Tue, 31 Jan - Thu, 02 Feb 2023
Bismarck, USA
https://www.ndrw.org/water-expo

FEBRUARY 2023

Water & Wastewater Equipment, Treatment & Transport (WWETT Show)
Mon, 20 - Thu, 23 Feb 2023
Indianapolis, USA
https://www.wwettshow.com/en/home.html

Water Expo
Thu, 09 - Sat, 11 Feb 2023
Kochi, India
https://www.waterindia.net/

Water Today's Water Expo
Thu, 23 - Sat, 25 Feb 2023
Chennai, India
https://www.watertoday.org/

InterAqua 2023
1 February, 2023 to 3 February, 2023
Tokyo Big Sight, Japan
https://www.interaqua.jp/eng/index.html

Water & Solid Waste Expo 2023
16-18 February 2023
Pragati Maidan, New Delhi, India
https://watersolidwaste.com/

World Water-Tech Innovation Summit 2023
21 February, 2023 to 23 February, 2023
London, United Kingdom
https://worldwatertechinnovation.com/

MARCH 2023

Watertech China
Thu, 09 - Sat, 11 Mar 2023
Guangzhou, China
http://expo.watertechgd.com/

Fri, 10 - Sat, 11 Mar 2023
New England Water Well Expo
Marlborough, USA
https://www.newwassociation.org/

Netherlands Aqua Trade Fair
Tue, 21 - Thu, 23 Mar 2023
Gorinchem, Netherlands
https://expotobi.com/aqua-nederland-vakbeurs

Oman Sustainability Week (OSW)
Sun, 12 - Thu, 16 Mar 2023
Muscat, Oman
https://www.omansustainabilityweek.com/

Watercon Conference
Mon, 20 - Thu, 23 Mar 2023
Springfield, USA
https://www.isawwa.org/mpage/Microsite_Registration

Water Korea
Tue, 21 - Thu, 23 Mar 2023
Goyang-si, South Korea
http://waterkorea.kr/

Water Philippines Expo & Conference
Wed, 22 - Fri, 24 Mar 2023
Pasay, Philippines

Watertech China
Thu, 09 - Sat, 11 Mar 2023
Guangzhou, China
http://expo.watertechgd.com/

Fri, 10 - Sat, 11 Mar 2023
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Marlborough, USA
https://www.newwassociation.org/

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https://expotobi.com/aqua-nederland-vakbeurs

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https://www.omansustainabilityweek.com/

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https://www.isawwa.org/mpage/Microsite_Registration

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Tue, 21 - Thu, 23 Mar 2023
Goyang-si, South Korea
http://waterkorea.kr/

Water Philippines Expo & Conference
Wed, 22 - Fri, 24 Mar 2023
Pasay, Philippines
https://www.waterphilippinesexpo.com/

Waptema Water Expo
March 3 - 5, 2023
Netaji Subhash Place, Pitampura, New Delhi
https://waptema.in/

Water India
Mon, 23 - Wed, 25 Mar 2023
New Delhi, India
https://www.waterindia.com/

KRWA Conference & Exhibition
Tue, 28 - Thu, 30 Mar 2023
USA
https://www.krwa.net

Canadian Underwater Conference and Exhibition (CUCE)
Sun, 26 - Tue, 28 Mar 2023

EVENT CALENDAR



APRIL 2023

Smart Water Systems
Mon, 17 - Tue, 18 Apr 2023
London, UK
https://www.smartwater.com/

WQA Convention and Exposition
18 April, 2023 to 20 April, 2023
Las Vegas, United States
https://www.wqa.org/convention/

Texas Water
Tue, 11 - Fri, 14 Apr 2023
Houston, USA
https://www.txwater.org/

MAY 2023

AZ Water Conference & Exhibition
Tue, 09 - Thu, 11 May 2023
Phoenix, USA
https://www.azwater.org/

Ozwater 2022
10 May, 2023 to 12 May, 2023
Brisbane Convention & Exhibition Centre
Australia
https://www.ozwater.org/

Watrex Expo
Mon, 15 - Wed, 17 May 2023
Cairo, Egypt
https://waterxexpo.com/

Trenchless Asia
17 May, 2023 to 18 May, 2023
Kuala Lumpur Convention Centre, Malaysia
https://www.trenchlessasia.com/

Water and Plumb Skills Expo
18 May 2023 – 19 May 2023
Pragati Maidan, New Delhi, Delhi
https://www.plumbskillsexpo.com/

JUNE 2023

Smart Water Systems
Mon, 17 - Tue, 18 Apr 2023
London, UK
https://www.smartwater.com/

WQA Convention and Exposition
18 April, 2023 to 20 April, 2023
Las Vegas, United States
https://www.wqa.org/convention/

Texas Water
Tue, 11 - Fri, 14 Apr 2023
Houston, USA
https://www.txwater.org/

JULY 2023

West Africa Water Expo (WAWE)
Tue, 11 - Thu, 13 Jul 2023
Lagos, Nigeria
https://elanexpo.net/waweexpo/

AUGUST 2023

The Water Expo
Wed, 23 - Thu, 24 Aug 2023
Miami, USA
https://www.thewaterexpo.com/

18th EverythingAboutWater Expo 2023
Thu, 24 – Sat, 26 Aug 2023
Pragati Maidan, New Delhi
www.eawaterexpo.com

SEPTEMBER 2023

Water Indonesia
Wed, 13 - Sat, 16 Sep 2023
Jakarta, Indonesia
https://www.waterindonesiaexpo.com/

THAI WATER
Wed, 30 Aug - Fri, 01 Sep 2023
Bangkok, Thailand
https://www.thai-water.com/

SR Onshore Wind Conference
Wed, 06 Sep 2023
Glasgow, UK
https://www.scottishrenewables.com/

Gat Wat
Wed, 06 - Thu, 07 Sep 2023
Cologne, Germany
https://www.gat-wat.de/

WasteEcoExpo
Tue, 12 Sep 2023
Krasnogorsk, Russia
https://en.waste-tech.ru/

Taiwan International Water Week
Wed, 20 - Fri, 22 Sep 2023
Taipei, Taiwan
https://www.taiwanintlwaterweek.com/

WCW Conference & Exhibition
Mon, 25 - Thu, 28 Sep 2023
Saskatoon, Canada
https://www.wcwwa.ca/page/AnnualConf

OCTOBER 2023

Wetex
Mon, 02 - Wed, 04 Oct 2023
Dubai, UAE
https://www.wetex.ae/

IFAT India
Wed, 18 - Fri, 20 Oct 2023
Mumbai, India
https://www.ifat-india.com/

Pak Water & Energy Expo
Wed, 25 - Fri, 27 Oct 2023
Lahore, Pakistan
https://pakwaterexpo.com/

AWT Convention and Exposition
Wed, 04 - Sat, 07 Oct 2023
Grand Rapids, USA
https://www.awt.org/events/annual-convention/

Envitech
Tue, 10 - Fri, 13 Oct 2023
Brno, Czech Republic
http://envitech.co.in/

VietWater
Wed, 11 - Fri, 13 Oct 2023
Ho Chi Minh, Vietnam
https://www.vietwater.com/en/

Water In Industry
Tue, 31 Oct 2023
Moscow, Russia
https://www.aquatechtrade.com/news/industrial-water/

NOVEMBER 2023

Aquatech Amsterdam
6 November, 2023 TO 9 November, 2023
RAI, Amsterdam, Netherlands
https://www.aquatechtrade.com/amsterdam/

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Date: 16-18 January 2023
Venue: ADNEC, Abu Dhabi Convention Centre
Website: https://www.worldfutureenergysummit.com/



Water & Waste Expo 2023

Confederation of Indian Industry (CII) is pleased to announce its second edition of Water & Solid Waste Expo 2023 schedule from 16 to 18 February 2023 at Pragati Maidan, New Delhi. This would be a co-located event alongside CII's 25th edition of its flagship event, International Engineering and Technology Fair (IETF 2023).

Water & Solid Waste Expo 2023 is a biannual event and aims at providing an excellent international platform, to showcase the full range of environmental technologies including water, sewage, refuse, recycling, and energy conservation management in India, focusing on basic to highly sophisticated machinery and environmental solutions from domestic and international exhibitors.



Date: 16-18 February 2023
Venue: Pragati Maidan, New Delhi
Website: https://watersolidwaste.com/

InterAqua 2023

The 14th International Water Solution Exhibition, is a unique exhibition for water industry which will showcase a material, component, and apparatus which are indispensable in the process of water reuse, industrial cleaning, drainage, and recycle use for water and its energy saving and cost reduction.

Against the backdrop of the ever-growing global need for quantitative and qualitative solutions in the water industry, various key players from Japan and overseas will gather to open up a path to the next generation in water-related business.

The three-day exhibition will offer an opportunity for participants to sow seeds of innovation, seek out technological cooperation and engage in business alliances through consultations and networking.



Date: 01-03 February 2023
Venue: Tokyo Big Sight, Japan
Website: https://www.interaqua.jp/

18th EverythingAboutWater Expo 2023

18th EverythingAboutWater Expo 2023 is one of the most unique & comprehensive annual events in India showcasing the latest technologies & solutions in the water sector. Also, recognized as South Asia's largest water event during recent times, this is a perfect gateway for stakeholders from across the globe to penetrate into the vast & dynamic ecosystem of the Indian Water & Waste management industry to share business opportunities, network & explore innovative water solutions.

The 18th EverythingAboutWater Expo 2023 will offer unparalleled business opportunities to both national as well as international players from the water industry to learn, explore the future trends in the Indian water market

Date: 03-05 August 2023
Venue: Pragati Maidan,
New Delhi, India
Website: www.eawaterexpo.com



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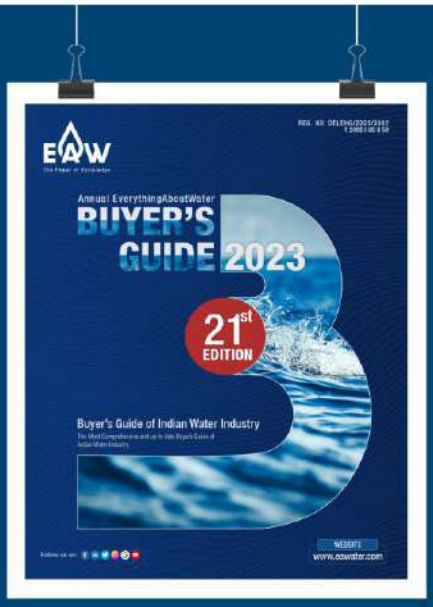
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8. AMR (Automatic Meter Reading)
9. Analyzers
10. Antiscalants
11. Automation Control Systems
12. Backflow Prevention
13. Biological Treatment
14. Bioremediation
15. Blow Molding
16. Blowers
17. Boilers – Chemicals / Components / Plants
18. Bottling – Equipment / Plants / Caps
19. Brine Systems / Equipment
20. Carbon – Activated / Granular Activated
21. Carbon Filtration Equipment
22. Cartridges
23. Centrifuges
24. Chemicals
25. Chemical Feed
26. Chemical Water Treatment
27. Chillers
28. Chlorinators
29. Chlorine – Testing Equipment
30. Clarifiers
31. Coagulators
32. Coatings / Linings
33. Compressors
34. Computer Software
35. Conductivity
36. Connectors
37. Consultants
38. Control – Equipment / Panels / Regulators
39. Cooling / Chilling Plants
40. Cooling Towers
41. Cooling Water – Chemical/ Treatment
42. Corrosion Control
43. Couplings
44. DAF Systems
45. Data – Acquisition / Transmission / Equipment
46. Dealkalizers
47. Dechlorinators
48. Degasifiers
49. Deionizers
50. Demineralisation Plants
51. Demineralized Water Systems
52. Desalination – Equipment / Systems / Plants
53. Detectors / Monitors / Recorders
54. Dewatering – Equipment / Services / Supplies
55. Diffusers
56. Disinfection – Equipment / Systems
57. Distillation Units
58. Drainage
59. Dredging – Equipment / Services / Systems
60. Drilling / Boring – Equipment / Supplies
61. Drinking Water Systems
62. Drives
63. Education / Training
64. Effluent Treatment – Chemicals
65. Effluent Treatment – Equipment / Plants
66. Ejectors
67. Electrical Accessories / Equipment
68. Electro Magnetic Treatment
69. Electrocoagulation
70. Electrodeionization
71. Electrodes
72. Electrodialysis
73. Energy Management Systems
74. Engineering Services
75. Erosion Control Products
76. Evaporators
77. Fasteners
78. Faucets
79. Feeders
80. Filter – Aids
81. Filter – Cartridges
82. Filter – Housings
83. Filter – Media
84. Filter – Presses
85. Filters
86. Filtration – Crossflow
87. Filtration – Micro
88. Filtration – Nano
89. Filtration – Systems/ Plants
90. Fittings & Connectors
91. Flocculants
92. Flow Controls
93. Flow Measuring Equipment
94. Fountains
95. Gaskets / Flange Adaptors / Jacks / Sealing Compounds
96. Gauges
97. GIS (Geographic Information System)
98. Greywater / Gray Water
99. Groundwater – Monitoring
100. Groundwater – Treatment
101. Heat Exchangers
102. Heaters / Geysers / Heating Elements
103. High Pressure Cleaning Systems
104. High Purity Water Systems
105. Hose / Hose Accessories
106. Housings
107. Hydropneumatic Systems
108. Hypochlorination
109. Impellers
110. Incinerators
111. Indicators
112. Industrial Wastewater Treatment
113. Industrial Water Treatment
114. Injection Equipment
115. Instrumentation – Analytical
116. Instrumentation – Field Use
117. Instrumentation – Flow
118. Instrumentation – Lab Use
119. Instrumentation – Recording
120. Instrumentation – Water & Wastewater
121. Iodinated Resin
122. Ion Exchange – Equipment / Media / Supplies / Systems
123. Irrigation – Equipment / Systems
124. Joints / Jointing Materials
125. Lamps, Sterilizing
126. Leak Detection – Equipment / Systems
127. Level Controllers
128. Locators
129. Magnetic Conditioners
130. Membrane – Bioreactors (MBR)
131. Membrane – Cleaning
132. Membrane – Degasifiers
133. Membrane – Diffusers
134. Membrane – Filtration
135. Membrane – Housings / Systems
136. Membrane – Microfiltration
137. Membrane – Nanofiltration
138. Membrane – Pre–treatment Systems
139. Membrane – Reverse Osmosis
140. Membrane – Treatment Systems
141. Membrane – Ultrafiltration
142. Membranes
143. Meters – Flow
144. Meters – Water
145. Mineral Water – Plants / Suppliers
146. Mixers – Equipment / Systems / Agitators
147. Monitors
148. Motors
149. Neutralizers
150. Nozzles
151. Odour Control Systems
152. Oil & Water Separators / Skimmers
153. On Site Wastewater Systems
154. Ozone Generators / Ozonators
155. Ozone Systems
156. Packaged Treatment Plants – Water / Wastewater
157. pH – Adjustment / Analyzers
158. Pipes / Pipe Fittings
159. Plumbing – Accessories / Fixtures / Tools
160. Pond / Lake Management
161. Portable Purifying Units
162. Precipitators
163. Pressure Switches
164. Pressure Tanks
165. Pressure Vessels
166. Probes / Sensors / Transducers
167. Process Control / Data Management Systems
168. Public Water Services Management
169. Pumps – Booster
170. Pumps – Centrifugal
171. Pumps – Dosing
172. Pumps – High Pressure
173. Pumps – Sewage
174. Pumps – Submersible
175. Pumps / Pump Spares / Services
176. Rainwater Harvesting Systems
177. Reclamation Systems
178. Regeneration Equipment
179. Regulators
180. Removal – Ammonia
181. Removal – Arsenic
182. Removal – Bacteria
183. Removal – Chlorine
184. Removal – Colour
185. Removal – Grit
186. Removal – Hydrogen Sulfide
187. Removal – Inorganic Contaminants
188. Removal – Iron
189. Removal – Lead
190. Removal – Manganese
191. Removal – Metal
192. Removal – Nitrate
193. Removal – Phosphate
194. Removal – Rust
195. Removal – Scale
196. Removal – Sludge
197. Removal – Sulphur
198. Resins
199. Reverse Osmosis (RO) – Components / Equipment / Housings / Systems
200. RO Cabinets
201. RO Plants – Commercial
202. RO Plants – Domestic
203. RO Plants – Industrial
204. Sanitary Ware
205. Sanitizers
206. SCADA
207. Screens / Screening Systems
208. Scrubbers
209. Sedimentation
210. Sensing Equipment / Sensors
211. Separators
212. Sequencing Batch Reactors
213. Sewage – Ejection Systems
214. Sewage Treatment – Equipments / Plants
215. Sewer – Rehabilitation
216. Sewer – Vacuum / Flushing
217. Silver Disinfection
218. Sludge – Disposal
219. Softeners – Components / Accessories / Systems
220. Solenoids
221. Sterilizers
222. Storm Water Management
223. Strainers
224. Surface Water Equipment
225. Surge Control
226. Swimming Pool Related Products
227. Switches
228. Tanks
229. TDS Indicators
230. Testing – Equipments / Kits / Labs / Services
231. Transducers
232. Trenchless Technology
233. Tubes / Tube Fittings
234. Turbidimeters
235. Turnkey Projects
236. Ultrafiltration Systems
237. Ultrapure Water Systems
238. Ultraviolet (UV) Systems
239. Valves – Equipment / Supplies
240. Variable Frequency Drives
241. Wastewater
242. Wastewater – Collection Treatment
243. Wastewater – Package Plants
244. Wastewater – Treatment Components / Plants / Systems
245. Water – Analysis
246. Water – Audits
247. Water – Conditioners
248. Water – Conservation
249. Water – Coolers
250. Water – Dispensers
251. Water – Distribution
252. Water – Proofing
253. Water – Purification
254. Water – Purifiers
255. Water – Quality
256. Water – Recycling / Reuse
257. Water – Standards
258. Water – Suppliers
259. Water – Treatment Components / Plants / Systems
260. Water / Wastewater Association
261. Water Vending Machines
262. Zero Liquid Discharge Systems
263. OTHER: (please write): .....

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WE HAVE IN DEPTH KNOWLEDGE OF INDIAN WASTE WATER PROBLEMS FROM VARIOUS INDUSTRIES LIKE.

- Agrochemical Industries
- Chemical Industries
- Edible Oil Industries
- Steel Industries
- Food Industries
- RO Reject Water
- Pharma Industries
- Edible Oil Industries
- Zero Liquid Discharge

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