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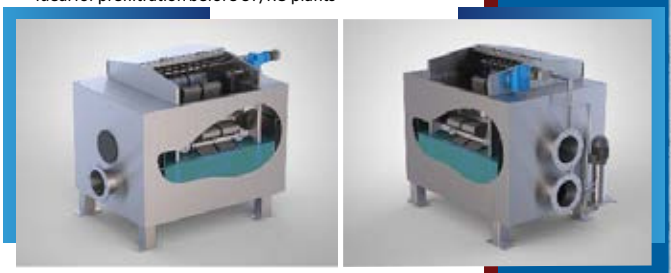
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SEAWATER DESALINATION IN INDIA: A PROMISING SOLUTION TO WATER SCARCITY



India, a country with a rapidly growing population and increasing water demand, is facing a significant challenge in meeting its water needs. With a diverse climate and uneven distribution of rainfall, water scarcity has become a pressing issue in many regions. In recent years, seawater desalination has emerged as a viable solution to alleviate water stress in coastal areas.

Seawater desalination is the process of removing salt and other impurities from seawater, making it suitable for human consumption and agricultural purposes. This technology has gained worldwide recognition as an effective means of obtaining freshwater from an abundant resource – the oceans. Desalination plants typically employ either reverse osmosis (RO) or thermal-based processes to convert seawater into potable water.

India's vast coastline of approximately 7,500 kilometers presents a significant opportunity for seawater desalination projects. Several regions, such as Gujarat, Tamil Nadu, and Maharashtra, face acute water scarcity despite being near the sea. Seawater desalination can offer a sustainable and reliable source of freshwater, especially in these coastal areas where alternative water sources are limited.

The advantages of Seawater Desalination are multi fold:
Water Security: Seawater desalination provides a reliable and continuous supply of freshwater, reducing dependency on rainfall and conventional water sources. It ensures water security and reduces the vulnerability of coastal communities to droughts and water shortages.

Diversification of Water Sources: By tapping into the ocean's vast reserves, seawater desalination diversifies India's water sources, reducing stress on rivers, lakes, and groundwater aquifers. This diversification can help in conserving precious freshwater resources and ensure their sustainable use.

Economic Development: Seawater desalination projects have the potential to create job opportunities and stimulate economic growth in the regions where they are implemented. The establishment of desalination plants can attract investment, promote local industries, and provide skilled employment.

Environmental Sustainability: While seawater desalination requires energy for its operations, the environmental impact can be mitigated through the use of renewable energy sources. Integration with solar power and other sustainable energy solutions can minimize the carbon footprint associated with desalination plants.

Despite the numerous advantages, seawater desalination in India also faces certain challenges that need to be addressed:

1. Cost: Desalinated water is generally more expensive compared to traditional freshwater sources. The high capital and operational costs associated with desalination plants pose a financial burden, requiring careful planning and cost-effective implementation strategies.
2. Environmental Concerns: Discharge of concentrated brine, a byproduct of desalination, can harm marine ecosystems if not properly managed. Implementing effective brine disposal techniques and monitoring systems are crucial to minimize environmental impacts.
3. Energy Consumption: Seawater desalination is an energy-intensive process. To make it sustainable, it is essential to explore renewable energy options such as solar and wind power to power desalination plants and reduce reliance on fossil fuels.

To overcome these challenges, a comprehensive approach involving government support, private sector participation, and technological advancements is required. Investments in research and development can drive innovation and lead to more efficient and cost-effective desalination technologies.

Seawater desalination holds great promise for addressing the water scarcity challenges in India, particularly in coastal regions. By harnessing our abundant seawater resources, we can secure a reliable source of freshwater, support economic growth, and improve the quality of life for millions of people. However, realizing the full potential of desalination requires concerted efforts from the government, private sector, and research institutions. By investing in innovative technologies, sustainable practices, and integrated water management strategies, we can overcome the challenges and pave the way for a water-secure future in India.

Thanks & regards,

Deepak Chaudhary

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FEDCO CEO ELI OKLEJAS WINS INDUSTRY-LEADING INNOVATION AWARD

FEDCO is thrilled to announce that our founder and CEO Eli Oklejas has been awarded joint first place in the Miriam Balaban Innovation Award at the 2023 European Desalination Society (EDS) Congress in Limassol, Cyprus. Eli Oklejas accepted the award during the event's closing ceremony on May 26th. The award is sponsored by ACWA Power, a global leader in desalination and solar power technology, and recognizes outstanding technological innovation in desalination.

Eli Oklejas' submission showcased the groundbreakingBiTurbo brine-staged reverse osmosis and was judged joint winner out of the 7 finalists competing for the award. The BiTurbo uses commercially available equipment in a patented configuration to deliver optimal membrane performance and higher water production, without increasing the feed flow to a desalination system.

The BiTurbotechnology has been deployed in five installations to date in Saudi Arabia, Mexico and Indonesia, for applications including brine mining, tourism and agriculture. This innovation brings down the cost and environmental impact of seawater desalination and has been used in pioneering brine mining applications in Saudi Arabia.

Eli Oklejas, who founded FEDCO in 1997, has led the company's innovative desalination technologies for over 25 years. FEDCO's success and recognition in the Miriam Balaban Innovation Award further solidify their position as a global leader in the field.

Eli Oklejas commented, "Receiving the Miriam Balaban Innovation Award is a special thrill for me and the entire FEDCO team given the gold standard of dedication and accomplishment set by Miriam Balaban herself in the desalination world. We believe that our submission – the BiTurbo RO technology – represents a crucial step forward for our industry in delivering sustainable, affordable water."

Eli Oklejas came in joint first place for the award tied with Carmelo Morgante (University of Palermo), who presented an innovative approach to membrane fabrication to produce a positively charged nanofiltration (NF) membrane. Carmelo Morgante's technology offers the potential for more targeted ion extraction, allowing more efficient and economical brine mining for elements such as magnesium.

The seven finalists, shortlisted from 44 applicants, each gave a five-minute presentation on their submissions and took part in a panel discussion chaired by Nikolai Voutchkov (ENOWA/NEOM) and Domingo Zarzo (Sacyr Agua). The winner was announced during the 2023 EDS Congress closing ceremony on May 25th by the award sponsor, ACWA Power.

TIWW 2023 RETURNS WITH A LARGER SCALE AND WIDER REACH

Taiwan International Water Week (TIWW), hosted by Taiwan External Trade Development Council, TAITRA, will open at Taipei World Trade Center Hall 1 from September 20th to 22nd, 2023. The exhibition is Taiwan's foremost B2B water tradeshow, displaying total solutions and applications of water transportation, storage, reclamation, purification, management, recycling, engineering and infrastructure. TIWW is still accepting booth space application, and the space is limited! Join now and become an active participant in the booming water resources market in Asia.

According to the Climate Change 2023 report by the Intergovernmental Panel on Climate Change (IPCC), global temperature will be expected to rise 1.5°C in the next decade, exacerbating the occurrence of global heat waves, storms, and droughts. Moreover, Taiwan has not seen a typhoon make landfall on the island since August 2019, leading to water shortage issues in the southern region, which relies on April showers, plum rain—the rain in the fourth and fifth lunar month, and post-typhoon rain for clean water.

Since extreme climate conditions and unpredictable rainfall has become a "New Normal", locating new water sources and reducing water consumption have become urgent priorities. The government of Taiwan plans to implement the amendment of "Reclaimed Water Resources Development Act" in July 2023, and complete 11 water reclamation plants by 2031. This initiative is expected to increase daily water supply by 289,000 tons and drive business opportunities in various energy-saving and environmental protection projects, as well as water reclamation and purification equipment, technology, and solutions throughout Taiwan.

In compliance with government policies and industry trends, TIWW 2023 features six exhibit areas: "Reclaimed Water & Treatment," "Transport &

Storage," "Smart Water Technology," "Water Purification Equipment & Drinking Water," "Process Control Technology & Automation," and "Water Environment & Other Services." These areas showcase the complete water ecosystem for visitors from around the world. Additionally, there will be various highlighted events during the exhibition such as international forums, seminars, new product launches, and business meetings.

TIWW 2023 has attracted government authorities, research institutes, and industry associations such as the Water Resources Agency, Public Works Department of Taipei, Department of Water Resources of Taoyuan, Industrial Technology Research Institute, Functional Water Association of Taiwan, Taiwan Environmental Manufacturers Association, Taiwan Fine Bubble Industries Association, as well as domestic heavyweights such as Sunny King Machinery, Gung Dai Technology, and LCY Group. Prominent foreign suppliers such as Fluence from the United States, Johnson Screens from Australia, Veolia from France, and AVK Valves from Denmark have also participated in this phenomenal show, bringing new products and technologies.

MASSIVE EXPANSION OF KSB CHEMICAL PUMP SERIES

KSB SE & Co. KGaA has added 19 sizes to its MegaCPK type series. This means that users can now choose from 55 sizes with more than 78

hydraulic systems for these standardised chemical pumps. The available materials of grey cast iron, nodular cast iron and cast steel, stainless steel as well as duplex and special alloys, such as titanium and Hastelloy, result in a very wide range of applications. Fluids that require heating or cooling can also be handled.

The pumps are characterised primarily by their high output per size and their low energy consumption. Not only does save on electricity consumption, it also reduces the user's initial investment costs. KSB's developers have placed particular emphasis on good suction behaviour, with a low NPSH value in order to minimise the risk of cavitation. This enables smooth and stable pump operation even under difficult operating conditions. It also ensures a high degree of reliability and improves the availability of an entire system.

By using the finite element method (FEM), a calculation method for the simulation of solids, the developers were able to achieve a high degree of strength and rigidity of the installed components, while at the same time optimising the use of materials. After optimising all hydraulic contours using computational fluid dynamics (CFD), the improvements were verified in extensive test set-ups.

The new seal chamber design allows the installation of gland packings, all common mechanical seals compliant with EN 12756, as well as a large number of cartridge-type mechanical seals. Fully confined casing gaskets and minimised axial thrust ensure long service life. To control and monitor operation, the pumps can be equipped with speed control, vibration and bearing temperature measurement and operating point monitoring.
In line with KSB's common practice for industrial pumps, every pump is supplied to the customer with the impeller diameter trimmed exactly to the duty point. Impeller trimming, combined with the large range of pump sizes, helps ensure that the pump's energy consumption is kept to the minimum necessary, even when run at fixed speed.

BENTLEY SYSTEMS ANNOUNCES ITWIN ACTIVATE: INFRASTRUCTURE INTERNET OF THINGS

Co-development Program to Accelerate Infrastructure Engineering Software Startups Focused on Infrastructure IoT Solutions

EXTON, Pa. – June 1, 2023 – Bentley Systems, Incorporated (Nasdaq: BSY), the infrastructure engineering software company, today announced the launch of iTwin Activate, a 20 week co-development program designed to accelerate early-stage startups in infrastructure engineering software. The program, which is organized in cohorts aligned to industry sectors, is managed by Bentley iTwin Ventures, a $100 million corporate venture capital fund that fosters innovation by co-investing in startups and emerging companies.

The iTwin Activate program supports startups in scoping and building industry relevant solutions by leveraging or interoperating with Bentley technology through program and co-development funding, solutions architecture support, and access to Bentley executives for commercial insights. Tom Kurke, Bentley's Vice President of iTwin Ventures, said, "Our first cohort was a small, invitation-only group of four startups focused on the electric grid industry. We were excited to see the innovative solutions that the startups built incorporating our technology. The projects serve as powerful examples of new capabilities that arise from these collaborations, and in some cases we are already seeing our shared users benefit from these new tools and the efficiencies they unlock."

iTwin Activate Cohort #1 – Grid supported four startups: Spatial Data.AI, Virtual Technology Simplified, Rebase Energy, and SurPlus Maps.

Spatial Data AI's solution automates the processing of LiDAR data from point clouds into ready-to-use vector formats, including SPIDAcalc models and various other CAD formats. This project focused on building a connector to Bentley's pole analysis solution (SPIDAcalc). Spatial Data founder Doug Culbert said, "Participating in the iTwin Activate program supported the automated development of a design-centric digital twin for electrical distribution and telecommunications companies. The outcome of this initiative advanced our technical solution and expanded our service offerings in these markets. Spatial Data would like to thank the

Bentley team for this accelerator program and is excited to continue co-developing products and services, enabling digital transformations across the infrastructure sector."

Virtual Technology Simplified (VTS) enables tablet and phone data capture of utility assets and developed a data mobility and visualization solution on the iTwin Platform. John Chwalibog, founder and CEO of VTS, said, "For us at VTS, two things particularly jumped out. One was that the VTS development team had access to Bentley's team of SME's who could help us identify problems and collaborate with us to find solutions to any technical issues that came up throughout the project. Second was the team of people that came together over the course of the cohort. They were able to address the challenges all startups face when going from startup to funded company. We would highly recommend the program to other startups in the geospatial community as the experience was extremely positive for the entire VTS team."

iTwin Activate Cohort #2 will focus on solutions for Infrastructure Internet of Things (IIoT) use cases and is open for all interested parties to apply. Cory Baldwin, Bentley's Vice President of Infrastructure IoT, described his goals for this cohort. "We are excited to work with startups in the IoT space and build technology and partnerships together to solve the needs of the infrastructure sector. We are particularly interested in working with teams focused on creating predictive analytics or deriving insights from the sensor data federated in the iTwin Platform, as well as those creating novel sensors or sensing technologies that can be brought into our digital twin ecosystem as part of a software-led motion."

If you are a team building infrastructure IoT solutions and would like to be considered for participation in the iTwin Activate Cohort #2, we encourage you to apply at https://bentleyitwinventures.com/itwinactivate/. Applications will be open through June 16, 2023, and we anticipate notifying participants of their application status by June 23, 2023. We expect to announce iTwin Activate Cohort #3, focusing on generative artificial intelligence for infrastructure use cases, in summer of 2023.

LANXESS ACHIEVES EARNINGS ACCORDING TO FORECAST IN THE FIRST QUARTER OF 2023

Mumbai, May 15, 2023 – The specialty chemicals company LANXESS has achieved its forecast earnings for the first quarter of 2023: EBITDA pre exceptionals came to EUR 189 million, within the range of EUR 180 million to EUR 220 million forecast in March. Compared with the previous year's figure of 262 million euros, earnings thus declined by 27.9 percent. Sales remained almost stable. They amounted to EUR 1.899 billion, down only 1.7 percent from the previous year's figure of EUR 1.931 million.

Earnings were squeezed in particular by weak demand in some customer industries, especially in construction, and continued destocking by many customers. This was particularly noticeable in the Advanced Intermediates and Specialty Additives segments. The Consumer Protection segment proved robust in comparison, with sales and earnings increasing despite slightly lower sales volumes. The Microbial Control business acquired from the U.S. company IFF in mid-2022 made a particularly positive contribution. LANXESS again successfully passed on the increased raw material and energy costs and benefited from positive currency effects in all segments.

Free cash flow improved significantly by EUR 264 million year-on-year and amounted to EUR 112 million. This was supported by stable working capital despite a seasonal increase pattern. Net income fromcontinuing operations reached EUR 10 million in the first quarter after EUR 66 million in the previous year. The EBITDA margin pre exceptionals came to 10.0 percent, against 13.6 percent a year ago.

"As expected, 2023 will be a tough year for the chemical industry and for LANXESS. Our figures for the first quarter make this very clear. It was therefore all the more vital that we transfered our high-performance plastics business to a joint venture as planned on April 1. We thus geared our portfolio further toward specialty chemicals and strengthened our balance sheet. This makes us even more resilient in the current difficult waters," says Matthias Zachert, CEO of LANXESS AG. "However, I expect the economic situation to brighten considerably in the second half of the year, which will also be reflected in our earnings."

For the coming months, LANXESS anticipates an economically challenging environment still characterized by high levels of uncertainty. The Group therefore expects earnings in the second quarter of 2023 to be roughly on a par with those of the first quarter. For the second half of the year, LANXESS expects a clear rebound of earnings based on a pick-up of the global economy and, in particular, a positive development of the Chinese market. Against this backdrop, the Group expects EBITDA pre exceptionals of between EUR 850 million and EUR 950 million for the full financial year 2023.

Focus on specialty chemicals sharpened further

LANXESS has continued to sharpen its focus on specialty chemicals and transferred its High Performance Materials (HPM) business unit to a joint venture with the private equity investor Advent International on April 1, 2023. The joint venture for high-performance engineering polymers is called Envalior and, alongside HPM, also comprises the former Engineering Materials business from DSM. LANXESS has a stake of around 40 percent in Envalior, Advent around 60 percent. As part of the transaction, LANXESS received a payment of around EUR 1.27 billion from Advent on March 31. The Group will use this primarily to reduce debt and thus strengthen its balance sheet.

Segments: Consumer Protection proves robust

Sales of the Consumer Protection segment amounted to EUR 647 million in the first quarter, up 27.9 percent on the previous year's figure of EUR 506 million. EBITDA pre exceptionals reached EUR 94 million, growing

by 9.3 percent compared to the previous year's figure of EUR 86 million. The segment benefited in particular from the contribution of the Microbial Control business acquired from IFF in July 2022. All the segment's business units also achieved higher selling prices. Lower sales volumes and a supplier's delivery problems had a negative impact on earnings. The EBITDA margin pre exceptionals amounted to 14.5 percent, against 17.0 percent a year ago.

Compared with a very strong prior-year quarter, sales in the Specialty Additives segment declined by 9.0 percent from EUR 730 million to EUR 664 million in the first quarter. EBITDA pre exceptionals decreased by 27.9 percent from EUR 136 million to EUR 98 million. Earnings were constrained in particular by weaker demand from the construction and automotive industries. Volumes fell short of the prior-year quarter in all business units of the segment. Earnings were also reduced by a weather-related production facility shutdown in the U.S. and higher freight costs. The EBITDA margin pre exceptionals was 14.8 percent, against 18.6 percent in the prior-year quarter.

Weaker demand, especially from the construction and chemical industries, and lower sales volumes negatively affected the Advanced Intermediates segment's sales and earnings. At EUR 516 million, sales in the first quarter were 15.8 percent lower than the previous year's figure of EUR 613 million. EBITDA pre exceptionals amounted to EUR 44 million, down by 49.4 percent from the previous year's figure of EUR 87 million. The EBITDA margin pre exceptionals was 8.5 percent, against 14.2 percent in the prior-year quarter.

LANXESS is a leading specialty chemicals company with sales of EUR 8.1 billion in 2022. The company currently has about 13,200 employees in 33 countries. The core business of LANXESS is the development, manufacturing and marketing of chemical intermediates, additives and consumer protection products. LANXESS is listed in the leading sustainability indices Dow Jones Sustainability Index (DJSI World and Europe) and FTSE4Good.

Forward-Looking Statements

This company release contains certain forward-looking statements, including assumptions, opinions, expectations and views of the company or cited from third-party sources. Various known and unknown risks, uncertainties and other factors could cause the actual results, financial position, development or performance of LANXESS AG to differ materially from the estimations expressed or implied herein. LANXESS AG does not guarantee that the assumptions underlying such forward-looking statements are free from errors, nor does it accept any responsibility for the future accuracy of the opinions expressed in this presentation or the actual occurrence of the forecast developments. No representation or warranty (expressed or implied) is made as to, and no reliance should be placed on, any information, estimates, targets and opinions contained herein, and no liability whatsoever is accepted as to any errors, omissions or misstatements contained herein, and accordingly, no representative of LANXESS AG or any of its affiliated companies or any of such person's officers, directors or employees accepts any liability whatsoever arising directly or indirectly from the use of this document.

SEWAGE TREATMENT SYSTEM UPGRADE: OFFICIAL REVIEWS PROJECT STATUS

Greater Mohali Area Development Authority (GMADA) is working to upgrade the existing sewage treatment plant (STP) and construct a new sewage treatment plant in the city to reduce the dependence on groundwater and make tertiary water available for non-potable activities such as washing, flushing, construction etc.

GMADA's Chief Administrator, Rajiv Kumar Gupta, inspected the site in Sector 83 to review the status of these projects on Saturday. The work of upgrading the sewage treatment plant with the existing capacity of 10 mgd to 15 mgd is in process.

The engineering team that accompanied Kumar apprised him that to treat the sewage water originating from sectors 53-82, a sewage treatment plant of 10 MGD capacity was already in place in sector 83, but considering future needs the work to upgrade this STP was started.

The engineering wing said that the work was halfway through and would be completed by the end of this year. On completion, tertiary water for non-potable activities will be available to the residents.

The administrator asked the engineering wing to meet the deadline of the project so that residents will be benefitted to the earliest.

Kumar also paid a visit to Aerocity, where the work to design and construct a 15 mld capacity main pumping station, 10 mld capacity sewage treatment plant and a 5 mld capacity tertiary treatment plant was being executed.

The engineering team said that this project is expected to complete by July 31 this year. The residents of Aerocity after that would be able to use this tertiary water for construction, washing of vehicles, gardening, etc. It would further reduce dependence on groundwater, besides saving the natural resources from getting polluted because of use of untreated water used for such purposes.

The official stated that to provide world class amenities to the residents, GMADA was executing different projects. The authority was committed to provide liveable and healthy surroundings to the inhabitants of different projects besides taking care that the natural resources are not wasted, he said.

DROPLETS
SNIPPETS

1. WABAG secures contract towards Design, Build & Operation of 270 MLD WTP of about INR 420 Crores from CIDCO, Maharashtra

June 07, 2023: VA TECH WABAG ('WABAG'), a leading pure-play Water Technology Indian Multinational Group, has secured an order worth about INR 420 Crores towards Design, Build and Operation (DBO) of a Water Treatment Plant (WTP) with a capacity of 270 Million Litres per Day (MLD) at Jite, Raigad for City and Industrial Development Corporation of Maharashtra Limited (CIDCO).

This project has been planned in order to cater to the future water demand for Navi Mumbai. Water from Hetwane dam will be treated at the proposed 270 MLD WTP and pumped to existing Master Balancing Reservoir (MBR) at Vihal location for further distribution. The scope of the project includes Design, Engineering, Supply, Construction, Installation and Commissioning of the 270 MLD WTP including clear water pumping station within a period of 42 months from commencement and followed by Operation & Maintenance (O&M) for a period of 15 years. The plant will use High Rate Clarifiers for the removal of high-suspended solids followed by Rapid Gravity Sand Filters along with disinfection by chlorine.

Commenting on this order win, Mr. Shailesh Kumar, CEO – India Cluster said, "This is an important and strategic success for us, as we foray back into the DBO space in Maharashtra with this breakthrough order in CIDCO. This project was won against tough competition based on our technical superiority and competitiveness and we are thankful to our client for the confidence they have reposed in us. This project once completed will address the growing water need of the area and also be a key reference in our journey."

2. Usha Subramaniam - New Country President for Grundfos in India

GUsha Subramaniam will leverage her solid Grundfos experience acting as the main representative for the company in India towards internal and external stakeholders.
Chennai, June 01, 2023: Grundfos is pleased to announce Usha Subramaniam as the new Country President for the company in India. In this important role, she will act as the main representative towards internal and external stakeholders, driving engagement with partners and progressing our promise to respect, protect and advance the flow of water, true to the company's purpose to pioneer solutions to the world's water and climate challenges and improve quality of life for people.

Usha Subramaniam, Country President, Grundfos India on the appointment said, "I am very proud to take on this new role and look forward to working with my many colleagues in India, as well as our partners and stakeholders, towards our



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goal of creating a sustainable future. The opportunities available in India where Grundfos can make a difference to the water and climate agenda is immense, and in collaboration, I believe we can realize the possibility in every drop and help to respect, protect, and advance the flow of water in India."

She will officially enter the role on 1st June 2023. Prior to the appointment, Usha Subramaniam has held a number of senior, global roles within Grundfos, the latest as the Senior Director and Head of Business HR, for the company's Commercial Building Services division.

3. KSB's new waste water impeller combines efficiency and reliability

In a further expansion of its range of pumps suitable for handling untreated waste water, the KSB Group has developed a new radial multi-vane, open design impeller. The D-max impeller is for use in the Sewatec and Amarex KRT pump type series. These pumps handle fluids containing solid substances, long fibres, coarse solids as well as entrapped gas or air.

The D-max impeller is highly suited to handling untreated waste water, combined sewage, recirculated and heating sludge as well as activated, raw and digested sludge with a solids content of up to 8 percent. This impeller type is also suitable for transporting fluids with a high viscosity.



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The new impeller's best efficiency is in the region of 84% and can be compared with the performance of closed multi-channel impellers. The impeller's free passage of at least 76 mm meets the requirements of many waste water plant operators. KSB's hydraulic experts employed computational fluid dynamics (CFD) to obtain detailed knowledge about the complex flow processes inside the pumps using computer-aided simulations. In addition to the computer-aided development of impellers, KSB also conducted waste water tests in the laboratory as well as intensive field tests around the world. The results of the test were then incorporated in the impeller's comprehensive development programme.

All customers receive an impeller trimmed to match the specified operating point, which is also common practice for multi-channel impellers. They are suitable for both 50 Hz and 60 Hz electric motors. The maximum head is approximately 90 metres and the maximum flow rate is approximately 2,800 cubic metres per hour. Depending on the composition of the waste water, an operator can choose between the materials EN-GJS-400-15 and 1.4517 as well as EN-GJN-HB555

4. LANXESS expands Lewatit range

Mumbai, May 15, 2023 – Specialty chemicals company LANXESS has grouped together 16 new ion exchange resins and absorbents for the pharmaceutical and bioprocessing industries under its trusted umbrella brand Lewatit. They are used in various pharmaceutical and bioprocessing applications to separate and purify biomolecules. Applications of these end products range from food and animal feeds to active pharmaceutical ingredients (APIs) that are used in medicinal products.

"Typically, our products support the separation of biomolecules from complex biomass mixtures and play a key role in their further purification or stabilization," explained Dr. Jenny Boettger, Technical Marketing Manager in the Liquid Purification Technologies (LPT) business unit at LANXESS. "As one of the leading manufacturers of ion exchange resins, we are hoping that this innovative product range will attract new customers from the pharmaceutical and bioprocessing industries and further strengthen our market position," added the chemist.

New resins for downstream processes

The production of biomolecules derived from natural extracts and biological fermentation processes is strongly supported by a wide range of Lewatit ion exchange and adsorber resins. This resin technology opens up a variety of separation and purification options for all kinds of operation scales. The new types are specifically designed to be used in downstream processing for production of various biomolecules, including products from animal- and plant-sourced natural extracts. All resins are based on hydrophobic (polystyrene-divinylbenzene) or medium hydrophilic (polyacrylic) polymers. They were specifically developed to meet the high demands in industries such as biotechnology, pharmaceuticals, biopharmaceuticals, nutraceuticals, and food production in order to detoxify, convert, decolorize, or demineralize the respective molecules more easily.

Through ion exchange or adsorption processes, biomolecules such as peptides, antibiotics, vitamins, amino acids, and polysaccharides can be separated and purified more effectively. All these biomolecules are indispensable in today's world. Antibiotics are essential for the treatment of bacterial infectious diseases. The intake of vitamins and numerous amino acids and proteins supports vital functions of the body. Diverse polysaccharides are found in part in everyday use. In the form of heparin and structure-like polysaccharides, for example, they are used to prevent venous thrombosis. In cosmetics, hyaluronic acid acts as a humectant due to its high water-binding capacity.

Outstanding features

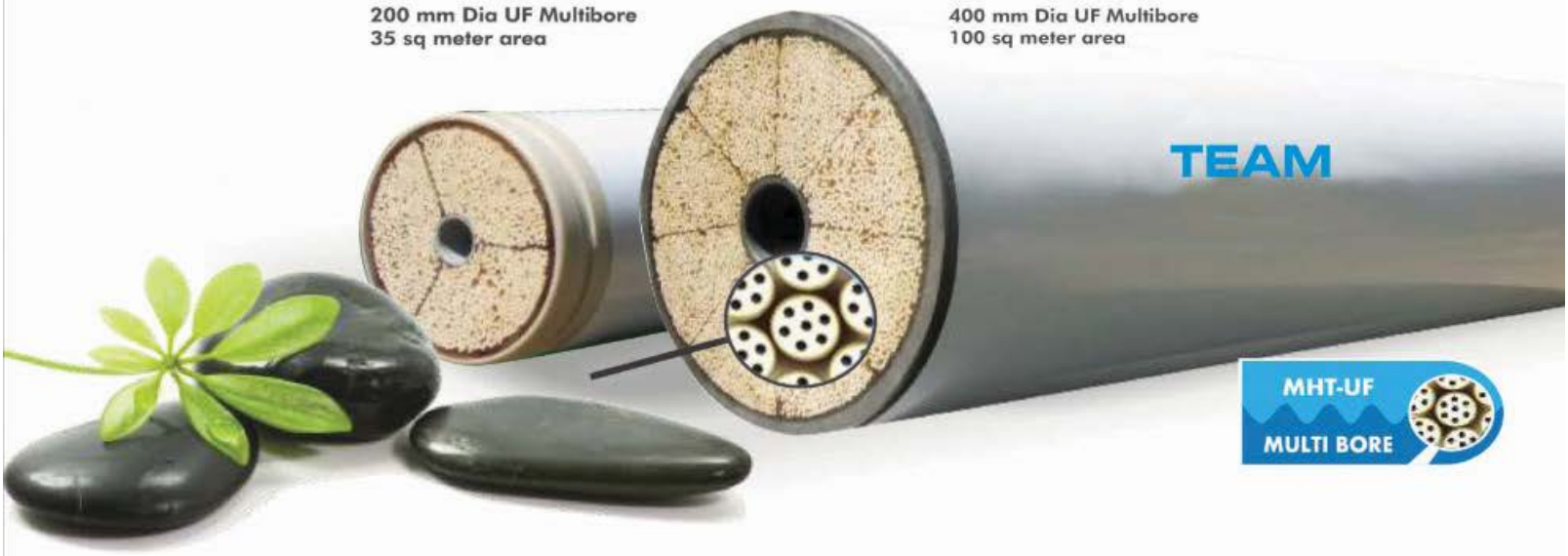
Benefits of Lewatit include good chemical and mechanical bead stabilities, excellent kinetics and selectivity's, high capacities, and good economics due to lean design and high performance. and come with a certificate and statement.

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UF - 400mm dia Modules

High Mechanical Strength
Reduced Foot Print



UF Applications

Boiler Feed Water - Colloidal Silica Removal
Pre - Treatment to R/O - Reduction of SDI
Drinking Water - Removal of pathogens, bacteria
Cooling Tower - Removal of Suspended Solids / Microbes
Treatment Sewage - TSS / Turbidity / SDI Reduction
Process Effluent Recycling - TSS / Turbidity / SDI Reduction
Brine Clarification - Chlor-Alkali - TSS / Turbidity Reduction
Pre-treatment to Desalination - SDI Reduction

Advantages - MHT UF Membranes

Low Operating Pressure (0.5 to 0.8 Bar)
High Performance anti fouling Characteristics
Operation in Dead end / Cross flow
MWCO Range 10KD to 100KD
Same UF feed pump used for forward flush A & B
Reduces Foot print with 100m2 membrane
Elimination of pre-coat filters
Lower Power Consumption

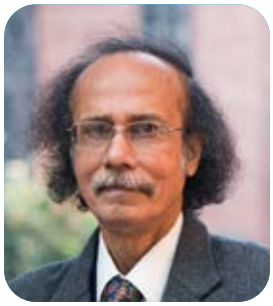
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REDUCING WATER WOES THROUGH DESALINATION

By SK Sarkar, Former Secretary, Ministry of Water Resources, Distinguished Fellow, TERI, New Delhi



Introduction

Water resources are finite, critical for life and essential for economic development. India has only 4% of world's fresh water resources although it has a population of over 1.4 billion people constituting about 18% of the world's population. India's water resources are under immense pressure. There are wide spatial and temporal variations in the distribution of water. For example, India receives more than of its rainfall during 4 months of the year (Southwest monsoon).Regarding unequal special distribution, the Barak and Brahmaputra basins have a per capita water availability, about 10 times greater than that of the Ganga basin. India's per capita water availability is likely to touch the water scarce scenario by 2050. The water crises has worsened in recent years due to climate change which results in delayed monsoon, consequently drying out reservoirs in several regions. One of the major implications of the climate change is the modification of the spatial and temporal variability of monsoon rainfall including an increase in extreme events. The light and moderate precipitation events are decreasing, and the heavy and extremely heavy rainfall events are increasing and likely to increase in the future. The spatial and temporal changes in the monsoon have major implications on the water cycle, and consequently on all water use sectors such as agriculture, power, domestic, biodiversity etc.

About 1199 bcm(billion cubic meter) of water resources are annually generated, and of this the water that can be utilized beneficially is 1123 bcm of the available water resources, 690 bcm of water resources are from surface water contributions and 433 bcm from groundwater contributions. India's storage capacity is substantially lower than the available resources. The live storage capacity of dams is about 258 bcm.Further the reservoirs are unequally distributed: for example dams in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh and Orissa have about 70% reservoir capacity, and Delhi, Haryana, Punjab and Rajasthan have only 5% of reservoir capacity. The insufficient surface reservoir capacity is putting a significant pressure on ground water resources.

Water scarcity in India is an ongoing crises that affects nearly thousands of millions of people each year. Water scarcity also threatens the lives of wild animals across India. Wild animals are forced to infiltrate villages and cities in India as they attempt to find potable water. Water is essential to the popular occupation of agriculture in India. Farmers are unable to produce crops in the absence of water. The scarcity of water has rendered lot of valuable farm land in India useless.

The available water supply in India is expected to be deficient compared to its demand by various users.An estimate shows that by 2050 the water demand will be 1180 bcm compared to the available supply of water to the extent of 1123 bcm. Unless there is water saving and optimal demand side management, the water sector will not be sustainable in future. The solutions often suggested are rain water harvesting which is an innovative way of collecting rainwater in order to recharge the ground water;use of coastal reservoir which is a fresh/river water storage reservoir located on the sea cost area near a river delta and which does not submerge the land area and there is norequirement of land acquisition and rehabilitation of displaced population;use of irrigation techniques for increasing water use efficiency in agriculture through drip and sprinkler irrigation (currently almost 351,000 hectares of irrigated land is under drip irrigation compared to just 40 acres in 1960s); use of desalination technique which is an advanced technique to solve problem of water shortage especially in coastal regions which involves treating sea water to remove its salt content, making it fit for drinking.

Desalination in Israel

In the past decades Israel has developed a systematic method to desalinate sea water into fresh water for its industrial and domestic uses. Israel has a requirement of about 1.9 bcm of fresh water per year but it gets 1.4 bcm from natural resources. The remaining water are met through using various techniques including desalination

process. In Israel 55% of domestic water comes from desalination. Water produced by desalination in Israel now cost about one third of what it did in 1990s. For example, in the case ofSorek desalination plants, the Israelihouseholds pay about USD 30 per month for their water which is similar to US cities and far less than Las Vegas (USD 47) or Los Angeles (58 US Dollar).

Desalination technique

Desalination process consists of moving the salt water through electrically charged membrane that trap salt ions dissolved in water allowing fresh water to be extracted. It essentially separates saline water into two parts – one that has low concentration of salt (treated water) and the other with a much higher concentration of that is the original feed water called concentrate. The saline water has TDS more than 10000 mg/liter while the TDS for drinking water is 300 mg/liter or less (WHO standard) or less than 500 mg/liter (BIS standard). The desalination process transforms the saline water with high TDS into drinking water with low TDS.

The desalination process involves reverse osmoses, solar distillation, electro dialysis, Nanofiltration, and gas hydrate formation. The National Institute of Ocean Technology, GOI (based in Chennai) developed world's first low temperature thermal desalination (LTTD) plant in Kavaratti, capital of Lakshadweep tocater needs of local population. This technology is alternative to reverses osmosis process. The LTTD technology does not require any chemical pre and post treatment of sea water and thus the pollution problem is less in this case. The technology works on principle that water in the ocean which is 1000 or 2000 feet below, is about 4-8 degree centigradecoolerthan the surface water. The LTTD technology is a process under which warmsurface sea water is evaporated at low pressure and the vapor is condensed with cold deep sea water. Desalination process requires a lot of energy. Salt dissolves easily in water forming a strong chemical bonds and these bonds are difficult to break. Energy and technology for desalination thus become expensive.

Indian efforts for desalination

The first desalination plan came up in Tamil Nadu in 2010 at Minjur, other plants have also established in Nemmeli. In Gujarat, Desalination plant have come at Dahej (100 mld), Dwarka (70 mld), Ghogha Bhavnagar (70 mld), Gir Somnath (30 mld) and other places. At Dahej plant,industries use about 100 ml desalinated water. The price of 1000 liter of treated water is expected to be Rs 26.

Concluding remarks

In the coming years India will face significant pressure on use of water resources due to increase in demand for water resources and due to finite supply of available water. Desalination is an option which should be enhanced.In India today the desalination process is costly but there is a need for research for inventing technologies which areless costly like what Israel did over the years. There is accelerating need for India to look this desalination option near coastal regions of the country to fulfill the water needs cities, (industries and domestic needs), etc.

About the Author

Dr S K Sarkar is Distinguished Fellow and Senior Director at TERI. He heads the Natural Resources and Climate Programme and is currently associated with TERI since September 2014. During 1998 till 2003 Dr Sarkar worked as Senior Fellow, TERI, and during 2005-2007 as Director, Division of Regulatory Studies and Governance in TERI. He is a Doctorate in Economics (1991) from the State University of New York. Dr Sarkar is an IAS officer (retired). He is a former Secretary to the Government of India (GoI) in the Ministry of Water Resources. He served other Ministries including Finance Ministry in the GoI, and worked in various capacities with Government of West Bengal. He worked as District Magistrate, Murshidabad and Member Secretary, West Bengal Pollution Control Board under State Environment Department during 2003-05 and formulated policies on plastic waste management. He also worked as consultant with the ADB and with the World Bank/ PPIAF (Public Private Infrastructure Advisory Facility). Dr Sarkar has got several publications to his credit, has authored and edited books on infrastructure issue and has presented a number of important papers in several conferences. He taught a course on "Public Policy" in the Kabul University (2007), Afghanistan, and also at TERI University.

To know more about the contributor of this case study, you can write to us. Your feedback is welcome and should be sent at:
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SAMUDRA MANTHAN≈ SEA WATER DESALINATION!

By Dilip Yewalekar and Manisha Kinge, Jain Irrigation





The Samudra Manthan…! Can be reckoned as the first kind of seawaterdesalination plantin the world ever found in the ancient script! In the Samudra Manthan process, harmful toxic minerals for living creatures & humans are separated in seawater. Samundra Manthan and modern Sea Water Desalination plants are more or less similar in process, outcome, and purpose. Unfortunately over the lapse of time, Samudra Manthan process was dejected, underestimated,not studied deeply, and finally stamped as a mythological story! But while going through various kinds of ancient literature, surprisingly the methodology of Samudra Manthan, the reasons behind it, and the outcome described are almost matching to today's seawater desalination technique. That's why small efforts were made to correlatethe Samundra Manthan and Modern Seawater Desalination plants and to bring notice among the readers the comparison (Table 1 & 2).This article highlighted similarities between Samudra manthan and modern seawater desalinization plants on technical ground and outputs to have a clear understanding and trust in this old technology mentioned in the literature.It means ancient people were aware of seawater quality, pollution, toxicity, and treatment.

Sea water?

Seawater is a complex mixture of 96.5 percent water, 2.5 percent salts, and smaller amounts of other substances, including dissolved inorganic and organic materials, particulates, and a few atmospheric gases. Seawater contains a high concentration of dissolved salts and is expressed in parts per million (ppm). Sodium, Chloride, Magnesium, Calcium, Sulphates, and Bromides, are present in seawater. Those chemicals are very reactive with metal in the presence of Oxygen and cause corrosion. Based on concentration level appropriate treatment is performed to reduce its corrosive effects.

Seawater Desalination

Water scarcity is a pressing global issue affecting numerous regions around the world. As population growth, industrial development, and climate change continue to strain freshwater resources, alternative solutions are needed to ensure access to clean water for both human consumption and agricultural needs. Sea Water Desalination, the process of extracting fresh water from seawater, has emerged as a viable and increasingly important method to meet the growing demand for fresh water. Seawater desalination is considered a solution to resolve water shortage in the world and helps to overcome the problem of at least drinking water in the majority of cities. Few of them are functional in India, Chennai, and abroad.

Samudra Manthan

It is the churning& cleaning of the Ocean to separate toxic elements and useful elements for living creatures as described in Hindu literature (Fig 1). It is said Ocean water was polluted for millions of years and water became poisonous and life of living creatures were in endanger.To make seawaterliveable for creatures, Samudra Manthan was performed. During the process, useful elementswere separated and left in the seawater only to balance the density, and toxic elements (poison) were disposed of by God Shiva, or can say, stored in a cold place Himalayas beyond the reach of humans!

On the other hand, a Seawater Desalination plant is a technological facility that removes salt and other impurities from seawater, making it suitable for various uses, such as drinking water, irrigation, and industrial process. Desalination plants use different methods, including reverse osmosis, distillation, and electro-dialysis to separate the salt and minerals from the seawater.



Figure 1: Idol found by Archaeological Dept

Table 1. Comparative Process Samudra Manthan and Desalination

Heads	Samudra Manthan	Sea Water Desalination plant.
Objective	To obtain Amrut/Nectar- Water.	To convert seawater to fresh water for drinking purposes.
Purpose	Involve the ocean and the extraction of valuable resources, they differ greatly in their nature, purpose, and real-world implications.	Sea water desalination plants are large-scale infrastructure projects that require advanced technology, such as Reverse Osmosis Membranes, High-pressure pumps, and Energy efficient systems to operate efficiently.
Uniqueness	Has religious and symbolic significance. Used natural materials, equipment, and natural power.It is a unique process in history and so far not possible to copy–cut–paste.	It is a real-world engineering solution developed by Humans.It is a human-made technology designedto provide fresh water from the seawater.
Source of water	The source of water is Ocean. A huge volume of water beyond imagination.	Pre-determined –a limited quantity of water is sourced by tapping at a single point.
Centre of Ocean	The entire Ocean water is treated at one central point. i.e.the South Pole.	It is not possible to treat entire ocean water. Even not possible to treat at the center point of ocean water.i.e. South Pole.
Process used	Churning,Stirring, Whirling, Swirling, Agitation, Shaking, Whisking, Whipping, Washing, Beating, Reeling, Wheeling, Squeezing, filtration, foaming, Drying, De-greasing, Oil –separations, Evaporations, Condensation.	Pre-filtration, Screening, Media Filtration, oil separation, Heating, Evaporation, Desalination, Membrane filter. In a seawater desalination plant, several techniques such as reverse osmosis, distillation, or electro-dialysis are employed to remove salt and other impurities from seawater, making it potable or usable for specific applications
Power Source	Solar energy, wind energy, sea energy, gravitationalenergy, electromagnetic power, Cosmic energy.	Only Electrical power is used for the operation of all plants, equipment, and machinery
Power Consumption	The power consumption ratio is very low or negligible to the volume of the entire ocean.	The power consumption ratio is very high wrt to the volume of water.
Environment-friendly (S DG)	The entire process was natural and no pollution or side effectswere seen post-processing. Environment friendly and already met the norms of SDG.	The entire process is defined by manmade, added to pollution in the environment, and managed to meet the norms of SDG.
Cost of processing	Cost processing wrt to volume is very low or negligible.	The cost of processing wrt to volume is very high.
Investment	Investment is low wrt volume of Ocean water.	Investment is very high wrt to limited water.
Wastage of water	No water wasted. No mineral wasted.	Almost 50 % of water is wasted during extracting fresh water. A lot of minerals are wasted.

Table 2. The difference in Output Samudra Manthan and Desalination

Elements	Samudra Manthan	Sea Water Desalination plant.
Toxic Element Disposal	Toxic Elements like Arsenic, Cyanides, Mercury, Lead, etc separated and disposed of in cold regions i.e.Himalayas without affecting the environment and creatures and out of reach of humans.	The process of separation of Toxic elements (Cyanides, Arsenic)is a tedious & costly affair, and disposal of it is a big question.
Radioactive element	Some of the radioactive elements were disposed of in the universe or on other planets or taken off from Earthwithout affecting the environment and life on Earth.	Separation of radioactive elements is a very difficult and costly affair. Disposal of it is also difficult on the earth.

Salts	Harvested - Sodium Chloride, Potassium, Carbon, Nitrogen, Oxygen, Mytheme, etc.	Harvested - Sodium, Chloride, Potassium, Magnesium, Sulphates, Carbon, Bromide, Boron, Fluoride, Phosphorus, Nitrogen, and Strontium.
Herbs/ Medicinal plant	Harvested - Herbs/Medicinal plants like Sanjivanibuty, Basil, Spirulina (Dr Danwantari)	Not possible to harvest such herbs/medicinal plants or species. Because of the screening process involved.
Treasury	Gems, Jades, Precious metal,	No evidence was found.
Crude oil	Found crude oil (Petroleum)	No possible to harvest.
Bio Gas/CNG	Bio-gas found	No evidence.
Amrut/Nectar	Water is useful for all purposes for living bodies in the sea, plants, humans& industries.	Sea water desalinationis the processed to get fresh/clean water for drinking irrigation & industrial use.

Seawater Desalination plant

Seawater desalination plant comprised of the intake structure located in the sea bed, intake pipe placed at the sea bed from sea to the water tank, filtration unit, desalination plant, finish water storage tank, and main water distribution tank, and distribution network to the community.

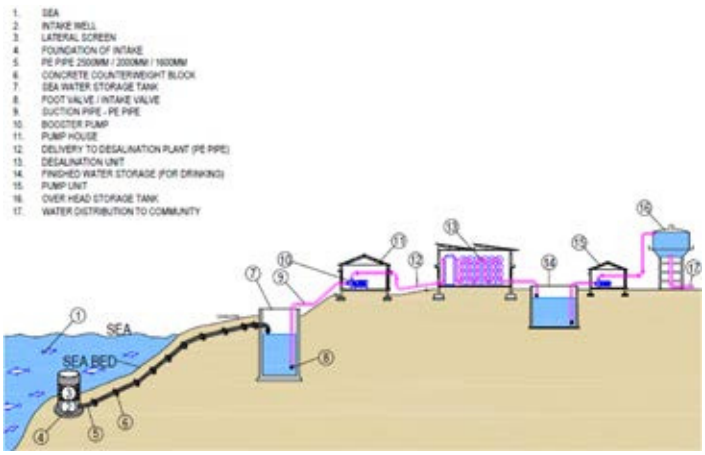


Figure 2. Schematic layout of a seawater desalination plant.

The schematic layout seawater desalination plant is shown in Figure2. Saline/Saltwater is containing high concentrations of various salts mainly in chloride forms. According to World Health Organization (WHO), the permissible limit of salinity in water is 500 parts per million (ppm) and for special cases up to 1000 ppm is generally considered fresh water, and is safe to drink and use for household and agricultural purposes, while most of the water available on earth has salinity up to 10,000 ppm, and seawater normally has a salinity in the range of 35,000–45,000 ppm in the form of total dissolved salts.In desalination, these mineral components are extracted from saline water to get pure water.

Principles of seawater desalination

Seawater desalination involves removing salt and other impurities from seawater and converting it into freshwater suitable for various purposes. The desalination process typically consists of several key steps:

1. **Pre-Treatment :**
   Seawater is pre-treated to remove large particles, debris, and sediment through the process of screening, settling, and filtration. This helps to protect the subsequent desalination equipment from potential damage and fouling.

2. **Desalination technologies**
   Various desalination technologies are utilized to extract fresh water from seawater. The two most common methods are:
   - Reverse Osmosis (RO) RO employs a semi-permeable membrane to separate salt and other impurities from the water. Seawater is forced through the membrane under high pressure, allowing fresh water molecules to pass through while rejecting salt and other contaminants.
   - Multi-Stage flash Distillation (MSF): MSF involves heating seawater to evaporate the water molecules, which are then condensed and collected as fresh water. The process utilizes multiple stages of evaporation and condensation to enhance efficiency.

3. **MED: Multi-Effect Distillation:** Multi-effect distillation utilizes multiple evaporations and condensation stages to separate freshwater from seawater. Each stage operates at a progressively lower pressure, resulting in reduced energy requirements compared to the multi-stage flash method.

4. **Post-Treatment:** After desalination, the freshwater produces undergoes post-treatmentprocesses such as remineralization, pH adjustment, and disinfection to ensure its quality and safety for consumption.

Challenges & limitations in the desalination process

1. **Energy Consumption**
   The desalination process, particularly RO, is energy-intensive often

relying on fossil fuel. Transitioning to renewable energy sources and implanting energy-efficient technologies can mitigate the carbonfootprint associated with desalination.

2. **Environmental impact**
   Discharge of brine concentrates generated as a by-product of desalination must be carefully managed to prevent its harmful impact on marine ecosystems. Dilution and dispersion techniques as well as brine disposal into deep sea areas, can minimize adverse effects.

3. **Cost and affordability**
   The high capital costs associated with building and operating desalination plants pose challenges to affordability, particularly in developing regions. Continued research and technological advancement aim to reduce costs and improve efficiency.

4. **Sustainability**
   Desalination should be integrated into a comprehensive water management strategy that includes conservation, water recycling, and efficient agricultural practices. Sustainable practices such as minimizing carbon emissions reusing brine for industrial purposes and optimizing water treatment processes are crucial to ensure long-term environmental and economic viability.

5. **Ecological impacts**
   Intake systems used to draw seawater may inadvertently harm marine organisms. Implementing effective screening and monitoring measures can reduce these impacts.

Benefits of Sea Water Desalination

1. **Increased fresh water supply**
   Desalination provides a reliable source of fresh water, especially in regions with limited access to fresh water sources. It reduces reliance on rainfall and groundwater, offering a stable supply even in arid coastal areas.
2. **Water Security**
   Desalination helps enhance water security by diversifying water sources. It reduces the vulnerability of communities to droughts, water shortages, and climate change impact ensuring a continuous supply of clean water.
3. **Employment & Economic aspects**
   Sea water desalination projects can create economic opportunities by generating employment, attracting investments, and fostering the growth of related industries such as technology, engineering, and water management.

Future R & D

Technocrats are aware of modern seawater desalination technology to address freshwater supply to overcome drought situations in the world. However, such technology has limitations and challenges on high energy consumption, environmental impact, and higher capex &opex.

That's why we would suggest, instead of assuming & debiting on Samadra Manthan as a mythological story, why not dig more aspects of it. It is quite possible to overcome the limitation,problems, and cost-effectiveness of modern desalination techniques, by integrating Samudra manthan technology for future reliance for all.

About the Author

Dilip Yewalekar is the Senior Vice President of Jain Irrigation Systems Ltd. He has over 36 years of experience. He has done M.Tech-Civil Structural Engg, PG Diploma in Piping Engg, AMIE, UK, ASAE, USA. He is a Google scholar, Member of ICID. He also has Fellowship of World Bank and Mashav, Israel and is a Faculty at Govt College of Engg, Jalgaon. He is also a faculty at Micro Irrigation Course of ICID & CWC, Govt of India. He has been awarded the EEF Global Water Leadership Award–Global Water foundations. Strategic Leader in Micro Irrigation – ABSA Award, Professional Excellence Individual Award–Aqua foundations and Best Innovative Article in Sabujeema International Magazine. He has 70+papers / publications at national/international conference / magazines / books to his name.

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

SEA WATER DESALINATION FOR MEETING FRESH WATER REQUIREMENT

By Hari Saran Das, Environment & Safety Advisor



Water covers about 71% of the earth's surface. 97% of the earth's water is found in the oceans 326 million cubic miles of water is on the planet out of which 320 million cubic miles of water is in the oceans.

Only 3% of the earth's water is fresh suitable for use. Out of 3% of available fresh water, 2.5% of the earth's fresh water is unavailable for use as it is locked up in glaciers, polar ice caps, atmosphere, and soil; highly polluted; or lies too far under the earth's surface to be extracted at an affordable cost.Therefore only 0.5% of the earth's water available is fresh water that amounts to an average of 8.4 million litres for each person on earth.

Water Source and Available Water:

Sl No	Water Source	Percent Water Available
01	Ocean	97.2
02	Ice Caps/Glaciers	2.0
03	Ground Water	0.62
04	Fresh Water Lakes	0.9
05	Inland Sea /Salt lake	0,08

While the global supply of available freshwater is more than adequate to meet all current and foreseeable water demands, its spatial and temporal distributions are not. There are many regions where our freshwater resources are inadequate to meet domestic, economic development and environmental needs. In such regions, the lack of adequate clean water to meet human drinking water and sanitation needs is indeed a constraint on human health and productivity and hence on economic development as well as on the maintenance of a clean environment and healthy ecosystems. Ways must be found through researchto remove these constraints in the face of multiple challenges especially given a changing and uncertain future climate, and a rapidly growing population that is driving increased social and economic development, globalization, and urbanization.

Seawater

Sea water that makes up the oceans and seas covers more than 70 per cent of Earth’s surface. Sea water is too salty and cannot be used for drinking, growing crops, and most industrial uses except cooling

The salt content in seawater is indicated by salinity (S), which is defined as the amount of salt in grams dissolved in one kilogram of seawater and expressed in parts per thousand. Salinities in the open ocean have been observed to range from about 34 to 37 parts per thousandwhich may also be expressed as 34 to 37 practical salinity units (psu). Seawater is a complex mixture of 96.5 percent water, 2.5 percent salts, and smaller amounts of other substances, including dissolved inorganic and organic materials, particulates, and a few atmospheric gases.

Seawater constitutes a rich source of various commercially important chemical elements The six most abundant

ions of Sea water are chlorides (Cl–), sodium (Na+), sulfate (SO24–), magnesium (Mg2+), calcium (Ca2+), and potassium (K+. By weight these ions make up about 99 per cent of all sea salts.

In addition, water from the sea, when desalted, can furnish a limitless supply of drinking water.

Drinking water scarcity is higher in coastal regions in comparison with the interior parts of India; in coastal areas, the groundwater is saline and not suitable for drinking. Therefore, desalination of sea water becomes an ideal solution to bridge the widening gap between growing water needs of urban population and scarcity in supply in major coastal cities in India. Extending supply from dams or transporting through tankers has been proven costlier than water supplied by desalination. Continuous efforts to amend the desalination technology have brought down the cost of desalination technique, thereby reducing the cost per liter of desalinated water

Many large desalination plants have been built in dry areas along seacoasts in the Middle East and elsewhere to relieve shortages of fresh water.

In India, IVRCL along with Chennai Water Desalination Plant Limited, commissioned seawater desalination project by reverse osmosis process to get potable water as per IS10500:1991. Today 2.5 million residents of this city get potable drinking water from the 100 Million Litres per Day desalination plant.

The Minjur Desalination Plant is a reverse osmosis, water desalination plant at Katupalli village, a northern suburb of Chennai, India, on the coast of the Bay of Bengal that supplies water to the city of Chennai. Built on a 60-acre site, it is the largest desalination plant in India.

Desalination

It is the process of removing salt and other impurities from water and rendering it fit for human consumption. Seawater has a high percentage of salt whereas pure drinkable water should ideally contain less than 10 ppm of salt.

Natures' Desalination process

Planet gets fresh water through rain by desalination of sea water. Sun Rays evaporates the sea water and the water vapours so formed forms cloud which ultimately results in rain
Reverse osmosis

Osmosis is a natural phenomenon, without which life would be made impossible. Osmotic processes enable plants to absorb nutrients from the ground. Our kidneys purify the blood in our bodies by means of osmosis.

The term "reverse osmosis" can be explained as follows:
To desalinate water, we must create a flow through a membrane, causing the water to leave the salty side of the membrane, flowing into the unsalted side. To achieve this, pressure must be created upon the water column on the salt side of the membrane; firstly, to remove the natural osmotic pressure and secondly, to create extra pressure on the water column, in order to push the water through the membrane. For the desalination of seawater, the pressure must be about 50-60 bars.

Desalination technologies

Two distillation technologies are used primarily around the world for desalination: thermal distillation and membrane distillation.Thermal distillation technologies are widely used in the Middle East, primarily because the region's petroleum reserves keep energy costs low.

The three major, large-scale thermal processes are multistage flash Distillation (MSF), multi-effect distillation (MED), and vapour compression distillation (VCD). Another thermal method, solar distillation, is typically used for very small production rates.

Membrane distillation technologies are primarily used in the United States. These systems treat the feed water by using a pressure gradient to forcefeed the water through membranes.

The three major membrane processes are electro dialysis (ED), electro dialysis reversal (EDR), and reverse osmosis (RO).

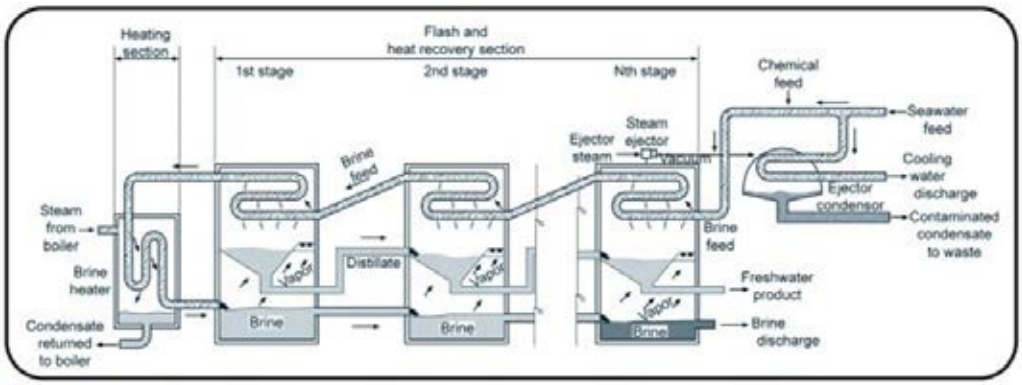


Figure 1. Example of a multi-stage flash distillation (MSF) process (Source: Buros, 1990).

Thermal technologies

Multi-stage flash distillation

Multi-stage flash distillation is a process that sends the saline feed water through multiple chambers (Fig. 1). In these chambers, the water is heated and compressed to a high temperature and high pressure. As the water progressively passes through the chambers, the pressure is reduced, causing the water to rapidly boil. The vapor, which is fresh water, is produced in each chamber from boiling and then is condensed and collected.

Multi-effect distillation

Multi-effect distillation employs the same principals as the multi-stage flash distillation process except that instead of using multiple chambers of a single vessel, MED uses successive vessels (Fig. 2). The water vapor that is formed when the water boils is condensed and collected. The multiple vessels make the MED process more efficient.

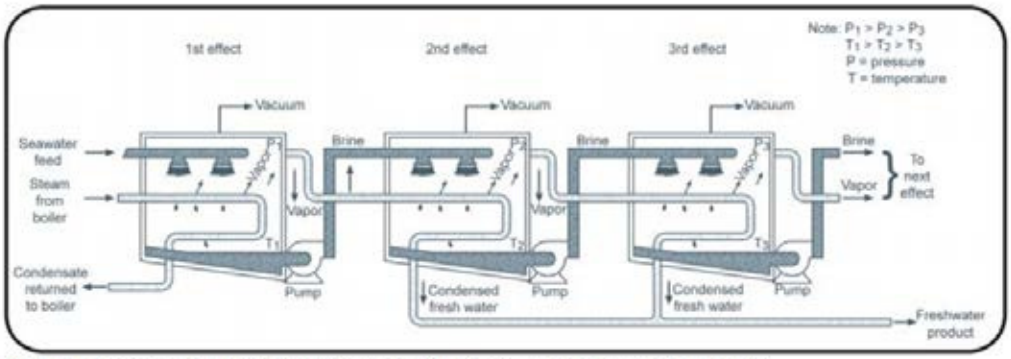


Figure 2. Example of a multi-effect distillation (MED) process (Source: Buros, 1990).

Vapour compression distillation

Vapour compression distillation can function independently or be used in combination with another thermal distillation process. VCD uses heat from the compression of vapour to evaporate the feed water (Fig. 3). VCD units are commonly used to produce fresh water for small- to medium-scale purposes such as resorts, industries, and petroleum drilling sites.

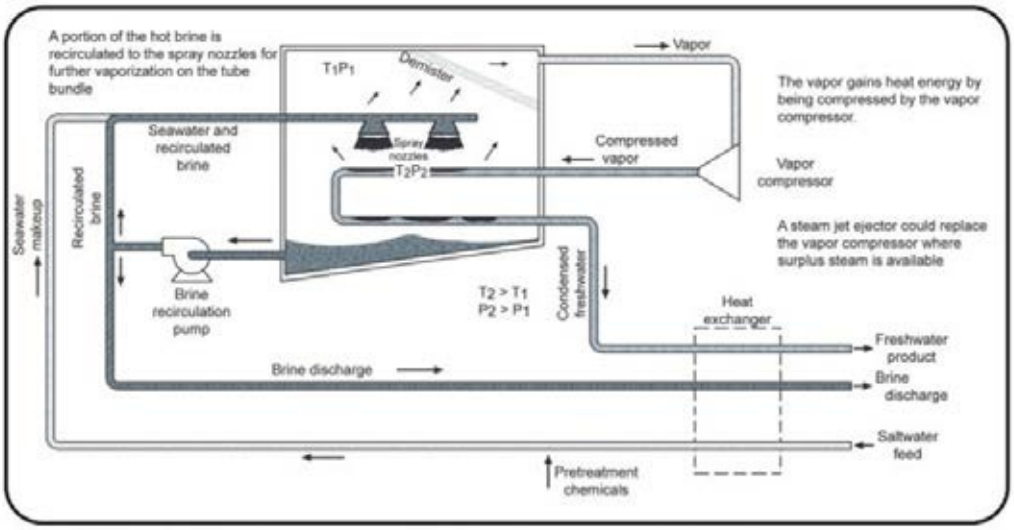


Figure 3. Example of a vapor compression distillation (VCD) process (Source: Buros, 1990).

Solar distillation

Solar desalination is generally used for smallscale operations (Fig. 4). Although the designs of solar distillation units vary greatly, the basic principles are the same. The sun provides the energy to evaporate the saline water. The water vapour formed from the evaporation process then condenses on the clear glass or plastic covering and is collected as fresh water in the condensate trough. The covering is used to both transmit radiant energy and allow water vapour to condense on its interior surface. The salt and un-evaporated water left behind in the still basin forms the brine solution that must be discarded appropriately.

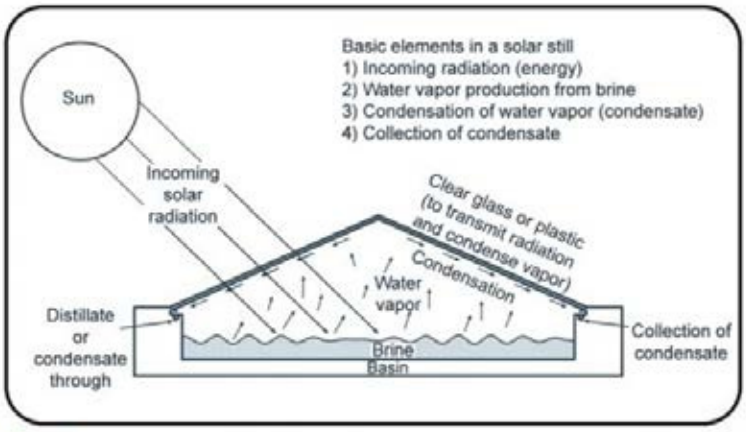


Figure 4. Example of a solar still desalination process (Source: Buros, 1990).

This practice is often used in arid regions where safe fresh water is not available. Solar distillation units produce differing amounts of fresh water, according to their design and geographic location. Recent tests on four solar still designs by the Texas AgriLife Extension Service in College Station, Texas, have shown that a solar still with as little as 7.5 square feet of surface area can produce enough water for a person to survive.

Membrane technologies

A membrane desalination process uses a physical barrier—the membrane—and a driving force. The driving force can be an electrical potential, which is used in electro dialysis or electro dialysis reversal, or a pressure gradient, which is used in reverse osmosis.

Membrane technologies often require that the water undergo chemical and physical pre-treatment to limit blockage by debris and scale formation on the membrane surfaces. Table 1 (page 5) details the basic characteristics of membrane processes.

Table 1. General characteristics of membrane processes (Source: Metcalf and Eddy, 2003).

Membrane process	Membrane driving force	Typical separation mechanism	Operating structure (pore size)	Typical operating range, (μm)	Permeate description	Typical constituents removed
Microfiltration	Hydrostatic pressure difference or vacuum in open vessels	Sieve	Macropores (> 50 nm)	0.08–2.0	Water + dissolved solutes	TSS, turbidity, protozoan oocysts and cysts, some bacteria and viruses
Ultrafiltration	Hydrostatic pressure difference	Sieve	Mesopores (2–50 nm)	0.005–0.2	Water + small molecules	Macromolecules, colloids, most bacteria, some viruses, proteins
Nanofiltration	Hydrostatic pressure difference	Sieve + solution/ diffusion + exclusion	Micropores (< 2 nm)	0.001–0.01	Water + very small molecules, ionic solutes	Small molecules, some hardness, viruses
Reverse osmosis	Hydrostatic pressure difference	Solution/ diffusion + exclusion	Dense (< 2 nm)	0.0001–0.001	Water + very small molecules, ionic solutes	Very small molecules, color, hardness, sulfates, nitrate, sodium, other ions
Dialysis	Concentration difference	Diffusion	Mesopores (2–50 nm)	--	Water + small molecules	Macromolecules, colloids, most bacteria, some viruses, proteins
Electrodialysis	Electromotive force	Ion exchange with selective membranes	Micropores (< 2 nm)	--	Water + ionic solutes	Ionized salt ions

Electro dialysis and electro dialysis reversal

The membranes used in electro dialysis and electro dialysis reversal are built to allow passage of either positively or negatively charged ions, but not both. Ions are atoms or molecules that have a net positive or net negative charge. Four common ionic molecules in saline water are sodium, chloride, calcium, and carbonate.

Electro dialysis and electro dialysis reversal use the driving force of an electrical potential to attract and move different cataions (positively charged ions) or anions (negatively charged ions) through a permeable membrane, producing fresh water on the other side (Fig. 5).

The cataions are attracted to the negative electrode, and the anions are attracted to the positive electrode. When the membranes are placed so that some allow only cataions to pass and others allow only anions to pass, the process can effectively remove the constituents from the feed water that make it a saline solution.

The electro dialysis reversal process functions as does the electro dialysis process; the only difference is that in the reverse process, the polarity, or charge, of the electrodes is switched periodically. This reversal in flow of ions helps remove scaling and other debris from the membranes, which extends the system's operating life.

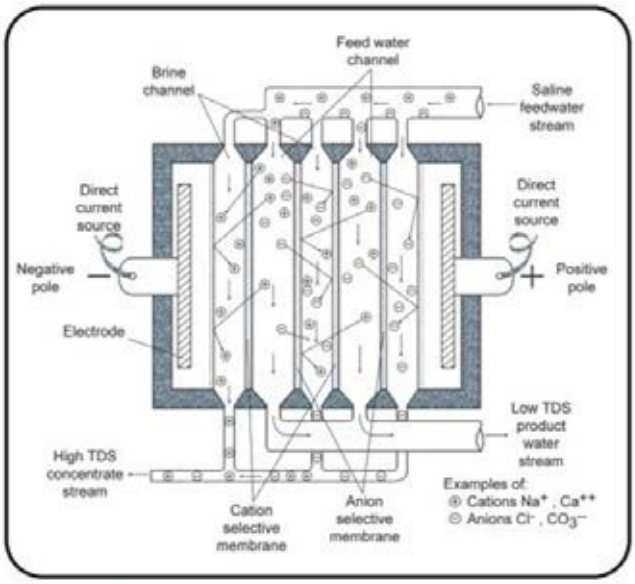


Figure 5. Example of an electrodialysis process showing the basic movements of ions in the treatment process (Source: Buros, 1990).

Reverse osmosis

Reverse osmosis uses a pressure gradient as the driving force to move high-pressure saline feed water through a membrane that prevents the salt ions from passing (Fig. 6).

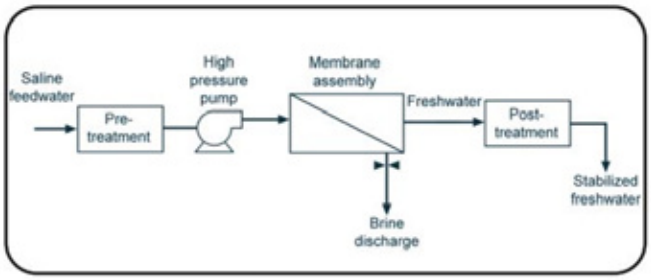


Figure 6. Basic components of a membrane treatment process.

There are several membrane treatment processes, including reverse osmosis, nanofiltration, ultra filtration, and microfiltration. The pore sizes of the membranes differ according to the type of process (Fig. 7).

Because the RO membrane has such small pores, the feed water must be pre-treated adequately before being passed through it. The water can be pre-treated chemically, to prevent biological growth and scaling, and physically, to remove any suspended solids.

The high-pressure feed water flows through the individual membrane elements. The spiral RO membrane element is constructed in a concentric spiral pattern that allows alternating layers of feed water and brine spacing, RO membrane, and a porous product water carrier (Fig. 8). The porous product water carrier allows the fresh water to flow into the centre of the membrane element to be collected in the product water tube.

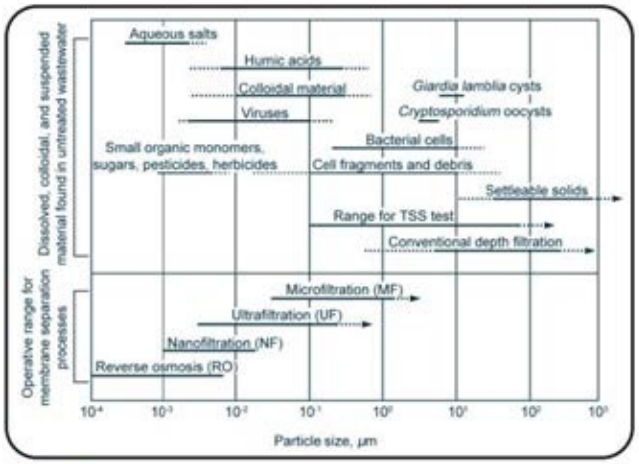


Figure 7. Range of nominal membrane pore sizes for reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF), and microfiltration (MF) (Source: Metcalf and Eddy, 2003).

To enable each pressure vessel to treat more water, the individual membrane elements are connected in series (Fig. 9). After the water passes through the membrane elements within the pressure vessels, it goes through post treatment. Post treatment prepares the water for distribution to the public.

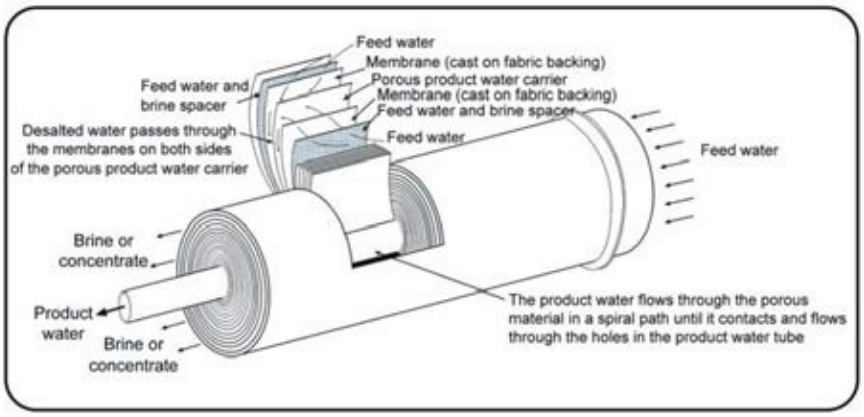


Figure 8. Cutaway view of a spiral reverse osmosis membrane element (Source: Buros, 1990).

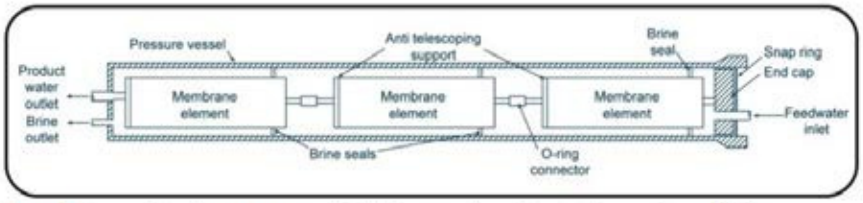


Figure 9. Cross section of a pressure vessel with three membrane elements (Source: Buros, 1990).

Concentrate management options

Both thermal and membrane desalination processes produce a stream of brine water that has a high concentration of salt and other minerals or chemicals that were either removed during the desalination process or added to help pre-treat the feed water. For all of the processes, the brine must be disposed of in an economical and environmentally friendly way.

Options for discharging the brine include discharge into the ocean, injection through a well into a saline aquifer, and evaporation. Each option has advantages and disadvantages. In all cases, the brine water should have a minimal impact on the surrounding water bodies or aquifers. Specific considerations for the water quality include saline concentration, water temperature, dissolved oxygen concentrations, and any constituents added as pre-treatment.

Summary

As high-quality freshwater resources decrease, more communities will consider desalination of brackish and salt water to produce drinking water. All desalination technologies have advantages and disadvantages based on site-specific limitations and requirements. Small-scale desalination of brackish water using solar stills is a promising method in remote locations where good-quality water for drinking and cooking is unavailable. For more widespread implementation, desalination processes need technological improvements and increased energy efficiency.

Coastal Regions of the world have abundant saline water and scarce in fresh water. Desalination of saline water is the only method to supply fresh water to save the humanity.

Fortunately, there have been tremendous development in solar energy production and the cost of solar energy is getting reduced progressively. More desalination plants using cheap solar energy will be coming up in the coastal Regions of the world to meet fresh water requirements.

About the Author

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He has published several research papers in reputed scientific journals and also several articles on water treatment and other issues in various important magazines. He also presented papers in the national & international workshops.

His one of the major contribution AMAI has established AMAI PAN-India Chlorine Emergency Response Network (CERN) and the Chlorine Emergency Toll Free Number 1800-11-1735 to help Chlorine Consumers & Transporters during any chlorine leakage incidents.

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

DESALINATION, SEAWATER REVERSE OSMOSIS (SWRO)

By Dushyant Jindal, Hitech Enviro Solutions



The increasing population as well as unavailability of abundant Fresh Water has forced mankind to make sweet water from salty sea water. Among the various available technologies Reverse Osmosis turns out to be most economical and easy to operate technology which can be implemented very small 1000 lph capacity to mega capacity plants as 100 MGD.

Osmosis is a physical phenomenon by which two liquids, in different concentrations, separated by a semi-permeable membrane, come into contact and tends to even themselves out. The liquid with the lower concentration crosses the membrane toward that with highest concentration.

Reverse osmosis process

In reverse osmosis desalination, water is taken from the sea and receives a first treatment to eliminate impurities, oil, seaweed, rubbish, and so on. Once free of organic substances, the saltwater can be subjected to reverse osmosis. After the filtering, we have two streams: brine and freshwater. The brine solution is diluted before being returned to the sea, avoiding high concentrations of salt which could harm the ecosystem. The freshwater passes through a remineralization and chlorination process, after which it is stored in tanks, and then sent to the distribution network for consumption.

Reverse osmosis is not only the most advanced desalination system in the world today; it is the most efficient and beneficial for the planet: it generates up to four-and-a half-times fewer greenhouse gas emissions than all other technologies, it doesn't harm the marine environment, and it's able to recover a large part of the energy used in the process.

In the late 1960s, reverse osmosis (RO) was developed for desalting saline water supplies. This process is based on the principal of osmosis and requires a membrane barrier to separate salts from water. Because reverse osmosis technology required considerably less energy to operate than distillation, it was considered to be the technology that would make desalination much more attainable to the world's water scarce areas. Indeed, RO for water purification has become widely utilized not just for drinking water applications but for high purity industrial process applications such as manufacturing of electronic components, pharmaceuticals, chemicals, boiler feedwater, medical applications and industrial and municipal wastewater recovery systems as well.

However, in the early days of RO commercialization, historical design and operations information was not available and, as with any new technology, many problems arose. Therefore, in the initial years of RO membrane plant application, many owners and operators experienced costly downtime attributable to lack of applications experience by engineers, vendors, etc. As both membranes and applications engineering became more advanced with time, RO systems were installed and operated with greater success. Today, with the necessary understanding of feedwater source conditions, pretreatment needs and high quality system engineering, RO can be applied to almost any ground or surface water desalination/purification application. Advancements in membrane manufacturing and applications engineering have made RO the leading process in the worldwide water desalination market.

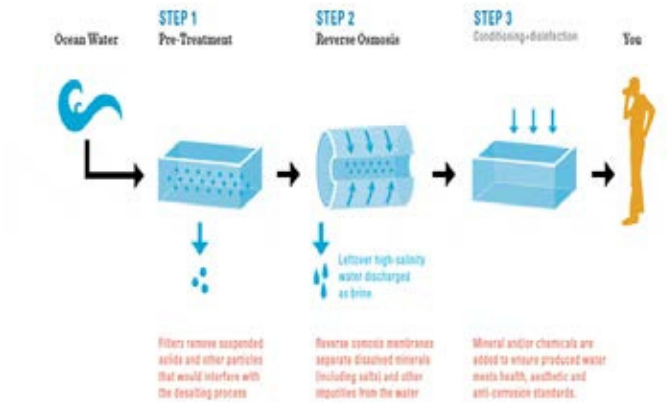
Reverse osmosis is an increasingly common method of desalination, because of its relatively low energy consumption and Modular design. In recent years energy consumption has dropped to ~3 kWh/m3, with the development of more efficient energy recovery devices and improved membrane materials. According to the International Desalination Association, for 2011, reverse osmosis was used in 66% of installed desalination capacity (44.5 of 67.4 Mm3/day), and nearly all new plants. Other plants mainly use thermal distillation methods: Multi-effect distillation and Multi-stage flash.

Sea water reverse osmosis (SWRO) is a reverse osmosis desalination membrane process that has been commercially used since the early 1970s. Its first practical use was demonstrated by Sidney Loeb and Srinivasan Sourirajan from UCLA in Coalinga, California. Because no heating or phase changes are needed, energy requirements are low, around 3 kWh/m^3, in comparison to other processes of desalination.

The typical single-pass SWRO system consists of the following components:

- Intake
- Pretreatment
- High pressure pump
- RO Membrane Banks
- Remineralisation and pH adjustment
- Disinfection

Last two components are required if the product water is used for drinking purpose.



There are three types of Intakes:

Deep Sea Intake: As the name suggests the sea water is lifted from deep sea near the sea bed so that consistent water quality is fed to membranes. This type is normally used for large plants.
Open Channel: An open Channel is built from Sea to the plant site to deliver sea water. This water is often has lot of silt and colloids, though this is cheapest option.

Wells: Water is extracted from the phreatic water-table level, at the coast. The well intakes have the advantage that the water is of higher quality, and accordingly it is a good option for desalination plants. Through the wells, a pump sucks the water, which is then subjected to different filtering systems so as to separate the sand and other impurities. The disadvantage of this type of seawater intake structure is that the hydraulic capacity will often be reduced by reason of the silting thereof (clogging with fine particles) that impedes the intake of the necessary flow volume.

Pretreatment normally consists of battery of filters to remove suspended matter & colloids. Sometimes DAF is also used to remove the floating oil if any. Few plants also have UF as pre-treatment to ensure consistent feed water quality.

High Pressure Pumps are required to overcome the Osmotic pressure of Saline water & have pressure ranging from 50 Bar to 75 Bar depending upon feed water TDS.

The spent energy from the reject is stream is recovered in large plant by Energy Recovery Devices (ERD). The plant size normally dictates the type of ERD. The Energy Recovery Turbine (ERT) and Pressure Exchangers (PX) are very popular.

RO Membrane Banks form the heart of the system & have piping manifolds, Membrane Housings and Semi-permeable membranes.

The permeate is often further treated by disinfecting it &remineralising it to make it stable (non corrosive), improve the taste and safe to drink. The system is fitted with adequate instrumentation & control for safe & steady operations.

A very important aspect of SWRO is material selection. The wetted material needs to be selected carefully for long life of the plant. High grade stainless steels like SS 904L, Duplex, Super Duplex, Bronze are some of the preferred materials for valves & piping.

Principles of Salt Water Reverse Osmosis

Desalination by RO requires the use of an osmotic membrane (i.e., one that allows water to pass through it at much higher rates than dissolved salts). Osmotic membranes occur naturally in living organisms everywhere. The osmotic membrane also is referred to as a semipermeable membrane because of its capability to allow some constituents to pass through it while holding back others.

The osmosis phenomenon in nature is one where a dilute solution is transported across a semipermeable membrane toward a concentrated solution on the other side. The process of RO is just the opposite of osmosis. In osmosis, the solvent water passes through the membrane until the pressure difference across the membrane is equal to the osmotic pressure (approximately 350 psig for a fresh water/seawater interface). In the reverse osmosis desalination process, a pressure greater than the osmotic pressure applied to the saline water will cause fresh water to flow through the membrane while holding back the solutes (salts). The higher the applied pressure above the osmotic pressure, the higher the rate of fresh water transports across the membranes.

System Design Consideration

When designing a seawater RO system, many factors must be considered. First and extremely important is the feedwater source. Salt water from the sea either will be drawn from a surface water supply,

a beach header-lateral face well system or a borehole well system. Typically, seawater well systems are preferred because they provide a low turbidity feedwater requiring less pretreatment. However, even well systems produce varying seawater quality depending on the origin of the strata they are constructed in.

Once the best feedwater source (i.e., the system that requires the least amount of pretreatment) is selected and characterized, both chemically and physically, the pretreatment system must be designed to create the optimum conditions for membrane operation and performance. With a high quality feedwater (one with low colloidal, microorganism, organics and iron content), a seawater RO system needs only five micron cartridge filtration for pretreatment.

Lower quality feedwater may require much more pretreatment including any and all combinations of the following:

- Infection coagulation;
- Clarification;
- Multi-media filtration;
- Sequestering and dispersant chemical feeds; and
- Five micron cartridge filtration.

After the pretreatment system, a pump pressurizes the feedwater salinity and recovery rate. Typical seawater ranges between 28,000 to 35,000 ppm total dissolved solids (TDS). However, some saline surface waters are much higher such as the Red Sea at 40,000 to 45,000 ppm TDS. The feedwater then enters the membrane system where organic and inorganic contaminants are separated into a product water stream and a concentrated reject water stream.

Optimum performances are obtained by hydraulically balancing velocities and flows of water along and through the membrane surfaces. System water recovery rates range from 20 to 40% for small to large systems, respectively, for typical 36,000 ppm feedwater.

A properly designed plant, from the aspects of feed water source, pre-treatment, and hydraulic balancing, will reduce organic, inorganic and biological membrane fouling tendencies, thereby minimizing membrane-cleaning requirements. To say that a membrane plant will never need cleaning is not an accurate statement. Thus, all land-based plants should be designed with an in-place cleaning system that also will act as a sanitizing system when needed.

On shipboard systems, especially small yachts and boats, there is very limited space, so membrane-cleaning systems are not sold with the desalination system. Instead, membranes generally are replaced each year.

Pumps

The two most basic individual components in a seawater reverse osmosis system are the high pressure feed pump and the RO membranes. These components comprise the heart of any RO system and require careful selection and application for successful operation.

There are two types of high pressure pumping units on seawater RO systems: centrifugal and positive displacement (PD) plunger pumps. Because plunger pumps operate at much higher efficiencies, these most often are the pumps of choice for plants less than 150,000 gpd and where high-energy costs exist. In larger plants, the centrifugal pumps are used most often because these pumps may approach 80 percent efficiency, are less costly and require less maintenance. However, the majority of RO desalination systems are in the 1,000 to 100,000 gpd capacity range. PD pumps are most common due to the lack of availability of higher pressure, low flow centrifugal.

Plunger pumps produce large output pressure variance (pulsation) due to their reciprocating action, which translates to vibration. This vibration not only is potentially damaging to the pump but to all other system components as well especially plumbing, instrumentation and the systems framework. In order to minimize vibration damage to system components, the pump requires a discharge pulsation dampener and, in some cases, a suction stabilizer (depending on the acceleration head attributed to systems feed plumbing). Another important factor is pump speed in RPM. The slower the pump speed, the less vibration transfers. Mechanical design for vibration isolation is also a key to minimizing vibration damage from the pumping system.

Because seawater RO pumps can generate pressures in excess of 1,000 psig, it is recommended that a safety switch, in combination with a pressure relief valve, be incorporated in the design. Severe damage or injury could occur if the pump pressure exceeds material strengths of the RO design.

Membranes

Membranes are the largest single consumable cost factor in RO desalination Therefore; increasing membrane life will contribute significantly to lowering operating cost. Membranes most often require replacement because of reduced capacity, which in most cases is attributable to colloidal and/or biological fouling. Fouling is a direct result of either an inadequate feed source or pretreatment equipment. As previously mentioned, installing the correct feed source and corresponding pretreatment system is critical in minimizing foulants.

It also was mentioned that a well-type feed source normally is the best source for reducing colloidal content in the feedwater. However, in some circumstances, either because of well development cost or lack of permeability of the ground structure, well systems are not feasible or therefore surface intake systems will be required. When surface water is utilized as a feed source, pretreatment systems can become extensive in order to reduce feedwater colloid load. Even then, stormy

weather conditions will make operation of the RO plant ill advised due to increased turbidity of the feed source.

Colloidal fouling tendency of an RO membrane is relative to the feedwater's Salt Density Index (SDI), an ASTM method for measuring small particulate/colloidal loading in water. Typical borehole well systems that have been constructed correctly produce SDIs less than 3.0 and many times less than 1.0 Header/lateral beach wells have produced SDIs less than 3.0.

However, it is advisable to expect a range of 2 to 5 for beach well systems. Surface water will produce SDIs much greater than 5 and, with an excellent pretreatment system; this can be lowered to 3 to 5. However, adverse weather conditions and upsets in clarification systems can make these intake systems unreliable. Intake systems, pretreatment and SDI must be stressed because membrane life and warranties are directly correlated to these parameters. Spiral-wound membranes have a maximum allowable operating SDI of 5.0, which is why they often are chosen.

The last item needing discussion relative to plant equipment longevity is corrosion of materials. Systems should be constructed with plastics and nonferrous components wherever possible. All low-pressure components should be constructed from PVC, fiberglass or plastics in general. High-pressure components that require the use of metals should be of an acceptable alloy to their location and application in the system. Seawater environments are highly corrosive, and only the highest quality of material is acceptable. As an example, welded pipe should not be any grade lower than super austenitic stainless steel.

Seawater RO system equipment capital costs range from $10/gpd production capacity to $2/gpd capacity for systems ranging from 500 to 1.0 million gal per day.

Intake and pretreatment costs can be substantial when considering a surface water source adding anywhere from $0.50 to $2.00 per gallon to the system capital cost where pretreatment costs predominant. Intake and pretreatment costs for a well system will add anywhere from $0.20 to $0.80 per gal where intake costs predominate. Systems that can utilize a well-feed source that produces a SDI of 3 or less are the least capital-intensive systems.

Operating costs will vary most predominately with varying power cost for the system as identified earlier. Typical operating costs will range from $2/Kgal of product to $8/Kgal of product for the land-based systems. When energy recovery equipment is incorporated, overall operating costs can be reduced by roughly 20 to 30 percent. Operating cost includes system consumables such as power, filter cartridges, chemicals, RO membranes and miscellaneous mechanical maintenance items and does not include labor or plant capital cost amortization.

Marketplace

An RO desalination system marketplace is justifiably anywhere there is a lack of adequate fresh water supplies, insufficient brackish water for lower pressure brackish RO operation and a good source of available seawater. This tells us that anywhere there is growth and development in water shortage areas, there is a candidate for desalination by RO. Historically, the world market has been in the equatorial zone, arid environments and island coastal communities. Remote resort developments have lead the way with this technology, but as quality water sources become more and more scarce, both industry and municipalities are recognizing the need for RO desalination. In California, Florida, The Caribbean, Central and South America, the Mediterranean, Middle-East and the Pacific Rim (i.e., anywhere there's an ocean and a need), RO desalination is a viable resource for the world's fresh water production requirements.

About the Author

Dushyant Jindal is an Engineer with MBA has an extensive experience working on environmental project for different sectors of Government and non-government organizations in India. He is the Co-Founder at Hitech Enviro Solutions, engaged in environmental monitoring services and consultancy.

To know more about the contributor of this article, you can write to us. Your feedback is welcome and should be sent at **deepak.chaudhary@eawater.com**

DESALINATION: GROWTH PATTERN AND DECISION MAKING

By Manoj Nainani, Executive Director, Egis India



As the water scarcity is increasing at an alarming rate, evaluation of alternate water supply source is intensifying. As per United Nations Environment Program [UNEP] 2015, by 2030 the world could face a 40 percent shortfall in water supply if no changes are made how water is managed. Major interventions include improving the efficiency and managing demand in industry and households. However, the efficiency improvement is very slow as compared to increasing gap in demand and supply.

With advances in desalination technology and reductions in production cost, desalination is playing considerable role in closing the gap between supply and demand in future years.However, despite significant reduction in cost, desalination remains expensive as compared to conventional water supply sources.

Today more than 150 countries are already using desalination in one form or another to meet particular segments of demand, supplying over 300 million people with potable water.

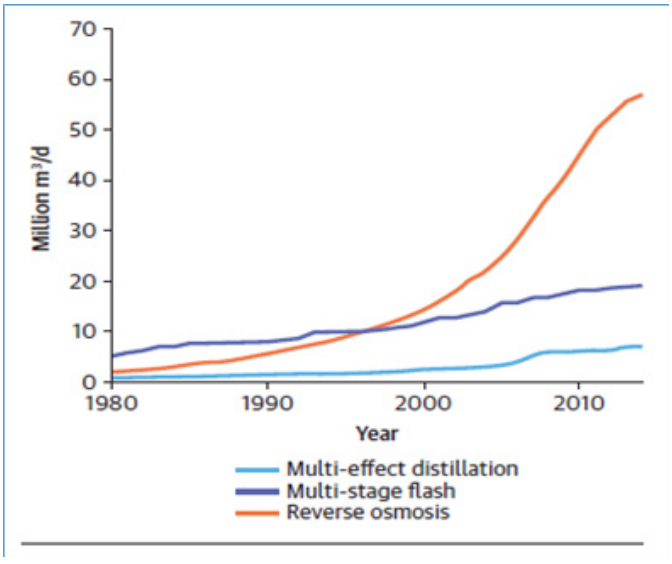
Desalination Methods

There are two main desalination methods, thermal and membrane, which can be combined as a hybrid. Thermal desalination is a process of boiling and evaporating salt water and condensing the resulting vapours. The two commonly used thermal processes are multistage flash distillation (MSF) and multiple effect distillation (MED). Both processes work in a way similar to the evaporation process: the saline water passes through a series of chambers, with each successive chamber operating at a progressively lower pressure. Membrane methods adapt the natural process of osmosis, and reverse osmosis (RO) is the most commonly used form because the seawater actually passes through the RO membranes they can easily be clogged. Seawater reverse osmosis (SWRO) plants usually build in pre-treatment facilities not used in thermal systems to pre-treat the source seawater. Membrane technologies can also be used for treating wastewater.

Growth Patterns of the Commonly Used Desalination Technologies

SWRO has overtaken thermal technology and nowaccounts for two-thirds of installed capacity worldwide.

In 2014, SWRO technology represented about63 percent of the global desalination capacity, followed by MSF (23 percent) and MED(8 percent). The remaining 6 percent of desalination Capacity was largely from hybrid technologies. However, thermal is still a leading technologyin the Middle East, especially in the GCC. In 2015, just Over half (53 percent) of all desalination plants in theMiddle East used thermal technology, whereas SWROaccounted for the balance (47 percent).



Global Cumulative Capacity of Seawater by Technology (Source: World Bank. 2019. "The Role of Desalination in an Increasingly Water-Scarce World.")

Desalination method		Capital costs (million US$/MLD)		O&M costs (US$/m³)		Cost of water production (US$m³)	
		Range	Average	Range	Average	Range	Average
MSF		1.7-3.1	2.1	0.22-0.30	0.26	1.02-1.74	1.44
MED-TVC		1.2-2.3	1.4	0.11-0.25	0.14	1.12-1.50	1.39
SWRO Mediterranean Sea		0.8-2.2	1.2	0.25-0.74	0.35	0.64-1.62	0.98
SWRO Arabian Gulf		1.2-1.8	1.5	0.36-1.01	0.64	0.96-1.92	1.35
SWRO Red Sea		1.2-2.3	1.5	0.41-0.96	0.51	1.14-1.70	1.38
SWRO Atlantic and Pacific oceans		1.3-7.6	4.1	0.17-0.41	0.21	0.88-2.86	1.82
Hybrid	MSF/MED	1.5-2.2	1.8	0.14-0.25	0.23	0.95-1.37	1.15
	SWRO	1.2-2.4	1.3	0.29-0.44	0.35	0.85-1.12	1.03

Note: Costs are at 2016 values. MED-TVC = multiple effect distillation with thermal vapor compression; MLD = million liters per day; MSF = multistage flash distillation; O&M = operation and maintenance; SWRO = seawater reverse osmosis.

Summary of Worldwide Seawater Desalination costs (Source: World Bank. 2019. "The Role of Desalination in an Increasingly Water-Scarce World.")

Desalination Costs

Overall costs have been rapidly decreasing. Recent typical costs of water production show considerable reductions for both thermal technologies (MSF and MED), but particularly for SWRO, which is now registering costs as low as US$ 0.64 per cubic meter in favourable physical and business environments. For the purposes of this study, a database was built containing over 50 desalination projects from around the world constructed over the last two decades.

Summary of Key Cost Criteria

Key criteria for choice include the following:

- RO desalination is the most cost-competitive technologyfor less saline environments, but thermaltechnology is more competitive for higher salinityenvironments.
- MSF is the most expensive desalination technologyin terms of CAPEX, but it is easier to operate andyields higher economy of scale benefits for mega sizeprojects than RO.
- MED-TVC technology is more competitive than MSFfor small- and medium-size desalination projects.

ChoosingDesalination

National Water Commission, 2011 has proposed a five Step decision-making process

Step One: Assessing sustainability of water source in long Term at the Basin Scale

- Sustainability of water supply source must be evaluated in an integrated approach
- Service area and planning horizon to be defined. Generally, the planning horizon covers several decades.
- Development of various scenarios based on planning horizon.
- Supply-demand balance and gap to be evaluated considering resources, constraints, risks and institutional context.
- Evaluation of various scenarios

Step Second: Evaluation of needs at local level

- Evaluation of local need for urban/ industrial development
- Assessment of water supply and demand for long term
- Identification of options for demand management and supply pattern
- Cost evaluation and Funding options planning
- Risk assessment of existing and proposed water supply options
- Policy guidelines and recommendations

Step Third: Detailed Assessment of existing Infrastructure and Framework
Subsequent to feasibility of desalination as possible water supply source, detailed assessment of Physical, Economic, and Institutional framework.

Suitability of desalination as water supply source:

- Demand gap is for high value market, particularly urban and industrial uses
- High Political or Climatic risks to water supply
- Higher willingness to pay
- Concentrated Demand
- Availability of suitable location for desalination technology
- Good quality feed water

Step Four: Feasibility and Risk Screening for Desalination Options

- Selecting the most appropriate technology
- Assessing and quantifying risks and their mitigation
- Assessing the external and internal political economy
- Evaluating the policy and institutional framework.

Step Five: Decisions

Subsequent to successful completion of above-mentioned steps, the authorities shall be in a position to compare the desalination options with alternatives in terms of feasibility, cost & financing, risk, political economy and institutional readiness. Techno-economic evaluation can be elaborated along with economic, social and environmental implications prior to finalization of desalination option.

Conclusion:

With the advancement of technology, the cost of desalination continues to fall across existing technologies. Desalination is increasingly becoming viable water supply source to plug demand supply gap in water sector.

Egis Experience in Desalination:

1. Supervisory Consultancy Services for Shuqaiq 3 IWPProject (450,000 m3/d)
2. Works supervision for the construction of the Salalahplant(150,000 m3/d)
3. Supervisory Consultancy Services for SharqiyahIWP Project (80,000 m3/d)
4. Works Supervision of BarkaWater Desalination Plant (281,000 m3/d)
5. Detailed Design and construction services for the extension works of the desalination plant at PetiteTerre in Mayotte (5,300 m3/d)
6. Building and Operating a Desalination Plant for Producing a Drinking Water Supply for theTown of Sur (3500 to 10,000 m3/d)

About the Author

Manoj Nainani has been with Egis since October 2015 and holds the position of Executive Director - Infrastructure (Water,Ports,Energy& Specialized projects and he is also IOSIS partner and holding position in Management team of Egis India. He is in charge of Pradhan MantriAwaasYojana (PMAY), DRIP, AMRUT (Water Project) which are largest projects of Egis in India

Manoj is a dynamic professional with over 28 years of rich experience in Strategic Planning, Business Development, Sales & Marketing and Key Account Management. He has held various senior positions in Essel Infraprojects and SPML, before joining Egis.

To know more about the contributor of this article, you can write to us. Your feedback is welcome and should be sent at **deepak.chaudhary@eawater.com**

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OVERVIEW ON WATER DESALINATION

By Dr. Mayur J. Kapadia, Retired – Additional General Manager, Quality Control, GNFC Ltd.



Introduction

Approximately only 3 % of the water available on earth is suitable for domestic purposes. The rest 97% is unsuitable for human consumption due to salinity of water. Sea Water comprises around 99% of this unsuitable portion of the water on earth, the remainder is saline groundwater.40% of the world population currently lives in arid areas or islands where fresh water is scarce. The 6th goal of the United Nations Sustainable Development Goals (SDGs) seeks to guarantee availability and sustainable management of water and sanitation for all by 2030. Therefore, purification of this unsuitable saline water holds good promise to meet with ever increasing water requirement for human consumption, though the process of purification of seawater is expensive, energy intensive and often has adverse impacts on ecosystems. Despite these drawbacks, water desalination can be an appropriate technological choice when combined with various technological advancements that reduce adverse impact on environmental vis a vis improve cost economics.Since a great majority of earth's water is found in the seas and oceans, desalination creates an opportunity for coastal communities to access virtually unlimited freshwater sources. In addition, desalination techniques can be used to purify brackish water in areas with seawater intrusion.

Desalination

Desalination is a process in which salt and other constituents are removed to produce pure water useful for various domestic purposes by human kind.Broadly, there are two basic methods of desalination:

- Evaporation(Thermal process) : A method to obtain fresh water by condensation of vapor produced from evaporation of seawater.

- Membrane Desalination :A method to obtain fresh water by filtering seawater,under applied pressure, electric current or temperature, through a semi-permeable membrane through which seawater cannot pass. Reverse osmosis (RO) is the most widely used membrane desalination technology. Other membrane technologies include Forward Osmosis (FO), Electrodialysis (ED), Membrane Distillation (MD), Nanofiltration (NF), Microfiltration (MF), Ultrafiltration (UF).

- The third method of desalination is based on the Emerging & Hybrid technologies that combine different processes together depending upon purpose of desalination, kind of water available, size of the plant, cost and environmental aspects.

Desalination of water results into two streams:

1. a pure product water and
2. a high-concentration waste stream or brine.

THERMAL DESALINATION

Thermal desalination processes generally use heat to evaporate water, leaving dissolved constituents behind. The water vapour is then condensed and collected as product water. Water distillation is a phase change process, which is the simplest form of thermal processes. Among various thermal processes like vapour compression distillation, freezing,crystallization, salting out;2 technologies named multi-stage flash distillation (MSF) and multi-effect distillation (MED) stand out. The rest of the techniques have high capital and operational costs.

Multi-Stage Flash (MSF) Distillation : MSF distillation process is based on the principle of flash evaporation. The economy and energy efficiency of this process are achieved by regenerative heating where the seawater flashing in each flash 'chamber' or 'stage' gives up some of its heat to the seawater going through the flashing process.Different from the approach of raising the temperature, the MSF desalination process, thus, evaporates water by reducing the pressure in a series of low-pressure chambers.MSF can be operated at even greater efficiency by utilising the waste heat from an adjacent power plant.

Multiple-Effect Distillation (MED): The MED process takes place in a series of 'effects', which are a kind of evaporators, and uses the principle of reducing the ambient pressure in different'effects'. This process

permits the water to undergo multiple boiling without supplying additional heat after the first 'effect'.The water enters the first 'effect' and is raised to the boiling point after being preheated in tubes. The evaporation and condensation are repeated from 'effect' to 'effect' each at a successively lower pressure and temperature.It is possible to achieve much greater efficiency in MED than in MSF.

Vapour Compression Distillation (VCD) : The compressor compresses the vapor taken from the evaporator and condenses it inside a tube bundle to give product water.The heat for evaporating the seawater comes from the compression of vapor.For smaller operations with volume needs of around 3000 M3/day, vapour compression distillation (VCD) can be an appropriate thermal distillation option.VCD is a technically simple, reliable and efficient process that is popular for resorts, industries and work sites where adequate freshwater is unavailable.

Freezing & Crystallization : It is also possible to desalinate water by freezing at temperatures slightly below 0° C. The salts are removed from salty water by the formation of ice crystals, which do not contain any salt. The process includescooling of the water feed, partial crystallization of ice, separation of ice from seawater and melting of ice to produce fresh water.Difficulties in movement of solid and liquid phases makes this process complicated and is therefore not commonly practiced. However, in a cold climate, natural freeze-thaw cycles have been harnessed to purify water at costs competitive with RO.

MEMBRANE TECHNOLOGIES

Due to the high values of the vaporization enthalpy of water, desalination technologies with phase changes consume substantial energy amounts. Rises in energy costs andgrowing regulations regarding greenhouse gas emission control have led to establishment of desalination plants that use membrane technology, which is a filtration operation through a semi-permeable membrane which retains the water with ions, and allows the passage of pure water molecules. The driving force in membrane-based technologies can be an electrical potential, a concentration difference, a temperature difference or a pressure, leading to establishment of different kind of membranes, viz.

1. electro-driven membranes[(Electrodialysis (ED) and Membrane Capacitive Deionization (MCDI)],
2. concentration-driven membranes[Forward Osmosis (FO)],
3. temperature-driven membranes[Membrane Distillation (MD)] and
4. pressure-driven membranes [Micro Filtration (MF), Ultra Filtration (UF), Nano Filtration (NF)& Reverse Osmosis (RO)].

While the first decade of this century was dominated by thermal phase change technologies, the second decade has been characterized by the increase in membrane-based desalination for treating sea water, brackish waters, tertiary wastewater, and saline surface waters. Approximately, 70% of desalination plants use membrane systems due to high effectiveness, relatively lower energy consumption and costs compared to thermal phase change technologies. Among membrane technologies, Reverse Osmosis (RO) is the fastest growing technology in the world, which is estimated to assume a market in the tune of 9000-10,000 million USD by end of this year.

1. Electro-Driven membranes

Electrodialysis (ED) :Electrodialysis is an electrochemical process that uses a system of different chambers separated by ionselective membranes. Ions are driven by the potential generated by a direct electrical current applied by electrodes immersed in saline water. The negative ions pass through the anion-permeable membrane and move towards the anode, whereas positive ions pass through cation-permeable membranes and move towards the cathode. Thus, ions are concentrated in some of the chambers, leaving desalinated water in others.ED is used for the wastewater treatment in the pharmaceutical, chemical, and food industries. The water recovery is higher than that of RO. Also, it does not call for pre-treatments or extensive post-treatment.

Reverse Electrodialysis (RED) :In this process, a salt solution and fresh water are held through a stack of alternating cation and anion exchange membranes. The chemical potential difference between salt and fresh water generates a voltage over each membrane. The process works through difference in ion concentration instead of an electric field, as in case of ED.RED has a good potential for industrial and domestic wastewater processes, desalination as well as energy recovery in RO / ED systems. RED is also applied for simultaneous generation of electrical energy, as well as energy storage leading to development of flow batteries. Large-scale RED industrial applications are economically not viable for natural waters as its power requirement is not achievable with natural waters.

Membrane Capacitive Deionization (MCDI): Membrane capacitive deionization (MCDI) cell compartment consists of two porous electrodes of commercial activated carbon fibre in parallel, wherein one is having anion-exchange membrane andthe other is having cation exchange membrane.Under an electric field between two porous electrodes, thecations and anions of water are removed by electrical migration. It is an energy-efficient and environment-friendly desalination technology. It is especially advantageous for treatment of low concentration salt solutions (lower than 5 g/L).

2. Concentration-Driven Membranes

Forward osmosis (FO) : Water molecules diffuse from the 'feed' solution of higher chemical potential to a 'draw' solution of lower chemical potential. The driving force for mass transport across a semi-permeable membrane is coming from the difference in osmotic pressure between the 'feed' solution and a 'draw' solution, which is caused by the concentration of solutions. FO is one of the most promising emerging technologies for desalination and wastewater treatment operations. It also has the lowest environmental impacts among electrodialysis /

reverse electrodialysis (ED/RED), and membrane distillation (MD).

3. Temperature-Driven Membranes

Membrane Distillation (MD) : Membrane distillation is a second-generation low-grade thermal separation technology having excellent performance for sea water desalination. The difference in vapor pressures caused by a temperature gradient across the membrane drives the diffusion of water vapor to the permeate side. Due to the membrane's hydrophobic properties, only the vapor can pass through its pores. Membrane fouling is a widespread problem that reduces both useful life and productivity of this system.

4. Pressure-Driven Membranes

The name of the process stems from the fact that pressure is used to drivewater molecules across the semi-permeable membrane in a direction opposite to that they would naturally move due to osmotic pressure. In this process, the high-pressure pump raises the pressure of the feed water to the pressure appropriate for the semi-permeable membrane such that the osmotic pressure of feed water can be overcome. As a result, the water flows across the semi-permeable membrane in the reverse direction of the natural flow taking place during osmosis process. This leaves the dissolved salts behind with an increase in salt concentration of the feed water and passes pure water to the other side of the membrane.

Microfiltration (MF): MF is widely used in concentrating, purifying or separating macromolecules, colloids and suspended particles from solution, therefore is a useful process in pre- and post-treatment in desalination process. The pore size of an MF membrane is in the range of 0.05–10 µm. It needs operating pressure below 2bar.

Ultrafiltration (UF): This is useful for pre- and post-treatment of water. The pore size of UF membrane ranges from 10 to 50 nm,which falls between NFandMF. As the pore size is larger than RO and NF membranes, UF operating pressure is low and in the range of 2–5 bar.

Nanofiltration (NF): NF membranes cannot reduce seawater salinity to potable levels but they have been used to treat waters with salinities below 1000 mg/L, with high hardness levels, organic content and bivalent ions.Nanofiltration (NF) membrane has a pore size ranging from 1 to 10 nm and cut off ability between RO and ultrafiltration (UF).

Reverse Osmosis (RO): This is a key technology in Desalination process. Because osmotic pressure must be overcome, the energy needed to drive water molecules across the membrane is directly related to the salt concentration.RO membranes have pore size of < 1 nm. Therefore, operating pressure of 60-70 bar is generally necessary for sea water.No heating or phase separation change is necessary in this process.However, pre-treatment of feed water is needed to eliminate undesirable constituents in the seawater, which would otherwise cause membrane fouling.As the water permeates through membrane, approximately 99.5% of the dissolved salts of feed water are removed and produces fresh water with minimal impurities. The concentrated stream from membrane – Brine -is discharged into ocean after following guidelines to ensure minimal impact on ecology of the sea.

The improvement in energy efficiency, more durable polymer membranes and pre-treatmentsteps have made it a leading technology in desalination operations as, in many cases, RO is more economical than thermal methods. It also has high flexibility to work under different salinity conditions, takes up little space, and is easy to operate and automate. RO units are commercially available in varied sizes, from household applications with capacities of around 100 litres / day to around 1000million litres / day (MLD) suitable for industrial and municipal use. This is currently the most reliable technology for seawater desalination at the lowest capital costs and lower energy consumption. It has, however, significant costs towards pre-treatment operations and membrane replacement. According to the water quality to be processed, RO operations are classified into brackish water plants (BWRO), with salinities between 500 and 10,000 mg/L and seawater plants (SWRO), with salt contents close to 30,000 mg/L. This process is growing at an annual average growth rate between 9-10% currently.

RO membranes have seen transformations from the initial asymmetric cellulose acetate (CA) membranes, followed by thin film composite (TFC) membrane, and now thin film nanocomposite membrane (TFN). RO can remove all colloidal material and dissolved solids with a size greater than 1 nm from feed water. The obtained water quality by RO process is relatively inferior (400-500 mg/L TDS) to thermal technologies (25-50 mg/L TDS). ButRO water quality isgenerally acceptable for most agricultural, industrial, and human consumption applications. Advancements towards transfer of hydraulic energy from the brine to the feed water has reduced energy consumption of high-pressure pumps. Various other Energy Recovery Devices (ERD) have helped in significantly curtailing the costs of RO process.

Hybrid systems

Each of the membrane technologies employ different driving forces. They also have their own advantages and disadvantages. Therefore, hybridization of different membrane technologies can overcome limitations associated with the physical and economic nature of the separate processes. Adequate selection of the hybridization of different technologies leads to reduction in energy consumption and environmental impacts, increasing the efficiency of desalination processes. The hybridization of thermal systems with RO systems gained popularity rapidly due to their efficiency. MSF-RO& MED-RO hybridization is widely used in plants in the Middle East due to low fuel prices and establishment of thermoelectric plants, in which waste

thermal energy and low-cost electricity are available. Hybridization of thermal desalination technologies with renewable energy sources is one of the trends in research and development.

Advantages of water desalination

- Desalination can greatly aid to diversification of water supply and resilience to water quality degradation. Diversification of water supply can provide alternative or supplementary sources of water when current water resources are inadequate in quantity or quality.
- Desalination can also help combating with reduced per-capita water availability due toshort-term drought and longer-term climatic trendsin parallel with population growth, land use change, and groundwater depletion.
- Desalination can provide access to fresh water for potentially water stressed or arid areas since it helps converting abundant saline waters into fresh water of quality desired for various domestic and industrial applications.
- When combined with post-treatment steps, desalination can also provide very pure water sources for industries like pharmaceuticals.

Challenges to water desalination

- The major challenges of current desalination processes include costs, energy requirements and environmental impacts.
- The environmental impacts include disposal of the concentrated waste stream and the effects of intakes and outfalls on local ecosystems.
- Brines are usually dispensed as discharges into surface and marine waters or in the sewage system causing change in salinity, pH, heavy metals levels in the marine environment. The brine also possesses other residual chemicals used in water pre-treatment and post-treatment stages, such as anti-scalants, coagulants, flocculants, and halogenated disinfection by-products. All these chemicals have their own toxic effects on aquatic life.
- The contribution towards increased greenhouse gas emissions could set back climate-change mitigation efforts.
- Countries such as Kuwait consume half of their oil production for seawater desalination and energy cogeneration, with environmental impacts on air quality, abiotic depletion, acidification and eutrophication of waters, depletion of the ozone layer, photochemical oxidation and release of compounds toxic to humans and marine life. Environmental aspects are important limitations for the expansion of RO.
- High salinity and brines generated increases the hydraulic pressure required to overcome the osmotic pressure difference between the feed and permeate in Desalination process. Energy cost is, thus, higher. Due to high energy cost, typical recovery in single stage RO system for seawater is 50% to 60%.
- Scale formation from less-soluble salts on membranes calls for additional costs in RO systems.
- Another major challenge with seawater reverse osmosis desalination (SWRO) is rejection of Boron, which is found relatively high in sea water. As Boron causes health problems in humans and plants, WHO recommends limit of 2.4 mg/L. Due to low retention of Boron by commercial RO membranes, Boron levels prescribed by WHO are sometimes not achieved, which necessitates post-treatment of the fresh water produced by RO, which can raise the cost of treatment by approximately 0.75 USD/M3.
- Precipitation of inorganic salts, accumulation of particulate material, and biofouling formation are the main causes of RO membrane fouling, increasing maintenance costs, making disinfection operations more difficult, and reducing their life time.
- Environmental impacts of the technologies used to fulfil energy requirement of RO system and noise pollution during operation and construction of RO plants are also important considerations.
- To avoid brine disposal in sea, Saline solids are generated by evaporation of brine and used for sanitary landfills. Such activity can cause changes in land use and groundwater contamination due to leaching of ions.

Financial costs

Costs are very much site-specific and can vary widely. Some of the factors affecting the cost per M3 include:

- Cost of energy,
- Scale of the plant, and
- Salt/TDS content of the source water
- Capital costs of construction

The operation cost of membrane desalination decreases sharply as the salt concentration decreases. Higher capacity plants have substantially lower costs.

SWRO plants of >10,000 M3/day have been reported to cost in the range of 0.5 to 1.5 USD/M3.Thermal methods of almost identical capacity plant could cost in range of 0.5 to 2 USD/M3. Operating cost of BWRO plants of 10,000 to 50,000 M3/day is reported to range from0.25 to 0.5 USD/M3, since TDS in feed water is drastically lower than seawater. The lower capacity BWRO plants (<1000 M3/day)could cost from 0.75 to 1.25 USD/M3. The operating cost indicated here are tentative and does not include cost of intake water, concentration discharge, capital and maintenance cost of plant and labour cost.

Organizational considerations and opportunities

Desalination enables access to a nearly unlimited and stable water supply of water for households and industry. However, in view of various challenges and barriers, water desalination should not be considered a panacea of the water scarcity. Desalination should remain the last resort, and should only be applied after having carefully considered cheaper alternatives in terms of supply and demand management. Wherever considered for implementation, desalination plants should be

considered in water sectors that are functioning well, have well-defined water policy, well-characterized water resource availability, accurately estimated demand over a period of time, technical expertise, and relatively little waste and inefficiency. The institutions, organizations and the governments must consider some very crucial and important points before pushing the efforts toward water desalination :

- Institutions should use an integrated water resources management (IWRM) approach to determine accurately the renewable freshwater resource potential, demand and consumption.
- They should develop a clear water policy.
- Desalination should be considered only when the inadequacy of conventional water resources is clearly established.
- Should implement conservation and water demand management in all sectors.
- Reduction of non-revenue water in piped systems, limited subsidies, and prevention of groundwater pollution should be addressed.
- Water desalination should be combined with other non-conventional efforts like reuse of treated wastewater, transportation ofwater across geographical boundaries, rainwater harvesting and creation of microcatchment areas.
- Should ensure an abundant source of brackish water with low salt / TDS for membrane systems.
- For thermal systems, the plant location should preferably on a coastline with an adjacent facility for power availability. The vicinity of a power plant can synergise the thermal desalination since power plant yields abundant waste heat.
- Consumers of water should be educated and convinced not to oppose the reuse of treated wastewater.
- Should constantly strive for technological advances for reducing the economic and environmental impacts of desalination.
- Should make sure that sustainable energy utilization and safe discharge methods are deployed.

Scenario

In 2017, there were almost 18,500 plants installed in around 150 countries to handle desalination of around 100 million M3/day, according to the International Desalination Association (IDA). The ever-growing technology has been raising the installed capacity year on year. Approximately, 60% of the units take seawater as feed water, whereas almost 30% corresponds to brackish water. More than 60% use of Desalination technology is towards municipal purposes and around 30% for industrial use.

Almost half of the desalination plants are concentrated in The Middle East and North Africa, with North America having approximately 12% of the capacities. East Asia and the Pacific add up to approximately 18-20%. It is estimated that the world desalination market will grow at a speed of 9-10% in the coming years, most of which is likely to come from Europe, the Middle East, and Africa.

Reverse osmosis (RO) is the dominant technology in membrane processes (70%), followed by multistage flash systems (18%) and multi-effect desalination (7%) of the installed capacity in large-scale desalination plants. Other membrane technologies such as Nano Filtration (NF) contributes 3% to desalination, while electrodialysis (ED) 2%, and reverse electrodialysis (EDR) 1%. In the Middle East, thermal desalination technologies continue to be overriding, due to their integration with power plants and useful life of more than 30 years.

Historically, Kuwait was the first country in the world to commission first distillation plant in 1951 to supply water for large-scale domestic use. Currently, there are some 20,000 desalination plants in the world.From scale viewpoint, the large capacity plants are located in the Middle East. The Ras-Al-Khair plant of Saudi Arabia is considered to be one of the largest hybrid desalination plants of world. This 1036 MLD plant uses both MSF and RO technologies to produce fresh water and power in the tune of 2400 MW. Saudi Arabia's Shuaiba3 and JWAP plants handle 880 and 800 MLD water respectively. DEWA Station plant of UAE produces 636 MLD of potable water and is one of the largest power and desalination plants of UAE with a power capacity of >2800 MW. UAE's Fujairah plant has a capacity of 591 MLD, out of which 450 MLD is thermal plant and rest is RO plant. This plant produces 2000 MW power. While Ras-Al-Khair is the largest hybrid plants of the world, the Sorek plant of Israel is the largest membrane plant of the world, which handles 624 MLD water.Taweelah and Umm Al Quwain plants of UAE will be of 900 & 683 MLD capacities respectively and are expected to be commissioned by this year end. It is believed that mega desalination plants in future will override Ras-Al-Khair plant, since Saudi Arabia is planning for a 1500 MLD plant. IDA believes that plants of such capacities will also come up in future in China, India and Abu Dhabi depending upon governments policies.

Future prospects

- Economies of RO desalination can be improved by use of renewable energy resources like Solar energy to facilitate direct evaporation and wind energy to supply electricity or mechanical power.
- The nuclear energy offers a higher energy density compared to other conventional and renewable energy sources.
- Other emerging technologies such as capacitive deionization, freezing, humidification-dehumidification, and use of gel hydrates for desalination have not reached enough maturity at this stage for extensive use.
- Desalination through carbon nanopores is a promising future technology for desalination.
- Development towards artificial intelligence can aid towardsefficient design and management of desalination plants, increasing productivity, reducing errors, optimizing operating costs, and freeing human beings from carrying out repetitive tasks.
- Energy storage systems and automated decision-making for production based on real-time demand analysis holds high potential

for the future of the desalination industry.

- Ample research opportunities exist in new membranes development and hydrodynamics process to bring about solutions to some of the present technical problems.
- Conversion of brines into valuable products will be crucial to reduce environmental impacts.
- Research towards achievement of Zero Liquid Discharge and Minimal Liquid Discharge will boost membrane desalination.
- Energy Recovery Devices for small-scale RO units can substantially save energy costs.

Conclusion

The population and economic growth, increased need of fresh water as well as deterioration of conventional water sources have put a great pressure towards fulfilment of good quality water for domestic and industrial consumptions. Therefore, Desalination of sea and brackish water has shown a significant increase in recent decades. Among desalination technologies,RO is the most advanced technology due to its relatively low energy consumption, flexibility, ease of operation, economy of operation and high efficiency. On the other hand, low boron retention of RO membranes, membrane permeability loss, fouling, and requirement of high operating pressures for desalination of high salinity water are some of the technical limitations. Brine disposal, noise pollution, impacts on the marine environment, and generation of GHGs are some of the environmental difficulties of this technology. However, advances in new membrane materials, improvements in high pressure pump efficiency, and development of energy recovery devices (ERD) have pushed implementation of RO process.

RO desalination is a knowledge, technology, and energy intensive process. Optimal utilization requires training, regular maintenance and access to spare parts. For water desalination to be successful, there has to be strong water policies, well-defined water resource availabilities and demand, and strong technical expertise. Monitoring and environmental impact assessment should also be instituted, depending on plant size and waste disposal methods.A multidisciplinary vision and on-going research are crucial aspects for industrial implementation and future growth of water desalination technologies.

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A SHORT REVIEW ON ASSESSING GROUNDWATER FACILITY FOR SMART SUSTAINABLE MANAGEMENT

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

Abstract

Monitoring and supervising groundwater resource facilities, including wells and pumps, are the most challenging management issues for both academia and industrial practitioner working in water management. These motivate this study to propose an intelligent Decision Support System (DSS) to interpret the huge data records for operating propositions authorized to decide based on the provided information. In this work, an integrated database of the influencing parameters, including water flow rate, water pressure, current intensity, voltage, and power of the wells and pumps, have been gathered by telemetry arrangements as a Knowledge-Based Systems (KBS). Statistical appraisals are carried out on these parameters in six randomly selected wells to define the thresholds of these effective factors. Then, a soft-sensor is designed using Random Forest (RF) machine learning prediction algorithm to forecast water flow rate, water pressure, and current intensity in wells. In this soft-sensor, online comparison of the achieved data from telemetry system with design catalogs of pumps and periodic field tests conducted on the wells and their facilities have provided an empirical framework for health monitoring of wells and pumps. Finally, a framework of management knowledge and operational experience of professionals at water and Wastewater companies generated by applying the Classical Delphi (CD) technique. The outcome of this work has been presented as the managerial insights for the wells and pumps monitored online with high precision.

Keywords: Decision Support System, Groundwater management, Machine Learning Algorithms, Classical Delphi method, Petri net modeling, Random Forest.

Introduction

Management of water resources and supplies has a key role in the growth of urbanization, industrialization, and standard of living. An abortive attempt to keep up with ever-increasing water demands through recklessly excessive abstraction of limited groundwater resources has led to threatening human life and damaging the natural environment (Mojtahedi et al., 2021). Hence, efficient and smart water withdrawal of water resources has been on the agenda for stakeholders and water users to achieve sustainable management of water demand and supply with respect to limited water resources. The first step of smart water resources management, e.g., groundwater systems, is to provide required water withdrawal data, including flow rate, hydraulic and electric parameters of wells and pumps. Supervisory Control and Data Acquisition (SCADA) systems can manage all this favoring a large variety of sensors widely used in water systems. The SCADA systems gather and analyze real-time data for monitoring the performance of the water supply systems, including their equipment such as pumps.

The data collected needs to properly be analyzed and interpreted as meaningful information for decision-makers. Various data-driven models and tools can conduct data analytics in water systems (Ali et al., 2021). Nowadays, machine learning (ML) is one of the popular tools due to its ability to predict the future with high levels of precision. Many researchers have employed ML models to successfully forecast water systems' performance. Some examples include Random Forest (RF), Support Vector Machines (SVM), artificial neural networks (ANN), and boosted regression trees (BRT). The RF model is an ensemble ML method for regression and classification that operates by building a huge number of decision trees using a random vector independently sampled from the input vector. Bagging is a method to produce a training dataset where a randomly selected part of the predictor variables is applied to construct each model's individual tree (Fathollahi-Fard et al., 2021).

The trees are grown to the maximum depth of the new training dataset using variables without pruning. This is one of the major merits of the RF regression over other tree methods such as the M5 model tree. Moreover, the RF is a suitable method for indicating the nonlinear influence of variables and can handle complex interactions between variables, and is not influenced by multi-collinearity. Band et al. (2020) showed that the RF models in forecasting nitrate concentration in groundwater are more accurate than other ML algorithms such as Cubist, SVM, and Bayesian ANN. Singh et al. (2017) investigated the potential of the M5P model tree, ANN and RF for predicting the effects of impurities such as ash and organic manure on soil infiltration rate in various geometries. The performance evaluation parameters have proved that the RF approach performs extremely accurately compared to the M5 model tree and ANN considered models for this dataset.

Ouedraogo et al. (2019) demonstrated that the prediction correlation of the RF algorithm for modeling groundwater nitrate pollution is much better than the multiple linear regression (MLR) method. According to the IDC report (Fig. 1), the spent financial resources for smart cities will be increased from 2018 to 2023. Also, this fact leads to an increase on the costs through smart systems and facilities. Plus, as per Fig. 2, the most spent finance is related to the implementation of smart infrastructures, and it illustrates that this section of facilities needs enhancement from

automation and smartening aspects. Besides, Fig. 3 demonstrated that Environmental smart monitoring through the smart city plan is divided into 16% connectivity, 9% software, 39% hardware, and 37% services. Therefore, increasing the software systems instead of hardware substructures makes the cost of smart city operations optimized.

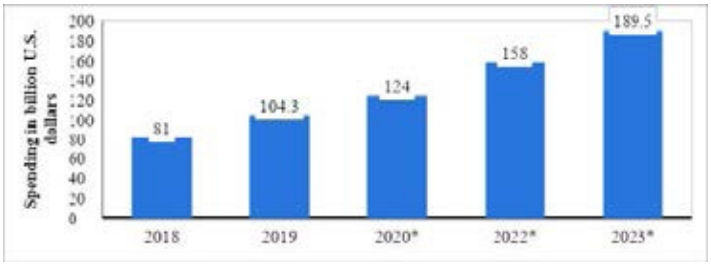


Fig. 1. Technology spending on smart city initiatives worldwide from 2018 to 2023 (in billion U.S. dollars), Source:IDC; ID 884092.

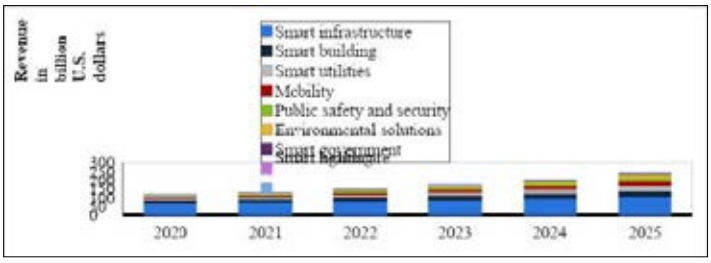


Fig. 2. Projected revenue of the smart city market worldwide from 2020 to 2025, by segment (in billion U.S. dollars), Source: Statista; ID 1111642.

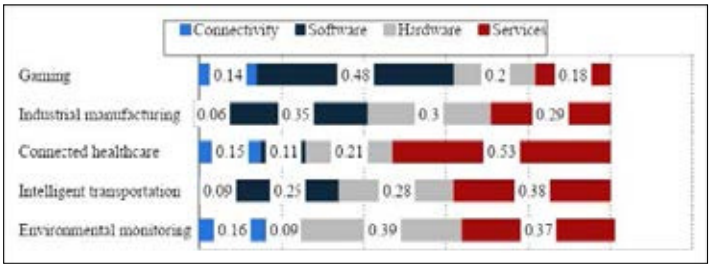
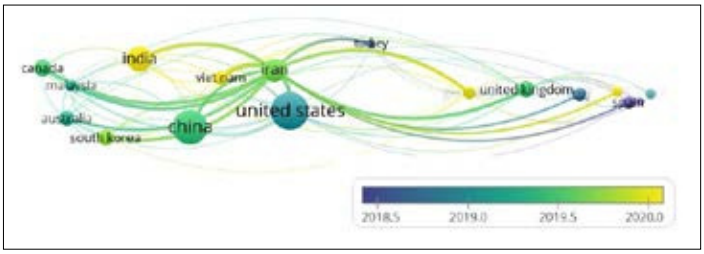


Fig. 3. 5G edge computing ecosystem market revenue share forecast worldwide in 2023, by segment/key industry, Source(s): KPMG; IDC; ID 1176665.

ML algorithms used as a predictive model need to be combined with decision-making methods in smart urban water management. Classical Delphi (CD) is one of the management techniques used for prediction based on the outputs of some rounds of questionnaires anonymously answered by a group of experts. The responses in each round are aggregated and shared with the experts. They can change their responses according to the previous round results. Ultimately, the information acknowledged by more than 60% of the experts is integrated and presented as the final outputs. This method is extensively employed when there are controversial opinions about a managerial problem (Chouhan et al., 2021). A large volume of water demands in warm and dry climates is supplied from groundwater abstraction as the main water resources via pumping stations. Smart management of water supply requires the key parameters of pumping facilities are collected and analyzed. These parameters in pump systems include hydraulic (water flow rate, pressure head and etc.), electrical (amperage, voltage and etc.), and mechanical (energy functions, electromotor problems, etc.) considerations. The pump performance should also be compared with specific standard tables designed for real-time equipment health monitoring.

Although current control systems in water resource management facilities provide much useful management information for optimum operation of pump systems, these control systems include physical sensors and electrical, mechanical, and structural costs which financially put a burden on the water resource management organization. Because of the financial burden of the capital cost and maintenance of physical sensors and other facilities used in water resource management, economic computerized telemetry tools can be established and employed in many industrial sectors such as water and wastewater companies. In comparison with all key parameters of pumping systems, prediction of flow rate, pressure head and water demand by ML has been common practice. Artificial Neural Networks, Support Vector Machines, fuzzy

(A)



(B)

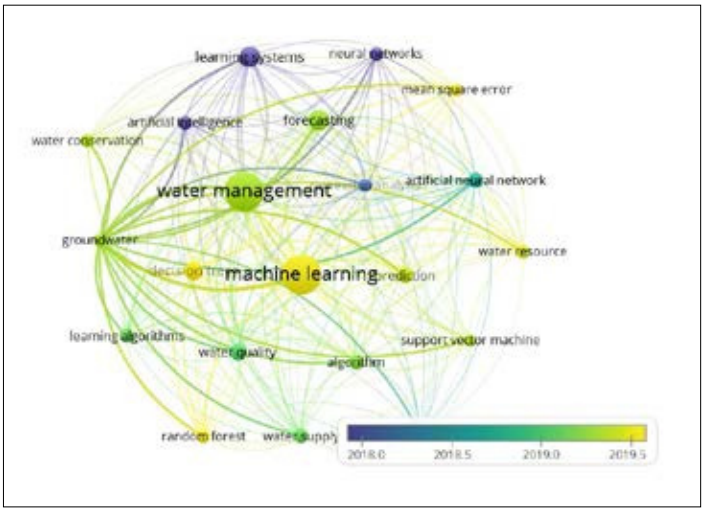


Fig. 4. The outputs of bibliography through this study as per (a) country distribution and (b) keywords occurrences.

logic, hybrid models, and RF have been employed to forecast water demands and other applications (Amini et al., 2021; Sun et al., 2021; Afrin and Yodo, 2022; Yang et al., 2021).

To determine this research area's importance, the library evaluation is done based on data mining of Scopus databank through the VOSviewer software. Due to creating the databank, smart systems' application in water management issues are extracted from Scopus datacentre. According to Fig. 4-a, it is clear that the United States and China had the most publications in the mentioned issues, and also, Iran increased its activities in the using smart system in the water management research area. Likewise, based on Fig. 4-b, integration of machine learning and water management systems is in tren and expanding this investigation area attracted both academia and industrial practitioners.

Conclusion

The necessity of smart water management in a rapidly modernized world with global concerns about water scarcity and considering recent advances in technology, smart water management telemetry systems have attracted attention worldwide. Although water management has already been automated and a huge deal of data is recorded in telemetry systems, more effort is required to analyze this data and provide practical decisions and propositions based on the recorded data to manage water resources smartly. Therefore, designing DSS for smart monitoring and controlling water resources is growing importance.

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SATELLITE RADAR FOR LEAK DETECTION IN SMART CITY UDAIPUR: ADVANCEMENTS IN PIPELINE MONITORING AND LOCALIZATION

By Riddhish Soni 1, Divyang Soni 2, Kartik Khatik 3, Dr. Kapil Sharma 4, Nirmal Chittora 5, Mukesh Pujari 6, Navneeta Mathur 7, Chandrakant Yadav 8, Navisha Goyal 9, Rohit Sharma10

Abstract:

This technological investigation delves into the capabilities of leak detection engineering based on satellite radar reflectometry and its confluence with SCADA systems. The focus of this study area is the pipeline infrastructure extending from Jaisamand lake to Titardi in the Udaipur District, with an aim to evaluate the benefits, challenges, and prospective advancements of this remote leak detection technology. The projecthighlights its imperative role in enhancing water conservation, facilitating risk anticipation, and augmenting infrastructural quality, thereby providing a broader perspective on its potential relevance to the pipeline operation and maintenance project.

Introduction

Udaipur, known as the "City of Lakes," faces a critical issue with its water infrastructure due to numerous detected leaks, impacting the availability and quality of water for residents and visitors. A collaborative project between the Udaipur Municipal Corporation, PHED and Aumsat Technologies LLP was initiated to inspect the 600 mm diameter pipeline connecting Jaisamand Lake to Titardi Water Treatment Filter Plant in Udaipur city. The 52.8 km pipeline, constructed in 1995 is supported by four pumping stations, transports 525m/minute of water to the Titardi plant daily. Over a three-month period from January 1, 2023, to March 20, 2023, satellite radar technology effectively examined the

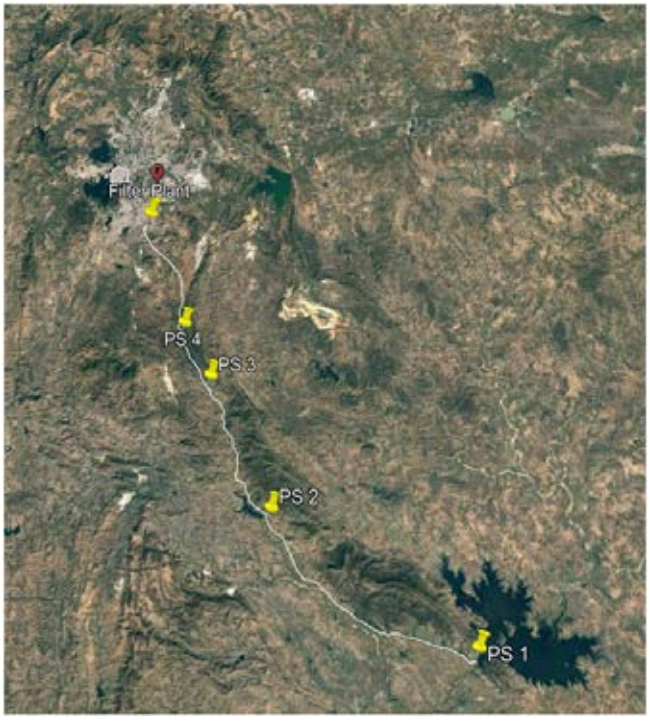


Image 1: Jaisamand to Udaipur Pipeline



Pump Station 1



Pump Station 2



Pump Station 3



Pump Station 4



Water Treatment Plant

pipeline, identifying 11 leak points and validating the leak detection methodology's effectiveness.

This technological advancement sheds light on the importance of addressing these leaks and their adverse impact on Udaipur's water supply. It also highlights the necessary measures to rectify the situation. Notably, a cost-effective remote solution has played a significant role, resulting in substantial cost savings of approximately 75% in logistical and economic aspects.

Pipeline Digitalization and SCADA integration

The Jaisamand-Udaipur pipeline, constructed in 1995, was transitioned from hardcopy paper maps to digital maps through scanning, GPS surveys, and geocoding. These digitized maps were integrated into a customized SCADA system, enabling real-time monitoring, remote control, data analysis, asset management, regulatory compliance, and enhanced safety and emergency response. This modernization improved operational efficiency, safety, and regulatory adherence.

Radar Satellite deployment

The satellite radar, with its extensive monitoring capabilities, accurately isolated water pixels and detected 11 leaks in a day. This capability facilitated swift identification, localization, and timely repairs, while also serving as an early warning system, ultimately minimizing water loss and ensuring proactive maintenance.



Image 2: Digitalizationof Pipeline Maps

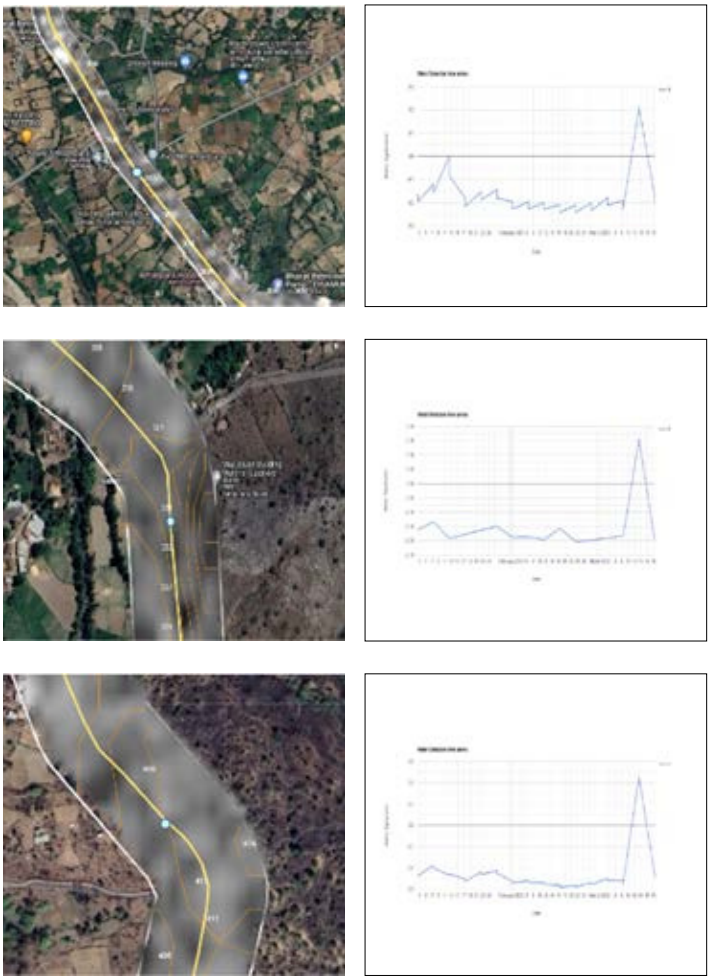


Image 3: Satellite Radar

Validation and Verification

The PHED Operations and Maintenance team diligently validated leaks using thermography and field observations. Their expertise enabled the identification and confirmation of 11 genuine leaks. This meticulous process prevented unnecessary repairs, optimizing leak detection efficiency. The team's commitment to accuracy played a crucial role in the effectiveness of leak detection and repair operations.

Conclusion

The results of this study provide substantial evidence of the significant advantages associated with the integration of satellite radar-based leak detection technology and SCADA systems for the Jaisamand lake to Udaipur pipeline. The technology demonstrated a commendable level of precision in the detection of leaks, facilitating swift intervention and reducing the likelihood of water losses. Furthermore, the amalgamation with SCADA systems bolstered real-time monitoring capabilities, enabling proactive leak detection and efficient maintenance planning. Additionally, the technology exhibited its potential in forecasting and mitigating prospective risks, thereby making a valuable contribution to the overall enhancement of the pipeline's infrastructure.

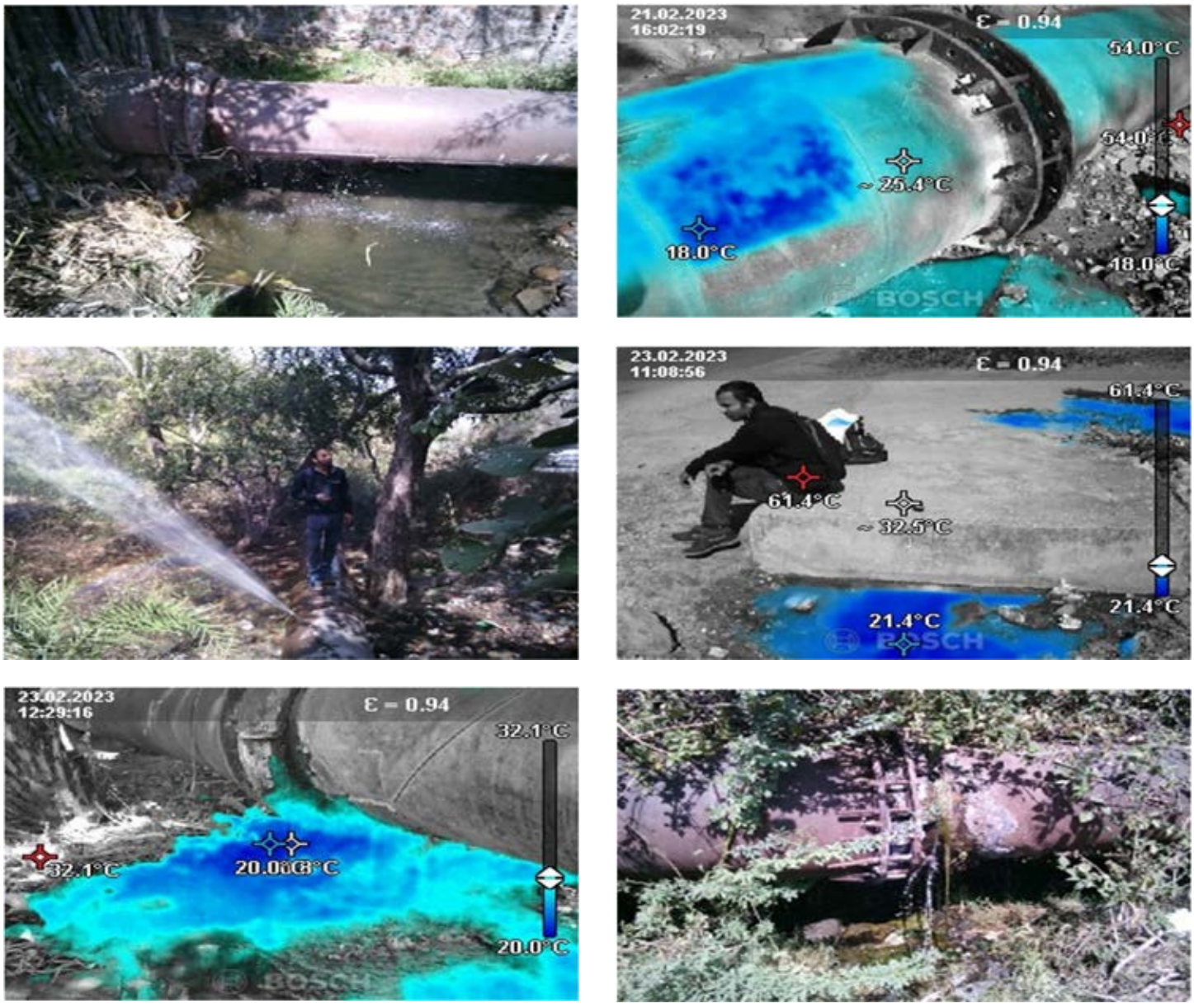
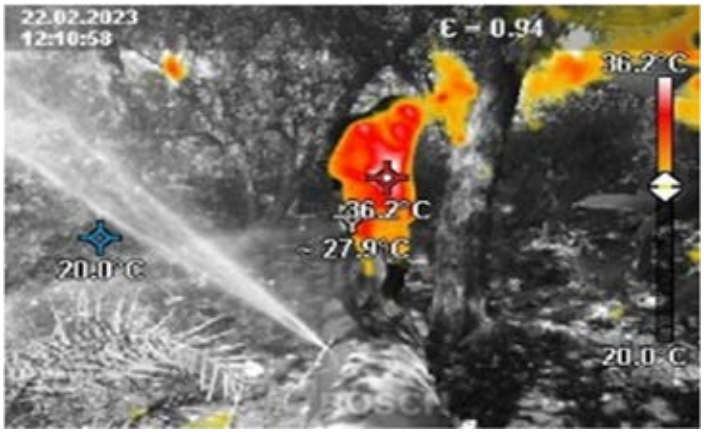
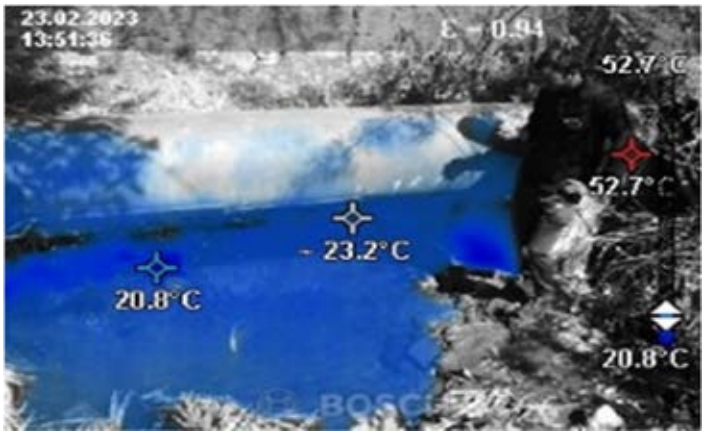


Image 4: Leak Validation and Verification









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CASE STUDY

ATLC INFRACONSULTANTS DESIGNS A WATER SYSTEM 25 DAYS AHEAD OF SCHEDULE, PROVIDING POTABLE WATER TO 300,000 PEOPLE IN INDIA

OpenFlows WaterGEMS and STAAD Helps Them Optimize Designs while Saving Costs



128 Villages Lacked Piped, Safe Drinking Water

Mirzapur, one of the southern districts of Uttar Pradesh, India, spreads over 4,525 square kilometers and includes Vindhyachal Dham, a significant Hindu temple. Until recently, the 300,000 people living in 128 villages of the Marihan Block in Mirzapur received water through individual and public hand pumps. To improve the quality of life for residents and for the many visitors to Vindhyachal Dham, the state government initiated a project to develop a piped water system, ensuring equal distribution of treated water to all 128 villages. ATLC Infraconsultants Pvt. Ltd. was contracted to design the project, which needed to continue operations and accommodate population growth through at least 2053, as well as meet state regulations. "The proposed Leduki water supply scheme has been designed taking into consideration the optimization of infrastructure, operations, and maintenance to achieve the service level delivery under the ambitious program of the state government," said Gaurav Gupta, director, ATLC Infraconsultants.

Designing a Water Network in the Mountains

In addition to the state government's requirements, they soon determined that the ambitious project would need numerous components. These included augmenting the existing water treatment plant, a new pumping station at the water treatment plant, four additional water pumping stations, and 12 service reservoirs, as well as the many kilometers of transmission and distribution mains and house connections with water meters. Properly placing the components in the mountainous area required a sweeping topological survey of the site areas, site data collection to determine the number of households to be served, and a source sustainability study to confirm the availability of water, as they did not know the current state of the water table.

After obtaining the site data, ATLC planned to undertake raw water and clear water hydraulic analysis, along with surge calculations. Since the hydraulic data would help inform the design of all components, the design team wanted to incorporate the hydraulic data into the modeling environment. ATLC tried to undertake the work in other applications, but they could not provide a comprehensive view of the undulating topography, which varied in height by as much as 140 meters, or provide alternate route alignment suggestions. The environment required multiple siloed applications to carry out the work, plus they could not easily analyze the effects of design changes on water pressure. ATLC realized they could not efficiently design a safe network and meet the required 90-day deadline with these older tools.

Hydraulic Analysis and Modeling in One Environment

After considering several options, ATLC determined they could seamlessly design the network and undertake hydraulic analysis with OpenFlows WaterGEMS and STAAD. The detailed hydraulic analysis revealed the exact state of the water table, which helped them determine where assets would need to be built and how to ensure clean water. Using OpenFlows WaterGEMS, the design team incorporated the site data and performed updated hydraulic analysis as needed to optimize the designs, ensuring their safety and reliability. This analysis included a complete evaluation of the water supply, pressure zoning for equalized distribution, and a determination of the most effective distribution to household connections. With STAAD, ATLC optimized the structural designs of intake wells, elevated service reservoirs, and water treatment plants.

As they combined their work in the two applications, they built a digital twin of the entire work area that clearly visualized the scope and details of the project, helping them share their work with project stakeholders. "We conceptualized a digital twin that helped us get approval of the design concept with the client," Gupta said.

Determining How to Improve Safety and Reduce Costs

By using OpenFlows WaterGEMS and its integration with Bing Maps, ATLC quickly visualized all project locations. The clear view of the project area helped them determine how to convert some areas previously targeted for pumping stations into a gravity network, which saved INR 50 million in development, in addition to future savings from lessened operations and maintenance costs. Further optimization on the pipeline layout helped them achieve a high level of quality while shrinking the total amount of piping from 750 kilometers to 674 kilometers and reducing the pipe diameter, saving INR 70 million.

The client will save additional money during operations as the applications helped ATLC relocate the location of a pumping station, lowering the pump head and ongoing energy costs. The application also streamlined the modeling process while improving the accuracy of designs. By integrating and optimizing the design and analysis process, ATLC delivered the design of the Mirzapur water network 25 days ahead of schedule. The recently completed water system provides safe, reliable service to over 36,000 households, greatly improving their standard of living and the state's economy. "Every one dollar invested in water and sanitation provides a four-dollar economic return by lowering health costs and increasing productivity," Gupta said.

Project Summary
Organization
ATLC Infraconsultants Pvt. Ltd.

Solution
Water, Wastewater and Stormwater Networks

Location
Mirzapur, Uttar Pradesh, India

Project Objectives
- To create a distribution network that will provide clean water to 300,000 people.
- To unify modeling and hydraulic analysis in the same design environment.

Products Used: OpenFlows WaterGEMS, STAAD

Fast Facts
- Until recently, 300,000 people living in Mirzapur received water through individual and public hand pumps.
- To improve the quality of life for residents, ATLC Infraconsultants had to design a distribution network ensuring equal distribution of treated water to all 128 villages.
- Their attempts to use multiple siloed applications could not easily analyze the effects of design changes on water pressure or meet the 90-day deadline.

ROI
- By using Bentley applications to unify modeling and analysis, ATLC determined how to convert some pumping stations into a gravity network, saving INR 50 million.
- Optimizing the pipeline layout helped them shrink the total amount of piping from 750 kilometers to 674 kilometers and reduce the pipe diameter, saving INR 70 million.
- By streamlining the design and analysis process, ATLC delivered the design of the Mirzapur water network 25 days ahead of schedule.

Callout Quote: "Using WaterGEMS and STAAD, we were able to deliver the project 25 days [before the deadline] and achieve our project milestone, which itself is a great feat. Timely and successful delivery of the project is great achievement, which was possible because of Bentley products." – Gaurav Gupta, Managing Director, ATLC Infraconsultants

About the Author

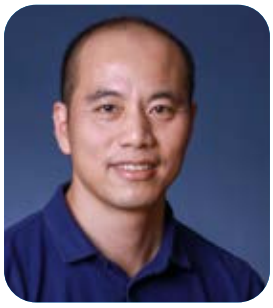
Sandra DiMatteo is the Industry Marketing Director, Water Infrastructure at Bentley Systems. She has more than 25 years of experience in reliability and asset performance management software, asset lifecycle information management, and is an expert in digital twin cloud solutions in the water and wastewater, energy and process industries. Sandra holds an honors degree in accounting and is a Certified Reliability Leader. She sits on the Reliability Leadership Institute Board of Advisors and founded the Ontario Chapter of the Society of Maintenance and Reliability Professionals.

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

CASE STUDY

VONTRON SEAWATER MEMBRANES ENABLES HIGH-PURITY WATER FOR RABIGH POWER PLANT

By Dr Liang Songmiao, Director, Time Vontron Technology Co., Ltd.



RO Membrane Usage in Power Generation

Thermal power generation is the most important type of power generation, accounting for more than 60% in the world, report from the International Energy Agency (IEA). The stable operation of thermal power plants is inseparable from high-purity water. At the same time, the increasing pressure of environmental protection and energy-saving policies poses a challenge to high-quality membrane products.

VONTRON tech provides complete solutions for each process of water treatment in power plant:

1. Boiler makeup water for steam generation
2. Cooling tower makeup water
3. FGD (Flue Gas Desulfurization) process makeup water
4. Treatment of cooling tower blowdown
5. Condensate polishing
6. Nox cooling water

RABEC Rabigh Independent Power Plant (IPP)

Rabigh IPP 2 × 660MW subcritical oil-fired power plant project is located 150 kilometers north of Jeddah, a port city in western Saudi Arabia.This power plant was officially put into commercial operation in early 2013.

Rabigh IPP mainly consists of pre-treatment section, sea water RO unit, brackish water RO unit and post Treatment section as demineralization plant. The final consumer is steam turbine unit boiler to produce the steam very extreme high-quality steam. The Sea water consist 4 number of SWRO streams.





Picture 1&2. Rabigh factory photos

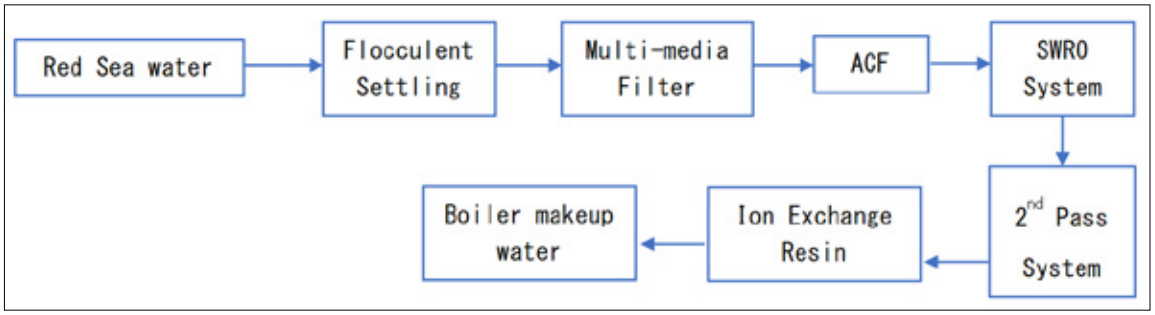


Figure1. Water treatment system process

Sea water RO system

There are four single-stage trains in the SWRO system, 20 pressure vessels per train and 7 elements per pressure vessel, all the SWRO systems operated under 43% recovery rate and 26-34ºc temperature, Table 1. Show the feed water quality.

Table1. Feed sea water stream quality (mg/L)

Calcium (Ca2+)	436.69	Bicarbonate (HCO3-)	144.04
Magnesium (Mg2+)	1,432.36	Carbonate (CO32-)	7.53
Sodium (Na+)	12,878.02	Sulphate (SO42-)	3,311.58
Potassium (K+)	362.36	Chloride (Cl-)	22,588.58
Barium (Ba2+)	0	Fluoride (F-)	1.26
Strontium (Sr2+)	0	Nitrate (NO3-)	0
Boron (B)	6.80	Silica (SiO2)	0.29
TDS	41162.00	pH	8.2

For seeking a SWRO membrane with highly productive, high quality (Low TDS) and less price for long term stable operation.Many competitors have conducted field comparison testsin cooperation with Rabigh power plant. At last, VONTRON membranes won the competition.



Picture 3.Sea water RO system



Picture 4.2nd Pass RO system

VONTRON Seawater Membranes Performance

Since VONTRON SW8040HR-400 membranes began operations on the Rabigh IPP SWRO system in November 2019 (Picture 5).



Picture 5. VONTRON membranesbeing loaded

The seawater reverse osmosis permeate has been well within specifications. Figure 1. Shows the normalized permeate flow and rejection.

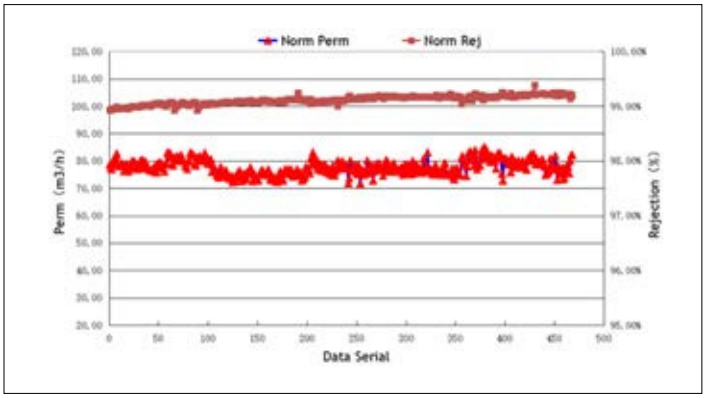


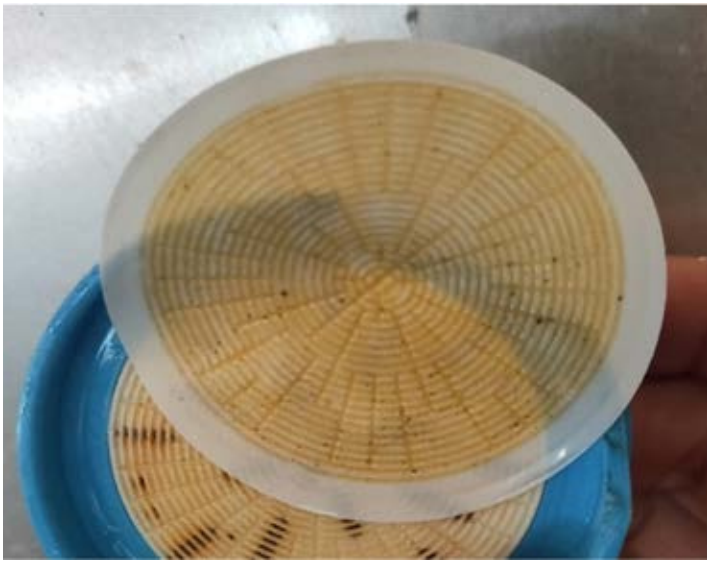
Figure 1. Normalization Permeate Flow and Rejection

After 450 days operation, at expected, all the parameters arestill under customer'sfirstyear permeate water requirements (Table 2.)

Permeate water parameter	unit	Design value	Actual value
TDS	ppm	<390	230-280
Cl-	ppm	<230	132-170
Boron	ppm	<1.45	0.98-1.11
Flow rate	m³/h	≥78	78-82
Differential pressure	Bar	<1.6	1.0-1.4

Table 2. Firstyear permeate requirements and actual value

Red Sea input water canbe high in SDI and TSSsometimes,maycause seriousorganic pollutionon the surface of the feed end, chemical cleaningsare done every 4 months.



Picture 6. SDI film full of colloid

After chemical cleaning, the feed pressure and differential pressurerecover to original figures.

Conclusions

Since the first day operation in November 2019, VONTRON membranes provide stable high-purity water for Rabigh IPP, and now VONTRON latest 440ft2 SW membranes are proceed orderly at Rabigh IPP.

About the Author

Dr Liang Songmiao, born in November 1977, graduated from Wuhan University, major in polymer chemistry and physics, doctor of science, professor-level senior engineer. From October 2007 to November 2008, he was a post doctor at the State University of New Jersey (Rutgers University). From November 2008 to November 2009, he was a postdoctoral researcher at Hokkaido University in Japan. From December 2009 to January 2020, he served as senior design and development engineer, director of the technical center, deputy general manager and director of the technical center, executive deputy general manager and chief engineer and director of The Time Vontron Technology Co., Ltd. Since January 2020, he has served as general manager, chief engineer and director of Time Vontron Technology Co., Ltd.

To know more about the contributor of this article, you can write to us. Your feedback is welcome and should be sent at:
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CASE STUDY

OSMOFLO CASE STUDY FOR GLOW ENERGY, THAILAND

By Osmoflow



Challenge

Osmoflo were contacted by the client in early 2020, to provide an emergency water solution and to assist in mitigating the effects of a drought crisis impacting on their Power Stations in Rayong.

Solution

Rapid response and engagement with the client to assess their site and then the proposal of one of our SW7000 rental assets consisting of 12 x 40" containers, 1 x 20" container, 2 x 11kV electrical transformers, 1 x 11kV HP Pump skid (5t in weight).

Osmoflo were also contracted by the client to manage the logistics for the 7MLD plant including cranage, road transport, shipping for our Dubai facility and delivery to the client site in Thailand.

A exceptional result achieved from client with an urgent need, Osmoflo with an equipment solution and a collaborate team effort to deliver in the middle of a pandemic.

Result

Working very closely with our client, we were able to achieve a 12 week delivery phase and water production, managing the effects of a Global pandemic (COVID-19) and the restrictions that imposed was a challenge overcome. Our project appointed technical advisor was able to provide intense remote guidance to a very capable on site construction contractor engaged by our client to reassemble the plant and transition into commissioning and performance testing before being placed into commercial operation. Commissioning was managed remotely by our specialist engineer while working from home (New Zealand). In the 3 months to date since commercial operation, the plant as easily achieve the minimum daily production capacity of 6.3MLD and in this current month being August 2020, has averaged in excess of 7.8MLD.

Client – Glow Energy Public Limited Company
Technology – Ultra filtration Sea Water Reverse Osmosis
Commissioned – May 2020
Project Scale – 700m3/d
Location – Rayong, Thailand

About the Author

Osmoflo is a progressive water treatment company that provides tailored, turn-key water and wastewater solutions across the industrial, resources and municipal sectors globally. The company is celebrating 30 years' in water treatment and has offices in India, Australia, Oman and Dubai.

Having built its reputation as the largest Australian-headquartered designer, constructor and operator of reverse osmosis desalination systems, Osmoflo continues to diversify its impressive portfolio of products and services. Today, with the strong support of their shareholder Hitachi Zosen of Japan, Osmoflo's innovative process and commercial solutions are provided to clients across four continents.

Osmoflo's experience covers the full range of seawater, brackish, waste and contaminated feedwaters for applications in process and potable waters, demineralised and high purity process water, dewatering, reuse, and environmental discharge. This includes one of the largest rental fleets for temporary and emergency water treatment and desalination.

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



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HOW TO EVALUATE AND SELECT AN OZONE GENERATOR- PART 3

Continuing from last month

It is a known fact that metals can accumulate dust because of electrostatic conditions. In air sanitization where plate type generators are mostly used, even with the best of filters, if one examines the air conditioning duct after months of operation, heavy dust build-up could be observed. This dust build-up attracts moisture on the corona plate .The dust also accumulates. This will result in failure of the cell if they are not cleaned regularly. The maintenance of the plate is very cumbersome and risky

The plate types of generators allow air to pass between two or more parallel plates with alternating negative and positive charges. The corona between the plates will generate the Ozone. Where the application uses air as feed gas the pre treatment of the feed gas becomes very vital. Air quality must be at least Minus 60 degrees Dew Point to prevent formation of Nitrous oxides due to ozone reactions with moisture and Nitrogen present in the air, This may not be a problem in very small-scale applications but becomes a very big factor large applications.

However this problem of Nitrous acid formation can be avoided in plate type systems by using oxygen as feed gas. So for applications where air feed is sufficient, plate type technologies are found to be expensive

There have been some improvements in plate type Ozone generators recently that has resulted in improved performance, but the technology is still largely considered as inferior to tube type generation for large commercial applications

THE TUBE TYPE CORONA DISCHARGE OZONE GENERATION

This is by far the most common and the most widely used method. This is the latest and the most reliable technology. The technology consists of a di-electric that could be glass /SS combination or Ceramic. Air / Oxygen as feed gas is passed through the minute gap between the dielectric and a high voltage applied. The ionization of oxygen takes place within this gap and ozone is formed.

The quantity of ozone formed with is Technology depends on the Technology used to generate high voltage .Ozone can be formed at concentrations between 6-16 % using this Technology. Most of the large ozone companies around the world use this technology and have continuing research to improve and make the technology more economical and better efficiency. For very large applications this technology provides the most economical way to produce ozone. Ozone produced by this method can be anywhere up to 40% more economical when compared to the plate type Corona ozone Systems



A tube type Ozone generator shell

ELECTROLYTIC OZONE GENERATION

Electrolytic ozone generators offer a consistent, cost-effective solution for continuous or discrete disinfection of cold storage and distribution systems for ultrapure water (systemic protection). The key advantage of this mechanism is that it is a straightforward and simple process of water electrolysis, that is the ozone is generated directly from the water. The design that allows reliable and fully automatic operations along with low maintenance. The applications it serves span across – PW (Purified water), HPW (High purified water), and WFI (Water for injection). Only a small amount of Ozone is generated using this technology, and the efficiency depends largely on the conductivity of the water and thus its application is limited to pure water only.



continued Next month

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NAVIGATING THE LAUGHTER LOCKS: THE FUNNY SIDE OF THE SUEZ AND PANAMA CANALS

The Suez and Panama Canals are marvels of engineering and international trade, connecting the world's major waterways and facilitating global commerce. While these iconic canals are primarily known for their historical and economic significance, they also hold a surprising and amusing side. From quirky anecdotes to hilarious mishaps, the Suez and Panama Canals have witnessed their fair share of comical moments. Join us as we take a lighthearted journey through the funny side of these legendary canals.

1. SIZE MATTERS - THE GIGANTIC LOCKS:

One cannot help but be awestruck by the sheer size of the locks in both canals. However, their immense proportions have occasionally led to amusing situations. From tiny vessels getting lost in the vast lock chambers to a captain accidentally underestimating the canal's dimensions, resulting in a tight squeeze, these incidents serve as a reminder that even the mightiest ships can sometimes succumb to the charm of the canals.

2. DANCE OF THE TUGBOATS:

The Suez and Panama Canals rely heavily on the expertise of tugboat captains who skillfully maneuver large ships through the narrow channels. However, the synchronized "dance" between the tugs and the ships often appears more like a comical choreography routine. Witnessing the tugboats darting back and forth, appearing to perform an elaborate tango with the enormous vessels, can bring a smile to anyone's face.

3. UNUSUAL CARGO SIGHTINGS:

The canals are known for accommodating a wide array of ships and cargo, some of which can be quite peculiar. Over the years, there have been instances of unexpected and amusing cargo sightings. From floating houses and giant rubber ducks to oversized inflatable animals, these unusual loads provide an entertaining diversion from the typical shipping routine.

4. The Art of Canal Negotiations:

As ships from various countries pass through the canals, a fascinating interplay of cultures and languages unfolds. Miscommunications and language barriers often result in humorous exchanges between ship captains and canal personnel. Picture a captain attempting to communicate using an impromptu sign language or engaging in a hilarious game of "broken telephone" through translators. These comedic encounters remind us that laughter can bridge even the widest cultural gaps.

5. Animal Antics:

The canals are not only navigated by ships but are also home to a diverse range of wildlife. Curious encounters between animals and passing vessels can lead to delightful and amusing moments. Imagine a group of mischievous monkeys hitching a ride on a passing ship or a pelican attempting to land gracefully on the deck, only to end up in a clumsy, flapping frenzy. The canals provide nature's own comedy show.

While the Suez and Panama Canals play vital roles in global trade and transportation, they also offer a lighter side filled with laughter and amusement. From the epic size mismatches to the dance of the tugboats, the canals have provided us with countless funny moments throughout history. Whether it's unexpected cargo sightings or comical encounters with wildlife, these lighthearted anecdotes serve as a reminder that even the most serious and awe-inspiring places can have a touch of humor. So, the next time you think of these iconic canals, remember to smile and appreciate the comedic side of these engineering marvels.

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TENDERS

Development Of Clarifloculator Bridge At 9mld Water Treatment Plant In Narasaropet Municipality Including Supply, Delivery, Fabrication, Welding ,Labour And Other Incidental Charges Including Electro Mechanical Items Etc.As Instructed By Departmental Authority

Authority Municipal Corporation
Address: Municipal Office, Narasaraopet, Pincode
City: Narasaraopet
Location: Narasaraopet | Andhra Pradesh | India
Bid Open Date: 16 May 2023
Tender Value: Indian Rupee 209.27 Crores
Doc Collection Date: 16 May 2023
FTID 230503457780

Supply And Engage Of 1 No Tata Ace In For Partolling And Maintenance Of 1000mm Dia Ci Pumping Main And 1400mm Dia M.S Pumping Main From Kbr Pump House To Water Treatment Plant S At Narava For Year 2023-24

Authority Municipal Corporation
Address: Tsr Complex, Pincode
City: Visakhapatnam
Location: Visakhapatnam | Andhra Pradesh | India
Bid Open Date: 15 May 2023
Tender Value: Indian Rupee 20.95 Crores
Doc Collection Date: 15 May 2023
FTID 230503461200

Hansi Town Upgradatation Of Sewerage Treatment Plant Of 7.50 Mld Based On Mbbr Technology In Hansi Town Distt Hisar
Authority Public Health Engineering Department
Address: O/O Ee Phed Hansi, Near Jind Chungi Hansi, Pin-125033, Pincode 125033
City: Hansi
Location: Hansi | Haryana | India
Bid Open Date: 09 May 2023
Tender Value: Indian Rupee 9.99 Lac
Doc Collection Date: 09 May 2023
FTID 23050345360

Uws Schemes Under Gomati District/1.3 Mgd Surface Water Treatment Plant At Banduar, Udaipur/ Repairing Of Centrifugal Pumps Under Dws Sub-Division No-I, Udaipur During The Year 2023-2024.

Authority Public Works Department
Name: Executive Engineer
Address: O/O The Executive Engineer Dws Division Udaipur
Location: South Tripura | Tripura | India
Bid Open Date: 25 May 2023
Tender Value: Indian Rupee 6.07 Lac
Doc Collection Date: 25 May 2023
FTID 23050327750

Uws Scheme Under Gomati District / Sh- Providing And Fitting Fixing Of Electrical Equipments, Accessories At 1.3 Mgd Surface Water Treatment Plant At Banduar, Udaipur During The Year 2023-2024.

Authority Public Works Department
Name: Executive Engineer
Address: O/O The Executive Engineer Dws Division Udaipur
Location: South Tripura | Tripura | India
Bid Open Date: 25 May 2023
Tender Value: Indian Rupee 14.26 Lac
Doc Collection Date: 25 May 2023
FTID 23050327780

Jaipur-Annual Maintenance And Operation Of 400 Kld Capacity Sewage Treatment Plant Based On Mbbr Technology At Ganpati Nagar Colony)For 2 Years).

Authority North Western Railway
Address: Pincode 302001
City: Jaipur
Location: Jaipur | Rajasthan | India
Bid Open Date: 23 May 2023
Doc Collection Date: 23 May 2023 FTID 2305034128000

Work Of Overhauling Of Various Vessels At Water Treatment Plant On As And When Required Basis For 12 Months.

Authority Gujarat State Electricity Corporation Limited
Address: Chief Engineer (Gen.) Kltps, Adm Building, Skv Nagar, Dist. Kutch. Pin Code No. 370601., Pincode 370601
City: Lakhpat
Location: Lakhpat | Gujarat | India
Bid Open Date: 30 May 2023
Tender Value: Indian Rupee 8.61 Lac
Doc Collection Date: 22 May 2023
FTID 230503461530

Procurement Of Electromagnetic Flow Meter For Effluent Treatment Plant Etp Of Ph-Iv, Stps, Sarni.

Authority Madhya Pradesh Power Generating Company Limited
Name: Se Pnw, Sarni
Address: Stps, Mppgcl, Sarni
Location: Betul | Madhya Pradesh | India
Bid Open Date: 08 May 2023
Tender Value: Indian Rupee 4.97 Lac
Doc Collection Date: 08 May 2023
FTID 230503216310

Provn Of Sewage Treatment Plant At Nd Minicoy Under Ge (Navy) Lakshadweep

Authority Military Engineering Services
Address: Commander Works Engineer Nb Kochi Kataribagh Naval Base Po Kochi 682 004, Pincode 682559
City: Lakshadweep
Location: Lakshadweep | | India
Bid Open Date: 31 May 2023
Tender Value: Indian Rupee 1.44 Crore
Doc Collection Date: 29 May 2023 FTID 230503415380

Repair Works To 100 Kld Sewage Treatment Plant Installed At C.G.O Complex, Poonkulam, Trivandrum

Authority Central Public Works Department

Address: 98 B Pocket F ::, Pincode
City: Trivandrum
Location: Trivandrum | Kerala | India
Bid Open Date: 08 May 2023



TENDERS

Doc Collection Date:
08 May 2023 FTID 2305034110170

Installation Of Solar Water Treatment Plant At Kedertala Uttar Primary School Under Khidirpur Gp. (A.C-56954621)

Authority Zilla Parishad
Name :Prodhan, Khidirpur Gp
Address: Khidirpur Gp, Po- Baruipara, Ps- Hariharpara, Pin- 742165, Dist-Murshidabad

Location: Murshidabad | West Bengal | India
Bid Open Date: 17 May 2023
Tender Value: Indian Rupee 9.36 Lac
Doc Collection Date: 17 May 2023
FTID 230503227110

Installation Of Solar Water Treatment Plant At Kumardaha Ghat Market Under Khidirpur Gp. (A.C-56955345)

Authority Zilla Parishad

Name: Prodhan, Khidirpur Gp
Address: Khidirpur Gp, Po- Baruipara, Ps- Hariharpara, Pin- 742165, Dist-Murshidabad
Location: Murshidabad | West Bengal | India
Bid Open Date: 17 May 2023
Tender Value: Indian Rupee 9.36 Lac
Doc Collection Date: 17 May 2023
FTID 230503227130

Installation Of Solar Water Treatment Plant At Mir Abdul Balika Vidhyalaya At Nichintapur More Under Khidirpur Gp. (A.C-56955034)

Authority Zilla Parishad

Name: Prodhan, Khidirpur Gp
Address: Khidirpur Gp, Po- Baruipara, Ps- Hariharpara, Pin- 742165, Dist-Murshidabad
Location: Murshidabad | West Bengal | India
Bid Open Date: 17 May 2023
Tender Value: Indian Rupee 9.36 Lac
Doc Collection Date: 17 May 2023
FTID 230503227160

Annual Operation Repair Maintenance Of Electrical Installations At 27 Scg Nsg Chennai During 2023 24 Sh Repair Rewinding And Servicing Of Various Types Of Motors Fans Repair Maintenance And Amc Of Sewage Treatment Plant R And M Of Solar Heater

Authority Dg, National Security Guard, Mha
Name: Sqn Cdr Engg
Address: 27 Rh Nsg Chennai
Location: Chennai | Tamil Nadu | India
Bid Open Date: 15 May 2023
Tender Value: Indian Rupee 10.72 Lac
Doc Collection Date: 15 May 2023
FTID 230503240020

Supply And Laying Of Upvc Pipeline 200 Mm Dia (10 Kg/Cm2 Approved Quality Brand) At Ward No 26 (Pump House) Sidhbaba Dongariya To Ward No 20 Water Treatment Plant .(Raw Water Rising Main)

Authority Directorate Urban
Administration And Development
Name: Cmo
Address: Nagar Palika Parishad Dhanpuri
Location: Shahdol | Madhya Pradesh | India
Bid Open Date: 02 Jun 2023
Tender Value: Indian Rupee 25.00 Lac
Doc Collection Date: 02 Jun 2023
FTID 230503259750

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- Suitable for MBR.
- Piped inlet.
- Continuous operation.

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EVENT CALENDAR



MAY 2023

World Utilities Congress
May 08-10, 2023
ADNEC, Abu Dhabi, UAE
www.worldutilitiescongress.com

AZ Water Conference & Exhibition
Tue, 09 - Thu, 11 May 2023
Phoenix, USA
www.azwater.org

Ozwater 2022
10 May, 2023 to 12 May, 2023
Brisbane Convention & Exhibition Centre
Australia
www.ozwater.org/

Watrex Expo
Mon, 15 - Wed, 17 May 2023
Cairo, Egypt
waterxexpo.com

Trenchless Asia
17 May, 2023 to 18 May, 2023
Kuala Lumpur Convention Centre, Malaysia
www.trenchlessasia.com/

Water and Plumb Skills Expo
18 May 2023 – 19 May 2023
Pragati Maidan, New Delhi, Delhi
www.plumbskillsexpo.com

Water Expo- Bangaluru
18 May 2023– 20 May 2023
BIEC, Bangalore, India
waterindia.net

Water Management Show
May 11-13, 2023
ICCB, Dhaka, Bangladesh
10times.com/water-management-show

E-World Energy & Water Exhibition
May 23-25, 2023
E-World Energy & Water Exhibition
www.e-world-essen.com

Western Canadian Shale Water Management
24 - 25 May 2023
Calgary, Canada
https://www.canada.shale-water-management.com/

Global Smart Water Summit
25 - 26 May 2023
Berlin, Germany
https://10times.com/global-smart-water-summit-berlin

IWA Leading Edge Conference on Water and Wastewater Technologies
28 May - 02 Jun 2023
Daegu, South Korea
https://iwa-let.org/

China International High-end Healthy

Drinking Water Industry (Beijing) Exhibition
28 - 30 May 2023
Beijing, China
https://10times.com/china-international-high

Power of Water Canada Technical Conference & Trade Show
29 - 31 May 2023
Niagara-on-the-Lake, Canada
https://www.owa.ca/conference/

Watertech Africa
31 May - 03 Jun 2023
Nairobi, Kenya
https://10times.com/e1r5-p9r2-k8fz

Florida Water Resource Conference
31 May - 03 Jun 2023
Kissimmee, USA
https://www.fwrc.org/

JUNE 2023

International Conference on Sustainable Water Management
01 - 02 Jun 2023
Mississauga, Canada
https://10times.com/icbmse-mississauga

Watertech Africa
01 - 03 Jun 2023
Kenyatta International Convention Centre, Nairobi, Kenya
expogr.com/watertech

Canadian IWA YWP Conference
01 - 03 Jun 2023
Vancouver, Canada
https://10times.com/e1kf-d00x-3s2x

International Conference on Sustainable Water Management
03 - 04 Jun 2023
Aarhus, Denmark
https://10times.com/icbmse-aarhus

Symposium on Health-related Water Microbiology
04 - 09 Jun 2023
Darwin, Australia
https://iwa-network.org/events/21st-international-symposium-on-health-related-water-microbiology/

Aquatech China
05 - 07 Jun 2023
National Convention & Exhibition Center, Shanghai, China
www.aquatechtrade.com/china

World Environment Expo
05 - 07 Jun 2023
Pragati Maidan, New Delhi, India
worldenvironment.in

Algeria Electricity & Water Expo
05 - 07 Jun 2023
Algiers, Algeria
expotobi.com/algeria-electricity-water-expo

International Chemical Waste Water Treatment Technology & Equipment Fair
05 - 08 Jun 2023
Shanghai, China
https://10times.com/cwtf

Annual Canadian Water Summit 2023
07-09 june, 2023
Ottawa, Canada
https://watersummit.ca/

Connecticut Rural Water & Wastewater Association Annual Conference
08 Jun 2023
Wallingford, USA
https://www.ctrwwa.org/conference

The Boundary Waters Expo
10 - 11 Jun 2023
Grand Marais, USA
https://10times.com/boundary-waters-expo

Conference of the UK Water Network
14 Jun 2023
Cranfield, UK
https://www.cranfield.ac.uk/events/events-2023/16th-conference-of-the-uk-water-network

Power & Water Nigeria Exhibition & Conference
20 - 22 Jun 2023
Lagos, Nigeria
pnwnigeria.com

Russian Water Congress Conference
20 - 22 Jun 2023
Expocentre, Moscow, Russia
https://www.watercongress.ru/en/

Vodexpo
20 - 22 Jun 2023
Expocentre, Moscow, Russia
https://www.watercongress.ru/en/#exposition

World Congress on Environment Management and Climate Change
22 - 23 Jun 2023
Bengaluru, India
https://10times.com/wcem

Water Environment Federation Stormwater Summit
27 - 29 Jun 2023
Kansas City, USA
https://10times.com/e1r1-80g3-xzrr

African Smart Cities Summit
28 Jun 2023
Gallagher Convention Centre, Johannesburg, South Africa
10times.com/asc-summit

JULY 2023

European Water And Wastewater Management Conference And Exhibition
04 - 05 Jul 2023
The Point at Lancashire County Cricket Club, Manchester, UK
ewwmconference.com

IFAT Africa
05 - 07 Jul 2023
Gallagher Convention Centre, Johannesburg, South Africa
www.ifat-africa.com

INDO WATER
05 - 07 Jul 2023
Jakarta Convention Center, Jakarta, Indonesia
indowater.com

Water Resources Research Centers Conference
11 - 12 Jul 2023
Tucson, USA
https://wrrc.arizona.edu/conference/2023

West Africa Water Expo
11 - 13 Jul 2023
Landmark Centre, Lagos, Nigeria
elanexpo.net/waweexpo

Delhi Water Expo
13 - 15 Jul 2023
Pragati Maidan, New Delhi, India
www.waterex.biz

Milwaukee Air and Water Show
22 - 23 Jul 2023
Milwaukee Lakefront, Milwaukee, USA
mkeairwatershow.com

Arizona Water Reuse Symposium
23 - 25 Jul 2023
Flagstaff, USA
https://watereuse.org/sections/watereuse-arizona/2023-watereuse-arizona-symposium/

AUGUST 2023

18th EverythingAboutWater Expo 2023
Thu, 03 – Sat, 05 Aug 2023
Pragati Maidan, New Delhi
www.eawaterexpo.com

Public Drinking Water Conference 2023
Tue, 8 – Wed 9 aug, 2023
Austin, USA
https://www.tceq.texas.gov/drinkingwater/conference.html

Water Tech 2023
10-11 aug 2023
New delhi, India
https://cam.mycii.in/OR/EventDetailOR.html?id=E000061989

The Water Expo
Wed, 23 - Thu, 24 Aug 2023
Miami, USA
www.thewaterexpo.com/

World Water Summit 2023
25- 26 Aug 2023
New Delhi, India
http://worldwatersummit.in/who-can-exhibit.html

International Conference on Water Resource, Environmental Protection & Sustainable Development
25 - 26 Aug 2023
Zhengzhou, China
https://10times.com/e13z-gh3s-fs30

SEPTEMBER 2023

Water Indonesia
Wed, 13 - Sat, 16 Sep 2023
Jakarta, Indonesia
www.waterindonesiaexpo.com/

CamWater
14 - 16 Sep 2023
Phnom Penh, Cambodia
https://www.camwaterexpo.com/

THAI WATER
Wed, 30 Aug - Fri, 01 Sep 2023
Bangkok, Thailand
www.thai-water.com

SR Onshore Wind Conference
Wed, 06 Sep 2023
Glasgow, UK
www.scottishrenewables.com

Gat Wat
Wed, 06 - Thu, 07 Sep 2023
Cologne, Germany
www.gat-wat.de

WasteEcoExpo
Tue, 12 Sep 2023
Krasnogorsk, Russia
en.waste-tech.ru

Contamination & Geotech Expo
13 - 14 Sep 2023
Birmingham, UK
https://www.ess-expo.co.uk/four-shows/clr

Taiwan International Water Week
Wed, 20 - Fri, 22 Sep 2023
Taipei, Taiwan
www.taiwanintlwaterweek.com

P3 Water + Energy Summit
21 - 22 Sep 2023
San Diego, USA
https://www.p3electrified.com/

Water Expo – Hyderabad
Thurs, 21 – sat, 23 sept 2023
Hyderabad, India
https://waterindia.net/

LANKAWATER
21 - 23 Sep 2023
Colombo, Sri Lanka
https://lankawater.org/

WCW Conference & Exhibition
Mon, 25 - Thu, 28 Sep 2023
Saskatoon, Canada
www.wcwwa.ca/page/AnnualConf

OCTOBER 2023

Wetex
Mon, 02 - Wed, 04 Oct 2023
Dubai, UAE
www.wetex.ae

AWT Convention and Exposition
Wed, 04 - Sat, 07 Oct 2023
Grand Rapids, USA
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
www.vietwater.com/en

Minnesota Water Resources Conference
17 - 18 Oct 2023
Saint Paul, USA
https://wrc.umn.edu/events/conference-2023

IFAT India
Wed, 18 - Fri, 20 Oct 2023
Mumbai, India
www.ifat-india.com

Pak Water & Energy Expo
Wed, 25 - Fri, 27 Oct 2023
Lahore, Pakistan
pakwaterexpo.com

Aqua Ukraine
17 - 19 Oct 2023
Kiev, Ukraine
https://10times.com/aqua-ukraine

Water In Industry
Tue, 31 Oct 2023
Moscow, Russia
www.aquatechtrade.com/news/industrial-water

NOVEMBER 2023

Water Loss Forum
01 - 03 Nov 2023
Lutfi Kirdar International Convention & Exhibition Center, Istanbul, Turkey
www.waterlossforum.org

Bangladesh Water Expo 2023
02-04 Nov 2023
Dhaka, Bangladesh
https://www.bangladeshwaterexpo.biz/

Aquatech Amsterdam
06 - 09 Nov 2023
RAI, Amsterdam, Netherlands
www.aquatechtrade.com/amsterdam/

The International Water Conference
12 - 16 Nov 2023
San Antonio Marriott Rivercenter, San Antonio, USA
iwconf.org

Smart City Expo - Dubai
14 - 15 Nov 2023
The Ritz-Carlton, Dubai, Dubai, UAE
10times.com/smart-cities-nh

WETEX and Dubai Solar Show
15 - 17 Nov 2023
Dubai World Trade Centre, Dubai, UAE
www.wetex.ae

Myanwater
16 - 18 Nov 202
Myanmar Expo, Yangon, Myanmar
myanwater.com

Sand Water Rv Expo
17 - 18 Nov 2023
Lake Havasu State Park, Lake Havasu, USA
sandandwaterexpo.com

Cairo Water Week
29 Oct - 02 Nov 2023
Cairo, Egypt
www.cairowaterweek.eg

East Africa Water Summit
29 Nov - 01 Dec 2023
Nairobi, Ikoo, Kenya
https://www.eawaters.com/

DECEMBER 2023

Water Bangladesh International Expo
07 - 09 Dec 2023
International Convention City Bashundhara (ICCB), Dhaka, Bangladesh
www.water-exhibition.com

BAYWATCH

The Water Expo is produced by SHOW WINNERS CORPORATION, a leading events promoter company located in Miami, Florida. With over 20 years of experience, S.W.C. and its executives have produced and managed over 40 top level Conventions, Fairs and Expos on a continental scale, serving industries of Construction, Health, Real Estate, Sustainability, Solar Energy and Water, among others. Some of these events have been classified in a top ranking level in the United States for several years.

SWC has developed a crafting expertise in connecting manufacturers and distributors from North America with the Latin American and Caribbean major markets comprised by dozens of countries with key differences among them. SWC has a fully bilingual staff and uses Miami, Capital of the Americas, as the proper commercial and multicultural hub to make this connection happen in an effective and successful way.

SWC trade shows produced in Miami also allow to highlight and serve the increasing market opportunities associated with current strong developments of major areas in the State of Florida and in particular in the ever-evolving and booming South Florida region.

Date: 22-24 Aug 2023
Venue: Miami Airport Convention Center, Miami, USA
Website: www.thewaterexpo.com



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Our success is credited to an experienced team of staff which is dedicated to provide the best service and support for our exhibitors, visitors, speakers and delegates. In addition, PT. Napindo Media Ashatama work closely with key government ministries and departments, embassies, associations and institutions in ensuring that the events organised contribute positively to the related industries.

PT. Napindo Media Ashatama is a leading exhibition & conference organizer in Indonesia which is responsible for Internetworks Indonesia Expo & Forum, Indo Telecom Expo & Forum, Indo Water Expo & Forum, IVAC Expo & Forum, Indo Waste Expo & Forum, Indo Renergy Expo & Forum, Indo Meelex Expo & Forum, Indo Wireless Expo & Forum, IndoCommIT Expo & Forum, Indo Livestock Expo & Forum, Indo Fisheries Expo & Forum, Indo Security Expo & Forum, Indo Firex Expo & Forum, Indo Defence Expo & Forum, Indo Aerospace Expo & Forum and Indo Marine Expo & Forum.



Date: 30 Aug – 1 Sep 2023
Venue: Jiexpo Kemayoran Jakarta, Indonesia
Website: www.indowater.com

BAYWATCH

The summit will focus on Synergies between water security and economic prosperity, finance and technology to deliver water solutions for both industries and utilities. The summit will bring the collective intelligence of stakeholders, exchange knowledge, latest technologies and also the acumen of visionary speakers in an effort to catalyze collaboration between the public & private water, utilities, technology providers, financers, industrial end-users, associations in addition to water, agriculture-food-beverage and sanitation agencies.



Date: 25-26 Aug 2023
Venue: Dr. Ambedakar International Centre 15, Janpath Road, New Delhi, India
Website: www.indowater.com



18th EverythingAboutWater Expo 2023 is one of the most unique & comprehensive annual events in India showcasing the latest technologies & solutions in the water sector. It is a perfect gateway for stakeholders from across the globe to penetrate into the vast & dynamic ecosystem of the Indian Water management industry to share business opportunities, network & explore innovative water solutions.

With increasing consumption of water in agriculture and potable areas, India is expected to be severe water stressed by 2025. Rapid industrialization and growing population have widened the water demand-supply gap for which both the Central and State governments are deeply concerned. Under this umbrella, the 18th Everything About Water 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 Aug 2023
Venue: Pragati Maidan, New Delhi
Website: www.eawaterexpo.com

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