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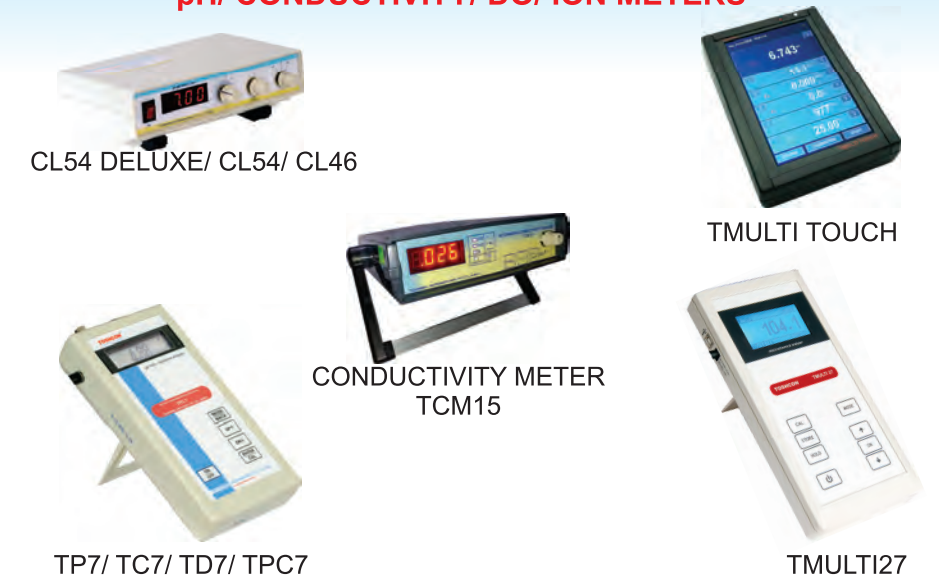
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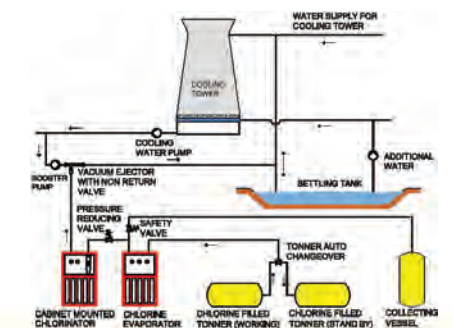
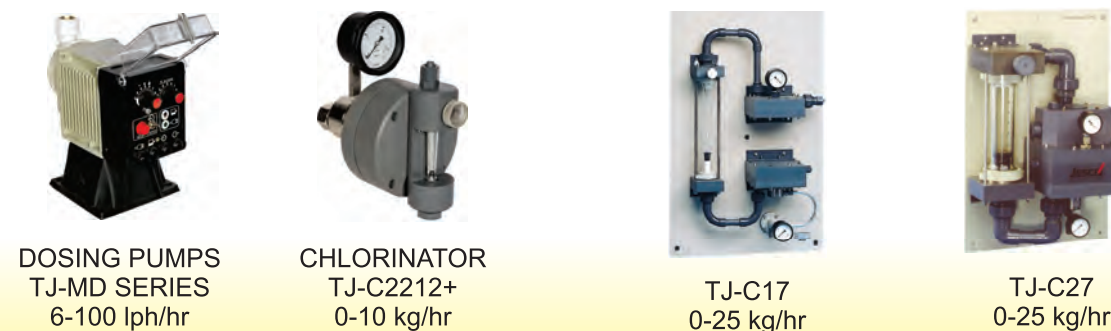
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SUCCESSFUL WASTE WATER MANAGEMENT

Successful waste water management is all about achieving the quality and ensuring that an equilibrium between environment and effective costs is maintained. Globally, most of the waste water produced remains untreated. As per an estimate by UNDP and UN-Habitat, in low-income countries almost 90% of all wastewater generated is released into the environment untreated. In many developing countries the bulk of domestic and industrial wastewater is discharged without any treatment or after primary treatment only.

Sewage being a complex mixture of chemicals and with many distinctive chemical characteristics is hard to be treated. Effective sewage treatment is a challenge as it faces problems like of pathogens, high concentrations of ammonium, nitrate, nitrogen, phosphorus, high conductivity (due to high dissolved solids), high alkalinity, with pH typically ranging between 7 and 8. With the spread of Covid 19,

sewage treatment is again in focus and a need to ensure the elimination of pathogens is in limelight.

With an annual per capita water availability of less than 1970 cubic meters, India is facing the brunt of water scarcity. Rising population and industrial activity is expected to increase water need by nearly 40 percent as India's water demand rises from the current 750 to 1050 billion cubic meters. This is likely to bring the per capita water availability to less than 100 cubic meters, making India a water-scarce nation like the Middle East. Water reuse and recycle is the only tenable solution to this problem. Demand management is a better option than augmenting water supply – it is less capital intensive and more environment friendly. Raw water costs have been drastically increasing in the last few years in many parts of the country. In some areas, the raw water cost is as high as INR 60 per cubic meter of raw water. Further, in water

scarce areas, industries have no option but to close down their operations if they are using outside water. Industries like Coca-Cola and the Jindal Group have had to endure this problem. Other industries, particularly in South India, like Chennai Petroleum, Madras Fertilizers and GMR Power Corporation have been the pioneers in sewage recycling.

Conserving water and minimizing its use becomes critical, particularly in applications using huge volumes of water. Metering, leakage prevention and monitoring of distribution lines play a key role in this aspect. At a more basic level, applying more water-efficient processes in manufacturing and utilities would help.

Finally, the massive scarcity of fresh water implies a need for reusing and recycling used water particularly for less critical applications.

Many industries have realized that the

wastewater within their industry might well be the cheapest and most reliable source of water for them. Applications like gardening, landscaping, washing and particularly, cooling towers consume huge volumes of water which need not necessarily be of very good quality. Recycled water makes ideal sense for usage in their uses.

Today, technology is good enough to produce the highest quality of water, as good as packaged drinking water quality. Still, there is a psychological barrier felt by people to drinking recycled water. Due to this reason, recycled water may be used for other non-potable purposes or be used in groundwater recharge.

A natural evolution of the same is the concept of Zero Discharge, where industries completely reuse every drop of processed water and nothing is discharged outside the unit. Reusing sewage for various bulk consumption needs is very important.

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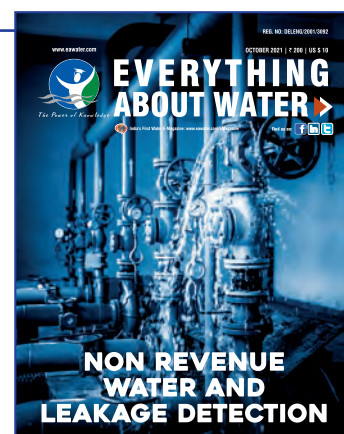
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GLOBAL W

Droplets

Snippets

Advanced Watertek shares operational insights at Offshore Jack up Middle East Conference

Dubai, UAE., November 2021: Speaking to Industry leaders of the Jack Up Rig & Liftboat industry, Melvin Eldin of Advanced Watertek highlighted the importance of a robust and energy efficient Water Maker to keep operating costs at bay. He also shed light on critical maintenance factors that are oft ignored but have high impact on OPEX.

Honest Water Filter Company Promotes Currie Gauvreau to Executive Vice President

PRESCOTT, AZ – October, 2021: Eric Brockmire, Founder and CEO of The Honest Water Filter Company, would like to announce the promotion of Currie Gauvreau to the position of Executive Vice President.

Currie specializes in organizational coaching and training helping companies in developing leadership, communication, sales, and business skills of plumbing, HVAC, and electrical service professionals.

LANXESS India is now Great Place to Work—Certified™

- Over 1100 organizations assessed in India
- Survey done across more than 22 industries

Mumbai, October, 2021: Leading specialty chemicals company LANXESS India has been Great Place to Work—Certified™ in India (from October 2021 to October, 2022) by the Great Place to Work® Institute. The certification recognizes organization's efforts in building a High—Trust, High—Performance Culture™ and delivering an excellent employee experience for all.

bp and LANXESS join forces on renewable raw materials for plastics production

Cologne, October, 2021: Specialty chemicals company LANXESS and energy company bp are entering into a strategic partnership for the use of sustainable raw materials in high—tech plastics production. bp will supply sustainably produced cyclohexane to the LANXESS' production site in

Grundfos joins 50L Home Coalition to promote water saving solutions in homes and cities



Bjerringbro, Denmark,

November 2021: Grundfos, the world leader in pumps and water solutions, joins the 50L Home Coalition with the ambition to promote circular water in homes and cities. The 50L Home Coalition is a global action-oriented platform that unites leaders from the private, nonprofit, and public sectors to address two of our most pressing global challenges: water security and climate change. Together, Grundfos and the Coalition will

focus on making the reuse and recycling of water the norm in homes, which calls for smarter approaches that allow for water 'fit—for-purpose' use.

By 2030, the global water demand is expected to be 40% higher than the amount of reliable water we have access to today¹. Global household water demand has increased by 600% since the 1960s and global fresh water supply is decreasing due to water stress and pollution². There is a critical and urgent need to innovate to reverse this trend. This is where coalitions such as the 50L Home can play a vital role. Grundfos will work with fellow Coalition members and partners to help identify and scale new technologies that can transform the way we use water and the energy needed to heat it.

Commenting on Grundfos joining the Coalition, Lars Spicker Olesen, Director, Circular Water, Grundfos FutureLab, said, "At Grundfos, we work tirelessly to improve water and energy efficiency for the greater good and believe in making a difference locally and globally. The world needs transformational innovation to change course and companies need impact partners to succeed. This strategic collaboration with 50L Home will help us move towards this ambition and will enable us to support the Coalition's mission to reinvent the future of water and change the narrative on domestic water consumption."

The 50L Home Coalition's primary objective is to leverage innovations in education, technology, and policy to create a resilient, low—carbon water future. Its unique initiatives address the systemic risks associated with water and climate change and how they proliferate due to changing lifestyle patterns, increased industrialization, population growth, and rapid urbanization. The 50L Home approach is to reimagine our relationship with water in homes and in cities around the world, collaborating on pilot projects and implementing new technologies to make 50 liters of daily water use per person feel like 500.

"We are thrilled to have Grundfos join our Coalition. We envision a future where companies, policymakers, innovators, researchers, and communities work together to create sustainable solutions that will solve the urban water crisis and create financially viable opportunities for our communities. We hope to instill the importance of responsible water consumption in cities around the world, making 50 liters of daily water use per person not just a reality, but an irresistible one. Having a company such as Grundfos – which is committed to pioneering solutions to the world's water and climate challenges and improving the quality of life for people – join us will help us strengthen our efforts toward achieving this goal," said Braulio Eduardo Morera, Director, 50L Home Coalition.

ATER NEWS

October 2021

LANXESS with strong third quarter of 2021

- » Sales up 33.5 percent year–on–year at EUR 1.951 billion
- » EBITDA pre exceptionals increase 44.0 percent to EUR 278 million
- » Earnings increase in all segments – Specialty Additives and Engineering Materials particularly strong
- » Increased raw material prices successfully passed on, but rising energy prices and high freight costs weigh on earnings
- » EBITDA pre exceptionals for 2021 expected to be at the lower end of the guided range of EUR 1 billion to EUR 1.05 billion
- » Growth continues: acquisition of IFF Microbial Control announced



Mumbai, November, 2021: Specialty chemicals company LANXESS holds its own also in a challenging environment: Despite a sharp rise in raw material, energy and freight costs, EBITDA pre exceptionals in the third quarter of 2021 increased by 44.0 percent to EUR 278 million, against EUR 193 million in the prior–year quarter.

The strong earnings were driven by all segments – especially Specialty Additives and Engineering Materials. LANXESS passed on the significantly increased raw material prices via higher selling prices. The three acquisitions completed in this fiscal year, especially that of Emerald Kalama Chemical, also contributed to the good results. Adverse exchange rates, mainly from the U.S. dollar, but especially higher energy and freight costs prevented a further increase in earnings. The EBITDA margin pre exceptionals increased to 14.2 percent in the third quarter, against 13.2 percent in the prior–year quarter.

“The third quarter of this year was again characterized by growth. Our operating business continued to develop positively, and we successfully passed on the significantly increased raw material costs. With the announced acquisition of IFF Microbial Control, we will also be significantly expanding our Consumer Protection segment again in the future. This will make us more stable and more profitable,” said Matthias Zachert, Chairman of the Board of Management of LANXESS AG. “However, the unprecedented increase in energy, raw material and freight costs is not leaving us unscathed. We expect the cost pressure to even increase in the fourth quarter.” Due to these cost increases, strained supply chains and power rationing in China, which is having a negative effect on production there, LANXESS expects EBITDA pre exceptionals for the full year to be at the lower end of the guided range of EUR 1 billion to EUR 1.05 billion.

With an increase of 33.5 percent year on year, LANXESS generated sales of EUR 1.951 billion in the third quarter of 2021. At EUR 68 million, net income from continuing operations was higher than in the third quarter of 2020, in which LANXESS generated EUR 25 million. This was due to the good development of the operating businesses and the contribution of Emerald Kalama Chemical.

Consumer Protection segment continues to grow

LANXESS continues to grow with the planned acquisition of the Microbial Control business from U.S. group

Droplets Snippets

Antwerp, Belgium, starting in the fourth quarter of 2021. The sustainable origin of the raw materials is certified according to ISCC Plus rules (“International Sustainability and Carbon Certification”). With this partnership, both companies, which already have a long–standing business relationship, want to significantly advance the production of sustainable plastics.

NX Filtration extends executive team with Chief Financial Officer



Enschede, the Netherlands, October 2021: NX Filtration, the global provider of breakthrough direct nanofiltration technology for pure and affordable water, proudly announces the appointment of Marc Luttkhuis (46 years) as Chief Financial Officer (CFO) of NX Filtration. Marc will join NX Filtration at the beginning of 2022 at NX Filtration’s headquarters in Enschede, the Netherlands. The Supervisory Board will nominate Marc for appointment as member of the Management Board at the regular general meeting of shareholders in 2022.

Marc Luttkhuis previously held CFO positions at Brink Group (Leading global manufacturer of towing systems in the automotive industry) and Heuver (leading European tyre wholesaler), with responsibility for finance, IT, HR and procurement functions. He has a broad financial background with a strong track record of performance improvements and will play a key role in achieving NX Filtration’s ambitions.

International Flavors & Fragrances Inc. (IFF). The two companies signed an agreement to this effect in August. The transaction is scheduled to be completed in the second quarter of 2022. IFF Microbial Control is one of the leading suppliers of antimicrobial active ingredients and formulations for material protection, preservatives and disinfectants. The company generates annual sales of around USD 450 million (around EUR 380 million*) and EBITDA of roughly USD 100 million (roughly EUR 85 million*). Within four years of the completion of the transaction, LANXESS expects an additional annual EBITDA contribution of around USD 35 million (roughly EUR 30 million*) as a result of synergies.

Segments: Increasing demand and prices drive earnings

Thanks to higher selling prices due to the passing on of increased raw material costs and continued good demand, the Advanced Intermediates segment posted higher sales in the third quarter of 2021. They rose by 28.7 percent from EUR 414 million to EUR 533 million. The segment's EBITDA pre exceptionals reached EUR 84 million, 18.3 percent higher than the prior-year figure of EUR 71 million, even though earnings were burdened by energy prices, which increased particularly in this segment, as well as higher freight costs and adverse exchange rate effects. The EBITDA margin pre exceptionals declined to 15.8 percent, against 17.1 percent in the prior-year quarter.

The Specialty Additives segment benefited from higher selling prices and improved demand in all business units. Sales in the third quarter of 2021 grew by 29.8 percent from EUR 466 million to EUR 605 million. Although earnings were burdened by increased freight costs and adverse exchange rate effects, EBITDA pre exceptionals was up 72.9 percent on the prior-year level of EUR 59 million. At EUR 102 million, the segment even achieved the best result in its history. The EBITDA margin pre exceptionals reached 16.9 percent, against 12.7 percent a year ago.

The Consumer Protection segment's sales and earnings developed positively in the third quarter of 2021. This is particularly attributable to the new Flavors & Fragrances business unit, which was established at the beginning of August with the acquisition of Emerald Kalama Chemical. The acquisitions of Theseo and INTACE and higher selling prices also had a positive effect. Sales grew by 27.0 percent to EUR 353 million, against EUR 278 million in the previous year. The positive earnings contribution from Emerald Kalama Chemical was almost offset by significantly increased energy and freight costs and an unplanned production shutdown at Saltigo. The segment's EBITDA pre exceptionals of EUR 60 million was thus only 1.7 percent higher than the prior year quarter's figure of EUR 59 million. The EBITDA margin pre exceptionals reached 17.0 percent, against 21.2 percent a year ago.

Due to higher selling prices and increased sales volumes, the Engineering Materials segment generated significantly higher sales; this was due in particular to the continued very good demand from the automotive industry. Sales increased by 53.0 percent from EUR 285 million in the third quarter of the previous year, which was heavily affected by the pandemic, to EUR 436 million. Although higher energy and freight costs had a negative effect on earnings, EBITDA pre exceptionals in this segment increased by 87.9 percent from EUR 33 million to EUR 62 million. The EBITDA margin pre exceptionals thus amounted to 14.2 percent, against 11.6 percent a year ago.

Memsift Establishes Partnership with Birla Cellulose for piloting innovative membrane technology for Resource Recovery Applications.



Singapore, October 2021: Singapore based Memsift Innovations Pte Ltd and Birla Cellulose have executed a partnership agreement to explore, co-develop and implement Memsift technologies for Zero Liquid Discharge (ZLD) and Resource Recovery applications from the waste streams at its global operations.

Under this agreement Birla Cellulose, a global leader in the man made cellulosic fibres (MMCF) and a part of the Aditya Birla Group (ABG), would be leading the piloting of solutions using the Memsift technologies with an objective of improving the closed loop technologies that can go beyond the currently available best available technologies and help set up new benchmark for closed loop processes in the MMCF industry.

Birla Cellulose plans to pilot and evaluate the state-of-the-art technologies from Memsift to recover more than 95% of water and chemical recovery from the waste streams and also with a benefit of lower carbon footprint by up to 80% compared to the conventional methods. The joint piloting is expected to be completed by mid of 2022 which will be followed by commercialization of the technology.

This partnership was facilitated by ABG Innovation Fund and it enables pilots and co-development of new technologies leading to scaling up support for Memsift and innovative solution deployment at ABG. It also enables Memsift to engage with other projects at ABG businesses at early stages. Memsift may licence the technology to ABG for sales in India and other identified geographies in a later phase upon successful implementation of pilots in ABG. The STOMATE® and TS-30™ systems would be also piloted in various ABG's manufacturing sites and adopted for initial reference before exploring the chemicals recovery and ZLD market in large.

Dr J. Antony Prince, Founder & CEO, Memsift Innovations said, "We are very excited about this partnership and happy to have ABG as a long-term partner in Memsift. This will allow us to work closely with ABG businesses to commercialize the state-of-the-art Membrane Distillation technology in industrial scale and we hope to build the largest MD unit for resource recovery application in the near future. This partnership is aligned to the vision of ABG innovation Fund which aims to work together with tech-start-ups to develop solutions for the world's most pressing problems like water (SDG-6) and climate change (SDG-13) to preserve resources and a clean environment for the next generation."

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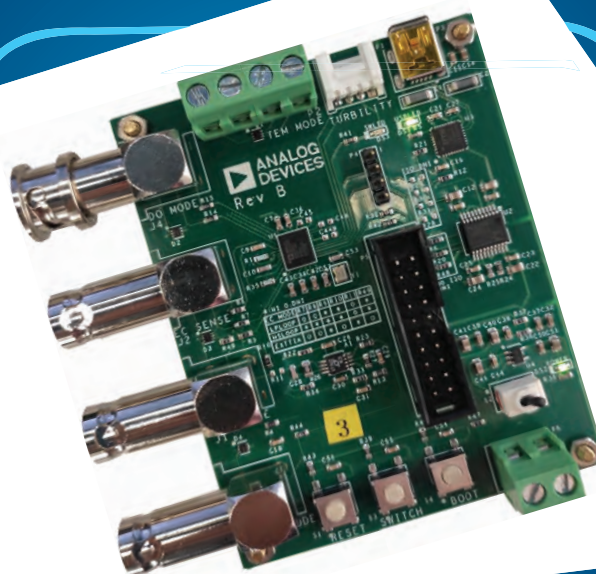
Cologne, Germany, October, 2021: LANXESS is driving forward the circular economy: The specialty chemicals company is increasingly using bio-based or recycled raw materials in its plastics production.



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A new variant of the composite Tepex is 100 percent based on the biological raw materials flax and polylactic acid. “We have combined fabrics made from the natural flax fibers with bio–based polylactic acid as a matrix material and thereby developed a composite manufactured entirely from natural resources. We are now able to produce it to a level of quality suitable for large–scale production,” explains Stefan Seidel, Head of Tepex Research and Development at LANXESS.

The extremely strong material is suitable for use in sports articles, in the production of automotive interior parts and in electronics for case components. LANXESS produces the composite at its site in Brilon, Germany.

Tepex can be recycled completely. After its use, the product can be shredded and easily processed into new plastic.

“Green” cyclohexane for plastics in automotive engineering

LANXESS also relies on sustainable raw materials for its Durethan brand polyamide–6 plastics. In the latest product, 92 percent of the raw materials have been replaced by sustainable alternatives; the long–term plan is to increase the proportion to 100 percent.

The sustainable origin of the raw materials is certified according to the rules of ISCC Plus (“International Sustainability and Carbon Certification”) using the mass balance approach. This method compares the quantities of raw materials used with the quantities of products produced and creates an accounting link between input and output, similar to the purchase of green power.

In the production of the high–performance plastic, LANXESS uses “green” cyclohexane from sustainable sources such as rapeseed oil or other biomass as raw material. For the supply of “green” cyclohexane LANXESS has entered into a strategic cooperation with energy company bp. The high–performance plastic is also reinforced with 60 percent by weight of glass fibers recycled from industrial glass waste.

The alternative raw materials are chemically identical to their equivalents of fossil origin. Therefore, the plastic has the same properties as its fossil–based counterpart. It was developed at the LANXESS site in Dormagen, Germany, and is manufactured at the site in Krefeld, Germany.

“A climate–neutral future can only become a reality if we increasingly use sustainable products,” says Frederique van Baarle, Head of the High Performance Materials business unit at LANXESS.

New “Scopeblue” brand label

In the future, LANXESS will add “Scopeblue” to its most sustainable products. The brand label marks products that either consist of at least 50 percent circular (recycled or biobased) raw materials or whose carbon footprint is at least 50 percent lower than the one of conventional products.

Bentley Education Program Expands to Global Scope



EXTON, Pa. – October, 2021: Bentley Systems, Incorporated (Nasdaq: BSY), the infrastructure engineering software company, as a commitment to expand access to its professional applications to education, today announced the global expansion of the Bentley Education program – offering seamless access to learning licenses of over 60 popular Bentley applications, at no cost, to all eligible students and educators, from middle schools through higher education levels, via the Bentley Education portal.

Following on the initial May 3, 2021 announcement of the launch of Bentley Education in the pilot countries of Australia, the UK, Singapore, Lithuania, and Ireland, the program is gaining a resounding response, with more than 500,000 students and educators across many countries visiting the Bentley Education portal. Now, with global expansion, the Bentley Education program is accessible to all students and educators at middle schools, high schools, community colleges, polytechnics, institutes, and universities across the world to employ Bentley applications in their classrooms, labs, and at home.

Vinayak Trivedi, vice president of Bentley Education, said, “With the global focus on infrastructure advancement for resilience and adaptation, there will be unprecedented demand for talented individuals who have the skills and ability to come on board prepared to work on the next level of projects and digital workflows. By providing students, educators, and universities around the world with appropriate software and resources to become ready for this opportunity, we are complementing the education system to attract and develop the talent required.”

With a blend of learning content created for students, the Bentley Education portal provides access to comprehensive training resources and project–based learning content that is maintained in collaboration with major universities and industry partners. By registering on the Bentley Education portal to access learning license entitlements, students and educators also gain access to bonus resources such as

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insights from industry professionals, firsthand perspectives of current students, and updates on the latest and current industry trends – all at their own pace, in a fun learning environment.

Katriona Lord-Levins, chief success officer at Bentley Systems, said, “Students today prefer the opportunity to learn at their own pace and explore what inspires them. The Bentley Education program provides just that – a community of students, educators, and practicing infrastructure professionals to help students to discover what’s possible and to kick-start potential rewarding careers in advancing infrastructure through going digital.”

Elkem to test the world’s first carbon capture pilot for smelters



Norway, October 22: Elkem, a global leader in silicon-based advanced materials, today announces that it will test the world’s first carbon capture pilot for silicon smelters at its plant in Rana, Norway. The project has received financial support from Gassnova CLIMIT and is a follow-up to the company’s recently launched climate roadmap to reduce emissions towards net zero while growing supplies to the green transition.

The carbon capture pilot is a collaboration between Elkem and Mo Industripark, SINTEF, Alcoa, Celsa, Ferroglobe, SMA Mineral, Norcem, Norfrakalk, Arctic Cluster Team and Aker Carbon Capture. The test unit will be installed at Elkem’s plant in Rana, which produces high purity ferrosilicon and Microsilica. In addition, emissions from SMA Mineral will also gradually enter the treatment plant. Aker Carbon Capture delivers the test unit, which is the only one of its kind in Norway.

The project is supported through the CLIMIT-Demo program, by state enterprise Gassnova SF. CLIMIT is Norway’s national programme for research, development and demonstration of CO₂ capture and storage technology. The main goal of the project is to verify the technology on real industrial exhaust gases from smelters, in order to prepare a full-scale plant for industrial carbon capture. The program runs over two years.

“Elkem aims to be part of the solution to combat climate change – and to be one of the winners in the green transition. Our mission is to provide advanced material solutions shaping a better and more sustainable future. We have recently launched a climate roadmap detailing our ambitions to reduce emissions while growing our supplies to the green transition. Carbon capture is a key technology to reach net zero by 2050,” says Elkem’s CEO, Helge Aasen.

Elkem recently launched a global climate roadmap detailing how the company plans to reduce its total CO₂ emissions by 28% from 2020–31 while growing its supplies to the green transition, thereby delivering 39% improvement of its product carbon footprint in the same period.

As a part of this work towards carbon-neutral materials production, Elkem has conducted a feasibility study for the establishment of carbon capture and storage (CCS). The purpose of the study has been to assess the technical and economic feasibility of installing carbon capture at its Norwegian plants in Bjølvfossen, Bremanger, Rana, Salten and Thamshavn.

“The test unit installation at Elkem Rana means that we are now moving one step forward. The work to be done in Rana will also be of great relevance to other plants both in Elkem and for other players in the industry,” says Trond Sæterstad, climate director in Elkem.

Mo Industrial Park will be the project owner and SINTEF will have a leading role in the project management of the program.

“In total the partners have identified 1.5 million tonnes of potential CO₂ capture in the region. This corresponds to three percent of Norway’s total emissions, and almost one third of the emissions from the metal industry,” says Jack Ødegård, Vice President Research in SINTEF.

“It is very relevant for CLIMIT to support the world’s first CO₂-capture from ferrosilicon and silicon industry. In this project, there are nine international industries collaborating in development of cost-effective CCS solutions. Important research work will be carried out by SINTEF as well. Knowledge from development of the full scale CCS project Longship is also applicable for this Elkem pilot,” says Ingrid Sørum Melaaen, Gassnova’s Head of Secretariat CLIMIT.

“The mobile test unit is for all practical purposes a large facility in miniature. It is very exciting that we can now follow up the feasibility study and test that the technology is also suitable for large-scale smelters,” says Jon Christopher Knudsen, Chief Commercial Officer in Aker Carbon Capture

“It is necessary to cut carbon emissions. In addition, this project will create new jobs and ensure the competitiveness of the industry. This is also aligned with Mo Industrial Park’s sustainability strategy and the initiative will add important cutting-edge expertise to the region,” says Jan Gabor, Executive Vice President Property Development in Mo Industrial Park.

The project has a total budget of NOK 23.6 million, of which Gassnova CLIMIT will contribute 13.8 million and the industry will contribute with the remaining amount.

Schneider Electric’s Smart Water Solutions to Help Build ‘Water Smart & Resilient India’

- ▶ Addresses challenges faced by water utilities in India at India Innovation Summit 2021
- ▶ Digitisation & smart water technologies can help water utilities achieve sustainability and improve operations



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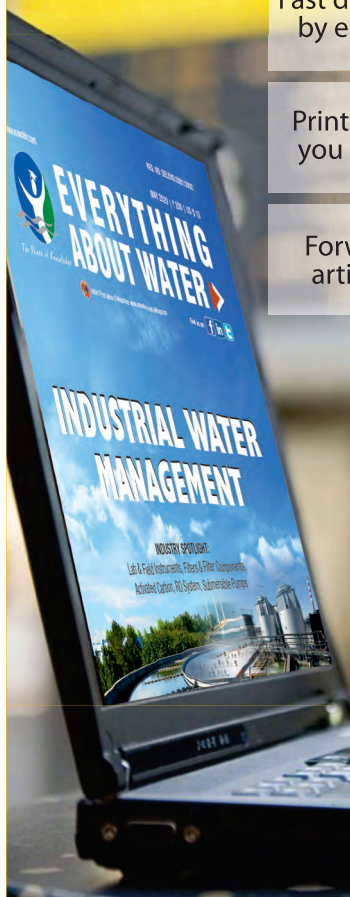
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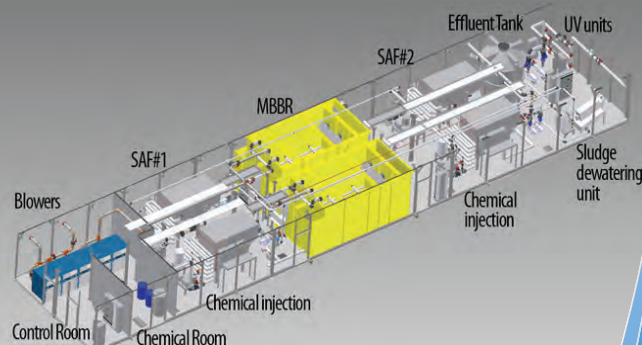
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New Delhi, October, 2021: Schneider Electric, the global leader in energy management and automation, has reiterated its commitment to enhance key processes across the water cycle by supporting water utilities in the country through integrated solutions and digitization. The organisation is committed towards building a 'Water Smart & Resilient India' by offering integrated solutions and smart water technologies to help utilities to improve operations thereby addressing the water shortage. This is in line with the government's recent announcement of the Jal Jeevan Mission app to ensure conjunctive use of conserved water, drinking water source augmentation, drinking water supply system, grey water treatment and its reuse.

Speaking at an expert session on 'Smart Water Management System for City Wide Water Distribution' at the Innovation Summit 2021, Mr. Anand Nigam, Senior GM, Control & Automation, Schneider Electric India said, "Digital technologies such as Internet of Things (IoT), data analytics and Blockchain are key enablers for the water industry to analyse, automate, predict and minimize the risks that are continuously present in the sector. To address the water challenges of the country and make India water positive, we at Schneider Electric provide integrated, digital solution for sustainability and operational efficiency across the entire water cycle. We support modernization of water and wastewater management through our IoT enabled EcoStruxure solutions that help to ensure efficient operations, thereby ensuring sustainability & resilience in water sector."

Industrialisation, fast-paced urbanisation and the emergence of smart cities are driving demand for water utilities in India. It is estimated that by 2050, more than 50 per cent of the country's population will live in cities. This will put more pressure on the already scarce water resources. To address the water shortage, State authorities and utilities are investing in water management and treatment solutions leveraging automation.

Schneider Electric implemented its SCADA technology for the Vadodara Municipal Corporation (VMC) to manage and ensure efficient water supply and safe drinking water (500 MLD) to over 2 Million citizens of Vadodara city thru real time monitoring and controlling of water process parameters. The water segment in Vadodara was faced with multiple challenges such as unequal water distribution, growing population, decreased water quality etc. The smart water technologies not only improved the quality of life by ensuring efficient water supply to citizens, it also provided faster resolution of customer complaints and improved overall water quality. Apart from this, it has also helped in bringing down cost by reducing NRW (non-revenue water), ensuring efficient utilisation of manpower, better reconciling of water, thereby increasing transparency towards stakeholders.

Talking about the challenges and solution, Mr. Manish Bhatt, Director IT, Vadodara Municipal Corporation said, "Schneider Electric's experience in executing multi-geography projects, strong engineering and integration capabilities, adaptable project management style including quick response and flexibility to have suit at site methodology as per client's needs, have contributed significantly to the project's success. It has helped us to effectively manage and administer water operations across the city. The solution is user friendly and everyone within VMC can access this central platform to derive information and data ensuring accurate and consistent reporting and analytics. Our team is now aware of the leaks within the distribution network which has helped us reduce NRW."

Speaking on how digitisation and smart water technology can ensure safe, clean and adequate drinking water for an ever growing population and steps taken by the city in this direction, Mr. Salil Srivastava, OSD – Chattisgarh Govt and Ex – Additional CEO – Nava Raipur Smart City Ltd. said, "Water is the most scarce and precious commodity today. Many cities in India and abroad, have been facing tough times in terms of water shortage mainly due to rising urbanisation. By using a sustainable technology like smart water, which we have executed in Nava Raipur, one can help bridge the gap and address the issues faced by the sector. I would advise other cities, especially brownfields, to a similar model as it will help them to not only estimate the demand but also understand real time monitoring, water circularity as well as asset management for water networks, thereby saving time energy and money."

Toshiba Honored with Two Accolades at GOOD DESIGN AWARD 2021

TOKYO: Toshiba Group clinched two awards at Japan's Good Design Award 2021, the annual awards sponsored by the Japan Institute of Design Promotion to honor good design and product quality. The award-winning products are the traction energy storage system for railway with SCiB™ and the HAORI inverter air conditioner. The product submissions were joint entries by Toshiba Corporation (TOKYO: 6502) (hereinafter "Toshiba") and Toshiba Infrastructure Systems & Solutions Corporation (hereinafter "TISS"), and Toshiba and Toshiba Carrier Corporation (hereinafter "TCC"), respectively.

The same products also secured distinctions at the iF Design Award earlier this year. Toshiba Group's recognition in both prestigious product design awards reaffirms the Group's commitment to high quality and excellent standards in user-centric designs.

Comments from the Good Design Jury on Toshiba's winning products:

1. Traction energy storage system for railway with SCiB™ – joint application by Toshiba and TISS

This regenerative power storage system for railways, the interface for important social infrastructure invisible to the general public, was created through collaboration between engineers and designers, and engages with new issues for B2B products and services. At a time when hiring young engineers is becoming difficult, and the number of skilled engineers working in the field is decreasing, the developers listened closely to opinions from the workplace, and are to be commended for advocating the importance of creating an interface that even inexperienced engineers will find easy to use.

2. HAORI inverter air conditioner – joint application by Toshiba and TCC

To realize air-conditioners that complement interior spaces, the body and the cover were separated, and the structure of the housing reconsidered. The finish is simple, with a fabric cover that can be changed to coordinate with the room. In addition, full consideration was paid to the appearance of the flaps after operation, a source of noise other than the cover. We evaluated this proposal of a new way to combine equipment with fabric and make it part of the interior.

About The Good Design Award

Established in 1957, Good Design Award is Japan's leading commendation system. Eligible for wide range of works including products, architecture,

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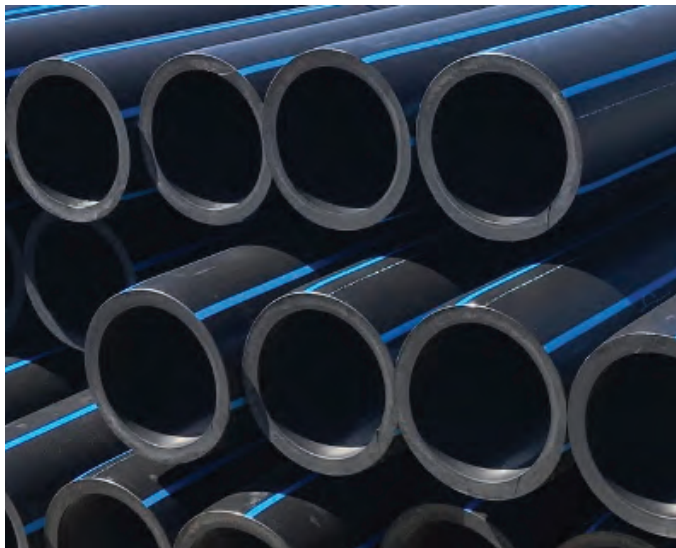
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application and software, projects and initiatives that utilize design and more. Through this system, many people come in contact with “good design” and appreciate their value. The recognition rate of the award is 84%*, with its familiar symbol, G-Mark.

*According to the latest survey by Japan Institute of Design Promotion in 2020.

ANSI/AWWA C906 HDPE UPDATES



IRVING, Texas –Oct., 2021: The 5th edition of the newly updated American Water Works Association (AWWA) C906–21 standard further clarifies the proper use and description of PE4710 high-density polyethylene (HDPE) pressure pipes and fittings. The revisions to ANSI/AWWA C906 are another step forward in the water industry’s increasing use of HDPE piping systems, according to Camille George Rubeiz, P.E., F. ASCE, Co-chair, HDPE Municipal Advisory Board and the Senior Director of Engineering, Municipal and Industrial Division of the Plastics Pipe Institute, Inc. (PPI). ANSI/AWWA C906–21 describes HDPE pressure pipes and fittings made from materials conforming to standard PE materials designation code PE4710 and has an effective date of Nov. 1, 2021.

“The goal of C906 has always been to provide the gold standard that clearly defines the use and manufacture of high-performance HDPE (i.e. PE4710) pressure pipes and fittings from four to 65 inches for waterworks with pressure classes (PCs) ranging from 100 psig to 335 psig operating at temperatures up

to 80oF,” Rubeiz stated. “For temperatures above 80oF, refer to AWWA M55 for reducing the pressure class of HDPE. Removing non-PE4710 resins from the scope and throughout the standard is certainly another vote of confidence for PE4710; the updated standard provides those specifying pipe with a thoroughly vetted standard to use. These changes compliment the recent revisions and publications of ANSI/AWWA C901–20 (effective date Feb. 1, 2021, 7th edition) and AWWA M55–20 (2nd edition). All owners and designers should immediately update their specifications to require these most current standards and manual.”

According to C906–21, “the [HDPE] pipes and fittings are primarily intended for use in transporting potable water, wastewater, and reclaimed water in either buried (open-cut and trenchless), marine or aboveground installations. In addition, “for PE4710, the PC calculations include a safety factor [SF] > 2 relative to the allowed operating stress,” and “the SF for Occasional Surge Pressure is > 2.” The standard cautions against “matching the ID of other pipe materials to the ID of HDPE for flow and PC [because that] will yield incorrect results. The standard recommends the use of “PPI–PACE [www.PPIPACE.com] to evaluate the flow capacity of HDPE to other materials.”

Other changes to the standard include the rewriting of the section on Oxidative Resistance (Section II.C), along with updating the definitions for design factor, hydrostatic design basis (HDB), standard dimension ration (SDR), and virgin PE compound. Definitions for PE4710, PE compound, potable water, reclaimed water, safety factor (>2), sample, specimen, and wastewater have been added in Section 3. Also, to ensure the pipe meets the appropriate ductility and tensile strength requirements, C906–21 has been update to clarify the alternate tests that shall be performed.

“It is also very important that the chlorine category requirement CC3 for potable water applications has been added to the C906–21 materials section (4.2.1.2),” Rubeiz explained. “This is because, in my opinion, the vast majority of utilities using chlorine and chloramines as residual disinfectants in the potable water system find that HDPE is the best solution for their piping systems and will provide lower installation costs, reduce maintenance costs and provide their communities with 100-plus year design life.

“The diligent, hard work of AWWA, its 263 Committee and the Standards Council to continually improve C906 shows that HDPE is steadily gaining national acceptance as the preferred material for potable water and sewer piping systems. And we thank AWWA and those industry professionals who participated in this latest update.” he said.



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CONCEPT NOTE ON

“NON– REVENUE WATER (NRW) AND LEAKAGE DETECTION”

Dr. Anil Kumar Mishra, Bacteriologist, Delhi Jal Board, Govt. Of NCT, Delhi



Water is an essential and vital component of life support system. The grounds as well as surface water resources are being utilized for drinking, irrigation and industrial and other purposes. However, due to rapid growth of population, urbanization, industrialization and agriculture activities, water resources are under stress. There is growing concern on the deterioration of water quality due to geogenic and anthropogenic activities. According to news published in daily News Paper “Dainik Jagaran” dated 14–06–2018; 13491 Million Quesec Meter (MCM) ground water available in Delhi, out of this 10,284 MCM (~ 76%) water is not fit for drinking and other purposes due to higher concentration of chemical contaminants. Due to lack of sufficient infrastructure of Rain water Harvesting in Delhi, ground water table decreasing day by day in the rate of 0.5 –2.0 meter /years; as citizens of Delhi extracting ~392 MCM ground water/year inspite of only recharging 287 MCM/year. It means a huge difference (~105 MCM) observed between rate of extraction and recharging of ground water in Delhi.

Non–revenue water (NRW), is water which is produced in water treatment plants and other sources but couldn't either reached till consumer houses or managing authority could not get revenue due to various reasons. NRW losses may be due to Real or Physical losses (losses caused by leakage in rising mains or other water pipe lines in distribution system,) and apparent losses (losses caused by metering abnormalities issues or theft). Due to high levels of NRW, quality and quantity of treated water reduced drastically; as managing authority or department not getting sufficient amount of revenue required for upgradation of distribution system or other quality monitoring system. Briefly, we can define NRW “as the volume of water lost as a share of net water produced from various sources in particular area or time. NRW is sometimes also known as unaccounted–for water (UFW).

Many national and international organizations have been developed, methodologies to access the various components which are required to manage or understand the concepts and components of NRW. The main components of NRW are as underneath: –

- » Authorized unbilled connection: Some consumers have taken water connections but not paying bill to agency or managing authorities due to various reasons like Govt. policies (like slab system of billing or metering) or some other personal reasons of consumers. Sometimes, government also provide free water to religious institutions, hospitals etc.
- » Apparent losses : Some consumers not getting water connection and using water from unauthorized ways either from

main water line or some other sources. Sometimes, some consumers tempered theirs water meter; resulting they are using more quantity of water but paying revenue for few quantities of water.

- » Real Losses: This is the major cause of NRW in various states of India; As some rising mains or distribution line are very old and due to corrosion, leakage in valves/chambers or due to some other reasons, water is leaking from pipeline and filled in surrounding areas; resulting quality of supplied water also deteriorated because in various states of country twenty four hours water supply facilities are not available (intermittent water supply system is available) and during non–supply hours when water pressure reduced in pipelines this leakage water again enters inside the water pipe lines and consumers getting contaminated water during next supply hours.

Most of the water utility departments are not well aware about the share of various components responsible for NRW. Due to lack of this basic information, they can't take proper actions or steps to reduce NRW. For confirmation of share of these components “Water Auditing” may be proved as a main tool. In such practices, water meter may be installed in the entry point of water pipe line (bulk water meter) in particular sector/ area and after that we may calculate that what amount of water supplied in that areas, same amount of revenue generating or not. In most of the developed countries, there are very limited apparent losses but in developing countries it is too high. Many countries have developed water auditing software for the validation of theirs water audit data related to various components sharing



for NRW and steps adopted for reducing it. On the basis of this data, they controlled NRW and planning to take corrective action to reduced it upto maximum quantity. In India (some states), and other countries adopted various method for reducing NRW and reduced it upto 5–10% from 40–50%. (According to various national and international organization/ guidelines maximum NWR should be between 15–20% in distribution system and upto 8% in production source). Water audit also may be classified into validated water audits (it is complex complex process that involves testing of production water meters, randomly testing of customer meters, eliminating systematic errors related to billing process and validating the number of illegal connections through aerial mapping, field surveys or cross-references between various existing databases etc.) and Un-validated water audits (include many estimates and their results may have some errors . Its main value is to identify where it is necessary to reduce the uncertainty of the water audit through validation.)

Factors responsible for NRW:

In India and other countries, many steps are being taken by utility bodies for significantly reduction of NRW but outcomes are still awaited, especially in developing countries in world wide. Although some states of India and other countries achieved it upto significant level but these are very few in number. There are many factors which are creating hindrance during the efforts made for reduction of NRW. Some of them are as underneath:

- » Involvement of political pressure in many countries by various ways.
- » Sometimes, responsible officers of water utility department think that designing of new projects related to pipelines or other water related infrastructures are easy instead of repairing of old and underground water pipe lines.
- » In most of the cities, due to heavy traffic in roads, field staff of utility department work related to repairing in night and that time it may possible some errors during rectification work. Resulting leakage may continually persist for long time. Sometimes

field staff not properly checking illegal water connections and those consumers getting sufficient water without paying any revenue and also misusing drinking water for other purposes.

- » Sometimes, meter readers adopting fraudulent practices for generation extra income.
- » Sometimes, plant or area managers spending less amount of fund required for up-gradation of water network and quality monitoring system or other rehabilitation related work which are necessary for proper supply of potable and wholesome water to consumers, resulting that system slowly become deteriorated and ultimately NRW may increase.
- » Sometimes, officers and officials of utility or maintenance division diagnose any problem by hit and run method instead of experimentation.
- » Sometimes, due to lack of coordination among the various stack holders of the project, either that project couldn't complete

in time or its proper implementations may not complete. Resulting the purpose / outcomes of project could not achieved.

Steps to be taken for reducing NRW:

- ▶ Efficient and quick steps must be taken for rectification or repairing of leaking pipes to avoid water losses and contaminations.
- ▶ Adopting district metered area (DMA) system (means divide the particular areas into small sectors) for proper supply and maintenance of water in particular area with sufficient pressure, which is required to collect water without booster upto top floor. This system also helpful for water auditing and revenue collection.
- ▶ Proper monitoring of water network from rising mains till consumers. For example by using water loggers or other instruments or technologies we can easily detected leakage in underground water pipelines and take corrective measure as soon as possible to avoid wastage of water.
- ▶ Proper and stable pressure management in water mains and network pipelines play important role for longevity and proper running of water pipelines. Water pressure in water pipe lines neither should be so high nor low and it should not be fluctuating, as these conditions forcing to bursting of pipe lines. For regulating this, control valves should be installed at proper distances and locations. By maintaining proper pressure we can also save energy consumption, required for pumping of water against gravity.
- ▶ Use all the data properly collected during water auditing or other methodologies for proper and efficient water management and on the basis of outcomes of that data set a limit for NRW and try to strictly follow it to achieve the target.
- ▶ Illicit use of water consumption is also a major component for increasing NRW. for reducing it adopt various methods or policies at various levels (Central or state government till Gram Panchayat level).
- ▶ Provide awareness among the consumers related to importance of water for life, its conservation, sustainably use of water, avoid water contamination etc. and provide training to employees of the utility bodies by applying different methodologies

related to various aspects of water and its conservation.

Importance of Reduction of NRW:

NRW, playing important role for reduction of revenue collection in any water utility organization because if NRW is much more then consumers may not get sufficient quantity of water and pay less amount of revenue to utility organization. Various national and international agencies have made study related to NRW and estimated the total cost of NRW to utilities worldwide at about many billions per year. If we reduced it, millions of people may get sufficient quantity of potable and wholesome drinking water. Some of the important benefits of reduction of NRW are as underneath:

- ▶ Revenue or financial status of water utility organizations increased. If we reduce, NRW then consumers may get more quantity of water and pay more revenue to utility organization or required to produce less quantity of water at water treatment plants or other sources for same population which reduced production cost of treated water.
- ▶ By reducing NRW, we may reduce water contamination in bulk storage tank or in distribution lines. Because leakage in pipelines shares a major component for increasing NRW. Leakage in pipelines increase the risk of water born disease because this leakage water again enters into distribution pipelines during non-supply hours or when water pressure reduced. This contaminated surface water contains many microflora or chemical contaminants which may causes threats for consumers.
- ▶ By reducing NRW, we can supply water to consumers with optimum and stabilized pressure. .If sufficient quantity of pressure available in water pipe lines then consumers will not use booster pumps in theirs houses. This will save electricity and also check water contaminations.
- ▶ By reducing NRW, we can save much quantity of water and this water may be utilized for providing water supply round the clock to consumers or may be given water connections to new consumers and may generate more revenue.
- ▶ For reducing NRW, Leakage reduction in pipelines is an important step and after that

consumers may get sufficient quantity of potable and wholesome water for house hold and other purpose. If consumers will satisfied with the services of utility department then they will not make any misbehave with the employees of organization. Resulting, relation among employees of utility department and consumers may be improved. NRW reduction, also helpful for reduction of legal liability and insurance payments.

In conclusion, we can say that water is 100% natural and no substitute for it. Use it judiciously and sustainably so that our future generations may also get sufficient quantity of potable and wholesome drinking water. If we may not maintain it significant number of population may not get good quality of water in coming decades (as various organizations are issuing warning time to time related to water and its uses). So for proper conservation and management of water, adopting various technologies for reduction of NRW, Rain water harvesting, reduce, recycle and reuse of water , reforestation etc. Bureau of Indian standards also emphasizing for reduction of NRW and DMAs creation for better management of drinking water supply from water treatment plants till consumers houses.

About the Author

Dr. Anil Kumar Mishra is presently working as "Bacteriologist" in Delhi Jal Board, Govt. of NCT Delhi since August 2007. He has qualified CSIR-UGC (NET) June 2002 for Lecturer ship and ICAR (NET) 2004 and 2006 for Lecturer ship. He also qualified UNERA fellowship of Australia government for advance studies in January and June 2006. He secured IInd level prize in senior level comprehension certificate test on Right to Information Act-2005 in the year 2011 conducted by Govt. of NCT Delhi. He is also the recipient of Best Employee Award for the year 2019-2020 for Delhi Jal Board by Chief Minister of Delhi.

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THE WATER PARADOX

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



Amongst the five essential elements considered as the basis for life, water is one of them. Life cannot be imagined without water. If there was no water, then the creation of the universe would not have been possible. The importance of it indicates with the historical fact that all great civilizations of the world developed near the water sources and all the ancient cities were located on the banks of rivers.

But today the value of water is again becoming significant as cities around the world experience exploding growth and declining water sources. The need to ensure that they should expand sustainably, operate efficiently and maintain a high quality of life for residents is becoming ever greater than historical times.

Water Scarcity

The water has become scarce – almost 2 billion people (a good 30% of world population) are living in countries or regions with absolute water scarcity. Out of this world total, a major portion of more than 600 million people in India is facing severe water scarcity issues. Big cities around the globe including Indian metropolis – Delhi, Chennai, Hyderabad and Bengaluru have declining water sources and facing the threat of day zero in near future unless drastic measures are taken. A Central Ground Water Board report suggest that as many as 256 of 700 districts have reported ‘critical’ or ‘over–exploited’ groundwater levels and fetching drinking water in these districts has become harder as the water table has sharply declined.



600 KLD Reverse Osmosis System for Boiler Feed

The National Commission for Women studied the plight of women in water scarce areas and reported that at an average they walk over 2.5 kilometres to reach a water source every day. This is probably an underestimation as in Rajasthan; they sometime have to walk for 8–10 kilometers before finding a proper source of water. The bottom-line is that our women and girls spend a significant proportion of their time fetching water for drinking and household chores.

Among India's major problems is the lack of freshwater sources. The country is having 18% of the world's total population, but accounts for only 4% of global freshwater resources. But it is among the world's largest consumer of groundwater consuming 124% more groundwater than China or US.

Infrastructure Conundrum

Even in regions where water is plentiful, water distribution systems are aging, demand is rising and management of this precious resource has become critical. The aging water infrastructure systems have long been an out-of-sight, out-of-mind problem. But water loss from leaking pipes, faulty or no metering and rampant water theft has become a big challenge to address which means huge loss of revenue for utilities and poor services to consumers.

Water utilities are struggling with aged infrastructure and depleting water sources to provide clean drinking water to increasing urban populations and expanding service areas with a high level of water loss. Reducing water losses is critical to efficient resource utilization, capable utility management, enhanced consumer satisfaction, and saving in capital-intensive capacity addition. With trillions of gallons of water required every day to quench the thirst from each habitation, we understand that water

Among the major challenges facing water utilities in India is the large proportion of water loss in distribution networks.



4000 LPD 6 stage Drinking water plant for Amazon Campus, Hyderabad

is fundamental for sustainable development as it affects health, economy, livelihood, and ecosystem protection.

Water–Energy Connection

India's thermal power stations which constitutes more than 70% of India's total electricity generation and 60% of its installed power capacity from coal to natural gas to nuclear plants are highly dependent on freshwater for cooling. A research report finds that growing water scarcity forced 14 of the country's 20 largest thermal utilities to shut down at least once causing \$1.4 billion in revenue losses. Data from Ministry of Power show that between 2017 and 2021, there have been approximately 8.2 terawatt-hours

(TWh) in lost energy production due to water shortage alone. That's enough electricity to power 1.5 million Indian households for five years. In fact, water shortages are the top environmental cause of power plant outages in India and the fifth-largest reason for forced outages overall, following equipment failures, reserve shutdown, fuel outages and uneconomical operations.

A classic example of India's problematic energy–water situation is the city of Chandrapur which is fed by the Erai reservoir. The declining water levels of the reservoir forced the authorities to cut the city's water supply in half, while Chandrapur Super Thermal Power Station shut down some of its power generation units for up to four months.



AWSPL Water Treatment Plant in Hyderabad

Power outage due to water-related risks also causes revenue loss and profits for thermal power companies. Between 2013 and 2016, 14 of India's 20 major thermal utility firms shut down because of water shortages, costing them about INR 91 billion (\$1.4 billion) in income. World Resource Institute has calculated that India's electricity growth between those years would have been 15% higher if the generation units had not shut down due to lack of water.

Water Economy

About 600 million people in India currently face acute water shortages and almost 200,000 lose their lives from lack of access to safe water. More than 12% of the country's population (approximately 163 million) are facing the threat of "Day Zero" scenario with no access to clean water within or near their homes. The COVID-19 pandemic has exacerbated the water crisis by increasing the demand for domestic water by 20–

25 percent as hygiene awareness has grown. With increasing populations, commercial activities, agricultural requirement combined with growing consumption patterns, water demand is projected to grow at a 2.8% Compounded Annual Growth Rate (CAGR) from 2010 to 2030, facing a supply gap of 50% by 2030. Agriculture would be the worst hit, followed by industries that are heavily dependent on water, such as food processing, beverages, textiles, metals, chemical, paper and leather. In economic terms, water shortage could result in a 6% loss in GDP of the country.

Wastewater as Resource

The potential source of new water is the wastewater. World over, both developed and developing countries are producing new water from their wastewater to cater the growing demand but in India it is highly underutilised. It is estimated that if India treat and reuse 80% of its untreated wastewater from only 110 of its most populous cities where most industrial units are situated, 75% of projected industrial water demand can be met by 2025. The sludge from treated wastewater can as well irrigate about three million hectares of land annually, while providing nutrients to crops and reducing fertiliser dependence by 40%.

The use of treated wastewater for non-potable use like industrial and agriculture saves freshwater for drinking purposes. India generates approximately 71 billion litres of municipal wastewater per day and it is growing continuously. As the load of wastewater increased exponentially, the treatment capacity merely grow from 23 billion litres to 28 billion litres a day, which is far short of the global standard. The existing treatment facilities are a mere 40% of the actual generation but in effect only 33% of India's urban wastewater is actually treated, and an even smaller portion is being reused. These figures are quite low when viewed against those of comparable countries. For instance, BRICS nations like Brazil and South Africa treat 45–55 percent of their wastewater.

The United Nations Water Report suggests that at least 50 countries worldwide are known to use wastewater for irrigation purposes, accounting for an estimated 10% of all irrigated land in those countries. India which has agriculture sector using over 80% of fresh water for irrigation can become a game changer if treated wastewater is reused to irrigate and produce crops.

International Best Practise

The water demand in Singapore is expected to double in the next four decades, with non-domestic water demand estimated to make up 70% of the overall water use. Singapore is efficiently working towards developing the necessary infrastructure with modern technologies to treat all its wastewater and turn into drinking water. Perth, the Australian city is recycling good amount of city's 134 billion litres wastewater into drinking water supplies. Israel is using nearly 90% of the country's treated wastewater for irrigation and other purposes. Florida, USA is at the forefront of US wastewater reuse program making use of two-third of generated wastewater. The city of Orlando has created a 1640 acre wetlands system using reclaimed water from the wastewater treatment facility. In Durban about 98% of the wastewater is recycled and reused by local industries. Beijing is using recycled water in infrastructure development to keep up with an ever-expanding mega city. Bangkok is treating wastewater as a resource and a valuable economic good. Kampala, Uganda is protecting its water source with an integrated plan to control, treat and reuse wastewater. Manila

Approx. 8.2 terawatt-hours
(TWh) energy is lost in production
due to water shortage.

is regenerating resources through wastewater treatment and reuse.

Water & Aquality Solutions

With water scarcity becoming a perennial issue and unclean water costing thousands of lives, Aquality Water Solutions as a conscious decision entered into the business of enabling clean drinking water to people. With advance technology and innovative solutions of water treatment for domestic as well as commercial and industrial, it has helped in providing clean and hygienic drinking water to people and businesses. The ISO 9001:2015 certified company; it uses proprietary technologies to provide custom-designed high quality water treatment solutions to consistently deliver safe drinking water to its diverse clientele that include civilian households to defence establishments, pharmaceuticals, manufacturing, commercial establishments, institutions, technology companies including ultrapure water to industries.

The Way Forward

We need to consider innovation in water sector as Singapore which has been adopting innovative technologies to ensure optimal use of its existing water resources. Almost 55% of the country's wells have dried up and the level of groundwater has reduced by 54%. Every year due to the rising heat, the problem of drought is expected to become more serious.

The ardent need is to expand and maintain a real-time monitoring system for optimisation of water sources, reservoirs and catchment operations and distribution network. The emphasis should be to use technological breakthroughs to deal with the water woes and overcome the challenges of increasing water demand, water loss, rising energy costs and land scarcity. Best practices to

Facing a supply gap of 50% by 2030, India is estimated to lose 6% in country's GDP.



Commercial Water Treatment Plant by Aquality Water Solutions

be studied and adopted that will include state-of-the-art auditing methods, leak detection monitoring, targeted repairs or upgrades, pressure management and smart metering technologies.

Fixing leaks should be a priority as it helps lower energy demand and cut costs by reducing energy needed for water production and distribution as it takes water to generate energy, and energy to generate water services. Our cities can no longer afford to lose billions of litres of treated water to aged and crumbling infrastructure.

About the Author

Mohammed Naser Azeez, a first generation entrepreneur with over 15 years of multi-cultural experience in water management and relevant industry segments. He established Aquality Water Solutions as a strong mission driven organization with the sole intention of providing clean drinking water facility to the masses.

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THE NEW ASSET MANAGEMENT MANTRA – ONE CITY ONE OPERATOR

By K. Mohamed Shaffi, Chief Business Officer –O&M, VA Tech WABAG



The desire for a cleaner Ganga has been subject of discussion for a long time and in 2011 the National Mission for Clean Ganga was formed, however the actions gained momentum in 2014 when the flag ship Namami Gange program was announced. The program was to drive two specific objectives, firstly to arrest large-scale pollution and secondly to rejuvenate the river Ganga. One big advantage of these policy missions is the associated benefits that come along like industrial effluent monitoring, river front development and river surface cleaning and creation of new sewage treatment infrastructure etc.

Under the Namami Gange program, the new sewage infrastructure created were to be developed on either on Design, Build and Operate (DBO) Model or Hybrid Annuity (HAM) Model and also adopt new technologies. Both these models had an inbuilt long term Operation and Maintenance (O&M) contract for a period of ten to fifteen years. Further, some of the old sewage treatment plants were also to be rehabilitated and upgraded with long term Operation and Maintenance Contracts. Inspired by the idea of long term O&M contracts of Namami Gange projects, the State Ganga River Conservation Authority (SGRCA), Uttar Pradesh (U.P) an agency that coordinates various conservation activities, decided to pursue Long Term Operation and Maintenance (O&M) contracts for the sewage treatment infrastructure of major cities in UP in a unique One City One Operator model. SGRCA mooted this idea as they realized





that major cities of UP were plagued with huge sewage infrastructural issues, specifically that of sewage collection system network. The SGRCA decided this contract duration should be a minimum of 10 years with a possible extension of another 5 years and also that the contract scope would include operation and maintenance of the entire sewage network of the city, pumping stations and sewage treatment plants (STP). The STP upon treatment shall discharge the treated effluent as per stipulated norms, thus bringing the entire sewage infrastructure management of the city under one contract.

The Features and Benefits of One City One Operator model

Most of the cities and towns are now growing both vertically and horizontally. Despite on best efforts, the municipal bodies have not been able to cope with maintaining the sewage infrastructure, mostly due to ageing assets and poor maintenance. The long term O&M contracts in One City One Operator model would establish new bench mark for system maintenance and effluent treatment standards. The new bench mark in-turn invites professional companies to manage these infrastructure assets.

The professional players will bring in expertise, innovative technologies and other new competencies to increase efficiency, optimize plant performances and thus ensure reliable operations and long term success. Professional players also would be the best partners for future technology and plant upgrades to conform to the latest standards.

Over the years, municipal assets, namely small to very large STPs have been

managed by private and professional companies but not the collection system or the associated network. Now, combining management of both the network and STP will ensure single point accountability and result in stable operations and ensure reliability of the sewage infrastructure system as a whole.

In order to ensure prompt replacement of defunct or obsolete equipment, special funding arrangement is provided for and is called the Major Replacement Fund. This fund is available for both the plant systems and the network / collection system. This fund is to be placed in an escrow account and made available for replacement of major equipment.

Due to growing awareness of water borne diseases these days, there is huge public concern over health and environment hence 24X7 customer care center is mandated in this model, thus propelling the services to several notches higher than what is presently being delivered. It is mandatory that the contractor resolves the problem in 24 hours so the response time to attend to a problem is cut down and ensures customer satisfaction. It is expected that the 24X7 Call Center, Complaint Kiosk and Mobile Apps will be made available by the contractor to be able to meet customer expectations.

Further, with the increased regulation and the pressing need to monitor microbiological contamination in real time, one can envisage that there would be remote monitoring of the treated effluents in particular and the sewage infrastructure as a whole and other new digital operational practices will also be adopted to meet customer expectations over a period of time.



In a sense of true partnership, the model also provides for profit sharing for sale of treated effluent or sludge thus enthusing the contractor with the hope of revenue generation. It is also possible that in some of the facilities, power generation is possible through Bio Gas Engines making the facilities power neutral with little or no power being fed from the grid. While the contractors bring innovative technologies, this will provide a huge opportunity to address the ills of manual scavenging with use of robotics and thus ensure increased human safety and reduced down time.

Water is an essential input for agriculture and industrial growth and existing conventional water resources are limited and hard-pressed to sustain growth, thus recycle and reuse of waste water, especially of the sewage is well established and can be done at a very low cost and supplied to the local industry and for irrigation purposes.

VA Tech WABAG chosen to Operate and Maintain two cities in UP:

In a competitive selection process, VA Tech WABAG was chosen to Operate

& Maintain two Zones namely Agra and Ghaziabad. The Ghaziabad zone includes other surrounding towns and cities namely Loni, Anupshahar, Rampur, Meerut, Bijnore, Saharanpur and Muzaffarnagar. Being the largest O&M player in the country in water & waste water segment, prior to take over WABAG was already managing some of the prestigious and widest portfolio of water utility assets in the country. WABAG was managing more than 50 sites spread across India and employs over 1500 strong skilled work force who are trained for O&M activities.

WABAG banks on its past experience of One City One Operator and performed a similar contract at Istanbul, Turkey. The city has a population of 16 million and second highest traffic density in the world. In this contract WABAG managed 64 pumping stations, 9 Mechanical Pretreatment Plants and 51 Biological Waste Water Treatment plants, a total of 124 locations through which 7.5 million cu.m of water per day was being treated. VA Tech WABAG had employed over 750 strong work force for O&M activities.

Drawing from our experience in Istanbul, WABAG has taken over the assets of



Agra and Ghaziabad. The details of the assets are in Table—1.

S. No.	City	Sewage Treatment Plant	Pumping Station	Sewage Network	Additional Pumping Stations	Additional Sewer Network
1	Agra	7	7	399kms	21	667
2	Ghaziabad	15	43	2735 kms	Nil	409

The initial survey suggested there would be a lot of work which had to be done in the initial years that include rejuvenation of certain plants and most of the collection and network systems would require rehabilitation. This is the single most significant challenge faced with. This brings us to a point of discussion about the likely challenges.

Despite the pandemic challenges of material and manpower movement, WABAG revamped and rejuvenated the below 4 STPs in record time

- 74 MLD STP at Indrapuram
- 56 MLD STP at Indrapuram
- 70 MLD STP Dundahera and
- 30 MLD STP at Loni

The Challenges:

Firstly, barring a few STP, most of the assets were old and the engineering documents were not available for the contractor to understand the design data or history, more importantly when it comes to sewage network the documents are not available but for the projects that were completed in recent past. The contractor has an uphill task of surveying almost the entire stretch of the decades old network, and these aged network could be fully choked and cleaning could sometimes be more expensive.

Secondly, Agra plant assets and network are within a periphery of 30 kilometers hence managing the city should be fairly easy unlike the Ghaziabad cluster which is wide-spread. The Ghaziabad cluster includes Anupshahar

and Rampur on the one end and Meerut and Muzaffarnagar on the other. The travel duration could be as long as three to four hours between one end to the other end of cluster, we intend to have localized command center to serve these constituent towns.

Thirdly, the contractor was provided with six months of stabilization during commencement of the contract and it was extremely difficult to get some of the STPs perform at optimum working condition in six months. Adding to the woes, we had to face the COVID –19 pandemic. Despite the challenges created by the pandemic, WABAG Team served the cities like real warriors and kept the systems going during both the first and the second wave. It is also observed that most STPs are not receiving adequate flow and this needs to be addressed and one of the reason is that STP is designed to meet a futuristic flow based on population growth, on the other hand there are certain STP that are over-burdened.

To conclude, the One City One Operator in India marks a paradigm shift in the sewage management sector with single point accountability and these contracts will create new bench mark in the industry for treatment standards and will also ensure cleaner and healthier eco systems thus contribute to the rejuvenation of the Ganga and its tributaries.

About the Author

K. Mohamed Shaffi is the Chief Business Officer – O&M at VA Tech WABAG. With over 28 years of varied experience in Water and Waste Water Treatment Industry, he possesses strong knowledge in various areas like Sales, Marketing, Process Application, Product Development, Pilot trials, Plant installation & commissioning and Project Management. Prior to joining WABAG, he was associated with corporates like Tecton Engineering & Construction and GE Water & Process Technologies.

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NON-REVENUE WATER AND LEAKAGE DETECTION

By Dushyant Jindal, Co-Founder, Hitech Enviro Solutions



Water is of paramount importance for the existence of life on planet Earth. It is essential for the survival itself as well as for most of the activities of human civilisations, be it manufacturing, agriculture, generating electricity or keeping and maintaining the health and wealth of the beings.

Although the planet Earth's surface is covered by nearly two thirds of water, there is not enough of it which can be accessed for the purpose of drinking, household activities or industrial activities. A large portion of population around the globe is devoid of clean drinking water. Moreover, this problem and this huge gap is increased by Non-Revenue Water (NRW).

Non- Revenue Water is the water that has been produced and lost before it reaches the customer due to several reasons. This water is unaccounted hence causing wastage of huge financial costs incurred on treating and pumping that water as well as the loss of revenue that could have been

earned through selling that water. If these water losses could be reduced, then more of the human beings could get access to the clean water and water utilities could earn more. High levels of NRW are detrimental to the financial viability of water utilities as well as to the quality of water itself. Hence, there arises the need for NRW management.

The NRW can occur through physical losses from leaking and broken pipes, which are caused by poor operations and maintenance, lack of active leakage control and poor quality of underground assets. Or these losses can be of apparent nature arising out of theft or metering inaccuracies.

The **International Water Association (IWA)** has developed a detailed methodology to assess the various components of NRW. Accordingly, NRW has the following components:

- » Unbilled authorized consumption
- » Apparent losses (**water theft** and metering inaccuracies)
- » Real losses (from transmission mains, storage facilities, distribution mains or service connections)

In many utilities the exact breakdown of NRW components and sub-components is simply not known, making it difficult to decide about the best course of action to reduce NRW. Metering of water use at the level of production (wells, bulk water supply), at key points in the distribution network and for consumers is essential to estimate levels of NRW.

The International Energy Agency has estimated that **34% of all water worldwide becomes non-revenue** water. The World Bank has estimated the

total cost of NRW to utilities worldwide at US\$14 billion per year. Reducing by half the current levels of losses in developing countries, where relative losses are highest, could generate an estimated US\$2.9 billion in cash and serve an additional 90 million people. The problem varies by region. Average NRW in India is around 38%; just above the global average range of 30% to 35% reported by the World Bank. Mexico and Denmark have 51% of non-revenue water, respectively, the two extremes. A challenge in many utilities is pinpointing the breakdown of NRW components and With a faster and more efficient leak detection, you reduce your cost per identified leak and can find the low-hanging fruits for reducing your Non-Revenue Water. Detailed knowledge about high-risk installations with possible leaks and the overall condition of your network will also enable you to prioritize your daily efforts to when and where they will have the biggest impact.

Leaks in resource transmission pipelines is a growing concern for the water transmission industry. This creates a need to prevent the threat of leaks and minimize their damages through extensive research in leak detection technology.

Leak detection technologies:

Multiple technologies have been developed throughout the years to help identify and locate leaks within water networks.

- » **Listening devices:** These devices rely on the high-frequency acoustic signals sent by the release of pressurized fluids, to detect leak existence and leak locations. Sound frequencies are then amplified and filtered at 1 kHz using a preamplifier to remove high-frequency noises that are not related to the network.

- **Geophones:** Both electrical and

mechanical geophones are used to listen to buried water pipelines from the surface. These devices are accurate and highly sensitive that they can detect the exact location of the leak however, the accuracy of geophones depends highly on the proficiency and the experience of the operator, and it also might fail to detect some leak classes.

- Hydrophones try to listen to leaks by sometimes being placed in the system and rarely on the surface of the ground. Hydrophones can be more accurate than geophones in detecting leaks, but they require more training than geophones to operate.
- » **Leak noise loggers:** A logger system is usually composed of a set of loggers that are placed throughout the network, a communication base that delivers collected data, and an analysis base that can be a desktop computer or a cloud engine using big data platforms. Leak Noise loggers are placed in utility holes without any trenching or drilling; they can be used as a permanent monitoring, semi-permanent monitoring, or leak surveying technique.
- » **Infrared thermography:** Thermography (IR) camera measures and images the emitted infrared radiation from an object. It can detect thermal contrasts on pavement surface due to water leaks. This technology has been tested on non-metallic pipelines and has shown accurate results, yet these results were not as accurate as the results provided by acoustic technologies such as geophones and are unreliable under the cases of damaged pipelines. Furthermore, IR Camera requires marking of the pipeline on the ground surface so that the machine can move above the pipeline. Also, the machine is profoundly affected by the surrounding weather and any variations in soil conditions and temperature.
- » **Tracer gas:** Tracer gasses is a leak detection technique that utilizes pressurizing nontoxic and insoluble gasses into leaks, these gasses contain ammonia, halogens, and helium, where helium is the most sensitive. Given that the utilized gasses are lighter than air they will tend to go out through

leaks and then seep out through the soil or pavements. Later on, these gasses are traced and detected using a man operated detector to identify the locations of leaks through detecting the seepage of tracer gasses

- » **Ground penetrating radar:** The Ground Penetrating Radar (GPR) technology utilizes electromagnetic waves (between 125 MHz and 370MHz) and transmits them into the ground to identify leak location via imaging the sub-terrain including the pipe and the leak. The advantages of this technology lie in its capability to detect leaks regardless of the material of the pipe, for any diameter size above one inch and reaching to a depth of 5m. Furthermore, this device can be easily transported between sites, and it does not require a lot of experience or training on behalf of the operator to operate it.
- » **Leak detecting robots:** Multiple robotic devices were developed to perform in pipe inspection and determine leak locations in sewers. These devices can be wireless devices or cord connected. Furthermore, some leak detection robots can also perform leak repair tasks. One example to present in leak detection robots is “smart ball”.
 - **Smart-Ball** is a free-swimming technology developed to detect leaks from within live large water pipelines. Smart-ball technology is composed of a foam ball with an aluminium alloy core, within the aluminium core, a highly sensitive detection instrument is placed. Smart ball does not create any noise when passing through the pipeline. Movement of Smart-Ball within a pipeline with results.
- » **Wireless micro-electro-mechanical systems (MEMS):** Micro-Electro-Mechanical Systems are microfabricated mechanical and electro-mechanical devices and structures. MEMS are usually composed of four main elements:
 - Micro-Sensors
 - Micro-Actuators
 - Micro-Electronics
 - Micro-Structures

Multiple types of MEMS were used in leak



detection of water mains mainly accelerometers, acoustic, and thermal. MEMS technology provides continuous water network monitoring for any leaks from the moment they are placed. MEMS have proven to be cost-effective tools when it comes to the detection of leaks with their low cost and high sensitivity to signal anomalies. On the other hand, MEMS are viable when used in metallic pipelines.

Benefits of NRW Reduction

Benefits of NRW reduction and leakage reduction, include

- Financial gains from increased water sales or reduced water production, including possibly the delay of costly capacity expansion
- Increased knowledge about the distribution system
- Reduced property damage
- Reduced risk of contamination
- More stabilised water pressure throughout the system

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.

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THE OPERATOR'S EXPERIENCE IN REDUCING PHYSICAL LOSSES ACTIVE LEAKAGE CONTROL AT BUDAPEST WATERWORKS, HUNGARY

By Evelin Madzin, NRW Expertise Center of Budapest Waterworks



The importance of drinking water

Access to clean, safe water is one of the world's most pressing needs, as described by UN's Sustainable Development Goal (SDG 6) also, billions of people live without access to safe drinking water, sanitation and hygiene. Beside the need for clean drinking water, areas of the globe suffer from water shortage; they have limited access to water sources enough for the growing population. So it is more and more important to ensure that the water already treated, ready for consumption should actually reach consumers. Yet today's water distribution systems lose a significant part of supply because of leaks. Beside the shortage of sources, the problems related to non-revenue water (NRW) increase the pressure on water utility suppliers already operating under hard circumstances.

Briefly about NRW

Due to various reasons and factors, water utilities cannot sell some of the water produced, so the amount of non-revenue water causes a significant loss of revenue.

The total cost to water utilities caused by NRW worldwide can be conservatively estimated at \$ 141 billion per year according to the World Bank. In addition, the real / physical loss part of NRW has supply and safety, economic, ecological and environmental effects as well.

According to the International Water Association's (IWA) methodology, we talk about real loss when a large amount of water disappears within a given time through various forms of damage to the network.

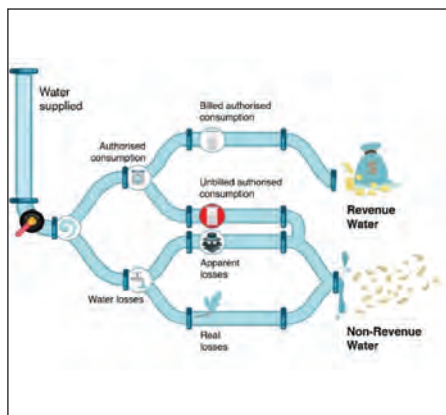


Figure 1: Non-revenue water

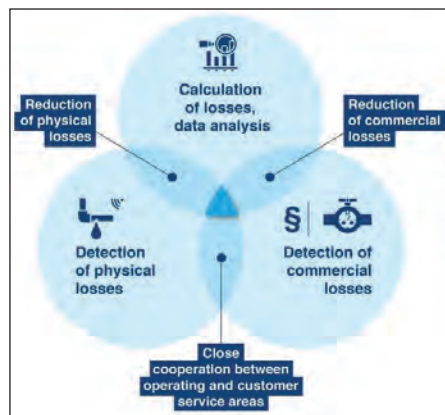


Figure 2: The complexity of the loss reduction activity



Figure 3: Location of Budapest

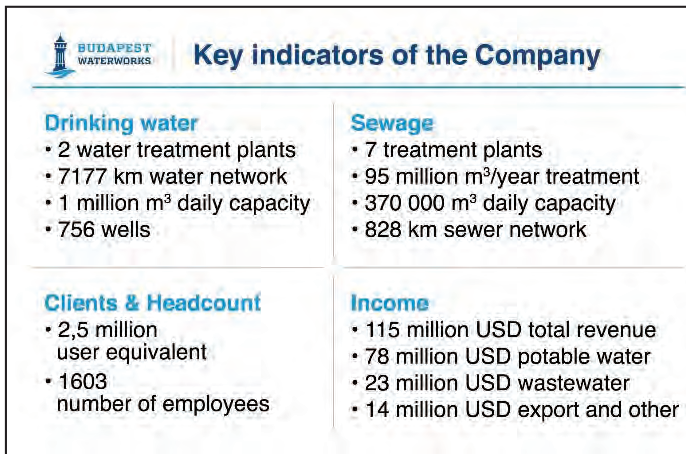


Figure 4: The key number of Budapest Waterworks

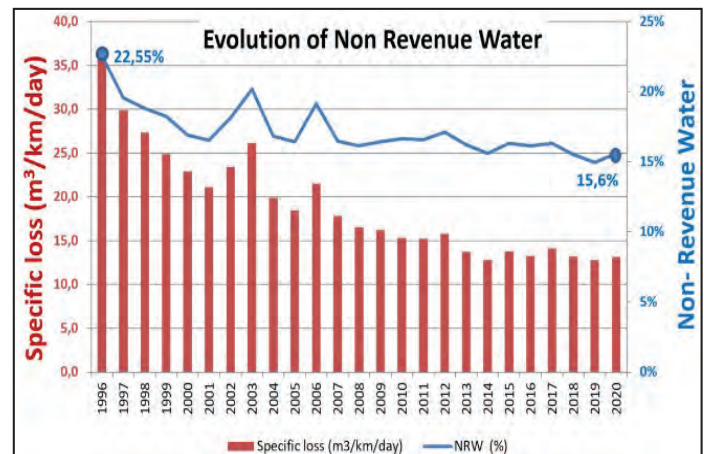


Figure 5: Evolution of NRW at Budapest Waterworks

However, in addition to physical losses, another component of the NRW is commercial losses. Significant commercial losses are caused by the inaccuracy of water meters, any form of unauthorized consumption, and data handling, billing errors.

In this article, the method of physical loss reduction activity of Budapest Waterworks is presented.

About Budapest Waterworks

Managing water loss in the water supply system of Budapest Waterworks is an elaborate and determinative task for several departments of the company. The problem of losses deserves attention and appropriate actions to reduce avoidable stress on our valuable water resources. As a result of the NRW reduction activity receiving special attention as a complex activity, we have been able to keep our NRW levels around the target rate for several years now, while operating a network of considerable average age and of

various pipe materials.

In terms of size and quality of technology. Budapest Waterworks, with its more-than-150-year-long history, is one of the leading water utility service providers in Central Europe.

Over 5,000 kilometres in length, our drinking water pipe network supplies the Hungarian capital and its conurbation area. Water treatment, network management and water quality testing activities are supported by world-class technologies. For today both drinking water production and supply systems are fully automated. Our activities related to wastewater treatment and network, among others, include the operations of the Budapest Central Wastewater Treatment Plant, which has a capacity of 330,000 m³/day and is equipped with state-of-the-art, environmentally-friendly solutions.

Using our experience in the core activities, we

launched international activities in the mid-2000s focusing on water and waste water facility construction projects and consultancy services to utility operators around the world.

Physical losses

According to the IWA methodology, we talk about real loss when a large amount of water disappears within a given time through various forms of damage – such as leakages, pipe bursts – to the network. This includes losses due to operational faults such as reservoir overflows, other control faults, careless closing and emptying, etc. losses incurring during the given period.

The loss of the network worsens the profitability of the operator because

- ▶ some of the water extracted and supplied, and therefore of value, is lost;
- ▶ it causes higher capacity requirements of the water supply network;
- ▶ Leaks – in addition to the value of the run–

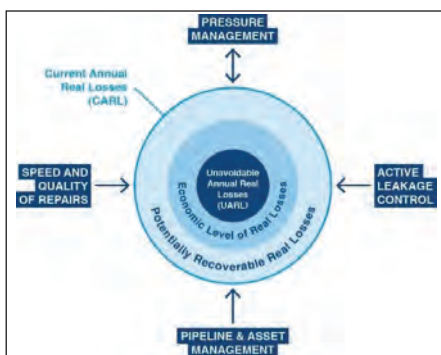


Figure 6: The 4 main activities to reduce physical losses

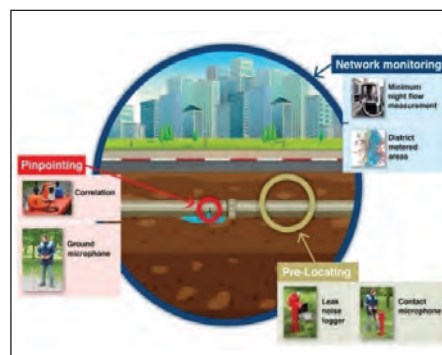


Figure 7: The 3 main steps of active leakage control activity

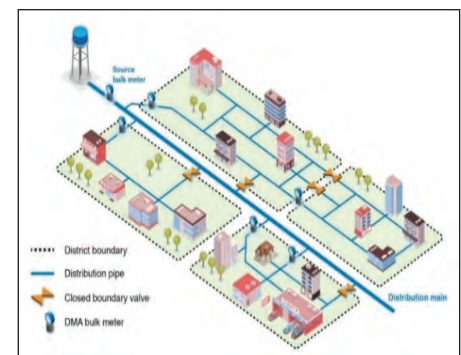


Figure 8: Illustration of DMA districts



Figure 9: Online measuring points on Budapest Waterworks water supply system

off water – cause consequential damage (basement soaking/flooding, public utility damage, etc.) to property in the vicinity.

Physical loss management

Based on the IWA's recommendation, the following four main activities can be used to reduce physical losses to a level that is as close as possible to the unavoidable level of loss:

- ▶▶ active leakage control activity (ALC);
- ▶▶ pressure management;
- ▶▶ speed and quality of repairs;
- ▶▶ pipeline and asset management.

From the above activities, the first one is explained in this article.

The purpose of active leak detection is to detect hidden damage of the water network.

In the leak detection process the first step is to monitor the network with minimum night-flow measuring vehicle and/or with DMAs. This will determine if there are hidden leakages in that area. If so, the measurement results can be used to estimate their quantity, extent. Thus, the place of the leakage can be determined in advance. The second step is to pre-locate. Thus, the faulty section will be specified. And finally the third and the last step is to pinpoint the location of the fault.

District metered areas (DMAs) are defined as an invisible area of a distribution network.

They are usually created by closing boundary valves and water meters. Measuring the water flowing into and out of the DMA, we get knowledge of how much the district's minimum night flow is. Based on minimum night flow data we can conclude the size/extent of leakages.

Active Leakage Control Activity at Budapest Waterworks in practice

Our active leakage control activity at Budapest Waterworks began in 1986. The number of staff supporting this activity and the tools used has been constantly improving. Our experience in the field of districts metered areas:

- ▶▶ 75 DMAs in 16 zones;
- ▶▶ 177 measurement points;
- ▶▶ SCADA integration;
- ▶▶ Several special reports and dashboards.

From every measuring point we get data once per day by SMS communication. Data contain quarter-hour flow values, which are processed, reported and analysed via SCADA and Power BI. Let's see some case studies.

Case study 1.

The first study is an example for data analysis of a district metered area. Zone 14. in Budapest consists of 3 districts via 2 measuring points: 14/1, 14/2 and 14/3. Diagram 1. shows an example of this method. This Diagram illustrates the input volumes of district no.14/3 in the given period. It can be seen that the value of water input grew very slow in January, 2019. After that a higher jump in values occurred suddenly. Diagram 2. shows the minimum values of daily district input. This values are typical at night period. As a conclusion of the fact that the night input curve has also grown, it can be said that a hidden leakage is the cause of this change.

After the data analysis, the ALC team examined the area. During the examination a big hidden leakage was detected in the pipeline. The failure was on a distribution pipe with 7 m³/h extension.

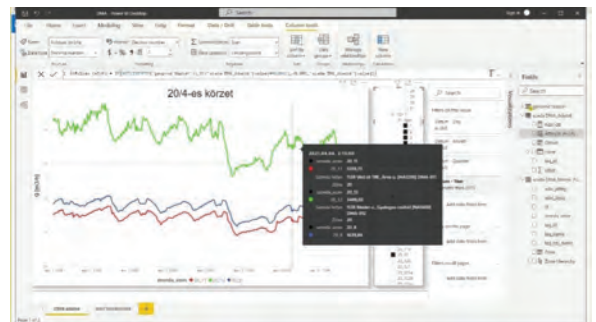
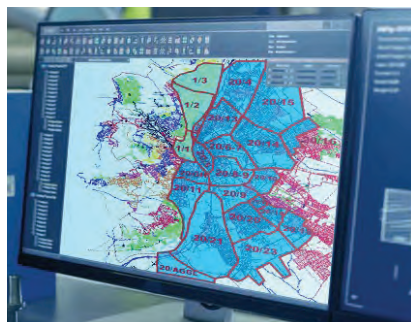
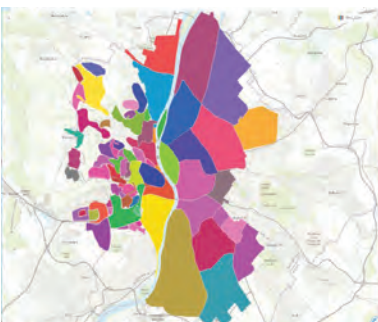


Figure 10: Data processing and analysis at Budapest Waterworks

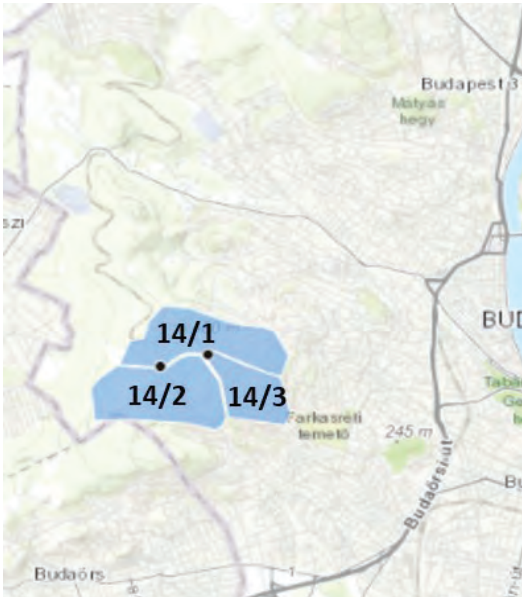


Figure 11: The situation of zone 14 districts

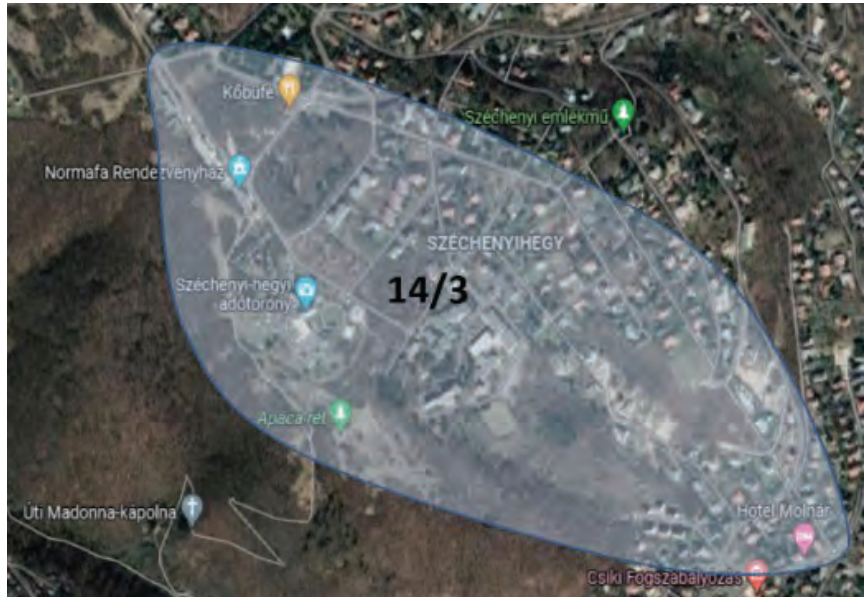


Figure 12: The situation of district 14/3 in the hilly area

As shown in Figure 12, the district is located in a hilly, rocky area, so water can flow unnoticed. After the repair works, the values decreased to the same level as the initial values – as can be seen in the chart at the beginning of March. Finally, with the onset of spring, the warmer weather increased the water demand of the area and, accordingly, the input values of the zone also increased.

Case study 2.

The second study is an example for a small zone, which does not contain DMA district because its water network is only 5.1 km long. This size is perfect to analyse water losses without breaking it down into smaller districts. Diagram 3. shows the

input volumes of Zone 6, called Ruthén between October, 2020 and January, 2021. It can be seen that in the middle of October the lowest values started to increase. Further growth was seen in November. During this period the values increased from around 20 to circa 33 m³/h. The change can also be observed in the minimum values at night in Diagram 4. This clearly indicated the presence of a leak or leaks. The ALC team examined the area. During the examination two hidden leakages were detected in the pipeline which were repaired in two steps, on 14, December and on 22, December. This failures caused a total of 18 m³/h drained water. After the repair works the values decreased to 15 m³/h.

Case study 3.

The example below is a great illustration of what happens when we are not doing ALC activity in a particular area. Diagram 5. shows the daily input values for Zone 10. between 2018 and 2021. The total network length of this zone is 92 km which is not divided into smaller districts. In the case of large amounts of water, it is clear that a few m³ of water exfiltration caused by leaks is difficult to detect. Sometimes it takes several years for a trend to show in the data.

Case study 4.

Diagram 7. below shows the daily consumption profiles of the different smaller zones, which have

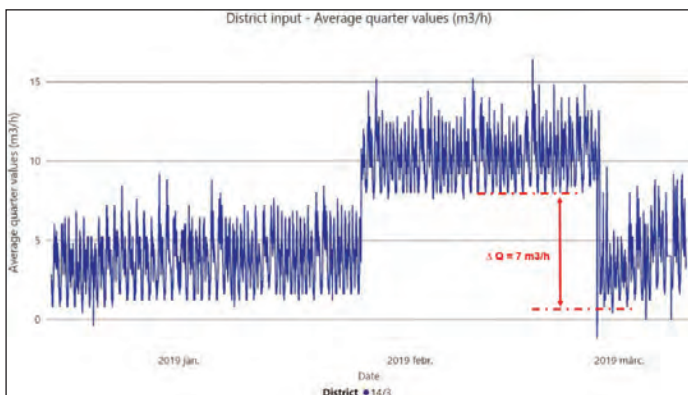


Diagram 1: Data analysis of district 14/3 – District input

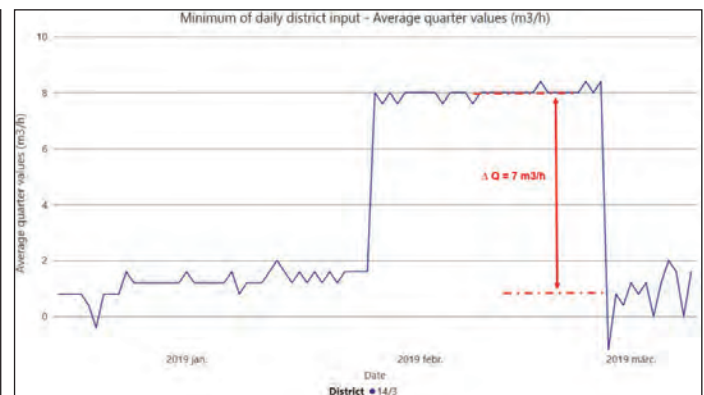


Diagram 2: Data analysis of district 14/3– Minimum of daily district input

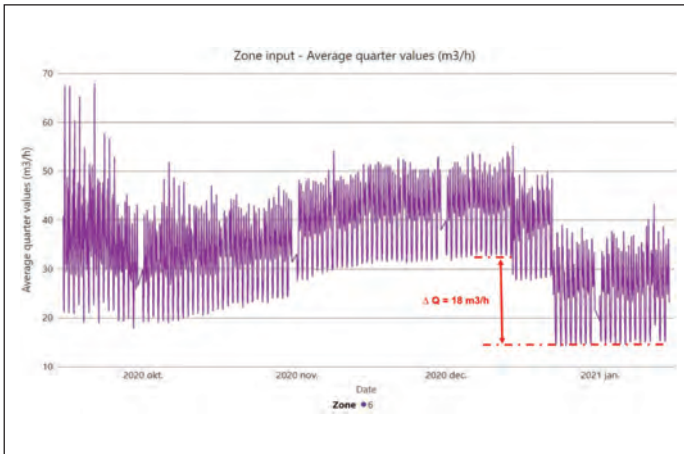


Diagram 3: Data analysis of Zone 6 – Zone input

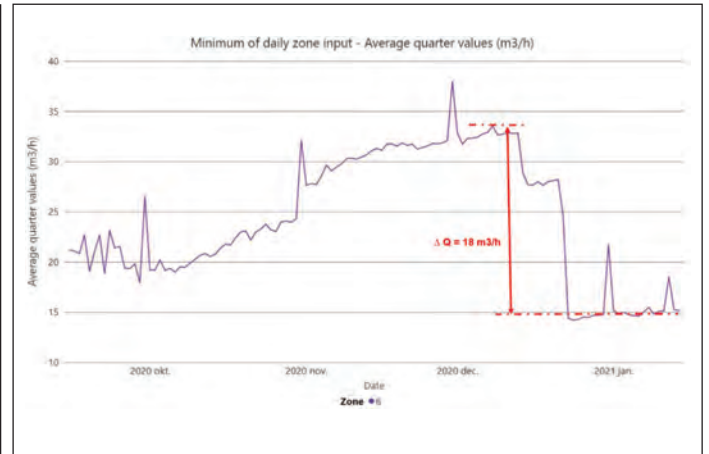


Diagram 4: Data analysis of Zone 6– Minimum of daily zone input

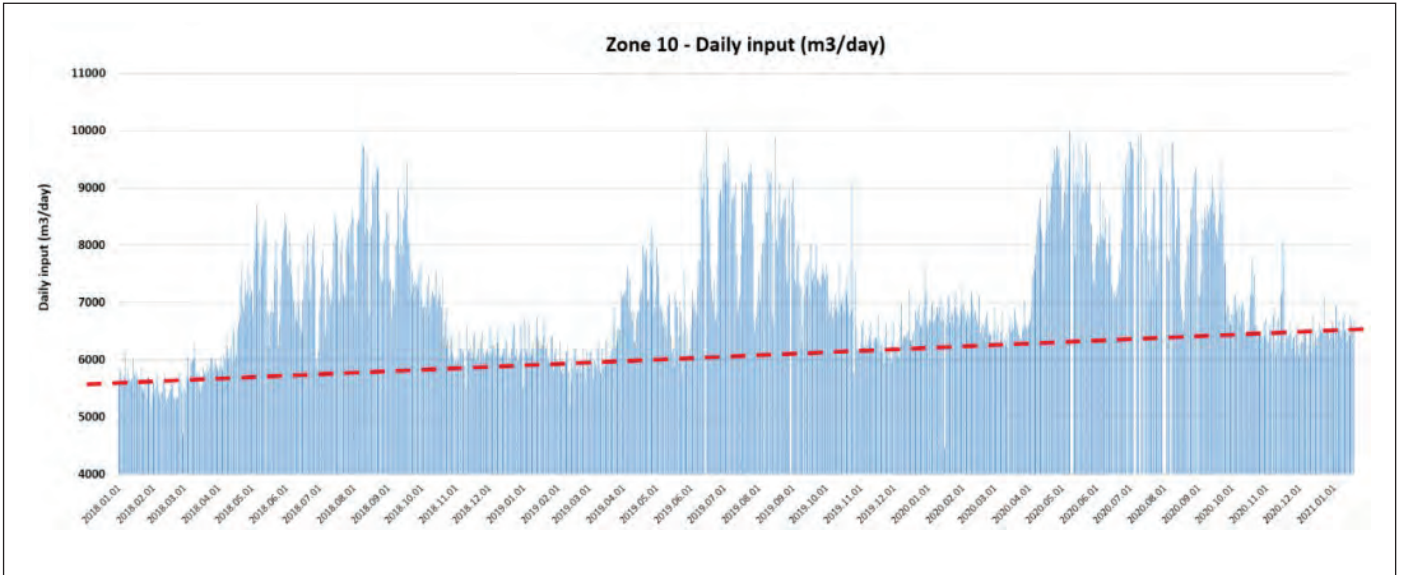


Diagram 5: Data analysis of Zone 10 – daily input

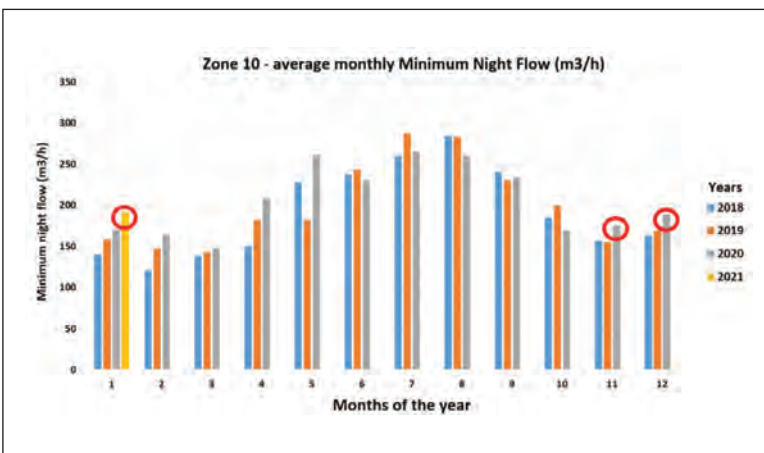


Diagram 6: Data analysis of Zone 10 – average monthly MNF

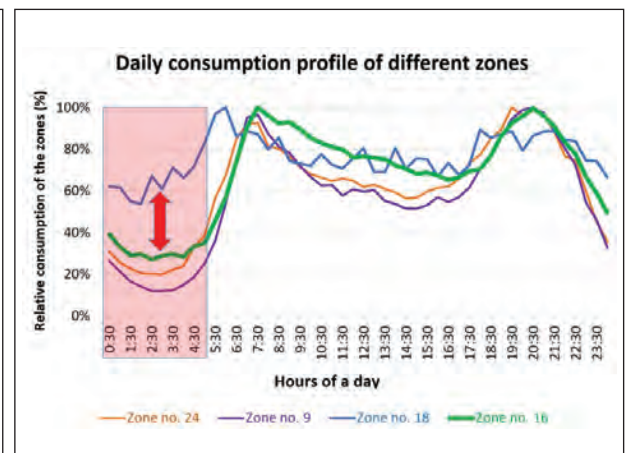


Diagram 7: Daily consumption profile of different zones

Photos of leakages



Figure 13: Photos of visible and invisible (hidden) leakages

the same features (e.g. length of network, number and types of buildings). That is why the daily consumption profiles are similar to each other in normal circumstances. The blue line shows the values of zone no 18., which is different from the others. This difference can be experienced in the night period of the day, because of this hidden leakage presence is concluded similarly to the former case.

Conclusion

The operation of a DMA system requires strong, safe, and robust IT background and connections. The structure of water distribution is based on

a SCADA system and DMA network; therefore, Budapest Waterworks can manage the supervision of about 120 separate zones. Several special reports and dashboards support the control of consumption trends of each area. These reports can help ourALC activity.

Active leak detection is not a task but an activity. Accordingly, feedback and continuous monitoring are important. Although clear, it is important to note that the reduction of NRW (whatever kind the loss is) is done through the steps shown in Figure 14. By creating a monitoring system and data collection; targeted and efficient fault location can be supported in order to focus on the losses that occur. The actual reduction in losses, on the other hand, depends solely on the speed and effectiveness of the repair (repair of pipe damage, replacement of meters, elimination of illegal connection, etc.). The analysis is based on strong and reliable data collection, however, loss reduction can only be done through actual physical or customer service administration work. Exploration of the reserves inherent in the operation, reduction of losses is of paramount importance in the current operation of the sector.

Our strategies have driven to optimum efficiency achieved, decreased source extraction, optimised system operation and energy usage. After 35 years

of hard work on the topic, Budapest Waterworks collected a wide range of experience concerning the reduction of water losses enabling us to fine-tune and revise original starting assumptions and expectations thus ensuring that the strategy we have developed will bring results.

As an operator active in international markets using our experience in the core activities, Budapest Waterworks can support other utilities in their work in the field of NRW reduction as well. If you have any questions, we are happy to answer, please contact us.

About the Author

Evelin Madzin holds a Masters of Science degree in Infrastructure Civil Engineering from Budapest University of Technology and Economics. She works at Budapest Waterworks in Hungary as a network engineer at Network Operation Department. She has gained experience in network operation, design and operation of DMA systems, pressure management, NRW reduction activity and project management. Besides leading the group of NRW Expertise Center of Budapest Waterworks, she actively supports the international activities of the company as well, as an expert in projects worldwide.

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.



Figure 14. – The whole process of physical loss reduction

NON – REVENUE WATER (NRW):

WAYS AND MEANS OF DETECTION

By S. Prasanna, Murugappa Organo Water Solutions Private Limited



Water, a highly indispensable resource is depleting in a faster rate. Due to various reasons like population, pollution, undue wastage and so on, water resource gets exhausted rapidly. It is estimated that a person uses 200 litres of water per day. One can't do without water but one can definitely make a spectacular change in treating the waste water. It's not a must that agriculture needs fresh water, even treated water will work wonders; same is the case of industries which can manage with treated water to function. Water Treatment Plants and Sewage Treatment Plants are the keys to make this happen and one should never forget to make it environment friendly as this is the need of the hour.

Water is a critical source of life on our planet; it plays paramount roles in agriculture, manufacturing, production of electricity, and to

keep humanity healthy. Approximately one billion individuals around the globe are unable to access clean drinking water (Krchnak 2016). Urban water is regularly transmitted using underground pipelines. Water transmission pipelines periodically lose an average of 20% to 30% of the water transmitted through them, and those numbers can escalate above 50% in old systems especially ones that have suffered from inefficient maintenance. There are multiple causes for loss of water in transmission pipelines which include leakage, metering errors, public usage such as firefighting, and theft (Hunaidi 2000; El-Abbasy et al. 2016). The most critical route for losses is a leak, as they are considered to contribute an estimated of 70% of water loss in water transmission systems, this value is expected to become higher in undermanaged networks (Van Zyl and Clayton 2007).

Proper management of solid and liquid wastes is an important determinant of improved sanitation in a country. The liquid waste poses serious threat of contaminating ground water. Management of waste water may focus on maximum reuse of waste for agriculture purpose with least operation and maintenance costs. People must be aware about 4R's for effective waste management. Reduction, Reuse, Recycling and Recovery. Where there is awareness there will be optimal reduction in wastage. Eco-friendly technologies in water industries result in favourable positive result ensuring healthy and safe environment.

Non – Revenue Water (NRW) is water that is pumped and then lost or unaccounted for. A World Bank study puts the global estimate of physical

water losses at 32 billion cubic meters each year, half of which occurs in developing countries. Water utilities suffer from the huge financial costs of treating and pumping water only to see it leak back into the ground, and the lost revenues from water that could have otherwise been sold. If the water losses in developing countries could be halved, the saved water would be enough to supply around 90 million people.

Non-revenue water (NRW) management allows utilities to expand and improve service, enhance financial performance, make cities more attractive, increase climate resilience and reduce energy consumption. In water constrained environment, NRW management often offers superior cost-effectiveness compared to supply augmentation. At the same time, revenues from saved water improve a service providers' bottom line whilst lower water abstraction increases city resilience. But the benefits that arise from reducing NRW are yet to become driving forces behind tackling this widespread challenge in developing countries.

In one instance, a study was conducted in the United Kingdom to identify the impact of water leaks on an urban water network. On a yearly basis, the country is expected to dig 4 million holes into its road network for pipe installations and leak repairs. The monetary impact of the repairs is estimated to be at 7 billion £ (around 10 billion US\$) annually. The overall cost can be divided into two main portions, 1.5 billion £ (around 2 billion US\$) indirect damage costs and 5.5 billion £ (around 8 billion US\$) in social impact costs. Another aspect of the dangers of leaks is their tendency to grow. The growth of leaks can allow the introduction of pathogens and

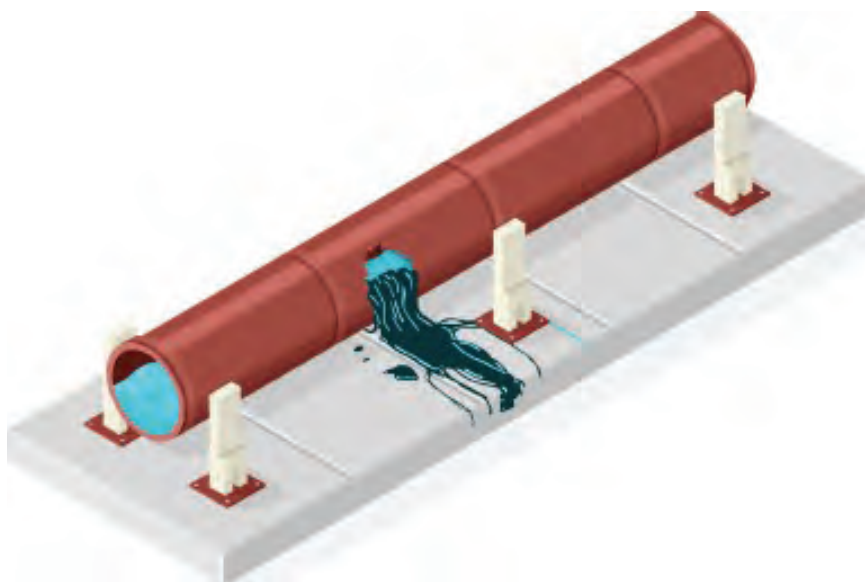
contaminants from the surrounding environment into the network in the case of water networks and quite the opposite in the case of oil and gas networks which would result in dangerous impacts on human life.

Why NRW Reduction Still Receives Scant Attention?

Reasons for utilities not making progress include weak capacity, lack of incentives, poor financial discipline and the effort required to find and fix leaks compared to building new treatment facilities. This has created a lethargy which is now being shaken by pressures coming from climate change, water scarcity and increasing expectations of consumers. As part of Stockholm World Water Week 2016, the World Bank, in partnership with the Inter-American Development Bank (IDB) and the International Water Association (IWA), hosted a workshop to explore the political, financial, technical and market constraints of this under-utilized, but impactful task. Using case studies, the workshop explored how constraints have been overcome and brainstormed with water experts about a global initiative on scaling up NRW management.

The workshop and a more formal partnership with IWA was a part of a broader initiative within the World Bank Water Global Practice to help build sustainable urban utilities. This initiative was supported with funds from PPIAF and was focused on how to increase the use of Performance Based Contracting (PBC) as one way to address high levels of leakage. Through PBCs, utilities can access the capacity and equipment that they lack – and with payments based on results the incentives to perform are high and the risk of non-performance by the contractor is reduced. A World Bank financed project in Ho Chi Minh City used a NRW PBC approach in a part of the city and saved half of the water that was previously being lost to leakage – 100,000m³/day (enough water to serve 500,000 people). A truly remarkable achievement which set a new benchmark for the NRW PBC model.

With the proof of concept now a given, the challenge is how to streamline and simplify the NRW PBC project preparation and contracting process. The World Bank and IWA are working



together in collaboration with the IDB to advocate for the reduction of NRW and create more dynamic markets at national and international levels.

The losses and damages created by leaks requires novel techniques and approaches to minimize their negative impact and deal with them as fast as possible. As a result, multiple researchers dedicated their efforts for the development of a vast variety of techniques for leak detection and leak location.

Defining Leak Detection

In 2009, Hamilton defined leak detection as a subsidiary of three main phases known as localize, locate, and pinpoint or LLP. Localize is defined as narrowing down a leak to a specific segment within the network or a specific district metered area after the suspicion of a leak. Several tools can be used in this domain such as district metered area and fitting surveys. The second phase is locating, and it is the first phase where a location for the leak is determined. According to Hamilton, the location of the leak is said to be within a radius of 30 cm. Furthermore, multiple tools are available for utility in this phase including correlators and microelectromechanical. Finally, the third phase, according to Hamilton, would be pinpointing. Pinpointing is another phase where another estimate for the exact location of the leak is determined but within a radius of 20 cm. In this phase, a variety of tools are available including hydrophones and geophones. The difference

provided by Hamilton between locating and pinpointing is a 10 cm-difference in radius, which is negligible and offers no actual differentiation between the processes or the actual outcome of each phase.

Therefore, it is more efficient to merge the two phases due to similarity. In contrast, multiple researchers in the field of leak detection have highlighted the existence of another challenging aspect in the development of leak detection systems and approaches. The challenge lies in differentiating the signs of leaks from other aspects such as pumps or an open hydrant. This problem is vivid in acoustic noise loggers and accelerometers and other wireless sensor devices that are used in leak detection. Sensors would pick up any form of signs and signals similar to those of leaks and end up providing false alarms. False alarms create an expenditure of workforce and funds for the bodies monitoring the respective networks. Therefore, a new phase of leak detection is proposed, and that is the identification phase.

Process In Leak Detection

Water is lost through leaks and cracks in pipes and their fittings. Since most infrastructure is underground, it is virtually impossible to visually determine the location of these leaks unless the water has reached the surface (causing ponding and sink holes, structural damage, buckling pavement, etc.), and the exact location may be indeterminate. Leak detection requires special



technologies that allow inspectors to precisely determine the location and severity of pipeline leaks. This is a field that continues to grow and advance by utilizing both established technology and by adopting emerging methods. The advances in leak detection research have grown remarkably in recent years, but the field of leak detection is not a new field of research. The damages created by leaks in pipeline networks presented researchers with the curiosity of developing reliable and immediate solutions to fight the leakage epidemic. Acoustic detection remains the primary means of detecting and locating pipeline leaks.

The method of acoustic leak detection is described as “the systematic method of using listening equipment to survey the distribution system, identify leak sounds, and pinpoint the exact locations of hidden underground leaks.” Water escaping under high pressure from a pipe leak or crack makes a distinct rushing or hissing sound that can carry considerable distance along the length of the pipe itself (in contrast, the loose soil surrounding the pipe in its backfilled trench makes a poor conductor of sound). In this sense, the pipe acts as a medium for transmitting sound. In doing so, it can act like the strings on a guitar, vibrating with different pitches for different pipe lengths, diameters, and materials. Small diameter metal pipes carry sound the greatest distance, up to 1,000 linear feet, while large diameter polyvinyl

chloride (PVC) pipes can carry sound only 100 feet. The listening devices used to detect this sound come in various operational modes. They can be mobile or fixed, direct or indirect, external or internal, or transit data via radio or utilize manual download into laptop computers. There are mobile acoustic sensors that are manually operated or run along the pipe segment on wheels. In either case, the sensors consist of ground microphones that listen below the surface as the operator walks along the pipe segment. As he operates his sensor, the signal will get louder as he zeroes in on its location.

Secondary leak detection methods utilize pressure differences. These are measured by strategically located flow meters and pressure gauges that can, by differences in the readings, bracket the location of the leak. Pressure drops compared to initial operating condition immediately after installation will indicate the escape of water and subsequent lowering of pressure from its original state. The two systems can be used together with the pressure and flow differentials used to bracket the leak’s location and mobile acoustic sensors running along this bracketed length to pinpoint its location. The use of the former saves considerable time and tedious effort by the latter.

Leak Audit Procedures

Leak detection is just the first step. To minimize

leakage loss, a water supply system must have a program of continuous audits, of which leak detection is just a part. A full-scale audit program should be performed at least annually with complete analysis of the leak data—not just for the current audit, but accumulated data records over time. A proper audit examines the accuracy and completeness of the system’s entire leakage database. This data does not just include reading on the leaks themselves, but also indirect measurements of potential leaks such as customer billing and receipts, along with flow meter and pressure gauge readings.

Pressure readings can be used to create pseudo-hydrostatic contours representing areas of low and high pressure. Low pressure zones thus revealed are another danger sign that a leak may be occurring in these areas. Audits are typically priced by the mile, and they are not cheap (especially for large water supply systems). But they are essential and are far less expensive than continued water loss. Audits provide update information on system performance, tagging what is failing and (more importantly) highlighting those areas that are functioning properly. This is important with regard to evaluating previous maintenance and repair operations prompted by the results of previous audits. In short, a water system audit provides its own information feedback loop. As a side benefit to the audits, complete inventories of the water system’s equipment, valves, and fittings can be collated.

The next step is to identify all potential sources of water feeding into the water supply system and sum up their measured flow rates (gallons per day). This gives the baseline value for the amount of water that should be flowing through the system and through each pipeline network subsection. Next, flow meter readings should be tallied up. This provides hard field data (adjusted for potential meter error) on actual water usage flow rates. Then water flows entering the system can be compared with water usage exiting the system to determine the gross magnitude of water leakage.

After this amount is determined, the audit can break down water usage by individual customers (residents, businesses, commercial and industrial

facilities, rental units, etc.). This involves both a thorough review of the data from the last year's audit and the meter readings over the past year. Increases in flow rates indicate that the customer has either increased its usage due to expanded operations and increased economic activity, or that the customer itself has unreported leaks. If the latter is the case, it is up to the customer to find and repair any leaks that are occurring on his side of the flow meter. The water utility is only responsible for leaks on the street side of the meter.

With each pipe segment of the water distribution system defined by flow and pressure monitoring points, both the approximate location and amount of water being lost at a leak can be determined. The manual detection can then proceed to find the precise location of the water loss. The kind of leaks can vary considerably and can include illegal water taps, broken and malfunctioning meters, leaking pipe fittings and fixtures, and worn out valves. In addition to pipeline leaks, leaks can occur in water storage structures such as water towers, storage tanks, and reservoirs.

Emerging Leak Detection Technologies—Inside And Outside

Detecting leaks within a customer's facility is not so much a matter of visibility, but of vigilance and continuous monitoring. New technologies are emerging that allow customers to pinpoint leaks within their facilities with a higher degree of accuracy than the traditional methods of water leak detection such as spot detectors, which detect leaks at a single point (such as a curbed area under a piece of equipment). Though economical and easy to use, spot detectors can only detect accumulated water in contained or low points. Water that doesn't touch the spot detector's probes will not be detected. An improvement on this system utilizes non-conductive sensing wire (which avoids shorting out if it comes into contact with metal surface or projections) and can detect any fluid, not just water.

Intelligent cable sensors are just one area of technological development. Each new advance will have to be rigorously evaluated for general usefulness and specific applicability. The factors used to evaluate new technology include: breadth

of application and how many uses it can be applied to; ability to adjust sensitivity to different liquid amounts; the ability to quickly reset its readings and re-establish its sensing operations; ease of installation; scalability and adjustment to future expansions; and ease of integration into the existing control and monitoring system. Future technological advances must pass all of these hurdles to find acceptance among both customers and utilities.

Water Signal measures water flow in real time, allowing for fast detection of leaks and water conservation. The system allows Portfolio managers to login with any internet-accessible device and see a centralized dashboard of current water consumption across all sections of the water supply system. Its unique hourly and daily alert levels warn managers about excessive losses and prevent subsequent high billings. This real-time water use reading is far more efficient than standard monthly meter readings. The Water Signal technology is directly installed on a water meter and then proceeds to manually calibrate the device to ensure accuracy. Data is then acquired continuously in real time and uploaded to a secure data center. The accumulated water use data is available to operators 24/7 through any internet device (iPhone, iPad, laptop, etc.). A sudden spike in water flow, indicating a catastrophic leak, will result in alerts being sent to the operators via email and SMS text message. The alert will include specific data indicating which water line has broken and how much water has been lost. This system has been used successfully in a number of commercial and public applications.

Conclusion:

The Advancement in Science and Technology have resulted in abundant water leakage detection and monitoring systems but it all works fine only with the potential involvement of people. She/he is the mastermind to help detect, resolve the water leakage and install devices to restrain the leakage or stop the precious water from getting wasted. This shouldn't be the last resort but taken into careful consideration when planning a water pipeline. The immediacy of action lies totally on human, they must realise the importance and arrest the leak at once to make the best use of water resource.

About the Author

S. Prasanna, holds an Engineering degree in Biotechnology and Master's in Environmental Science and Technology. He started his career as Process and Proposal engineer at L & T construction, handling mega projects like 2 MLD STP at Rashtrapathi Bhavan, Delhi, SMART city projects like DHOLERA, Gujarat. He joined Murugappa group in 2018 as Deputy Manager handling Marketing, Process and Proposal and heading a team of ten. They provide customized, end to end solutions for complex Industrial effluents, design and execute projects and products, which is done by few companies.

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.

AUTOBIOGRAPHY

I was born into a warm and loving family. My father Sankar G is an Industrialist handling fabrication job, and my mother Malarvizhi T was teacher at a Government High School. We were in a conservative family those days, and my parents worked hard to make sure we had an exciting childhood. As many Indians, I hold an Engineering degree in Biotechnology and due to my aspiration for nature I pursued my master's in environmental science and technology so that I thought I can contribute towards sustainable living for the future. Water scarcity was a bigger problem at my place and hence, I always have a concern on saving water for the future. Without doubt or second opinion, I wanted to have a job in the field of water treatment and as per my aspiration I started working as Process and Proposal engineer at L & T construction handling mega projects like 2 MLD STP at Rashtrapathi Bhavan, Delhi, SMART city projects like DHOLERA, Gujarat. I joined Murugappa group in 2018 as Deputy Manager handling Marketing, Process and Proposal and heading a team of ten. We provide customized, end to end solutions for complex Industrial effluents, design and execute projects and products, which is done by few companies.

I hope that I have contributed a little to preserve our nature and strongly believe that positivity, smart work and optimistic approach leads to success always.

ROLE OF SPACE TECHNOLOGIES IN REDUCING NRW

Riddhish Chetan Soni, Karan Behar and Vikram Gulecha

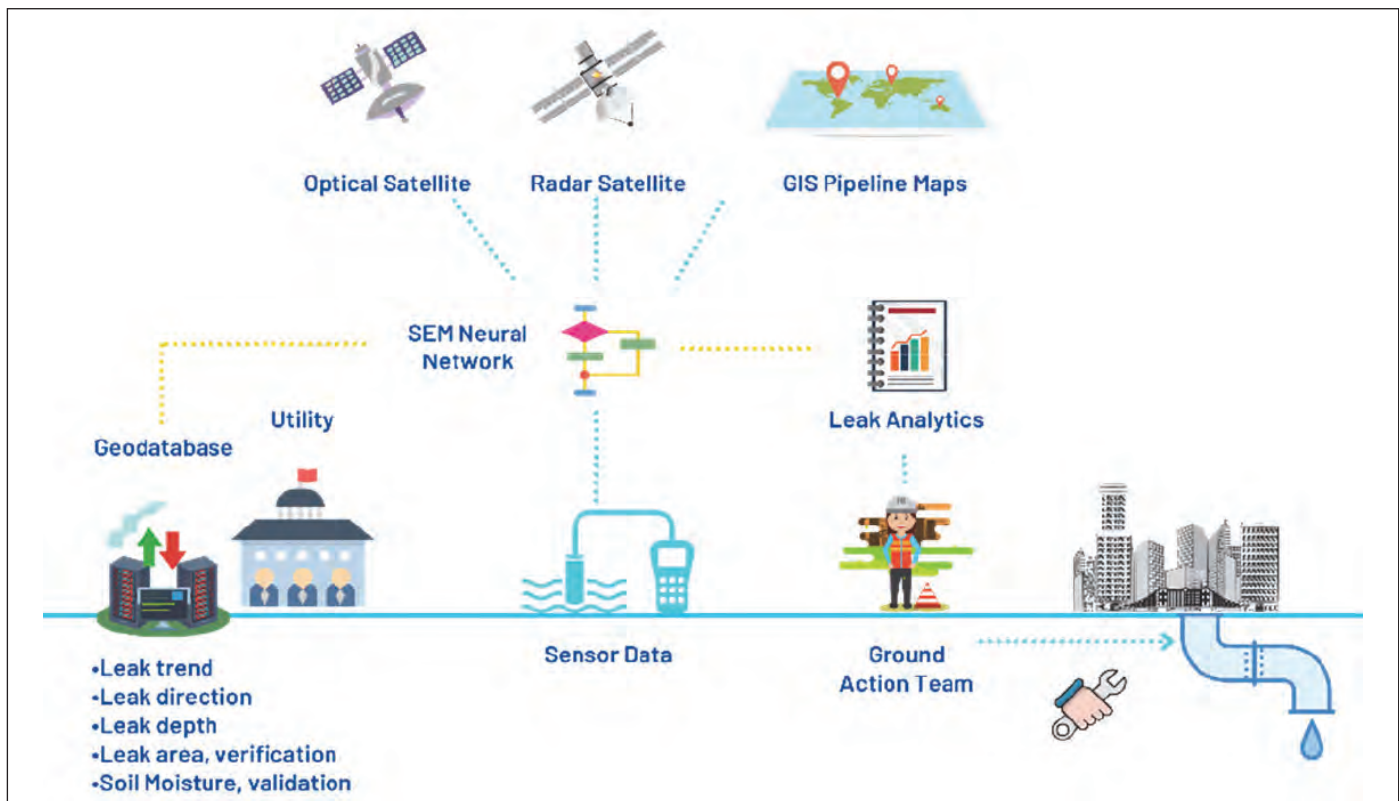


Image 1: Jalashaya Workflow

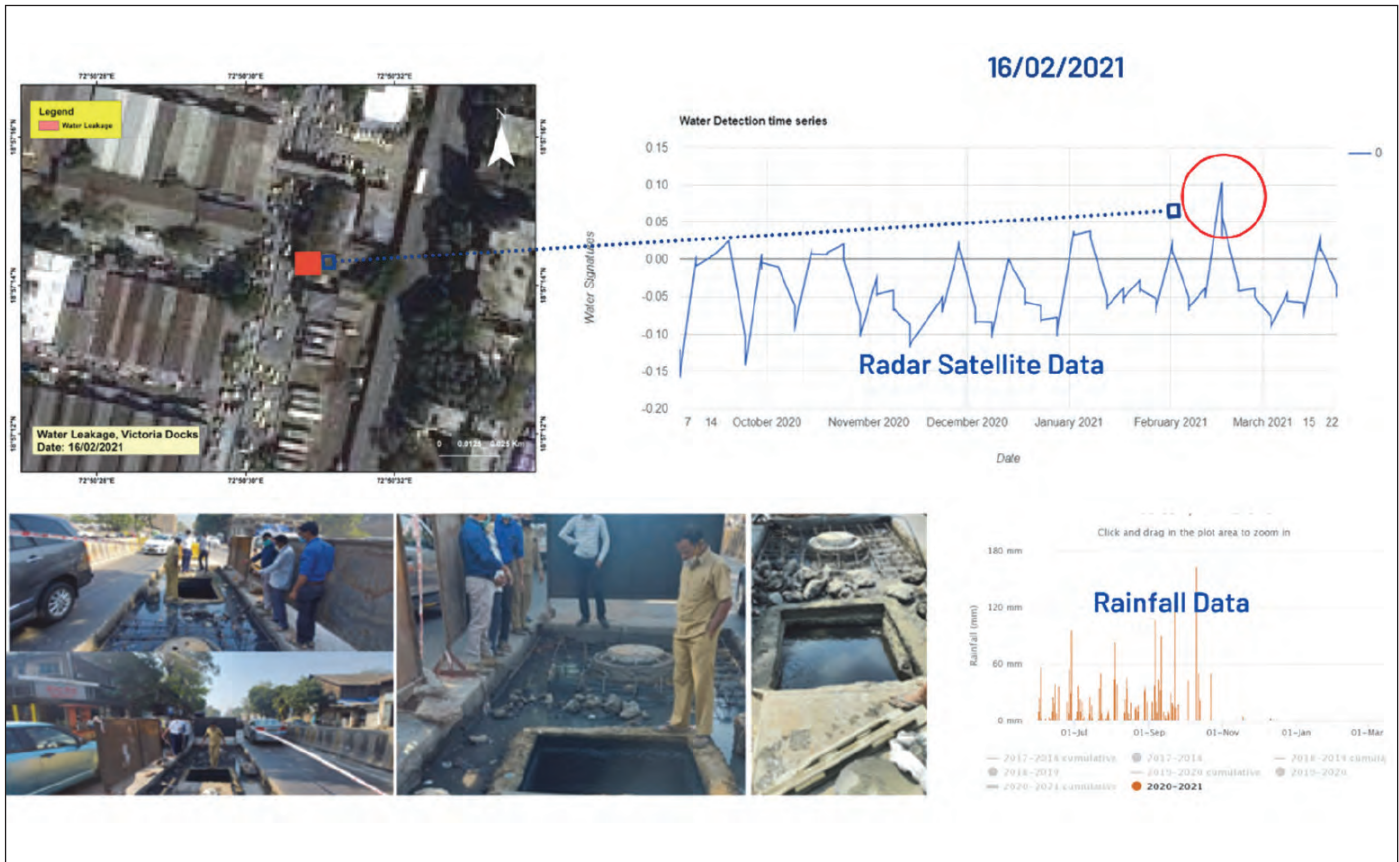


Image 2: Leakage Detection in Victoria Docks, Mumbai

Introduction

Civil structures such as pipelines, roadways, and buildings ensure economic growth and prosperity in a society. In particular water supply pipe line networks ensure the distribution of potable water to all stakeholders within a community. These are subjected to deterioration over time leading to problems similar to as the reduced utilization of hydraulic installations, water losses, slowdown in industrial activities, and deteriorate water quality. Also the increasing consumer demand for water creates new problems similar to reduced water pressure at demand junctions. This raises the incoming water pressure of the water distribution system, which in turn increases the frequency of leakage. The common causes of pipeline leakages are shown in Table 1.

Monitoring and mapping water leak locations have been a problem ever since the traditional methods of field surveys are not only expensive but also time consuming. In most cases, the leak

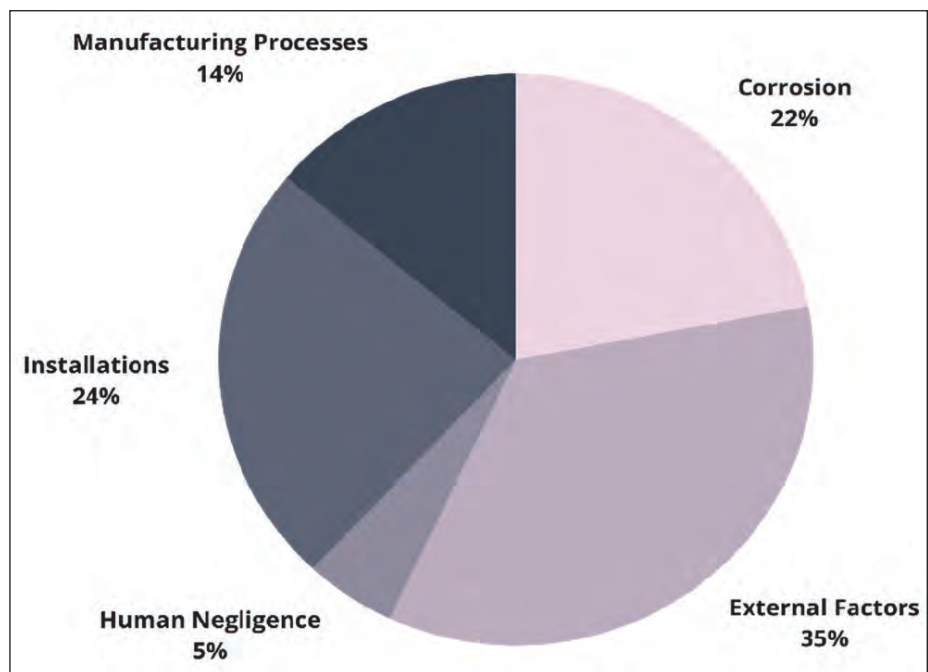


Table 1



Image 3: Pipeline leak detection Dunearn Road, Singapore

can only be detected after a longtime, since water networks are often in accessible, along a network of the management operations and nonstop cost effective distribution of water resources within a water distribution system require an effective decision support strategy.

Leak Detection Technology using Radar

The radar technology originated during war is being applied throughout the globe. Radars used to monitor enemy missiles, have all weather, vegetation penetrating and ground penetrating capabilities, covering a broad range of microwave and radio wave electromagnetic spectrum.

Satellite based synthetic radar can be used to detect ground objects and discriminate objects such as urban areas, water bodies and vegetation Project Jalashaya is a combined effort between Aumsat Technologies LLP, iSenses Incorporation Private Limited and Oceo Water Private Limited with a vision to bring down global non-revenue water pipeline losses by a tleast 25%.

Project Jalashaya

Jalashaya provides Precision driven, AI-enabled,

Satellite-based hydroanalytics for detecting, predicting and forecasting pipeline water leaks. Unlike traditional costly and time consuming survey methods, we are able to provide water leak analytics without physically being present on the field thereby reducing the cost of water utilities by 80%. Jalashaya evaluates the dynamic interactions between land, water and air to determine the best possible spot for locating pipeline water leakages.

We have unique features allowing clients to visualize interactive maps with simple, user friendly, digitally deliverable, remotely accessible analytics of different aspects of water leaks like the leak trend, location, flow, direction, area, etc. CaseStudy1: Victoria Docks, Mumbai, India In order to develop a proof of concept, we were able to detect the exact location of pipeline leak on16th February 2021 at Victoria Dock, Mumbai. The results matched the findings of the ground action team of Brihanmumbai Municipal Corporation.

Case Study2: Dunearn Road, Singapore Pipeline leaks are strictly monitored by the Public Utilities Board in Singapore using acoustic, sensors,

IoT sensors, listening sticks and noise loggers. Nevertheless, leaks were detected on 20th September 2019 due to construction activities. Jalashaya was able to detect the position, size and dimension of the leakage using remote sensing observations.

Conclusion

Population, urbanization, and water scarcity are on the rise again and Climate Change continues to affect millions of people today. Public investment in water management requires much greater support and increased investment in water infrastructure. Incorporating our solutions into the system would improve basic socio-economic and water demand and supply by enabling an equitable distribution of water resources due to more accurate water pipeline leakage forecasts and more precise assessment of Non-revenue water losses.

Benefits of Space Remote Monitoring:

- ▶▶ Synoptic view of an entire water system in a single screening.
- ▶▶ Minute leakages of 0.1liters per minute are

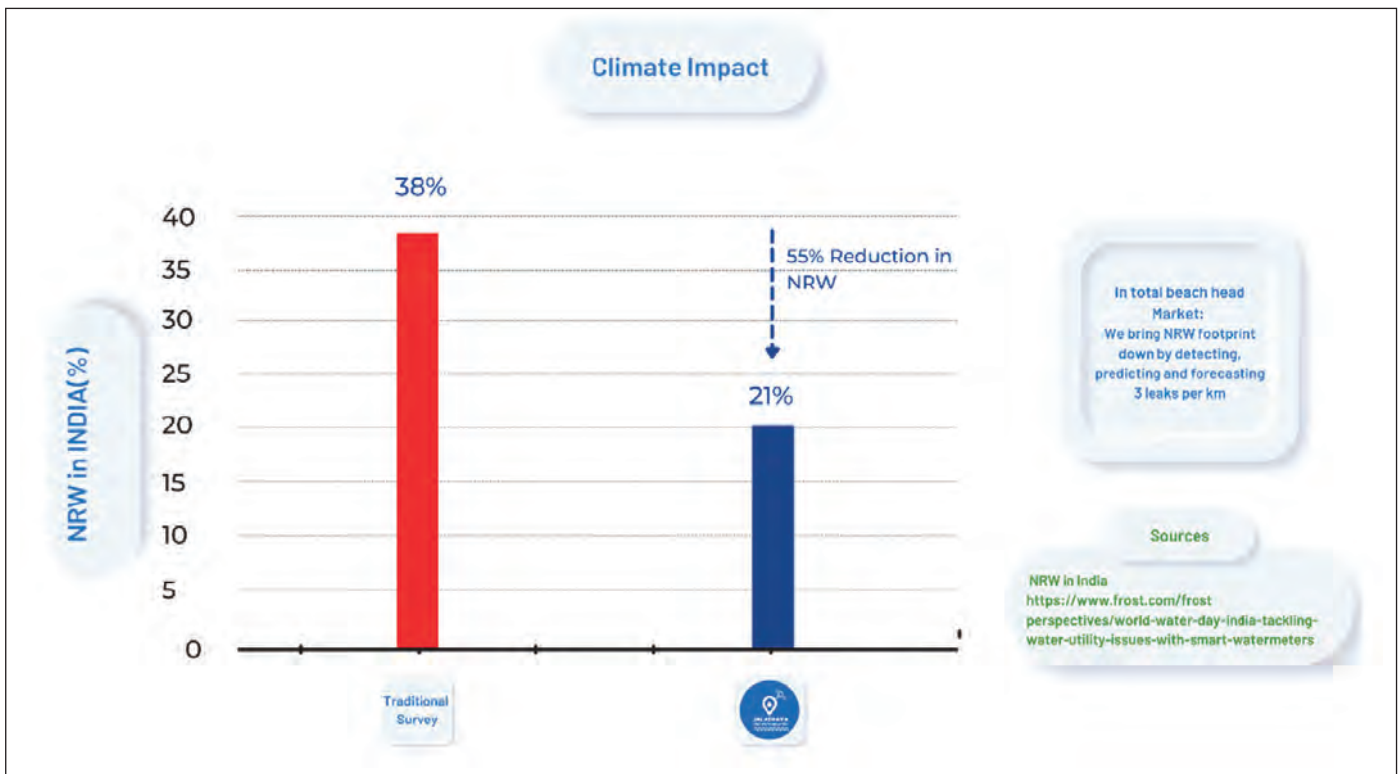


Image 4: Climate Impact by reduction in NRW losses

detectable.

- » Inter operable solution with existing SCADA system.
- » 40 years of satellite data available for leak detection model analysis, validation and data archival.
- » No Capex cost associated with Jalashaya program. No replacement to existing infrastructure required digitally delivered remote solution.
- » Jalashaya program is most effective at reducing NRW, both economically and logistically.

About the Authors

Riddhish Chetan Soni is the CEO, Aumsat Technologies LLP. He has 7 years' experience in Satellite Technology and Applications. He has worked with UN, ISRO and Chandrayaan 2 Lunar Mission.

Karan Behar is the Technical Head, iSenses Incorporation Private Limited. He holds a US patent in object detection. He has 12 years' experience of working with Google, JP Morgan Chase USA, DRDL, Agni Missile Labs.

Vikram Gulecha is the Co-Founder, Oceo Water Private Limited. He has been awarded for Innovation in Drinking by Prime Minister of India and Prime Minister of Israel.

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WASTEWATER TREATMENT HOLDS THE KEY TO MAKING INDIA A WATER-PLUS NATION

By Mr. Arun Lakhani, Chairman & Managing Director, Vishvaraj Infrastructure Ltd



While the world continues to fight COVID-19, there is another long-term existential threat that requires equally urgent global attention. Climate Change is intensifying, and it is exacerbating water stress across the globe, thereby endangering the lives of millions. Water availability is becoming less predictable in many places, and increased incidences of flooding threaten to destroy water points and sanitation facilities and contaminate water sources.

The situation in India is quite critical. India has the dubious honor of being the world's 13th most water stressed country in the world and has more than three times the population of the other 17 extremely highly stressed countries combined¹. With nearly half of the country's

population facing severe water duress, there is an urgent need to implement more sustainable practices to strengthen water management and achieve the 2030 SDG Goals on clean water and sanitation. Left unchecked, the rising population and growing industrialization will deepen the demand-supply water divide, which in turn will impact livelihoods, aggravate food insecurities, and increase water pollution. By 2030 the country could face severe water shortages when the demand is expected to outstrip supply by c.100%².

For far too long, the world has observed a linear approach, which assumes natural resources to be abundant and has followed a take-make-dispose model. Now, countries are moving towards



a circular economy approach to mitigate the pressure on finite resources. The shift to a circular economy will reduce the dependency on natural resources by following a reuse–recycle concept. With India's annual per capita water availability already falling below 1,500 cubic meters and fast approaching the official water scarcity level of 1,000 cubic meters, applying this paradigm shift in outlook to water management is not only a civic necessity but also the only solution to avert a major humanitarian crisis in the country.

Nearly 80% of the water that is supplied to cities and towns comes back in the form of sewage; this is too high a volume to be ignored. Given the rate at which natural water resources are depleting, adopting a circular water economy will enable cities to diversify their water sources in a cost–effective manner and, ultimately, also help minimize economic losses. This opens up avenues for cities to build resilient water systems alongside opening up additional revenue streams. As an example, the byproducts from wastewater treatment can be used to create fertilizers or generate energy which can generate financial benefits.

Treated water can be well used for varied non–potable purposes such as watering public parks, construction work, and industrial use in power plants, paper mills and manufacturing units. This will reduce the burden on existing resources and make cities self–sufficient in terms of water needs. Nagpur, for example, is one of the first Indian cities that has already taken steps towards being water–secure. The Nagpur Reuse Project focuses on treating nearly 200 million litres per day (MLD) of sewage and treating it for reuse. In turn, this allows 200MLD of fresh water to be released for consumption by citizens and secures city's additional water requirement for the next 25 years.

While this is a start, the magnitude and complexity of water challenges requires collective action from all fronts. As governments actively explore methods to conserve and reuse water by redesigning water systems, private players also need to step in and play their part for this to be a success. A strengthened wastewater treatment and management industry offers a high value



proposition for the entire country. This can be a promising investment opportunity if the role and objectives of all players are clearly laid out and an ecosystem of trust is created between the private and public players. Establishing a market for treated water will enable India to secure a fast–paced economic development while ensuring the society's wellbeing at the same time.

This onus, however, goes beyond the private and public sector. Water stewardship efforts are meaningless without the support of the largest stakeholder group – people. As agents of change, people can play an integral role in driving projects forward whilst managing the equation between demand and consumption. Yes, the transition won't be easy but it is not impossible. Cities like Cape Town have already set the precedent. Within days of the Day Zero deadline announcement, the public took it upon them to be more water–wise. This changing attitude and behavior from the public towards water consumption played a central role in enabling the city to avert its Day Zero deadline. Two years later, recycling and reuse are not just concepts to the city's residents but inherent practices.

The growing scarcity of water resources will see treated water becoming a primary source for industrial and other commercial uses and promoting its usage will require a combined effort from all stakeholders. Implementing customized treatment and reuse solutions that address local water challenges and progress mapping to measuring impact calls for a 4P (Public, Private, and People Partnership) model to ensure that projects are attuned to diverse needs and are

sustainable in the long run.

Under the able guidance of our Prime Minister and the Jal Jeevan Mission program, five crore households in India now have water connection and tap water is reaching every household in about 1.25 lakh villages. With the Union Government working towards providing every household with access to piped water by 2024 under the Jal Jeevan Mission, emphasis on sustainable water management through wastewater treatment will secure supply of clean running water in the taps for all future generations. By adopting this model, India can drive measurable improvements in water self–sufficiency and become “sujalamsufalam” once again.

About the Author

Mr. Arun Lakhani is a technocrat and a Social Entrepreneur. VEPL is pioneer in India's largest PPP (2.7 million population) in 24x7 water supply project” and also the largest PPP (200 MLD) in Sewage treatment with reuse in Nagpur. He believes in adding fourth P – “People” to PPP model in water sector. VEPL is in GWI's top 50 water companies in the world.

He has advised NITI Aayog on Water Sector and Ganga Cleaning from time to time. He is President of Maharashtra Badminton Association and Vice President of Badminton Association of India. He is also President of a trust which operates 700+ single teacher schools in heart of tribal belt in central India.

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NEW GROUNDWATER GUIDELINES FOR INDUSTRIES & SMART WATER MANAGEMENT TECHNOLOGIES

By Vinay Chataraju, Co-Founder & Head Business, Kritsnam Technologies Pvt. Ltd.



current guidelines are 1) Annual Water Auditing for industries consuming more than 100KLD 2) Industries have to adopt suitable methods to reduce water consumption by 20% in 3 years 3) Installation of tamper proof flow meters with telemetry at groundwater abstraction structures 4) Hydrogeological and impact assessment report have to be submitted for projects drawing more than 100KLD in OCS areas.

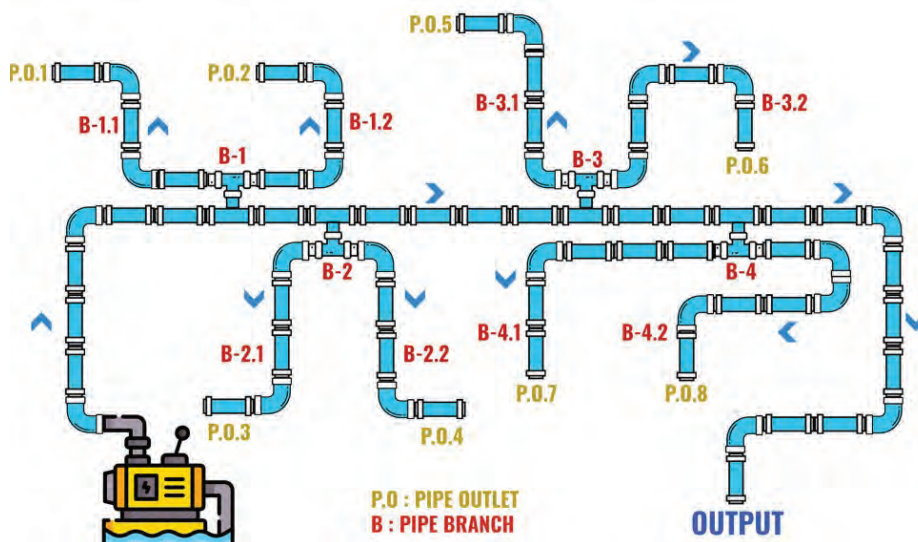
Though it may sound like a big deal for industries to reduce water consumption by 20% in 3 years, our experience says that it is practically possible to reduce the consumption by 20% in 3 years just by disciplined and informed usage of water without changing the major infrastructure.

Many manufacturers/industries don't have the information they need to manage the water that flows through their processes—information that is critical for improving productivity. Technology providers are starting to develop products that can help these industrial companies improve the way they track their water usage and monitor their progress. Until now water management in India is majorly a guesswork based on heuristics. Most of the bulk water users including government departments are yet to adopt appropriate scientific methodologies for managing fresh water. The future is data driven intelligent decision making to support water security and sustainability.

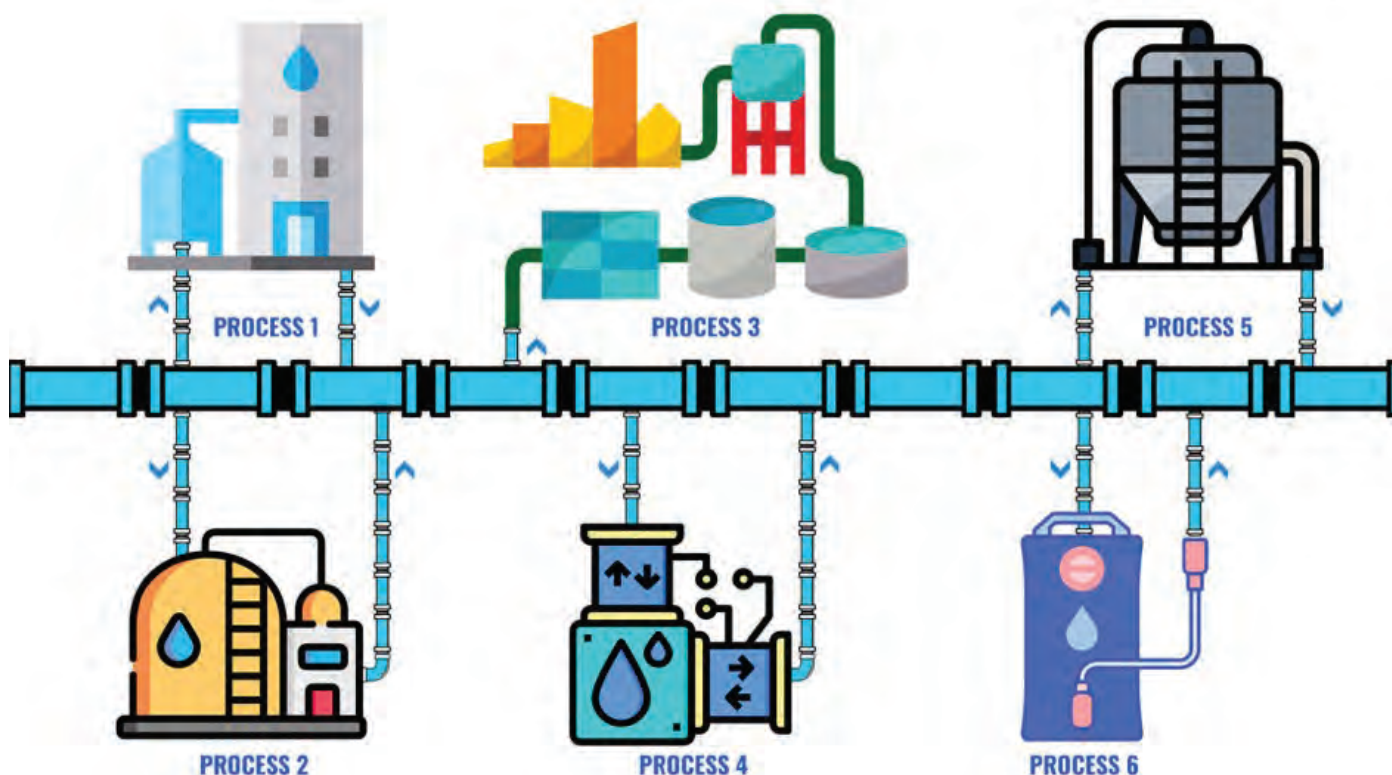
Collectively as a nation, starting from household

With the rapidly depleting groundwater table, NGT has passed orders for strong regulations on effective usage of groundwater especially targeting bulk water users such as industrial, commercial and bulk housing. After much discussion, Central Ground Water Authority (CGWA) released a gazette notification on 24-Sep-2020 with guidelines for groundwater extraction for industrial and infrastructure projects. Though the guidelines exempted projects drawing less than 10KLD from taking an NOC, there has been increasing pressure on CGWA not to dilute the regulations.

The current guidelines clearly indicate the regulations are going towards efficient and sustainable usage of groundwater for commercial purposes. Some of the outstanding moves in the



Modelling the entire pipe network



Segregating the batch processes for an industry type

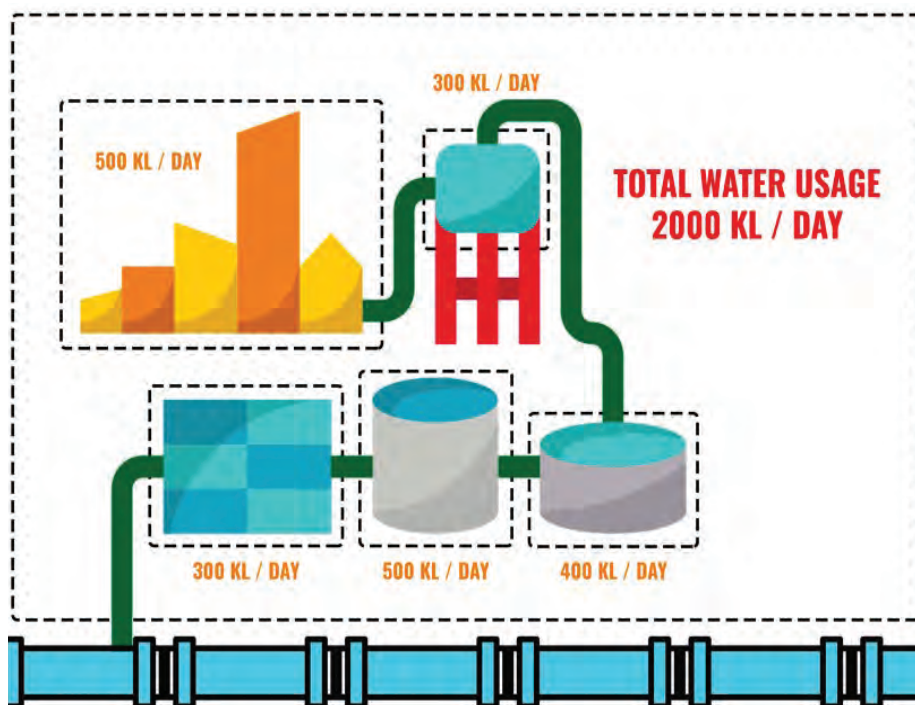
water management to managing large water systems such as rivers and reservoirs should increasingly adopt data-driven water resources management techniques for effective use of our precious freshwater resources.

We at Kritsnam Technologies have engaged in extensive R&D for the past 7 years to solve our local problems in deployments, measurements and data usage. We have developed a suite of reliable IoT enabled instruments to remotely track the water levels and flow. The real-time level and flow data from these instruments is easily accessible to the users, right at their fingertips through SMS, WhatsApp, Web & Mobile apps.

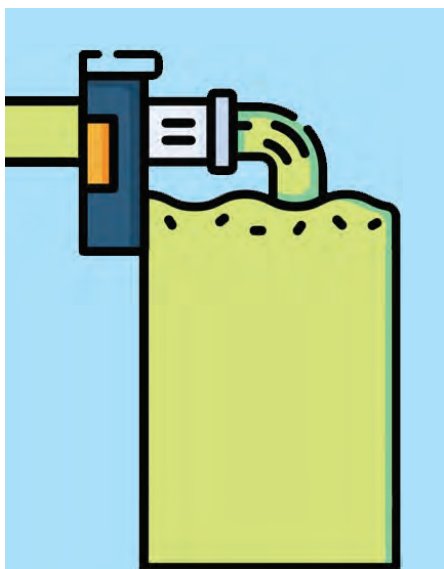
Continuous internal water auditing system

Why should industries opt for Continuous internal water auditing system?

- ▶ Potential to reduce up to 20% fresh water extraction in 2–3 years (As per CGWA guidelines)
- ▶ Monitor the actual cost of water associated

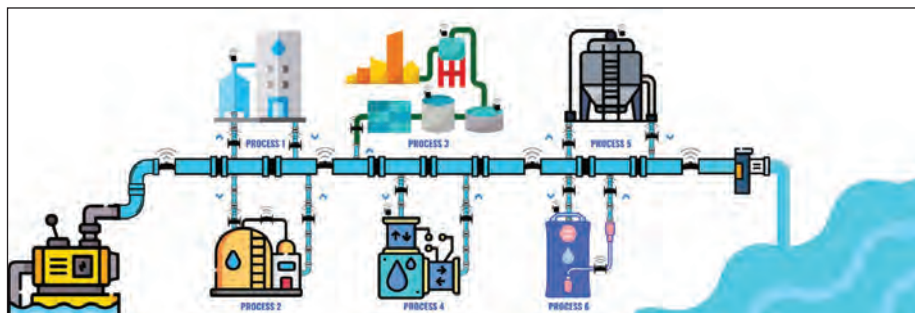


Estimating the optimal water requirements for each process and sub processes

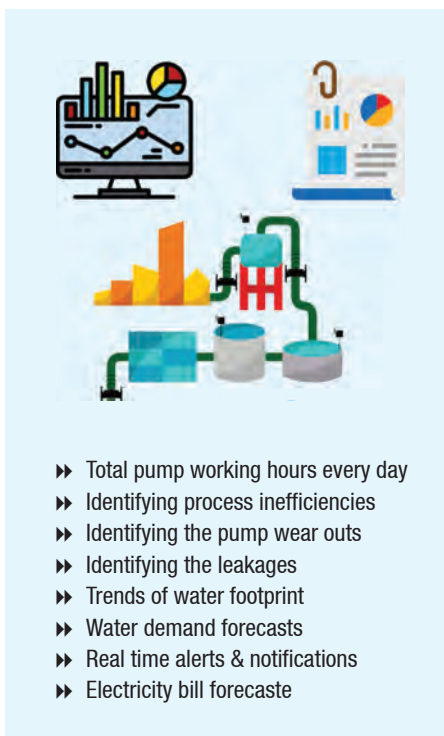


Testing the re-usability of the output water from each process exit

- » pH
- » Electric Conductivity
- » Dissolved Oxygen
- » Turbidity
- » Anions
- » Cations



Ultrasonic flowmeters and level meters to track water distribution continuously and transmit the data online



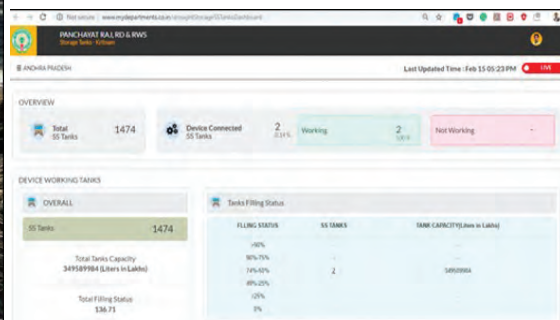
- » Total pump working hours every day
- » Identifying process inefficiencies
- » Identifying the pump wear outs
- » Identifying the leakages
- » Trends of water footprint
- » Water demand forecasts
- » Real time alerts & notifications
- » Electricity bill forecaste



Alerts on WhatsApp/SMS



Dashboard with graphs



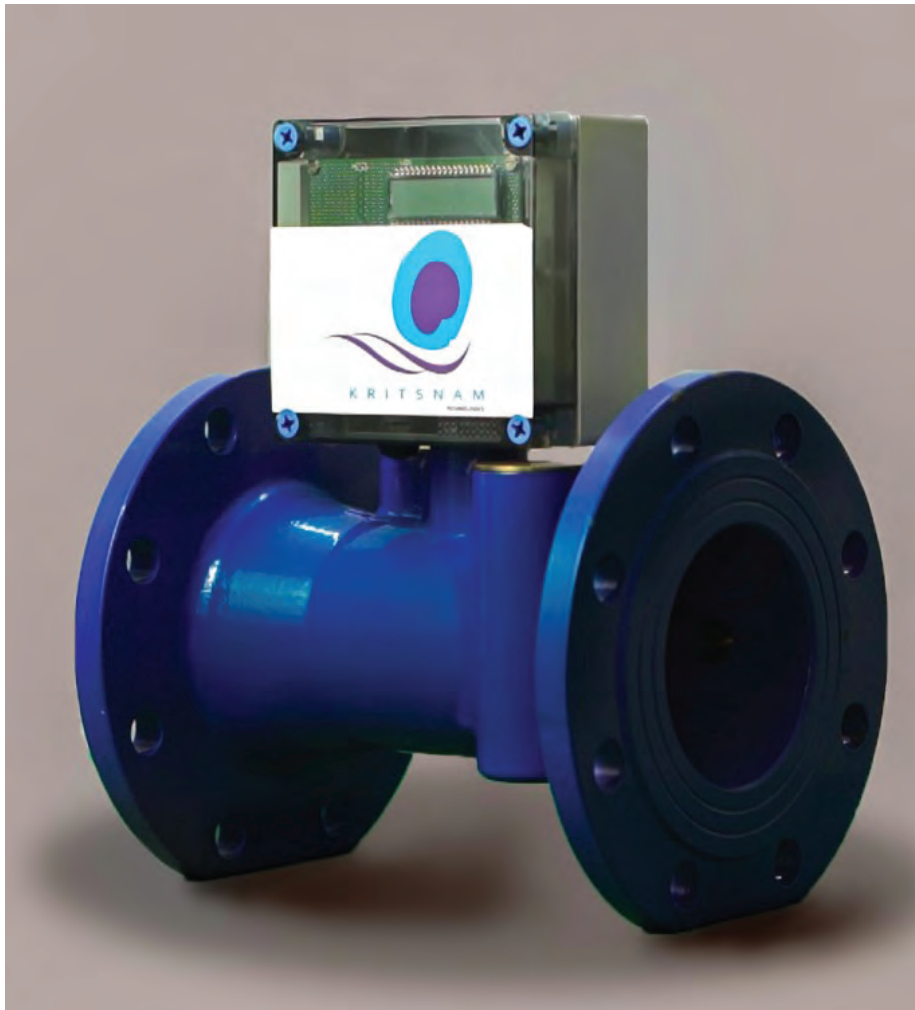
Integration with ERP and other dashboards

with the product unit economics – pumping, storage, treatment

- » Track the inefficiencies in water use, reduce water wastage and improve organically
- » Regulate the load on ETP's
- » Improve batch to batch product uniformity and product quality
- » Be ready for ISO 46001 standard
- » Prepare for upcoming stringent regulations on water usage

What are the steps involved in Continuous live internal water auditing system?

- » Digitising the pipeline network from source till reject
- » Identifying the different processes from fresh water input and waste water output
- » Benchmarking the average water requirement per process
- » Analysing the output water quality for every process
- » Indicating the strategic representative points to measure the water quantity in real-time
- » Installation of flowmeters in the pipelines and level meters in the storage tanks
- » Calculation of water usage per process and deriving advisories for water reduction
- » Daily reports on total water usage and water costs, per process water usage and costs, identification of processes consuming more water than required etc.
- » Weekly, monthly and yearly reports on water usage patterns



Dhaara Smart Ultrasonic Flow Meter by Kritsnam Technologies

About the Author

Vinay Chataraju is the Co-founder & Head Business at Kritsnam Technologies which is a spinoff from IIT Kanpur research and innovation centre working on sustainable water management solutions. Through a suite of IoT enabled hardware and data analytics solutions, Kritsnam envisions to drive the freshwater management through scientific and data backed approach.

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TECHNIQUES TO 'SAVE WATER' IN THE EXISTING COOLING TOWERS

By Dr. Jagjit Singh Sehra, President, CST Associates



Today we find new challenge of water that is being used in the cooling tower. In my previous article we have discussed how power industry evaporates nearly 2900 liters of water while producing 1 Mega Watt of power. Since the alternative methods of using Adiabatic Cooling towers have been discussed in my previous articles, which require huge investments.

Right now, industry all over the world is passing through the time times because of Corona. Currently companies are very much scared to go in for the huge investments. But on the other hand, we have great challenge of environment which needs to be taken care to avoid further damage to our 'Great Mother Earth'.

At this movement need on an hour is to provide a solution to the power industry & air conditioning

industry that can save great amount of water by adding certain or modifying their cooling tower.

Controlling the Fan Speed

Most of the contractor companies while doing bidding don't consider installing the VFD on their cooling towers. There can be any reasons for the same. One the reason is the cost. But they forget how much harm they are doing to the environment by not doing so. We are already losing billions of liters of water in the cooling tower because of this worldwide. This needs to be control immediately & governments should bring this as a mandatory law in order to save the environment. This will ultimately help everyone.

As discussed in my earlier articles as the world population increased the required for the power and air conditioning also increased which resulted into more and more waste of water because of open cycle cooling towers. If this water is saved millions of people can take benefit from the save.

Let us understand the concept by taking an example of the power plant first and then for the air conditioning.

Water Saving in the Open Cycle Cooling Towers used in the Power Plants

In the thermal power plant maintaining vacuum is very important for the steam to follow smoothly. Normally the cooling towers are designed maintaining the water outlet temperature (from cooling tower) as 32 Deg.C & return temperature of 42 Deg.C. This is the design condition which is required even at the extreme ambient air

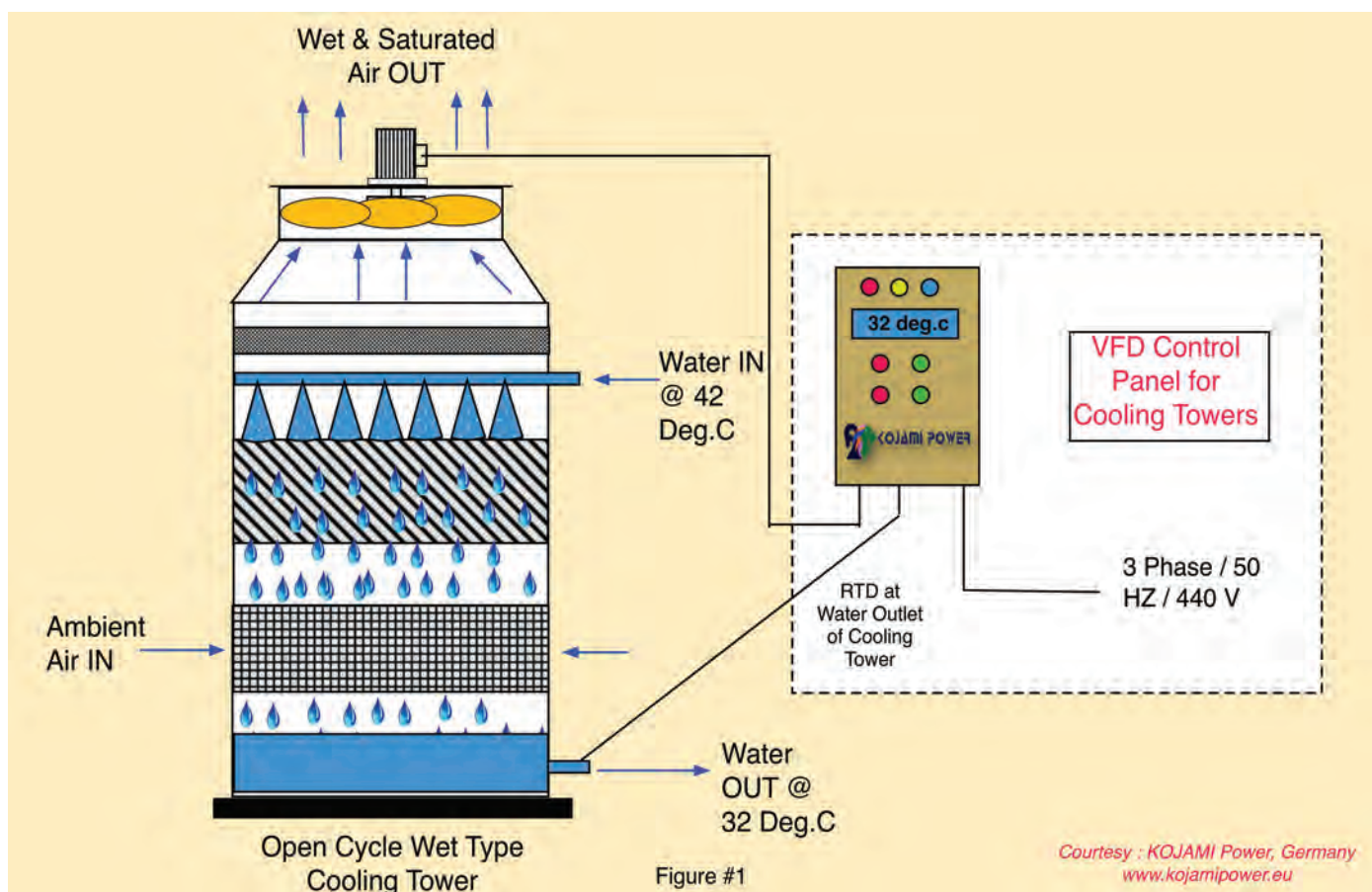
condition. Since the cooling tower water is directly cooled by using the ambient air, therefore we must have a device which reads the ambient temperature and adjust the requirements as per the ambient temperature.

Different zones on our plants have different air temperature profiles. Also, the air temperature keeps on changing every hour. For example, in the extreme summer we may touch a temperature (DB) of 50 Deg.C in the day time, but on the same night the temperature (DB) can become as low as 30 Deg.C. In this case if the cooling tower do not adjust to the new temperature, then there is a great wastage of water. Since the cooling towers are selected and design considering the maximum ambient air wet bulb temperature & on the concept of A. Which is Water outlet minus the Wet bulb in temperature. Lower the A, higher will be the size of the cooling tower & higher the A, lower will be the size of cooling tower.

Another factor of the selecting the cooling tower is LG ratio. Which is maintained as 1.5 in most the cases. Now if the fan speed is fixed all the time, then we will have problem of water being over cooled in the lower ambient temperature and becoming hot over the higher temperature.

So, at this point if we have a VFD (Variable Frequency Drive) in between the Fan & the supply then the fan speed will keep on changing with the variation of the ambient temperature.

Coming back to our our example we require 32 Deg.C at all the times. When ambient temperature goes higher then let us say 50 Deg.C DB & 27



Deg.C WB the fans will run at the full speed. As the ambient temperature comes lower and lower than the fan speed will come down gradually. A temperature range of 32 Deg.C will be maintained all the time.

This can be clearly seen from the above Figure #1. This kind of VFD Panel boxes is not readily available in the market. After doing research it was found a very few companies like Kojami Power, Germany offers such kind of product. This can be brought in India through their agents. For more details on the company, you can visit their website as www.kojamipower.eu. The readers can also explore few more sites.

How Does the System Works?

The panel consists of three major components, One is the VFD, which varies the fan speed as per the linear approach, second is the PLC which is connected to the third component called RTD. The RTD reads the outlet water temperature of the

cooling tower. This feeds the signal to the PLC, which sends the signals to the VFD to adjust the speed by adjusting different frequencies.

We can set the water outlet temperature present on the HMI screen. The system when starts read the water outlet temperature, suppose we set it as 32 Deg.C & PLC reads that this is 38 Deg.C. The speed of the fan will automatically increase this bringing the temperature at 32 Deg.C. Once the temperature is achieved then the fan will run a constant speed to match the water outlet temperature. In the similar fashion if the temperature at the outlet is lower than the fan speed gets slow till the set value is achieved. This is so simple and easy to use.

Benefits of this system:

- **Saving of Water:** Since the cooling towers are designed at the optimum capacity, which is for few days in a year. So, reducing the fan speed means that we are also controlling the

blow down losses. Which is a direct saving.

- **Saving of Power:** We also save on the power as the motor current drawn decreases. Thus, power required to run the cooling tower is decreased. Which is a direct power benefit in terms of revenue. Like they say penny saving is penny entered.
- **Savings on the life cycle of components:** When the motors and fans are not running at the full speed at that point the life of the moving component is also increased thus saving on the regular replacement cost.
- **Maintenance Cost:** Since the cooling tower will not be operating at 100% designed capacity it also decreases the scale formation in the tower. Which in turns saves great amount of cost that incurred on chemicals and man power.

How much quantity of water can be saved ?

This is a very broad question it is not easy to work

out how much water will be saved. But these can very easily be calculated on the case-to-case basis. While calculating the water quantity to be saved, we need to consider the following parameters.

- » Weather it is a new cooling tower or a retrofit?
- » What is the temperature profile for the 8760 hours in a year?
- » What the cost of water & power in the area?
- » Application where cooling tower is installed.
- » Size of the cooling tower in terms of the capacity.

These are the few parameters that need to be studied while working on the project.

An advice to the Pollution Board or Ministry of JAL Shakti in India

Large Buildings

As we are facing the water problem in almost all every city, where large building is run the air conditioning systems with the water-cooled chillers or VAM's. It is advice to make this product mandatory so that the Huge amount of water can be saved.

Industries

Industries that use the open cycle cooling towers to cool the machines, should be also advised to install these units so that the water usage can also come down. This will further help to maintain the water level on a large way.

Power Plants

Power industry which depends so much on water and also consumes great amount to water should

also be advised use this product as mandatory so that we can run the plants efficiently. It will also give benefits to the power plants as the power that they save from cooling towers can be sold to the consumers thus bringing extra revenue.

Next Article

In the next article we will give some light on how we can convert the sewage water that we can use for the cooling towers.

About the Author

Dr. Jagjit Singh Sehra's life was moved by two personalities, one Sikh's first Guru Nanak Dev Ji & Other Dr. Abdul Kalam, ex-President of India. Guru Nanak Dev Ji wrote a shalok in Japji Sahib 'Pawan Guru, Pani Pita, Matta Darat Mahat', which means Air is teacher and water is a father and they both are nurturing mother earth. Till mankind takes care of these resources nothing will happen on earth.

Dr. Abdul Kalam wrote a letter on 'Save Water'. In this letter Dr. Kalam, imagined a son who writes a letter to his father in the year 2070. Where he explains how bad is the situation of drinking water. It is not a letter, but this is a warning, that we cannot misuse the water. You can see this letter in the form of a beautiful video on Youtube.

The time has come when we need to blend laws of Physics and Law of Nature and give solutions to the world how to save water and air. Humans are searching for life on other planets, the first things they look for are water and air. But on our own planet, we are misusing both. Everyone on this planet is for a short span, we need to educate the people to save the natural resources that have been given free to us. As responsible citizens of the global village, it is everyone's responsibility to take care of these natural resources and handover a clean environment for the next generation.

Dr. Jagjit Singh Sehra invites people to join him and help companies and farmers both to grow if you feel that you can contribute more on this mission please contact him at deepak.chaudhary@eawater.com

EverythingAboutWater

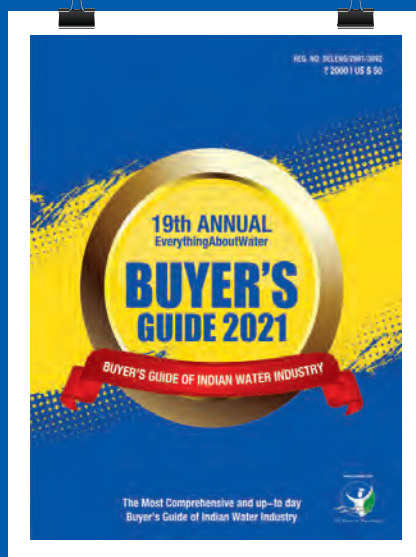
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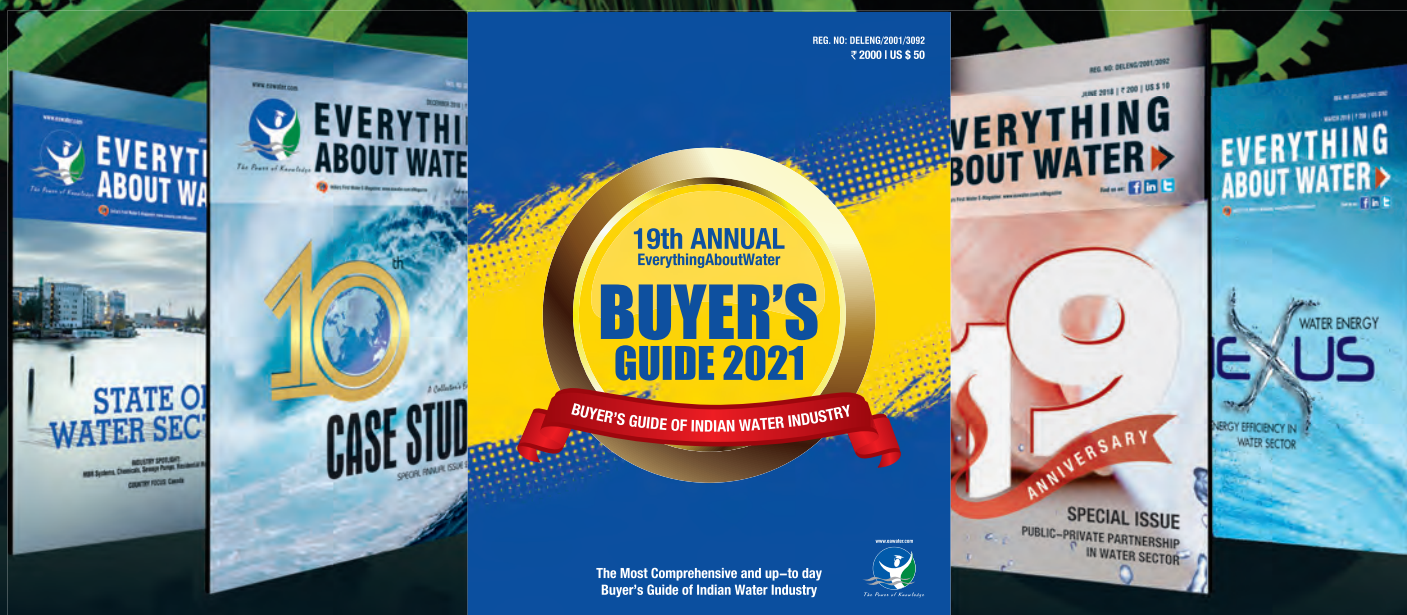
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HUNTER WATER TRANSFORMS HOW IT WORKS AND SEES SIGNIFICANT LEAKAGE REDUCTION FOLLOWING DIGITIZATION

By TaKaDu, Israel



Background

Hunter Water is a State-Owned Corporation (SOC) providing drinking water, wastewater, and recycled water services to almost 600,000 people in the Lower Hunter region, north of Sydney, Australia. From its earliest days in the 1880s, Hunter Water, like the region it serves, has grown greatly. Today, it manages more than AU\$2.5 billion worth of infrastructure, including 10,000 km of water and sewer mains. The utility notes that it is constantly looking for new ways to provide great services, enable good development and be a thought leader.

Clear goals for transformation

In 2016, Hunter Water developed a new long-term strategy to improve management of infrastructure, enhance customer experience, reduce water losses and become a more resilient organization. As part of this strategy, in 2018 Hunter Water selected TaKaDu Central Event Management (CEM) system to monitor and assist with reduction of water losses in the area.

As Hunter Water forged ahead with its long-term strategic program, including integrating the TaKaDu solution, the utility understood that it needed to adapt its operations. It set clear goals for developing its people, processes and technology – commonly known as PPT transformation.

In terms of people, Hunter Water aimed to increase collaboration across business units, foster continual learning and innovation, and, importantly, maintain a clear focus on the customer.

In parallel, Hunter Water wanted to develop new processes that would allow for flexibility and resilience in the face of a changing environment. It also aimed to institute new processes that would improve the accuracy and consistency of the network's various data sources.

Regarding technology, Hunter Water wanted to nurture its appetite to take risks in the name of innovation and technology, to adopt new technologies and gain the full benefits of digitization across its operations.

Organization and process changes drive collaboration



As a first step in changing its organizational structure, Hunter Water created a core Non-Revenue Water (NRW) team, assigning a Business Lead to coordinate all NRW activities. Team members were assigned new roles to manage and operate the TaKaDu CEM solution. The utility's active leak detection managers were integrated into the NRW team, and new team members were

added to develop, deliver and commission new District Metered Areas (DMAs). As part of this, Hunter Water invested in training team members and developing the in-house skills needed to create new DMAs and manage the TaKaDu system.

Hunter Water then worked to create a broader and more integrated NRW team by developing





processes for input and collaboration from other groups within the organization, including GIS, SCADA, Asset Information, Planning, and Billing.

It established new processes and procedures to facilitate the input of data into the TaKaDu system, address data discrepancies, and process events generated by the system. In parallel, priorities were defined for following up water loss events identified by the TaKaDu system and for targeting leak detection activities.

Additionally, Hunter Water introduced new processes to validate asset configuration and populate consistent asset data across business systems. The water utility also refined procedures to standardize the creation of new DMAs as well as specifications for flowmeters and data transfers.

Technology and network changes, supported by new procedures

As Hunter Water continued to integrate TaKaDu in its network management operations, it redefined DMAs based on best engineering practices. It modified the reflection of their water network

through TaKaDu for smoother data configuration and input and created automated routines to update the TaKaDu system from the live SCADA system. The changes were reinforced through business processes, procedures and templates to ensure consistent data inputs from DMAs into the TaKaDu software.

Transformation driven by adoption of TaKaDu

At time of writing, three years after beginning to work with the TaKaDu CEM solution, Hunter Water has made great strides towards its goals for transforming its operation and gaining the benefits of a digital network. For example, according to the National Performance Report for 2019–2020, water leakage in the Hunter Water supply area is down by 34% compared to 2015–2016.

TaKaDu is used to monitor areas and to prioritize leak detection work across the water network, providing Hunter Water with a management tool that complements the SCADA alarm and monitoring system. As a browser-based solution, TaKaDu reports and insights are always available to anyone in the organization, no matter where they are.

With 24/7 monitoring and a dedicated, automated system collecting and analyzing all the data, Hunter Water now better understands the performance of its DMAs and Pressure Management Areas (PMAs).

Dean Palmer, NRW Business Lead, noted that “TaKaDu is enabling us to transition from a leak detection approach based on suburb and rate of rise to a more effective and efficient method based on DMAs and water balancing. We also see that TaKaDu has the potential to help us reduce and control non-revenue water. It adds real value to our asset management system.”

Next steps: more integrations, more control

Building on its success so far with implementing TaKaDu and developing its people, processes and technology, Hunter Water is now gearing up for the next steps in its transformation strategy.

It plans to expand DMA coverage by adding newly established areas into the system, validating

existing PMAs and adding new ones. Additionally, Hunter Water plans to monitor other attributes of its water and sewerage network, such as pressure, chlorine levels, temperature, and vibrations in the pipes.

Hunter Water already requires that all stand pipes (portable hydrants for filling water carts and tankers) be metered, enabling it to charge for external water use. Going forward, Hunter Water will investigate importing the data from these smart standpipes into TaKaDu, to monitor external consumption and reduce unauthorized water usage.

The water utility also plans to investigate integrating TaKaDu with additional enterprise systems. It is currently looking at integrating TaKaDu with billing data to enable mass balancing across its network. Hunter Water will also look into linking TaKaDu to its new Operation and Maintenance system once it has been commissioned.

About the Author

TaKaDu (www.takadu.com) is a global leader in Central Event Management solutions for water utilities. TaKaDu's cloud-based service enables utilities to detect, analyse and manage network events and incidents, such as leaks, bursts, faulty assets, telemetry and data issues, operational failures, water quality and more. TaKaDu acts as the central management layer for all network events detected by its own data analytics engine and other external alerting systems (e.g. acoustic loggers, sensor alerts). TaKaDu is integrated with other IT systems (e.g. GIS, work order, CRM, call center and asset management), as well as being part of a comprehensive Smart City solution.

Converting raw data into knowledge using big data analytics and algorithms, TaKaDu provides visibility and actionable insights for increased efficiency, water loss reduction and improved customer service. A cloud-based SaaS platform, TaKaDu brings together huge amounts of information in an easy-to-use, flexible and scalable solution. TaKaDu's IoT solution is operational 24/7 in leading water utilities in 12 countries.

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CASE STUDY ON NRW MANAGEMENT THROUGH IMPLEMENTATION OF DMA IN NETWORK

By Rudranarayan Kumar, Chief Manager and Devipriya Rout, Executive, Business Development, Swach Environment Pvt Ltd.

Overview

Non-Revenue Water (NRW) is a burning issue with water supply utilities in India, which includes both physical and commercial losses and free authorized water for which payment is not collected. One of the major issues affecting the Indian water utilities is the pronounced difference between the amount of system input volume (SIV) into the distribution system and the amount of water billed to consumers, which is the NRW. Average NRW in India is around 38%; just above the global average range of 30% to 35% reported by the World Bank.

Mexico having 51% and Denmark at 6% of recorded non-revenue water, represent the two extremes. An emerging challenge in many utilities is pinpointing the breakdown of NRW components and sub components, which makes it burdensome in order to point out the necessary course of action to reduce NRW.

There have been developments in several technologies to reduce NRW such as leak detection technologies, Smart Metering, IoT enabled Digital Network Management, DMA based monitoring system etc. However, their adoption in India has been sluggish, primarily due to the limited revenues that municipalities generate, secondarily inability of personnel to cater eco system development. With privatization along with the urbanization on the rise, many water utilities

are supposed to deploy leak detection systems to improve water networks and reduce NRW.

Smart Water Meters (Advance Metering Infrastructure-AMI) paving way for the Digital Transformation in the Indian Water Utility Sector. Emerging technologies such as IoT-based Smart Water Meters have been very effective in curbing huge water loss and reducing NRW globally. Smart meter also favors in dynamic water billing & identifying consumption pattern of individuals

which leads to efficiency & effectiveness of the system.

AMI system would drastically reduce time spent on billing as compared to the manual work; this helps the short-staffed water utilities to focus on critical roles such as improving system service to house connections and considering predictive analytics for improving system efficiency.

The increase in revenue generation for water

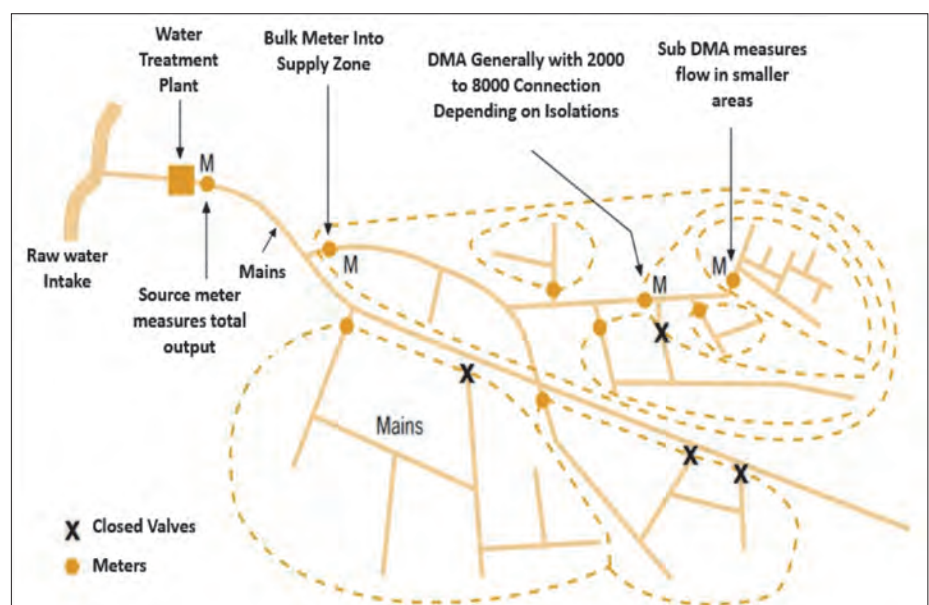


Figure 1: Typical installations in DMA command areas

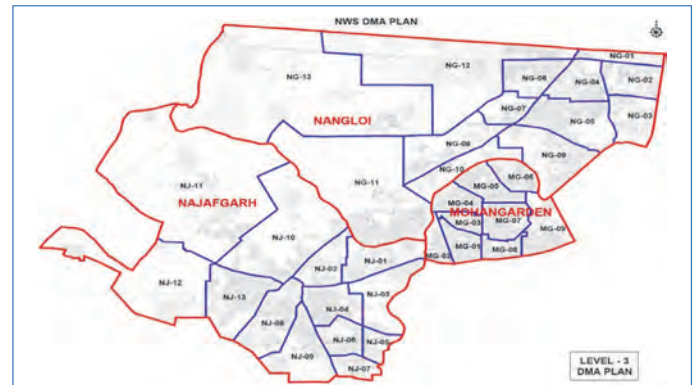


Figure 2: Proposed area at Nangloi WTP, Source: ©Nangloi Water Services Pvt Ltd ³

utilities through enhanced water conservation, billing efficiency and resource optimization, are the key drivers of the AMI market in India. Government drives, for example, the Smart City projects are additionally spurring interest for shrewd water meters.

There is a consistent rise in demand for IoT-based Advanced Metering Infrastructure (AMI) smart water meters due to its numerous advantages such as real-time data monitoring & smart communication, tamper proof design and accurate measurement leading to reduction of NRW drastically.

A recent Frost & Sullivan analysis reveals that the demand for smart water meter can reach up to 500,000 units by 2025, from 220,000 units in 2019. The smart water meter market in India is forecast to grow at a CAGR of 14.7% during 2019–2025 ².

System Input Volume	Authorized Consumption	Billed: Authorized Consumption	Billed Metered Consumption	Revenue Water
			Billed Unmetered Consumption	
	Unbilled: Authorized Consumption		Unbilled Metered Consumption	
			Unbilled Unmetered Consumption	
	Apparent Losses		Unauthorized Consumption	Non-Revenue Water
			Customer Metering inaccuracies	
Water Losses	Real Losses		Leakage on transmission and/or Distribution mains	
			Leakage & Overflows at utility's storage tanks	
			Leakage on service connections up to Point of customer meter	

Municipal water corporations from Chandigarh, Pune, and Hyderabad have

started to implement Smart Water Meters. Pune Municipal Corporation is in the process of implementing 2,75,000 smart water meters over 3 years starting 2019. Usage of smart water meters by utilities to bill the customers for actual water consumption would encourage people to install individual AMI meters.

Such meters would help them track their water consumption patterns and implement sustainable water conservation methods to reduce water bills. This widens the prospective customer base for smart water meters.

Marketers need to develop end-to-end solutions using cloud-based IoT real-time data analytics to generate more revenues, reduce asset optimization & asset maintenance costs water production costs and reduce energy consumption. The market is supposed to witness a more collaborative approach from different stakeholders such as product suppliers, software designers/developers, and water OEMs to develop such end-to-end arrangements. Software-as-a-Service (SaaS): In the long-term, the water utilities would open up to cutting edge digital technologies such as Big Data Analytics, Artificial Intelligence (AI).

The adoption of advance digital technologies could also assist us in challenging times such as the COVID-19 global pandemic. When social distancing is the need of the hour, digital solutions such as the smart water meters (AMI/AMR) ensure service / business continuity with minimal human interventions.

Reasons for Non-Revenue Water:

- ▶▶ Leakages cause water loss from the pipe network at pipe bursts. The same never be used by customer. Water loss due to leakages therefore affects both the economy and the environment of the utilities by possible nuisances, consequently contributes to necessary waste of resources. Leakages and pipe bursts an occur suddenly or gradually develop over time due to lack of maintenance, corrosion or wear and tear.
- ▶▶ Faulty Meters and In accurate meter reading are also reasons for commercial losses and Non Revenue Water,
- ▶▶ Illegal Connections & Unauthorized consumption
- ▶▶ Water used by utilities for operational purposes, water used for firefighting, and water provided for free to certain consumer groups.

Strategic efforts and Advance technologies

Dividing the supply network into smaller sections e.g. District Metering Areas (DMAs) – is a more efficient technique, wherein it is possible to calculate water losses in each DMA individually.

Several factors are being considered while forming DMAs in an existing network such as number of users or connection, topography, isolation & inter-connectivity, cost of setting up DMAs, slopes & elevations etc.

Leakages can be easily detected through noise loggers integrated in ground level surface boxes, enabling operators to set in exactly when and where needed.

Nangloi Water Services – A Case Study

Overview & Scope of Discussion:

Nangloi Water Services (NWS) work on behalf of the Delhi Jal Board (DJB) and under its direct supervision. NWS is in charge of improvement and revamping of existing water supply system, transmission and distribution network under the command area of Nangloi Water Treatment Plant, as specified in the 15-year PPP contract which was signed last year between the DJB and NWS. This is the largest public-private partnership ever to be formed by State Government of New Delhi in the water sector.

Project Snapshots:

- » Rehabilitation of existing water treatment plant infrastructure
- » Construction/revamp of Booster pumping stations
- » Construction/revamp of Underground Reservoirs
- » Construction of Sludge Re-Circulation System
- » Expansion of Water Supply, Transmission and Distribution Network of 1500 KM
- » Expansion of HSCs (House Service Connections)
- » Creation of DMAs to maintain low NRW (Non-revenue water)
- » Operations & Maintenance of Water-treatment Plant, Booster pumping station, Network Piping for a period of 15 years

Application of DMA techniques at NWS

Challenges being faced:

Unknown Existing Pipe Network Layout, Local Public hindrance in isolating the area. (Fear if the area will be isolated, water will not reach to their houses)

- » Political Hindrances
- » Water Theft & Leakages
- » Improper Operation and Production Management
- » Narrow streets– difficulty in laying/replacing the HCS/Pipelines
- » Zero Billing

DMA Methodology

One of the disadvantage of creating DMAs is the initial setting cost, but if considered the numerous benefits out of them, in long run the savings

achieved will exceed the initial investment with a huge profit margins. The below table shows the typical KPIs of DMAs achieved at Nangloi WTP area.

Performance Benchmarks					
Parameter	Standard	Mohan Garden		Najafgarh Enclave	
		Previous	Present	Previous	Present
Coverage	100%	30%	100%	5%	100%
Per Capita Supply of Water	135 lpcd	70	100	15	110
Extent of Metering	100%	45	60	0	90
Extent of Non-Revenue Water	15%	79	48	Tanker	30
Continuity of water supply	24*7	3 hours	5 hours	Tanker	4 hours
Efficiency in resolution of customer complaints	80%	NA	75	NA	90
Quality of water Supplied	100%	Tubewell	>90%	NA	>90%

Source: ©Nangloi Water Services Pvt Ltd. ⁴

Result:

Below graph shows the effectiveness of incorporating DMA technique at the Nangloi Water Services command area.



Source: ©Nangloi Water Services Pvt Ltd. ⁵

Conclusion:

Water losses have been known to appear in the limelight when talked about Water Management System of India. It has become a need for mankind to work on measures to reduce these losses from water utility system, which play a critical role in efficient resource utilization, resource optimization & resource management.

Where pandemic made us separate in our own ways there are digital technologies that has kept us together in order to eradicate these losses effectively & efficiently. DMAs are highly evolved concept, accepted globally as a standard practice. Creation of DMAs is one of those technologies which has proved its significance through performance benchmarks.

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About the Author

Mr. Rudranarayan Kumar is spearheading the business development activities of Swach Environment Pvt Ltd as Chief Manager – Business Development. He holds a Degree in Mechanical Engineering from Institutions of Engineers, India and an MBA in Finance from Jadavpur University. He is a Chartered Engineer (India) and a Corporate Member of Institution of Engineers (India).

Mr. Kumar has over 15 years' rich experience of successful engagement with various Consulting Firms as well as EPC companies in the field of water and waste water Infra Structure Project.

Devipriya is from Dhenkanal, Odisha and has completed her MBA from KLIT School of Management in the stream of Marketing and Operation. Prior to her MBA, she had completed her B.Tech from Veer Surendra Sai University of Technology in the stream of Mechanical Engineering.

Devipriya is a keen musician and loves singing. She has passion for social causes and devotes her free time for upliftment of under-privileged children. Devipriya has parents in Odisha both working for the Health Department in Govt of Odisha.

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CASE STUDY ANALYSIS & IMPROVEMENTS

By Sumit Kumar, Embassy Services Private Limited.



Executive Summary:

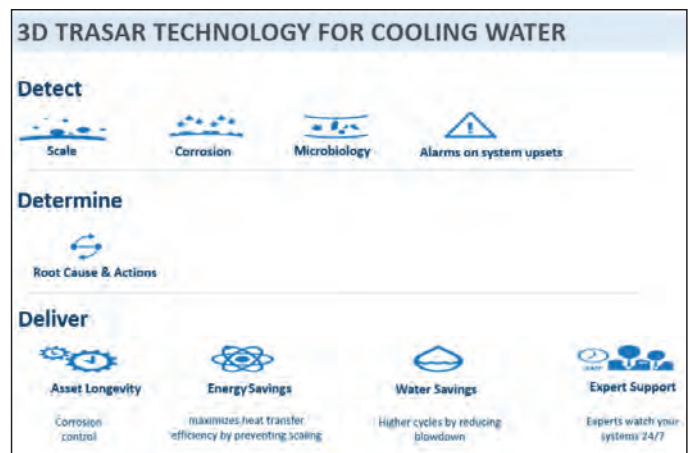
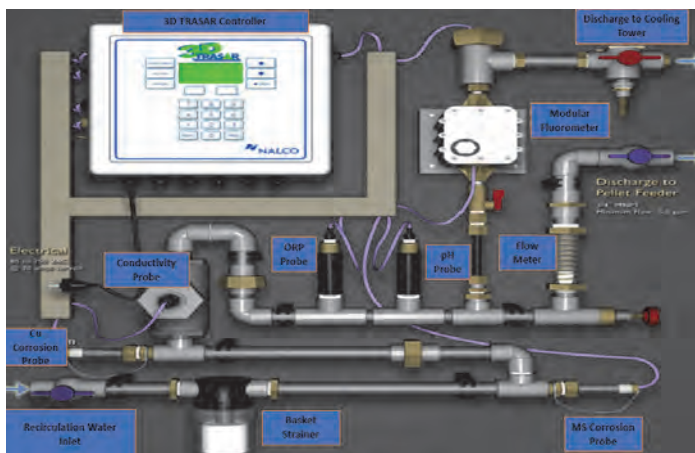
Energy saving is an essential key performance indicator for every commercial building specially where major part of energy is consumed by HVAC system. To maintain ideal IKW/TR rating of the chiller the condenser & condensate system

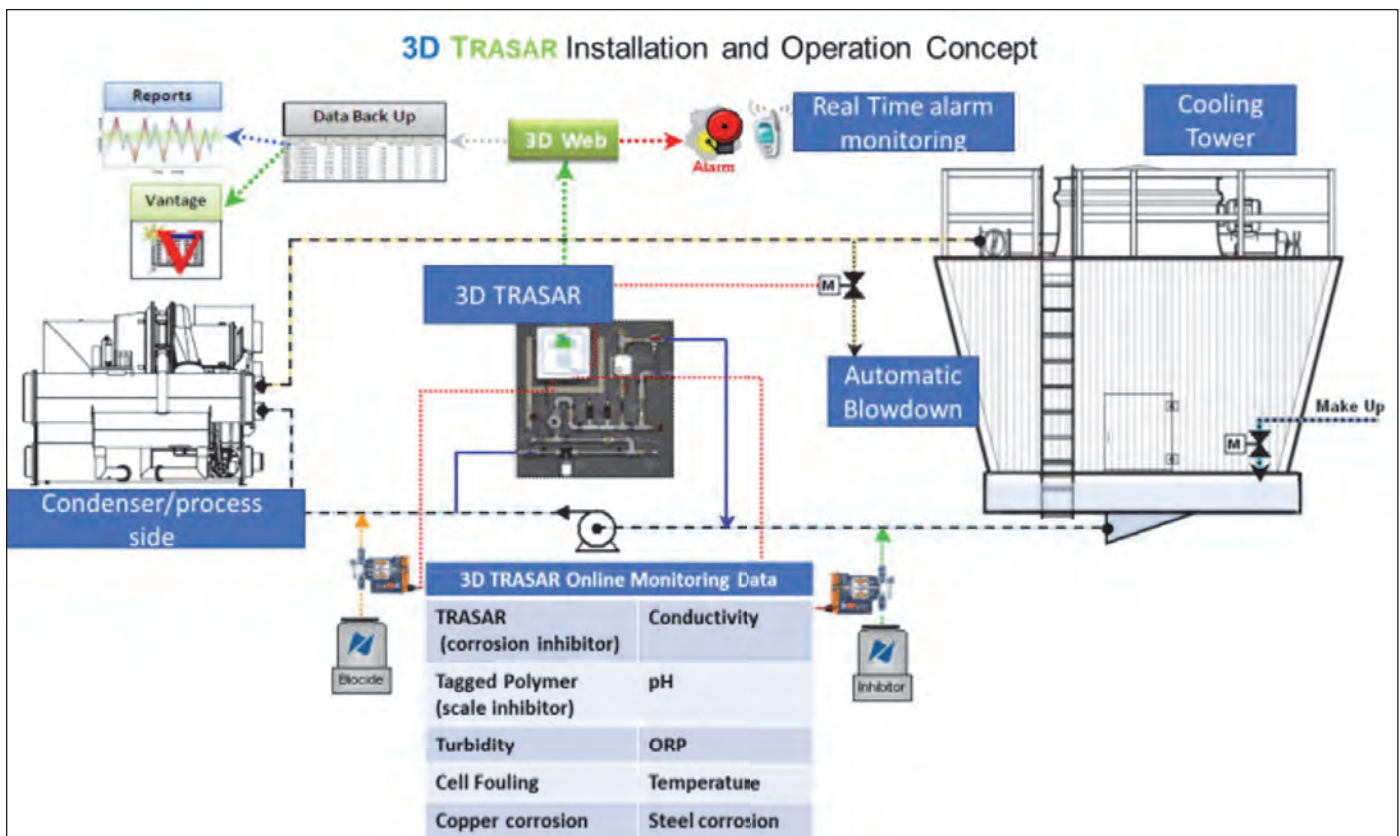
plays major role. During operations of HVAC system, the energy rating is majorly affected by approach temperature across condenser. Regular approach temperature can only be maintained with high quality of water parameters used in condensate system with the support of latest water management & treatment techniques. One such technology called as Nalco's 3D TRASAR system provides a 24*7 dosage of scale inhibitor based on active polymer level by using fluorescence technology. As declared by different chiller manufacturers every 01 degree increase in condenser water approach will increase energy consumption by 3%. Keeping this in mind, the right selection of chemistry with automatic 24*7 dosage Nalco's 3D TRASAR has been installed after complete study of water parameters and system requirements for water & energy conservation. The system successfully maintained condenser approach temperature by 2 degrees throughout the year. During the analysis for a period of one year post installation of Nalco's 3D TRASAR, it was observed that the condenser approach value was constant & below 2 degrees with approx. + 0.5 deg C variation during operations.

Case Study:

Before July 2019, one of the ESPL prestigious site at Noida— had tremendous challenges to maintaining its chiller plant asset due to serious corrosion & erosion in the HVAC pipelines and the chiller condenser tubes. The corrosion & erosion was caused due to poor ground water quality at Noida region with presence of high amount of TDS & Chloride salt. This led to regular higher approach values of the condenser tubes in multiple numbers of chiller plants across the site. Frequent condenser tube cleaning which leads to copper tube deterioration was a major challenge to maintain the operations capabilities of HVAC system. During regular operations the water quality parameters also tends to increase drastically due to which the Chiller tonnage capacity was also reduced as due to sudden increase in the condenser approach significantly decrease in refrigeration capacity.

Nalco system was introduced for condensate water management for chiller operations from July 2019. A pre-survey of the system was conducted and following concerns were recognized jointly as primary focus for improvement





- » Very high approach temperatures due to scaling
- » Frequent cleanings
- » Line Punctures due to corrosion & erosion
- » Frequent flushing of water of condensate system.
- » To reduce time for condensate system

In addition to above an overall improvement in cooling water management in terms of performance, safety, program administration and communications remains key objective of Nalco 3D TRASAR cooling water program

Below are the parameters used for the comparison as before & after the chemical program implementation.

- » pH – pH measures the relative acidity of the water. The control and measurement of pH are the keys to a successful cooling water program. Significant improvement in pH control by the 3D TRASAR program
- » Conductivity – Conductivity is a measure of free ions in the water. The control of

conductivity within a predefined limit is important to the success of corrosion and scale control in a cooling water program. Significant improvement in Conductivity control by the 3D TRASAR program

- » Mild Steel Corrosion Control – Average Mild Steel Corrosion Rate reduced
- » Cu Corrosion Control – Average Cu Corrosion Rate reduced
- » Real Time data monitoring and auto generated alarm & reports receiving

Challenges:

Before July 2019, one of the ESPL prestigious site at Noida had tremendous challenges maintaining its chiller plant asset due to serious corrosion in the HVAC pipelines and the chiller condenser tubes. This problem was caused due to the ground water quality of Noida region is very poor due to presence of high amount of TDS. This led to higher approach values of the condenser tubes. There was a need of frequent tube cleaning which in turn lead to copper tube deterioration also exceeding the recommended water quality standard etc.

Chiller tonnage capacity was also reduced as due to increase in the condenser approach significantly decreased refrigeration capacity.

Solution:

Including Nalco multiples suppliers were invited to support the site engineering team in evaluating its current water treatment program. A Mechanical, Operational and Chemical (MOC) survey of the cooling water system was conducted, because of MOC with all the supplier the implementation of its state-of-the-art 3D TRASAR based program has been finalized. The program includes PSO chemistry, non-oxidizing and oxidizing biocide and a bio-reporter. The 3D TRASAR system incorporates chemistry, algorithms, hardware, and software, which perform together to provide optimal control of a cooling water system. It detects stressful conditions within the cooling systems which can create upsets by forming scale, corrosion and microbio related problems and delivers appropriate responses every 5 seconds on a real-time basis. This ensures a more efficient and safe cooling water system with



Images of Nalco's 3D TRASAR system installed

minimal maintenance, and increased control over key parameters.

Results and Environmental Benefits or Health & Safety Benefits:

Energy & CO₂ Emission reduction:

After implementation of the Nalco 3 DTRASAR cooling water program the system performance has improved significantly. The rise in approach temperatures has reduced drastically & significantly for a similar length of operation which has resulted in an energy savings of approximately 101199 kWh in 8 months. Alternatively, the CO₂ emission reduce due to the efficient operation of chiller plant approx. 82983 kg has been reduced in the same month of operation (Refer to the below table).

Month	Energy Saving (kWh)	CO ₂ Emission reduction (kg)	Cost Reduction (INR)
Aug-19	22629.0	18555.8	219307.9
Sep-19	33191.0	27216.6	330914.6
Oct-19	13833.2	11343.2	144824.7
Nov-19	5268.7	4320.3	55038.4
Dec-19	20530.0	16834.6	221023.0
Jan-20	1169.0	958.6	12545.3
Feb-20	3113.1	2552.7	31230.3
Mar-20	1464.6	1201.0	14632.4
Total	101199	82983	1029517

Equipment Protection:

- » Condenser Tube Corrosion Rates reduced
- » Pipeline erosion Rates reduced
- » Condenser Tubes Repair & maintenance reduced
- » Life of condensate piping system improved.
- » Down time for chillers is negligible due to condensate system
- » Hazardous chemistry & safety:
- » Condenser tube descaling has been reduced, with the aim of the requirement of acidic chemical is reduced.
- » Operators' health & safety:
- » Due to auto-dosing system physical contact between operators and chemical is negligible.

Conclusion:

Due to implementation of The Nalco 3D TRASAR cooling water technology below mentioned results are observed: –

- » The health and hygiene of chillers got improved.
- » Provided operational support with overcoming from water treatment problems of condensate system.
- » Very positive results observed in reduction of operation cost.
- » Reduction in equipment breakdown and improvement in down time of chillers especially due to condensate system.
- » Improvement in HVAC efficiency and overall

sustainability profile.

- » Water conservation by avoiding irregular blow downs & Cooling tower basin cleaning etc.
- » Energy conservation by maintaining OEM recommended & constant condenser approach.
- » Health and environmental benefits.

About the Author

Sumit is an Electrical engineer working with Embassy Services Private Limited since, 2019 for Noida Region. He has been involved in various operations activities related to sites including for energy & water conservations. Presently the monitoring of Nalco system is under his direct supervision.

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



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CHITTAGONG WATER SUPPLY IMPROVEMENT & SANITATION PROJECT, PHASE I 2014–2015, PHASE II 2018–2019

By DHI India



LOCATION:

Chittagong, Bangladesh

TYPE OF PROJECT:

Water supply and water distribution hydraulic modeling

CLIENT:

Chittagong Water Supply & Sewerage Authority, Chittagong, Bangladesh

Description

Chittagong is the second largest city of Bangladesh with an estimated 4.2 million population. It is a very important industrial base and the water network has been managed by CWASA since 1963. CWASA is implementing the Chittagong Water Supply Improvement and Sanitation Project (CWSISP) with funding support from the World Bank (80.5241.01).

The model covers approximately 560 km (350 miles) of main pipelines – the maximum pipe diameter being 1,200 mm (48 inches). Surface water sources, groundwater sources, and tube wells provide approx. 6.5 m³/s (230 ft³/s) of water to 600,000 households and industry – and the water losses are estimated to be 48%.

The hydraulic model will support long-term planning, including a) designing a permanent control system to manage losses by the time the additional water production comes on-line; b) defining and designing network improvements; c) designing new transmission pipes; d) coordinating and supervising the execution of all the interventions; e) restoring 24-hour supply;

f) developing capacity for comprehensive active leakage monitoring and control.

It'll also support non-regret investments – investments that need to be done irrespective of the long-term plans. Such investments are needed to bring about immediate improvements in the water supply conditions and in the case of the CWSISP, amount to approximately USD 25 million.

About the Author

DHI India Water & Environment Pvt. Ltd is a wholly owned subsidiary of the DHI Group. Established in India as an independent company in 2001, it represents over 19 years of dedicated research and expertise from the different projects executed all over India. DHI India focuses on water resources, marine and environment consultancy services and sales.

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ENERGY EFFICIENT OZONE SYSTEM DESIGN

Power consumption for small ozone systems is insignificant. However in installations such as chemical oxidation, municipal wastewater treatment, municipal water treatment, effluent treatment, cooling tower water treatment and pulp bleaching the ozone systems are large. Power requirement assumes considerable importance. Today we are in era where we need to conserve power and solutions using ozone should address this and ensure power savings are part of the solutions provided. The solutions provided should have a balance between CAPEX and OPEX costs.

Ozone generation means power consumption: You cannot generate ozone without power. Power (high voltage) is utilized to split oxygen to produce ozone. Power is utilised to produce required quality Air/oxygen for producing ozone. Power is used to produce chilled water to cool the ozone electrodes during ozone production. Power is used to inject ozone during process. Power is used to destroy the unused ozone. Hence a design of an ozone system should consider all these aspects so that the total power required for ozone production is minimized. How do we do it?

Ozone Generator: Today the prime consideration of selecting an ozone generator is its energy efficiency. Ozone production consumes power two ways:

a) Production of ozone b) requirement of chilled water to cool ozone electrodes

The normal power requirement for an ozone generator for ozone production is around 8–10 W per grams of ozone for ozone produced from oxygen, and around 18 W per grams of ozone for ozone produced from Air. Today the most energy efficient ozone system produces ozone from oxygen at less than 8 W per gram of ozone, but only a handful. Few ozone systems strive for higher ozone concentration to save on oxygen consumption but at a higher power requirement for ozone production. The choice will depend on the cost of oxygen at the location of the plant

The production of ozone generates heat and heat damages the electrodes and also destroys ozone produced. Hence chilled water is used to remove this heat produced. Most ozone generators require chilled water between 12–20 degrees to optimize ozone production. Producing chilled water requires a closed loop chiller that will also require energy. The most energy efficient ozone generators can now produce ozone with cooling water temperature as high as 30 – 35 Degrees cel,

As mentioned earlier choice of Air or Oxygen will depend on the application and the requirement of correct air–liquid ratio when diffusers are used for ozone contacting.



A Large Ozone Generator a

Air preparation is costly in terms of OPEX. Oxygen preparation is costly in terms of CAPEX. Depending on the application, you need to choose correctly between Air feed and oxygen feed as wrong choice will compromise efficacy of the system.

Diffusers or injectors. Using Air feed and injection system is energy intensive since large injection systems are required for handling large volumes of gas. Diffusers do not require energy and are preferred if the volumes water are large and efficacy depends of the Air liquid ratio in the ozone contactor. In injection systems choices of the correct injectors and energy efficient pumps can reduce OPEX costs

Issued In Public Interest By V.Baratharaj

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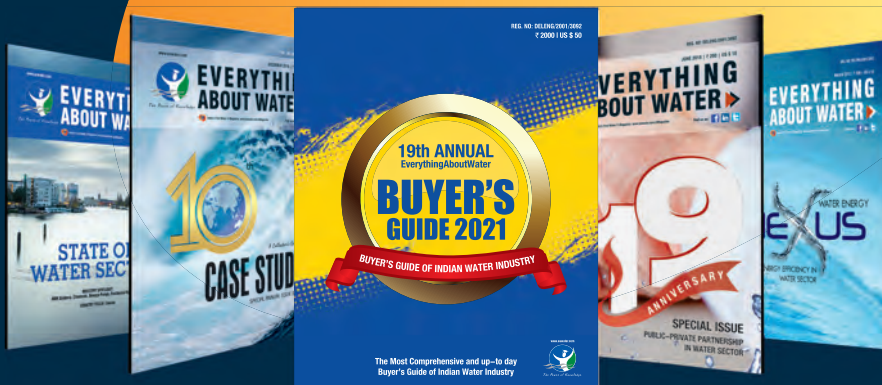
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- Account Number: 10056535743
- IFSC/RTGS/NEFT Code: IDFB0040101
- Bank Address: Unit No. 18-A, Ground Floor, Gurgaon- 122102

Date _____ Signature _____

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T E N D E R S

Ownership: Co-operatives

Tender Value: 912,000.00

Location: Uttar Pradesh – India

Closing Date: 31–12–2021

Ref No: 46112088

Extension work of pipe line from various places. Construction work of boring, water tank, RCC slab including pyau. Repair work of over head tank. Installation work of water cooler. Installation work of mini tube well. Supply of 01 nos pump set complete (5.00 K.V.A.). Supply of 01 nos pumpset complete (08 K.V.A.). Construction work of water Harvesting.

Ownership:

Corporations/ Associations/ Others

Tender Value: 498,701.00

Location: West Bengal – India

Closing Date: 9–12–2021

Ref No: 46120574

Improvement of surface drain at bengali bazar n/h/no. b–54/a and iron gate road bye lane n/h/no.b–58 in ward no. 135, brt–xv slum area. improvement of drainage near pr. no. x–64/5/5 aman math slum area in ward no. 140, br.–xv. removal of silt from drainage networks of the slum areas of riverside road & jelia para road in ward no. 141, br.–xv. repairing of leakage in water supply pipeline at raja ram mohan roy road near h. no. 20 in ward no 121, br.–xiv. repairing & maintenance of computers at road roller department. development of water supply by changing 150 mm dia and 100 mm dia filter water main at taltala library row from 98/4 s.n. banerjee road to 11/a doctor lane in ward no. 53. repairing, overhauling of 0.42 mgh capacity pump and its delivery valve including other allied works for pump unit no. 1 at watgunge pumping station. repairing of photocopy machine and allied electrical works at asphaltum goragacha. repairing of road surface at 2/21,2/67c sree colony and its surrounding area in ward no.–099, br.–x under roads mechanical department. construction of sump pit near bustee site at goragacha Plant under roads mechanical department. dismentling and cleaning of dilapitated

boundary wall and trimming , felling of trees including transportation from goragacha Plant under asphaltum department, g.g. construction of sae(c) office room and toilet above new ex. engg. (m) office building and other allied works under road's mech. dept. construction of box drain near bustee side in goragacha Plant under roads(m) department. manufacturing and delivery of scrappers for DM–45 Plant at asphaltum department, palmer bazar. renovation of power distribution circuit to 1st floor office building under asphaltum department palmer bazar. annual maintenance contact of cleaning of bucket elevator system of DM–50 Plant under road(m) department. repairing of old computers, printers, cpu etc. by replacement of various spare parts for asphaltum deptt. palmer bazar.

improvement of road surface and footpath of palmerbazar road from chingrighata workshop to k.m.c. electricity deptt. gate under asphaltum department(palmer bazar). procurement of tar cans for bitumen emulsion under roads(m) department. repairing & fitting, fixing of bitumen pump, gear box and allied works of bitumen reservoir tank no. 2 at asphaltum deptt., palmer bazar. cleaning and sweeping inside garage premises, chinrighata premises etc. under asphaltum department (palmer bazar).

procurement of ucp215 d1 block with bearing and bu t213 d1 block with bearings for DM–50 Plant under roads(m) department. improvement of road surface of p.a. shah road (from premises no. 188/93ato 302/aand 302/a/2 to 43 j.p. garden) in ward no. 93, br.–x, under asphaltum palmer bazar department.

procurement of hard picks for departmental cold milling machines w100h2, w–100, w–50 etc. of asphaltum deptt. palmer bazar. improvement of road surface of lake

gardence co–operative (from premises no. 164/1 to 164/78) in ward no. –93, br.–x under asphaltum palmer bazar department.

improvement of road surface of jodhpur park road (from premises no. 275 to d/2) in ward no. 93, br.–x, under asphaltum palmer bazar department. continuation of operation & maintenance of DM 45 and DM 50 Plants at asphaltum palmer bazar department. laying of 12 inch diameter pipeline on the southern end side of patuli booster campus for feeding of padma patuli head works. restoration of reinforced concrete road surface for laying of 1600 mm diameter raw water m.s. pipeline from raw water pumping station (phase–II) uptoend of conveyor belt inside cesc southern generating station. repairing of leak of 900 mm dia reserved main at 18 k. n. sen road (2 spots) in wd. no. 67.

improvement for f.w. supply of old 100 mm dia pipe replacing by new same dia d.I. pipe from 50 to 60/1 b.b. chatterjee rd. in wd. no. 67. improvement for filter water supply by replacing the old 150 mm dia pipe by new 150 mm dia d.I. pipe from 9 to 31 tiljala rd. with nishan masjid in wd. no. 66.

maintenance work cut & flush stand pipe repairing at different places under ward no. 92.

development of water supply by replacing 100 mm pipeline at different locations under ward no. 92.

maintenance of water supply like cut & flush and stand pipe repairing at different places in ward no. 91.

sinking of a new tubewell (200x150) mm at bopsekur masterpara in ward no. 91, br.–x.

Ownership:

Corporations/ Associations/ Others

Tender Value: N.A.

Location: Maharashtra – India

Closing Date: 3–12–2021

Ref No: 46118390

Appointment of consultants for vetting of designs, drawings, dtp and construction supervision transaction advisor for 200 MLD Desalination Plant expandable to 400 MLD for

Ownership:

State Government

Tender Value: 4,858,190.00

Location: Gujarat – India

Closing Date: 3–12–2021

Ref No: 46137013

New construction of Sewage Treatment Plant at m.g. hospital.

Ownership:

State Government

Tender Value: 912,500.00

Location: Goa – India

Closing Date: 2–12–2021

Ref No: 46127081

Operation and maintenance of 15 MLD WTP at chandel in pernem taluka providing trasportation to the staff

Ownership:

State Government

Tender Value: N.A.

Location: Uttar Pradesh – India

Closing Date: 1–12–2021

Ref No: 46125686

Construction of STP (8MLD) laying of sewer line & its appurtenant work and renovation of old sewer pipe line schemes of nagar palika parishad distt.

Ownership:

State Government

Tender Value: N.A.

Location: Uttar Pradesh – India

Closing Date: 1–12–2021

Ref No: 46135937

Construction of STP (8MLD). laying of sewer line & its appurtenant work and renovation of old sewer pipe line schemes of nagar palika parishad in distt inducing all necessary works required for commissioning the system including one year defect liability period after successful trial run and commissioning under amarut program.

Ownership:

T E N D E R S

Corporations/ Associations/ Others
Tender Value: N.A.

Location: Gujarat – India
Closing Date: 30–11–2021
Ref No: 46115489

Proposals for conservation and restoration of ani kotha with defect and maintenance liability period for five years under smart city mission. Construction of Rain water Harvesting system for government buildings.

Ownership:

State Government
Tender Value: 17,412,980.00
Location: Maharashtra – India
Closing Date: 30–11–2021
Ref No: 46123120
Providing services of operational staff for all pumping station at barrage, 24 MLD Water Treatment Plants, badlapur under water supply scheme.

Ownership:

Corporations/ Associations/ Others
Tender Value: N.A.
Location: Maharashtra – India
Closing Date: 30–11–2021
Ref No: 46130532
Operating, maintenance & repair of Sewage Treatment Plant at belapur. Marathi

Ownership:

Corporations/ Associations/ Others
Tender Value: N.A.
Location: Chhattisgarh – India
Closing Date: 29–11–2021
Ref No: 46118851
Procurement of equipment for bovine embryo transfer and in vitro fertilizations for large animals, laboratory equipment, consumables, media and chemicals for bovine embryo transfer and in vitro fertilization, ultrasound machine, monitor, probe and ovum pick up assembly for bovines, portable diagnostic veterinary ultrasound scanner, embryo freezer, co2 incubator, bio safety cabinet class ii type b, air Purification system, denudation pipette for bovine oocytes, ethylene oxide sterilizer with sealing machine, packing material and

cartridge, bench top centrifuge, bench top tri Gas incubator, water Purification system, ivf workstation, double distillation assembly, vertical autoclave, hot air oven, fumigator, vortex, garment storage cabinet, embryo cup filter warmer, slide warmer, volatile organic compounds level monitor, heat stage, refrigerator.

Ownership:

Education & Research Institutes
Tender Value: N.A.
Location: Bihar – India Closing Date: 29–11–2021
Ref No: 46121848
Construction of buildings including the Central Library comprising of Basement (–4.5 m + ground floor (+3.6m) + five floors (average 3.8 m), one 500 user capacity Yoga Center cum Meditation/ Multipurpose Hall (Ground floor – with minimum 8.0 m ceiling height), one 250 user capacity Cafeteria (Ground Floor – with minimum 4.0 m ceiling height) and one 2000 Seater capacity Auditorium (G+1 storied – with minimum 16.0 m ceiling height) – Civil Composite work including all wired and piped services including internal water supply, sanitary installations, Façade works, Interior works, Electrical works including Internal Electrical Installations (IEI), Extra Low Voltage (ELV) works, Firefighting, Fire Alarm System, HVAC, Lifts, Solar water heating system, External Electrical Installations, Site Development works including roads, pathways, drainage, Horticulture & Landscaping Works, STPs, other miscellaneous works etc. all complete on EPC basis for Nalanda University Main Campus at Rajgir, District Nalanda, Bihar.

Ownership:

Central Government/Public Sector
Tender Value: N.A.
Location: Tamil Nadu – India
Closing Date: 29–11–2021
Ref No: 46127454
Supply, installation and commissioning of water distillation unit 100 l/hr

Ownership:

State Government
Tender Value: 917,377,000.00
Location: Uttar Pradesh – India
Closing Date: 29–11–2021
Ref No: 46135365
Remaining construction work of 05 EWS tower (EWS A5, A6 EWS–1, EWS 1, 2), 01 LIG tower (LIG –1) and 02 MMIG tower (MMIG–5 and 6) and external development work of scheme. Road and drain work in sector – D–1 (commercial). Operation and maintenance work of installed 22 nos tube well for 03 years. Laying work of sewer line in scheme.

Supply work of labor, fertilizer chemical for annual maintenance work of industrial maintenance in park.

Annual maintenance and operation and maintenance work of installed V.R.V. air conditioning system. Internal water line laying work. Improvement work of drain and side track.

Ownership:

Corporations/ Associations/ Others
Tender Value: 826,000.00
Location: Uttar Pradesh – India
Closing Date: 29–11–2021
Ref No: 46135968
Work of 80 pole/45–50 watt.
Work of 130 pole/45–50 watt.
Repair work of/renovation of anapara. Installation work of 100 L.P.H. R.O. Plant (submersible pump and including boring).

Ownership:

Corporations/ Associations/ Others
Tender Value: 17,412,980.00
Location: Maharashtra – India
Closing Date: 29–11–2021
Ref No: 46138676
Providing services of operational staff for all pumping stations at barrage, 24 MLD Water Treatment Plants at badlapur for two years

Ownership:

Central Government/Public Sector
Tender Value: 65,490.00

Location: Karnataka – India
Closing Date: 26–11–2021
Ref No: 46124580
Supply of potable water Purification system Reverse Osmosis or UV based (q3)

Ownership:

Central Government/Public Sector
Tender Value: 4,000,000.00
Location: Himachal Pradesh – India
Closing Date: 25–11–2021
Ref No: 46123010
Repair to water proofing Treatment inc flooring, plastering, cleaning of water tanks, repair sunken flooring, Rain water piping for all roof and repair/ replacement of pvc tanks, float valves of rcc facia and chajjas in zone–ii area

Ownership:

Corporations/ Associations/ Others
Tender Value: 4,049,500,000.00
Location: Punjab – India
Closing Date: 24–11–2021
Ref No: 45749143
Design, build, operate and transfer (dbot) drinking water supply system including WTPs to supply treated water to a large group of villages in the districts of fazilka and ferozepur, punjab including 120 months operation and maintenance.

Ownership:

Education & Research Institutes
Tender Value: N.A.
Location: Madhya Pradesh – India
Closing Date: 24–11–2021
Ref No: 46113957
Supply of consumables – progard ii pre Treatment pack, silver impregnated , 1u cartridges , 5u cartridge, pcb elix–rios interface and servicing of water Purification system as per appendix a and b.





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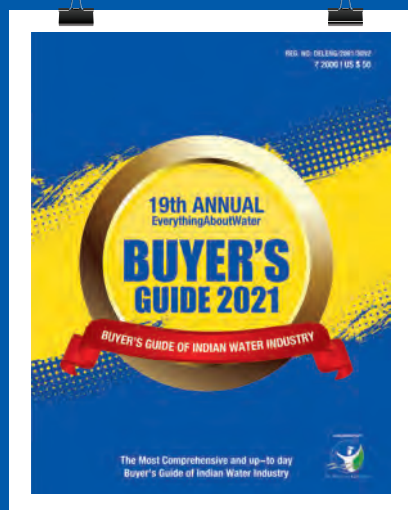
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