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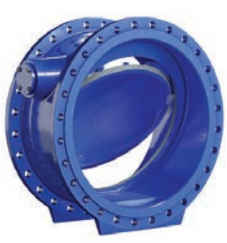

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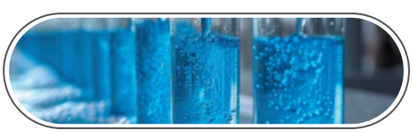

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Gulshan Polyols reports Q1FY25 results

Dr Chandra Kumar Jain, Chairman & Managing Director, Gulshan Polyols Limited

New Delhi, India: Gulshan Polyols Limited has announced its unaudited financial results for the quarter ended 30th June 2024. The revenue from operations increased by 54.89 per cent from ₹29,347.25 lakhs in Q1 FY24 to ₹45,455.64 lakhs in Q1 FY25. The main contributor to growth was the ethanol plant at Boregaon District, Chhindwara, Madhya Pradesh. The revenue from operations stood at ₹45,455.64 lakhs for the quarter ended June 30, 2024. EBITDA increased from ₹1560.52 lakhs in Q1 FY24 to ₹2570.55 lakhs in Q1 FY25.

Commenting on the results, Dr Chandra Kumar Jain, Chairman & Managing Director, said, "As a leading speciality chemical and ethanol manufacturer, our strategic focus continues to revolve around the expansion in both domestic and global markets. Our established capabilities have played a key role in achieving this success, underscoring our unwavering commitment to excellence in the industry."

The company's 500 KLPD grain based ethanol manufacturing unit is running successfully at 60 per cent capacity utilization, which is likely to go up to 80 per cent capacity utilization in the coming quarter. Besides, the company has also started the commercial operations of ethanol at its 250 Kilo Litres Per Day capacity grain based ethanol plant at Goalpara, Assam.

Deepak Fertilisers and Petrochemicals reports strong growth in Q1FY25

Sailesh C. Mehta, Chairman & Managing Director, Deepak Fertilisers and Petrochemicals Corporation Limited

Pune, India: Deepak Fertilisers and Petrochemicals Corporation Limited (DFPCL), one of India's leading producers of industrial and mining, chemicals and fertilisers, announced its results for the first quarter ended June 30, 2024. Revenue delivered was ₹2,281 crores, marginal decline by 1.4 per cent on YoY basis due to lower commodity prices. EBITDA margin improved to 20.4 per cent against 12.1 per cent on YoY basis. PAT was ₹200 crore which is 76 per cent higher on YoY basis. Chemical Segment (Mining and Industrial Chemical) contributed about 57 per cent of total revenue which grew by 5 per cent YoY mainly driven by improved demand in Technical Ammonium Nitrate Business. Commenting on the performance, Sailesh C. Mehta, Chairman & Managing Director, Deepak Fertilisers and Petrochemicals Corporation Limited, said, "DFPCL has delivered an impressive performance for Q1FY25, with notable increase in EBITDA margin by 823 bps YoY, up from 12.1 per cent to 20.4 per cent. The businesses are reaping the benefits of backward integration of ammonia plant which has helped mitigate supply chain risk as well as price volatility and the benefits are captured within the group. Also, the strategy of moving from commodity to speciality has been working to sustain and enhance the margins of the businesses."

Safex Chemicals appoints Kamal Gupta as Global CFO

Safex Chemicals Group has announced the appointment of **Kamal Gupta as the Global Chief Financial Officer (CFO).** Kamal Gupta brings over 22 years of financial leadership experience, most recently serving as the Deputy Chief Financial Officer at Jubilant Ingrevia Limited. Kamal's expertise in finance business partnering, investment decision evaluations, capital structure optimization, and investor relations will be crucial in driving Safex Chemicals' financial strategy and supporting its vision for future growth.

"I am honored to join Safex Chemicals at such a pivotal time in its growth journey. I look forward to leveraging my experience in financial leadership to drive the company's financial strategy and support its ambitious vision for global expansion," said Kamal Gupta, Global CFO, Safex Chemicals Group.

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Shogun Organics develops, patents Renofluthrin

New Delhi, India: Shogun Organics, a part of Safex Chemicals Group, has announced the successful development of Renofluthrin, India's first indigenously developed and patented mosquito repellent molecule.

Speaking on this invention, Neeraj Jindal, Group Director, Safex Chemicals Group, said, "Renofluthrin is not just a new product, but a testament to India's growing prowess in molecular development. After ten years of dedicated scientific work and substantial investment, we are proud to introduce a solution that makes India self-reliant in mosquito control technology."

The research and development of Renofluthrin was carried out in partnership with Godrej Consumer Products Limited (GCPL), combining Shogun's expertise in molecule development with GCPL's market reach. Shogun Organics holds the patent for Renofluthrin and has partnered exclusively with GCPL for its use in India.

Aether Industries, Chemoxy International sign agreement

Mumbai, India: Aether Industries Limited has entered into a contract / exclusive manufacturing agreement with Chemoxy International Limited, a wholly-owned subsidiary of the Seqens group. Headquartered in France, the Seqens group is an integrated global leader in health, personal care, and speciality Ingredients, operating 16 production sites and nine research and development centers worldwide, with an annual revenue of EUR 1.1 billion. Under this take-or-pay contract, Aether will produce a series of natural bio-based products exclusively for Seqens. The contract spans an initial period of three years. The production is expected to commence over the next 10 months with a volume of 100+ MT per year. The innovative manufacturing process, which involves a complex process and continuous reaction technology, was collaboratively developed by Aether and Seqens over the past three years. This venture marks a significant milestone for Aether's renewables and sustainability business segment, enhancing Aether's reputation as a leading India-based speciality chemical manufacturer and provider of sustainable and carbon-neutral chemistry solutions across the industry spectrum.

LyondellBasell to fully acquire APK AG

Rotterdam, Netherlands: LyondellBasell (LYB) has entered into an agreement to acquire full ownership of APK AG in Merseburg, Germany. LYB believes APK's solvent-based recycling technology is a perfect fit with its already existing mechanical and advanced recycling technologies. Therefore, it already invested in the company in the past and made collaborative efforts on bringing the technology to scale. By acquiring APK, LYB secures the future of the company after it entered into insolvency at the end of May 2024.

The recycling technology is a unique solvent-based kind for low density polyethylene (LDPE). LYB aims to increase the recycling of hard-to-recycle flexible plastic waste materials – which today make up the majority of mixed plastic waste from the consumer sector. The technology separates the different polymers of hard to recycle, flexible plastic waste materials and produces recycled materials with a high degree of purity suitable for new flexible packaging of, for example, personal care products. The materials produced will be sold under the LYB Circulen portfolio.

Rainier van Roessel elected Chairman of Supervisory Board - LANXESS

Dr Rainier van Roessel (66) has been elected as the new Chairman of the Supervisory Board of LANXESS AG. At its constituent meeting, the Supervisory Board of the specialty chemicals company elected the business graduate and former member of the Board of Management of LANXESS AG as successor to Dr Matthias Wolfgruber (70), who resigned from office at the end of annual stockholders' meeting.

Rainier van Roessel has been a member of the Supervisory Board of LANXESS AG since 2022. He started his professional career at Bayer and has worked for LANXESS AG since it was founded in 2004, serving as Labor Director and member of the Board of Management since 2007. He left the LANXESS Board of Management at the end of 2019.

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Praj announces Q1 FY25 results

Shishir Joshipura, CEO & MD, Praj Industries

Pune, India: Praj Industries has announced its unaudited financial results for the quarter ended June 30, 2024. Income from operations stood at ₹6,991.41 million, while Profit Before Tax (PBT) before exceptional items is at ₹788.80 million for the period. Commenting on the company's performance, Shishir Joshipura, CEO & MD, Praj Industries said, "This quarter's performance reflects the changing dimensions of the business dynamics. Our continued focus on innovation at the leading edge of technology will enable us deliver healthy performance going forward." Praj has successfully produced the first batch lactic acid 90 per cent, a building block for bioplastic, at its state-of-the-art demonstration plant for biopolymers in Jejuri near Pune. Besides, the company has also established a Centre of Excellence & Innovation (CoEI) with Vasantdada Sugar Institute for the integration of farm to fuel model with alternate feedstock development.

MGC achieves ISCC PLUS certification for Meta-xylene and MXDA

Chiyoda-ku, Tokyo: Mitsubishi Gas Chemical (MGC) Company, Inc. has announced that it has acquired ISCC PLUS certification for Meta-xylene and Meta-xylenediamine (MXDA) produced at MGC's Mizushima plant. With this certification, MGC would be able to start manufacturing and selling ISCC PLUS-certified Meta-xylene and MXDA, which is manufactured from sustainable raw materials based on the mass balance approach.

Meta-xylene is used as a raw material for agrochemicals and a number of MGC's products, including MXDA and purified isophthalic acid. MXDA is a raw material for coatings and adhesives — due to its excellent corrosion and chemical resistance — as well as for Nylon-MXD6, which is known for its excellent gas barrier properties. Meanwhile, purified isophthalic acid is used as a secondary raw material for the modification of polyester.

SBL Energy inaugurates TNT plant in Nagpur

Dr Ajay Kumar, Former Defence Secretary of India, inaugurating SBL Energy Limited Trinitrotoluene plant at Nagpur.

Nagpur, India: SBL Energy Limited, one of the largest mining and industrial explosives manufacturers in India, has inaugurated its Trinitrotoluene (TNT) manufacturing plant. The TNT plant, set up at the company's 225-acre manufacturing facility at Yenvera in Nagpur, Maharashtra, is only the second such initiative in India's private sector. The state-of-the-art TNT plant comes with 3,000 tons per annum capacity. It is an export-only plant that will help SBL Energy to triple its exports to markets such as Australia, Europe and the US.

Sasol appoints Muriel Dube as Chairman of the Board

Muriel Dube has been appointed **Chairman of the Board of Sasol Limited,** with effect from 13 September 2024. Muriel joined the Sasol Limited Board as an independent non-executive director in 2018. She holds an MSc degree in Environmental Change and Management from Oxford University and degrees in BA Human Sciences and BA Honours Politics. She has an extensive background in sustainability, commercial, finance and leadership roles.

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SBL Energy aims to boost domestic production of TNT to reduce import dependence, ensure supply security, bring in cost efficiency and strengthen defence manufacturing. Dr Ajay Kumar, Former Defence Secretary of India, inaugurated the TNT plant on September 3, 2024.

The setting up of the Nagpur TNT plant is part of SBL Energy's fund deployment strategy to expand its manufacturing capacity in India and launch new products.

Nissan Chemical to acquire all shares in Nippon Polytech

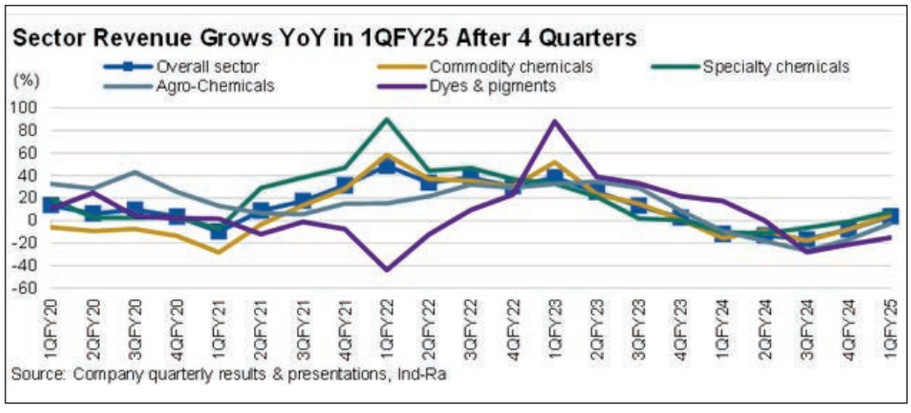
Tokyo, Japan: Nissan Chemical Corporation has announced that it has agreed to acquire all outstanding shares in Nippon Polytech as of August 27, 2024. Nippon Polytech manufactures the solder resist used in chip-on-film (COF) for displays. It has excellent electrical reliability, low bleeding performance, and high bending resistance, while meeting the market demand for fine pitch wiring, and has high market share. Through this acquisition, Nissan Chemical will expand its portfolio in the display field and make maximize the use of the know-how and resources held by Nippon Polytech in the development of Nissan Chemical's materials for the display and semiconductor packaging fields.

FluoRok raises funds for fluorochemical production

Oxford, Oxfordshire: FluoRok, an Oxford-based start-up, has raised USD 9.8 million to scale-up, manufacture and commercialise novel fluorochemical reagents and battery electrolyte salts. The oversubscribed round was led by BGF alongside Green Generation Fund and included battery specialist Volta Energy Technologies, current investors (Oxford Science Enterprises and University of Oxford), Excellis Holding and angels.

Founded in 2022, FluoRok is a University of Oxford spin-out that has developed an innovative patented method to access fluorochemicals, chemicals containing the element fluorine and key to global energy transition, healthcare and food supply.

Q1FY25 chemical sector performance: Revenue grows y-o-y



Mumbai, India: India Ratings and Research (Ind-Ra) has published the second edition of its Chemical Insights Report covering the quarterly performance of the chemicals sector in Q1FY25. The report contains a detailed review of revenue growth, EBITDA margins, and price trends across key chemicals, i.e. commodity chemicals, specialty chemicals, agro-chemicals, dyes and pigments and various key chemistries i.e. soda ash, caustic soda, benzene, fluorine, poly-vinyl chloride (PVC), oleochemicals, amines, phthalic anhydride, carbon black, thermoplastics, and styrene.

"The domestic chemical sector recorded 4 per cent yoy revenue growth in Q1FY25, largely attributed to the specialty chemicals segment where volumes rose although prices remained weak. However, margins within the chemical sector were subdued yoy at around 13.5 per cent in Q1FY25, due to a fall in the margins within the commodity and agro-chem segments. Commodity chemicals' margins were impacted by lower soda ash prices, while those of agro-chemicals were impacted by weak pricing and volumes in the export market," said Siddharth Rego, Associate Director, Corporate Ratings, Ind-Ra. ■

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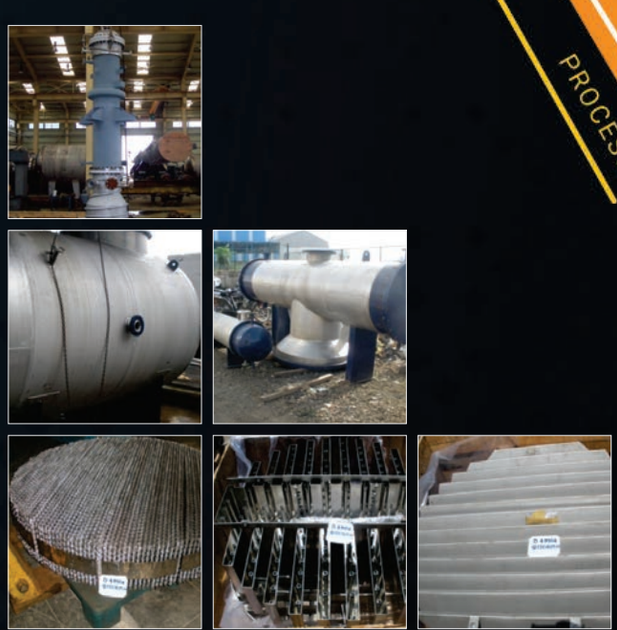

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WABAG wins order from Saudi Water Authority

Chennai, India: VA TECH WABAG, a leading pure-play water technology Indian Multinational Group, has bagged a mega order worth ~USD 317 Million (~INR 2,700 crores) from the Saudi Water Authority towards Engineering Procurement, Construction & Commissioning (EPCC) of a 300 Million Litre per Day (MLD) Mega Sea Water Reverse Osmosis (SWRO) Desalination Plant in Yanbu, Kingdom of Saudi Arabia (KSA).

The EPCC contract includes the scope of design, engineering, supply, construction and commissioning of the 300 MLD Mega Desalination Plant which will be developed on a greenfield site located in the west coast of the KSA, and is scheduled to be completed within a 30-month period. The mega desalination plant will operate using dual media filters followed by a two-pass reverse osmosis process and re-mineralization to produce clean potable water, which will be further distributed by the SWA. The plant will be built with the state-of-the-art desalination technologies, designed for superior energy efficiency and will produce stellar quality of water complying with the environmental regulations of the KSA.

Thermax partners with Ceres for green hydrogen production

Pune, India: Thermax, a leading energy and environment solutions provider, has announced a strategic collaboration with Ceres Power Limited, a subsidiary of Ceres Power Holdings plc (CWR.L), a leading developer of clean energy technology. The two companies have entered a non-exclusive, global license agreement for Thermax to manufacture, sell and service stack array modules (SAM) based on Ceres' advanced solid oxide electrolysis cell (SOEC) technology.

Thermax will also develop, commercialise and sell SAM balance of modules (SBM) and multi-megawatt SOEC electrolyser modules. Under this partnership, Thermax will leverage its extensive experience in heat integration and waste heat recovery to manufacture a first-of-its-kind pressurised SAM and design, engineer, and develop SAM balance of module (SBM), a building block for further development of a multi-MW SOEC electrolyser module. The collaboration is expected to deliver systems that are up to 25 per cent more efficient than incumbent low-temperature electrolysis technologies and effectively utilise steam generated from industrial process heat/waste heat recovery. This makes it an optimal solution for decarbonising hard-to-abate industries such as ammonia/fertiliser, steel, refineries and chemical production.

As a step towards commercialisation, Thermax plans to establish a manufacturing facility for the electrolysers, develop the supply chain, and localise critical components.

KCI sets up formaldehyde, hexamine manufacturing plants

Ankleshwar, Gujarat: Kanoria Chemicals & Industries Limited (KCI) has announced the inauguration of a new formaldehyde manufacturing facility at its existing manufacturing site in GIDC, Ankleshwar. The new state-of-the-art plant, with a capacity of 345 Metric Tons per Day (MTPD), will significantly boost KCI's total formaldehyde production to 763 MTPD. The new unit, built with the latest Metal Oxide-based technology, will cater to the growing demand for formaldehyde across various sectors including engineering wood, textiles, agrochemicals, pharmaceuticals, and more, both in the region and in export markets. Meanwhile, the company has also set up a new hexamine manufacturing facility with indigenous technology at its GIDC, Ankleshwar site. With a capacity of 18 Metric Tons per Day (MTPD), the addition of this state-of-the-art plant will effectively double KCI's Hexamine production to 36 MTPD. The new facility is designed to meet the increasing demand for Hexamine across sectors such as pharmaceuticals, rubber, explosives, and resins, both in domestic and international markets.

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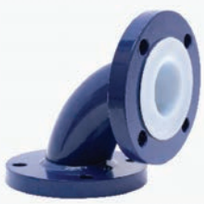

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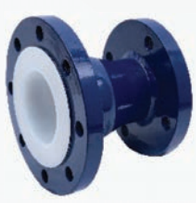

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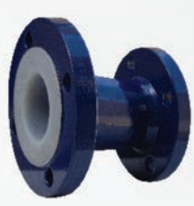

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LanzaTech signs master license agreement with Sekisui Chemical

Chicago, USA: LanzaTech, the carbon recycling company transforming waste carbon into sustainable fuels, chemicals, and materials, has signed a Master License Agreement with Sekisui Chemical Co., to deploy, at commercial scale, a jointly developed platform that converts syngas derived from municipal solid waste and industrial solid waste into ethanol. Sekisui intends to build multiple facilities in municipalities across Japan which incorporate equipment packages, engineering and advisory services, consumables, and intellectual property provided by LanzaTech.

Sekisui expects its first commercial-scale facility to produce 10 to 12 kilotons of ethanol annually. The ethanol output is synthetic alcohol (Japan Alcohol Association Standard) and can be converted into ethylene and kerosene for use as Sustainable Aviation Fuel (SAF) as well as widespread material and chemical applications such as apparel, personal care, and packaging.

Gensol Engineering, Matrix Gas & Renewables bag green hydrogen project

Ahmedabad, India: Gensol Engineering Limited in collaboration with Matrix Gas & Renewables Ltd have won a project to set up India's first Green Hydrogen Valley project in Pune. Gensol-Matrix will set up green hydrogen production plant on Build Own and Operate (BOO) basis to supply green hydrogen to specialty chemical sector with the firm offtake for 20 years.

Commenting on this achievement, Anmol Jaggi, Managing Director, Gensol Engineering Ltd., said, "We feel immense pride to develop India's first Green Hydrogen Valley project. Government of India has taken a great step in promoting these Hydrogen Valleys through Department of Science & Technology. We are going to supply Green Hydrogen to the specialty chemical sector in Pune, Maharashtra on round the clock basis to develop the green hydrogen economy in India."

Chirag Kotecha, Whole-time Director, Matrix Gas and Renewables Ltd., added, "This Green Hydrogen valley is being facilitated by National Chemicals Laboratories, Pune in Kurkumbh region. We will have an opportunity to establish such Green Hydrogen generation concepts, its applications and research and development facilities. We have been selected through competitive tender as the best bidder (both technically and commercially) to set up a green hydrogen generation plant on BOO basis through electrolysis route."

Hindalco to ramp up capacities

Union Minister for New and Renewable Energy, Pralhad Joshi, during a visit to Hindalco's stall at the 4th edition of Renewable Energy Investors Meet & Expo (RE-Invest 2024) in Gandhinagar, Gujarat

Gujarat, India: Hindalco is in the process of ramping up capacities and building new capabilities and innovative products as copper becomes a critical manufacturing component in India's transition towards a developed

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V2, Sep 2024

economy and net zero emissions. "Electric mobility and renewable energy sectors are driving the demand in a major way," said Rohit Pathak, CEO - Copper business, Hindalco.

Hindalco's copper sales topped 500,000 tonnes for the first time in FY2023-24. The company is building India's largest Copper Inner Groove Tube plant at Wagodia, Gujarat. The project will be commissioned by the end of this calendar year and will reduce the import dependence for this key component in air conditioners. The company has also started work on the first and the largest e-waste and copper recycling facility in Dahej, which will further enhance the country's capabilities in copper recycling.

The new Namo Bharat Rapid Rail, built on the Vande-Bharat platform and being introduced for inter-city travel, runs on electric lines that are made from copper, mostly produced by Hindalco. The company is also a key supplier of the metal for the motors and internal wiring in the gleaming new-age trains in the country. The Aditya Birla Group flagship's copper is used in electrifying every two in three households in India, and about 95 per cent of the railway electrification. Its newly developed Cu-Silver alloys are ushering in the next phase of high-speed and urban transportation, dedicated freight corridors and the rapidly expanding metro rail network. It is making progress to develop Copper-Magnesium alloys which will further upgrade the next generation, sustainable electrification.

OQ Chemicals launches new water-based coating

Monheim am Rhein, Germany: OQ chemicals has launched Oxvolt S221, a new co-solvent for water-based electrode coatings that enables crack-free surfaces after coating and drying for lithium-ion batteries. The automotive industry in particular requires high-performance, durable and environmentally friendly batteries as the basis for e-mobility. Oxvolt S221 is particularly suitable for high energy graphite anodes. It acts as a film-forming agent (also coalescing) and ensures a uniform coating of the graphite anodes. The new product reduces the viscosity of the slurry and facilitates processing by optimizing the mixing properties of the slurry and the quality of the electrode after coating and the first drying phases. It is water soluble and is added to the water as a co-solvent at a few percent. It evaporates completely during the drying process.

Nouryon expands sodium chlorate capacity in Brazil

Amsterdam, The Netherlands: Nouryon has announced that it has commenced operations at its new integrated manufacturing model site in Ribas do Rio Pardo, Mato Grosso do Sul, Brazil, which includes the production of hydrogen peroxide, sodium chlorate, and chlorine dioxide. The new investment, designed in partnership with a long-term customer in Brazil, significantly increases Nouryon's total sodium chlorate capacity available to the market, and supports the growing pulp and paper industry in the region.

"Our increased sodium chlorate capacity will support the fast-growing pulp and paper industry in South America," said Larry Ryan, President at Nouryon. "The launch of another Integrated Manufacturing Model site in Brazil builds on our commitment to the pulp and paper industry and supports our successful growth strategy in South America," he added.

Covestro (India) sets up new unit in Ankleshwar

Mumbai, India: Covestro (India) Private Limited, one of the leading manufacturers of high-performance polymers, has inaugurated a Trimer production facility at its Ankleshwar site in the state of Gujarat. The facility is the first of its kind in India and is a testament to Covestro India's commitment to the 'Make in India' initiative, bolstering local manufacturing capabilities and contributing to India's position as a global manufacturing hub.

The new unit will manufacture a comprehensive range of Desmodur ultra trimer products, used in automotive, construction, wooden furniture, consumer electronics and more. Covestro aims to meet the growing demand for high-performance and sustainable solutions in coatings and adhesives industry across the Asia Pacific region. ■

“Adoption of AI and cloud computing in water and wastewater treatment sector is set to grow rapidly”

The integration of Artificial Intelligence (AI) and Cloud Computing (CC) into water and wastewater treatment products is revolutionizing the industry. Real-time monitoring and AI-enhanced analysis through cloud platforms enable continuous tracking of water quality and system performance, with predictive analytics facilitating proactive maintenance and minimizing downtime. In an exclusive interview with *Chemical Engineering World*, **Dr. Bijal Sanghvi, Managing Director, Axis Solutions Pvt. Ltd,** discusses the role of AI and CC in the growth of water and wastewater treatment industry and how the company is gearing up to reap its benefits.

DR. BIJAL SANGHVI
Managing Director
Axis Solutions Pvt. Ltd.

How would you describe the growth of the water and wastewater treatment industry in India over the years?

The Indian water and wastewater treatment industry has experienced notable growth and transformation, driven by several key factors. As India grapples with severe water scarcity — only 4 per cent of the world’s water resources support 18 per cent of the global population — there is an urgent need for advanced water management solutions. This scarcity has intensified environmental concerns and led to stricter regulations aimed at ensuring safe drinking water and effective wastewater management.

Technological advancements have played a crucial role in this evolution. The industry has integrated cutting-edge technologies such as membrane filtration, biological treatment processes, and advanced oxidation methods to enhance treatment efficiency and effectiveness.

Additionally, smart water technologies leveraging Internet of Things (IoT), AI, and data analytics have improved monitoring, control, and decision-making in water systems, leading to more efficient and proactive management.

Investment in infrastructure has been substantial, with both government and private sectors investing heavily in modernizing and expanding water treatment facilities, pipelines, and distribution networks. Sustainability has become a central focus, with increasing efforts towards water reuse, resource recovery from wastewater, and the adoption of greener technologies. These initiatives aim to minimize the environmental impact of water treatment processes and promote more sustainable practices.

Overall, the growth of India's water and wastewater treatment industry reflects a comprehensive approach to addressing water scarcity, enhancing treatment technologies, investing in infrastructure, and adopting sustainable practices to meet the pressing demands of a rapidly changing environment.

What are the challenges faced by this industry?

The water and wastewater industry faces a range of significant challenges that impact its efficiency and effectiveness. Ageing infrastructure is a major concern, leading to frequent leaks and costly breakdowns, while maintaining high water quality is increasingly difficult due to contaminants like pharmaceuticals and micro plastics. Compliance with stringent regulations adds complexity and risk, with non-compliance potentially resulting in hefty fines and public health issues. Resource scarcity, driven by population growth, urbanization, and climate change, intensifies competition for limited water supplies. Integrating new technologies, such as AI and IoT for digital water management, offers opportunities for improved efficiency but requires substantial investment and training. Additionally, engaging the public in water conservation efforts remains a challenge, and the industry's growing reliance on digital solutions heightens its vulnerability to cybersecurity threats. Overcoming these obstacles demands a collaborative approach involving government, industry, technology developers, and the community to ensure sustainable and resilient water management.

Could you throw more light on Axis Solutions' water analysers?

Axis Solutions provides solutions to measure various parameters of drinking water, sewage water, and effluent water, such as pH, chlorine, turbidity, dissolved oxygen, Oxidation Reduction Potential (ORP), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), etc., using digital technologies, including IoT, cloud, and data processing. This makes water systems more efficient and sustainable. Optimizing water usage is a growing concern for industries and institutions worldwide. Advanced AI, Machine Learning (ML), and digital twin technologies are used to detect water leakages and predict situations in water networks.

All components of our analysers are manufactured by Axis, including sensors for turbidity, chlorine, and pH, as well as data transmitters. Utilizing the latest technology, our sensors deliver high accuracy, long life, and are offered at a low cost. We have developed analyser models that operate in areas without electricity by utilizing solar power. These analysers are ideal for installation in remote locations where continuous electrical supply is not available.

Industries are urged to maintain Zero Liquid Discharge (ZLD) whenever possible, enhance technology to reduce wastewater output, reuse wastewater, and recycle wastewater, where Axis is giving solutions to check ZLD system along with the Pan-Tilt-Zoom (PTZ) camera and online analyser with IOT enabled system.

Rainwater harvesting is a very effective method of conserving natural water and replenishing the groundwater level. In this method of conservation of water, the rain water is collected and allowed to percolate into a deep pit or a reservoir, so that it seeps down and improves the ground water table, where Axis is giving solutions to measure all the water parameters for the ground water as well as reservoir water.

Water Conservation Campaigns and Schemes like Jal Jeevan Mission (JJM) helps in water conservation in India, where Axis is giving solutions for the pH, turbidity, chlorine analysers along with the chlorine dosing system.

How would you describe the integration of Artificial Intelligence (AI) and Cloud Computing (CC) into your products?

The integration of AI and CC into water and wastewater treatment products is revolutionizing the industry by significantly enhancing operational efficiency and decision-making. Real-time monitoring and AI-enhanced analysis through cloud platforms enable continuous tracking of water quality and system performance, with predictive analytics facilitating proactive maintenance and minimizing downtime. AI-driven insights optimize treatment processes, improving resource allocation, energy use, and sustainability efforts. Cloud computing provides scalable, flexible solutions for data storage and processing, allowing remote management and integrated risk assessment. These technologies collectively enable more efficient resource recovery, better emergency response, and reduced environmental impact, positioning utilities to effectively meet future demands and regulatory requirements. As technology advances, the collaboration of engineers, tech developers, and policy makers will be crucial for leveraging AI and cloud computing to address emerging challenges in water management.

How do you foresee the growth of adaptation of artificial intelligence and cloud computing in this industry? To what extent will this help in improving efficiency and at the same time maximizing profits?

The adoption of AI and cloud computing in the water and wastewater industry is set to grow rapidly, driven by increasing investments and awareness. These technologies will enhance efficiency by enabling predictive maintenance, optimizing operations, and improving energy management. AI will facilitate cost savings and identify new revenue opportunities through resource recovery, while cloud computing provides scalable infrastructure for future growth. This integration will boost profitability by reducing operational costs, improving resource management, and enhancing customer engagement. Additionally, AI will help address climate resilience and regulatory compliance challenges, contributing to more sustainable and adaptable water management systems.

What are the future plans of Axis Solutions?

Axis is planning to enhance the use of AI and Machine Learning technologies for predictive analysis of water parameters and various fault conditions. This will enable clients to manage analytical systems in remote locations effectively. Additionally, it will benefit the process industry, where critical parameter values require proactive actions to prevent failures.

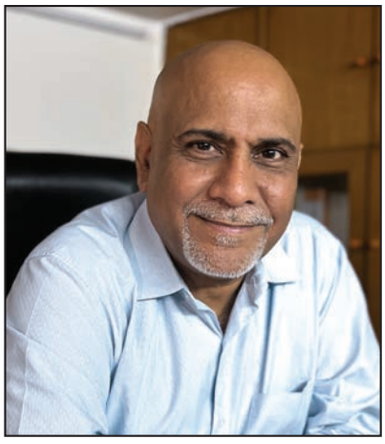
We will also be providing complete solution for water industry data analysis and automation with different analysers, pressure, level and flow transmitters, cloud and data monitoring system. It is also our plan to integrate various dosing systems, with our analyser. Axis analyser will generate output with the use of Proportional-Integral-Derivative (PID) control which will again control dosing system to keep the parameter value at specified set point. We want our products to be 'Made in India' and world class and will be exporting to other countries.

Can you share a recent case study of Axis Solutions?

Axis is doing project in the field of Water Conservation Campaigns and Schemes like Jal Jeevan Mission (JJM), PM Krishi Sinchayee Yojna, Sahi Fasal campaign, Mission Amrit Sarovar, etc., which helps in water conservation in India.

The Jal Jeevan Mission's ambition to bring safe drinking water to all rural households is likely to be highly valuable, preventing around 1,36,000 child deaths annually. The water management trends and startups outlined in this report only scratch the surface of trends that we identified during our data-driven innovation and startup scouting process. Among others, decentralized grid, water recovery, and desalination will transform the sector as we know it today. Identifying new opportunities and emerging technologies to implement into our business goes a long way in gaining a competitive advantage. ■

Cutting-Edge Trends in Wastewater Treatment: Advanced Oxidation Processes



Prof. Lalit Vashishta
CEO-Founder
Diva Envitec Pvt Ltd

The increasing demand for sustainable water management solutions has placed wastewater treatment at the forefront of environmental concerns. As industries expand and urbanisation accelerates, the need for efficient treatment of diverse and complex wastewater streams has never been more pressing. Among the various methods being developed to address this challenge, Advanced Oxidation Processes (AOP) stands out as one of the most promising approaches. **Professor Lalit Vashishta, CEO-Founder, Diva Envitec Pvt Ltd,** throws more light on the innovative AOP techniques highlighting their principles, advantages, limitations, and future prospects in reviving water sustainably.

The complexity of wastewater treatment is driven by a multitude of challenges. Key among these are the diverse characteristics of wastewater, which arise from various sources contributing distinct contaminants, complicating uniform treatment efforts. The variable composition of effluent, characterised by fluctuations in pollutant loads, necessitates adaptable treatment solutions that can respond dynamically. The shocks in the system with high toxicity, disturbs the biological systems, disrupting the complete process. High Total Dissolved Solids (TDS) present another obstacle, as elevated osmotic pressure can impede treatment efficiency, requiring specialised methods.

The highly variable pH in wastewater can significantly impact the effectiveness of treatment processes. Compounding these challenges is the high toxic and refractory Chemical Oxygen Demand (COD) posed by persistent organic pollutants, which often elude conventional treatment methods. Non-biodegradable organic pollutants add another layer of complexity, as many contaminants resist degradation. The issues related to the performance of Moving Bed Biofilm Reactors (MBBR) highlight the limitations of biological treatment systems in the face of high TDS and toxicity.

Operational disruptions, including unplanned shutdowns and inconsistent treatment, can also lead to untreated effluent discharges, compromising environmental standards. Given these complexities, traditional biological treatment methods frequently prove inadequate, underscoring the urgent need for more robust alternatives such as AOP.

Understanding Advanced Oxidation Processes

Advanced Oxidation Processes encompass a suite of chemical treatment techniques designed to generate highly reactive hydroxyl radicals (·OH) and other Reactive Oxygen Species (ROS). These reactive agents are critical for the oxidation and breakdown of complex organic and inorganic pollutants in water. AOP is characterised by two essential features:

High Oxidation Potential: AOP systems produce strong oxidising agents, including hydroxyl radicals, which are recognized for their exceptional oxidation capabilities. This high oxidation potential enables rapid and effective degradation of stubborn contaminants.

Non-Selective Nature: AOP methods are inherently non-selective, allowing them to effectively target a wide range of pollutants, including micro-pollutants like pharmaceuticals, pesticides, and agrochemicals. This broad-spectrum efficacy makes AOP a highly attractive option when conventional methods fail to deliver satisfactory results.

Role of AOP in Wastewater Treatment

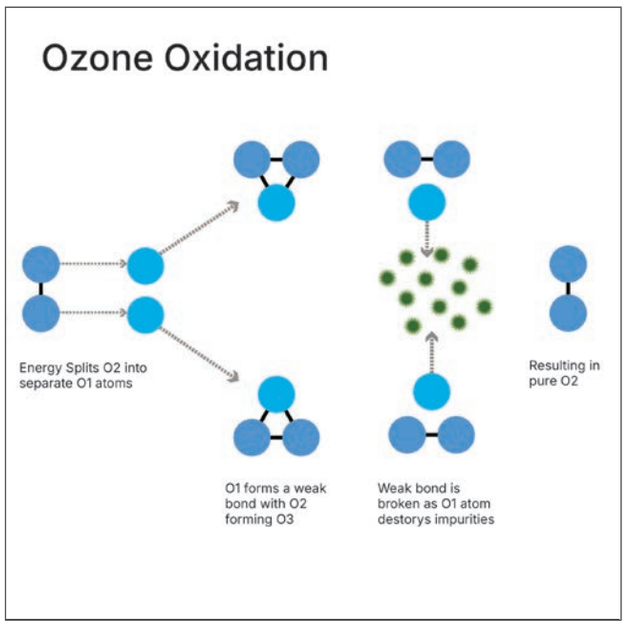
AOP has gained prominence for its ability to address specific challenges in wastewater treatment, particularly concerning recalcitrant and toxic COD. The demand for AOP arises in scenarios where traditional biological treatment methods fall short, with the primary goal being the in-situ generation of oxidants such as hydroxyl radicals and reactive oxygen species.

Key Types of Advanced Oxidation Processes

AOP can be categorised into two main types: homogeneous and heterogeneous processes, each characterized by distinct mechanisms and applications.

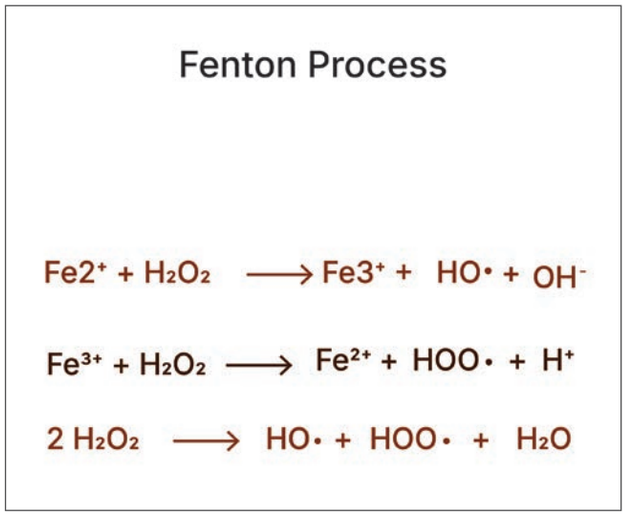
Homogeneous Processes: These processes utilise oxidants like hydrogen peroxide (H_2O_2) or ozone (O_3) to degrade pollutants.

Hydrogen Peroxide/Ozone Oxidation: This method involves the addition of hydrogen peroxide or ozone to the wastewater. The oxidants react with organic contaminants, breaking them down into simpler, less harmful substances. The effectiveness of this process largely depends on the concentration and ratio of hydrogen peroxide to ozone. Careful dosing is crucial, as excessive concentrations can lead to safety hazards and the formation of by-products that may complicate treatment.

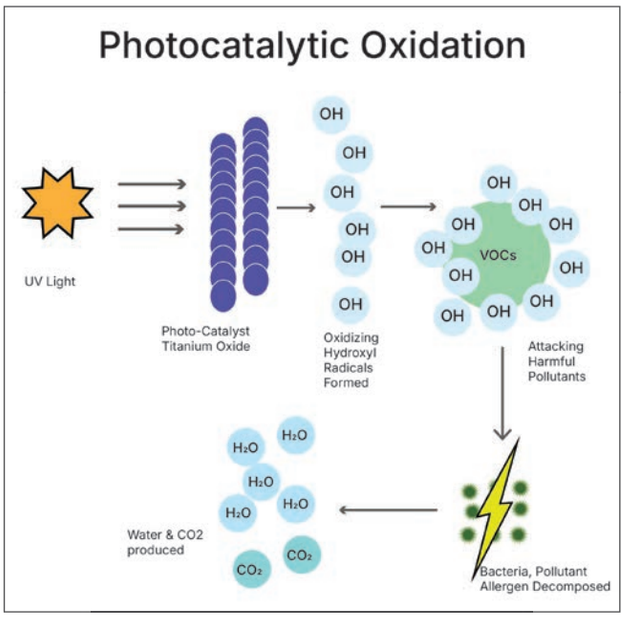


Fenton Process: This widely adopted method combines hydrogen peroxide with iron salts (such as ferrous sulfate) to generate hydroxyl radicals. The generated hydroxyl radicals are highly reactive and can oxidize various organic pollutants, making the Fenton process particularly effective for wastewater containing phenolic compounds, dyes, and other recalcitrant substances. The process operates best under acidic conditions (pH 2-4), which can limit its application in certain scenarios.

Heterogeneous Processes: These processes employ solid catalysts to facilitate pollutant degradation.

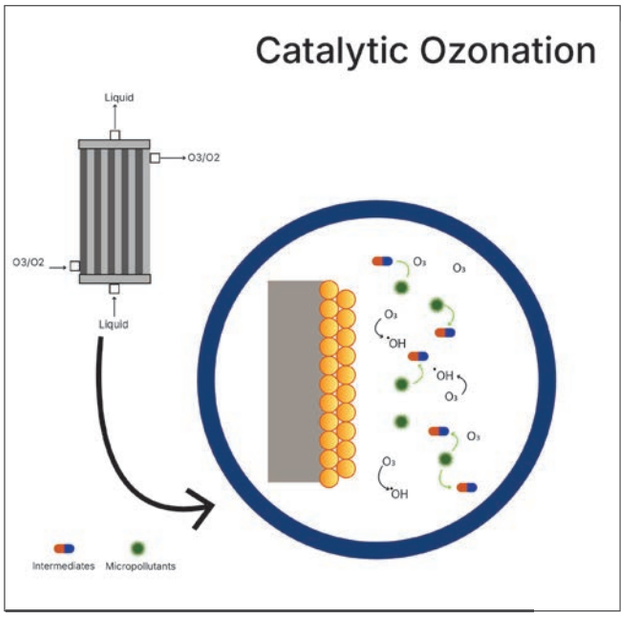


Photocatalytic Oxidation: In this method, a photocatalyst (commonly titanium dioxide, TiO_2) is activated by UV light. The activated catalyst generates hydroxyl radicals from water and reacts with organic pollutants, leading to their degradation. Photocatalytic oxidation is effective against a wide range of contaminants, including dyes



and pharmaceuticals. However, its effectiveness can be limited in environments with low light penetration or when contaminants absorb UV light.

Catalytic Ozonation: This process combines ozonation with solid catalysts to enhance pollutant degradation. The catalyst accelerates the decomposition of ozone into hydroxyl radicals, improving the overall efficiency



of the oxidation process. This method is particularly advantageous for treating wastewater with high organic loads, as the catalysts can be reused, reducing operational costs.

Emerging AOP Technologies

Several innovative AOP technologies are being explored to enhance wastewater treatment efficiency:

Plasma Technology: This technique utilizes electrical discharge to generate reactive species such as hydroxyl radicals and ozone. Plasma treatment can effectively oxidize a wide range of contaminants, including pharmaceuticals and pesticides, without the need for additional reagents. The process is flexible and can be tailored to treat specific types of wastewater.

Sonication: This method employs ultrasound waves to create cavitation bubbles in the liquid medium. When these bubbles collapse, they produce localized high temperatures and pressures, leading to the generation of reactive species that can degrade organic pollutants. Sonication has shown promise in treating oily wastewater and emulsions, particularly in the food and petroleum industries.

Hydrodynamic Cavitation: This process uses high-pressure water jets to create vapor cavities, which then collapse violently, generating reactive radicals and shock waves. Hydrodynamic cavitation has been shown to enhance the degradation of organic pollutants and suspended solids, making it a versatile approach for treating complex wastewater streams.

The effectiveness of AOP in wastewater treatment is increasingly being demonstrated through various applications. For instance, an integrated treatment scheme involving membrane filtration and AOP has shown to significantly reduce operating costs compared to traditional methods while effectively lowering COD levels and ensuring compliance with discharge regulations.

Challenges and Limitations of AOP

Despite the compelling advantages of AOP, it is essential to recognize the challenges and limitations associated with its implementation. High capital and operating costs pose significant barriers, as AOP systems often require considerable investment for both

implementation and operation, particularly in terms of energy consumption and chemical reagents. The complex chemistry involved in AOP also necessitates skilled engineers and careful design considerations, complicating implementation.

Moreover, systems that utilize hydrogen peroxide must carefully monitor and manage residuals to ensure safety and compliance with environmental regulations. These challenges underline the need for ongoing research and innovation to optimize AOP technologies for wastewater treatment.

Future Directions and Innovations

The future of AOP in wastewater treatment holds great promise, with ongoing research and innovation propelling advancements in the field. Key areas of focus include process optimization to enhance efficiency and reduce costs through advanced design and integration. Combining AOP with biological and physical treatment methods can create comprehensive and holistic solutions. Sustainability considerations, such as exploring renewable energy sources and eco-friendly reagents, are also essential for increasing the sustainability of AOP systems.

Conclusion

As the global community grapples with the dual challenges of water scarcity and pollution, Advanced Oxidation Processes emerge as a viable path toward sustainable wastewater treatment. By harnessing the power of reactive species, AOP can effectively degrade complex contaminants that often elude traditional methods. While challenges persist, the ongoing development of innovative AOP technologies — coupled with collaborative efforts across the industry — holds the potential to transform wastewater treatment practices and secure a sustainable water future. ■

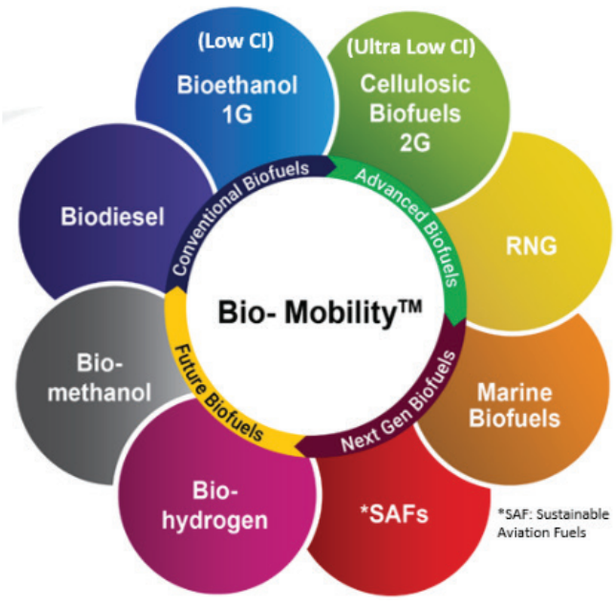
Harnessing the Power of Biofuels

Atul Mulay
President - Bioenergy, Praj Industries and
Chairman – Bioeconomy Committee, IFGE

Biofuels, as renewable and carbon-neutral energy sources, can reduce India's fossil fuel dependency. Biofuels emit fewer pollutants, improve air quality and public health, and stimulate rural economies by creating jobs and supporting local industries. **Atul Mulay, President - Bioenergy, Praj Industries and Chairman – Bioeconomy Committee, IFGE,** explores the challenges and impacts of climate change and how biofuels can mitigate its adverse effects.

The escalating climate crisis, driven by excessive fossil fuel consumption, presents a pressing global challenge. India, heavily reliant on oil imports, faces a dual challenge of energy security and environmental sustainability. India's reliance on oil imports, amounting to 232.5 million metric tonnes in 2023-24, contributes significantly to its greenhouse gas emissions, which increased by 190 million tonnes in the same year. Biofuels, derived from renewable organic resources, offer a sustainable solution to address these challenges. By replacing fossil fuels with biofuels, India can reduce its dependence on imports, lower greenhouse gas emissions, and promote a cleaner and healthier environment. Biofuels also contribute to rural development and job creation, providing economic opportunities for farmers and rural communities. Moreover, biofuels can be seamlessly integrated into existing energy infrastructure, making the transition from fossil fuels relatively straightforward.

They offer a climate-friendly solution by balancing the CO_2 emitted during combustion with the amount absorbed by plants. Investing in biofuels can reduce greenhouse gas emissions, promote economic growth, and support environmental conservation.



Bio-Mobility Technology Platform

Bio-Mobility Platform

Praj Industries, pioneer in developing advanced biofuel technologies, has introduced Bio-Mobility™ advanced technology portfolio, with the help of which fossil fuels are replaced with the bio-based renewable fuels.

The Bio-Mobility™ platform champions the use of renewable resources to produce low-carbon transportation fuels across all modes of mobility - land, air and sea. This platform includes the following:

Bioethanol

- **Low-carbon bioethanol:** It is derived from sugar and starch-based feedstocks such as B & C molasses, sugarcane juice, cassava, grains, and sugar beet.

- **Ultra-low carbon Intensity (CI) bioethanol:** Ultra low CI ethanol, also known as cellulosic ethanol (2nd generation), is produced from non-food sources like agricultural residues, forestry waste, energy crops, etc. Praj Industries has commercialized two technologies: Enfinity® and Celluniti™. Enfinity® is designed for processing agricultural residues like wheat straw, rice straw, corn stover, and bagasse, as well as energy crops, hardwood. Celluniti™, developed in collaboration with Sweden's Sekab, is optimized for non-food softwood feedstocks like pine and spruce. Both technologies support decarbonization in road transportation and the chemical industry by serving as the foundation for biorefineries that produce advanced bioethanol, cellulosic sugars, and valuable by-products like lignin and biogenic CO_2 from sustainable, non-edible feedstocks.

Praj's proprietary enfinity® technology has been scaled up for commercial use, with Praj establishing three large-scale plants in collaboration with Fortune 500 companies - Indian Oil Corporation Limited (IOCL), Hindustan Petroleum Corporation Limited and Bharat Petroleum Corporation Limited. The IOCL plant is already operational, and the other two facilities are set to be commissioned within the next 6-9 months.

Ecodiezel™

Biodiesel is produced from used cooking oil, palm fatty acid, palm stearin, tallow, and other sources using enzymatic technology.

Compressed Biogas

Compressed Biogas (CBG), a renewable fuel produced via the anaerobic digestion of organic feedstocks, can be derived from both organized feedstocks (such as industrial byproducts like press mud and spent wash) and unorganized feedstocks (including agricultural residues like rice straw, cotton stalks, and cow dung).

CBG offers a sustainable solution for reducing CO_2emissions in both transportation and industry. By switching to CBG, businesses can lower costs and contribute to a cleaner environment.

A typical 20 TPD CBG plant brings significant environmental and economic advantages such as:

- **Reduced Emissions:** Slashes greenhouse gas emissions by a remarkable 70 per cent, saving an impressive 16,400 MT annually. Delhi's CNG policy signifies importance of the shift from the diesel to CNG. Delhi's annual average Particulate

Year	Delhi's annual average PM 2.5 concentration (µg/m^3)
Pre-CNG-conversion era	130
Mid-2010	120
2021–22	100

Matter (PM) 2.5 concentration in 2021–22 was improved to 100 µg/m³ compared to the pre-CNG-conversion era (130 µg/m³).

This signifies the GHG reduction potential of the CBG.

- **Clean Transportation:** Enables 300-420 trucks to operate daily on CBG, a cleaner-burning fuel source, potentially covering a massive 5.3 crore kilometres each year.
- **Diesel Displacement:** Effectively replaces up to 880 diesel trucks per year, promoting cleaner transportation solutions.

In essence, CBG offers a sustainable solution for both transportation and industrial sectors, promoting a cleaner and more cost-effective future.

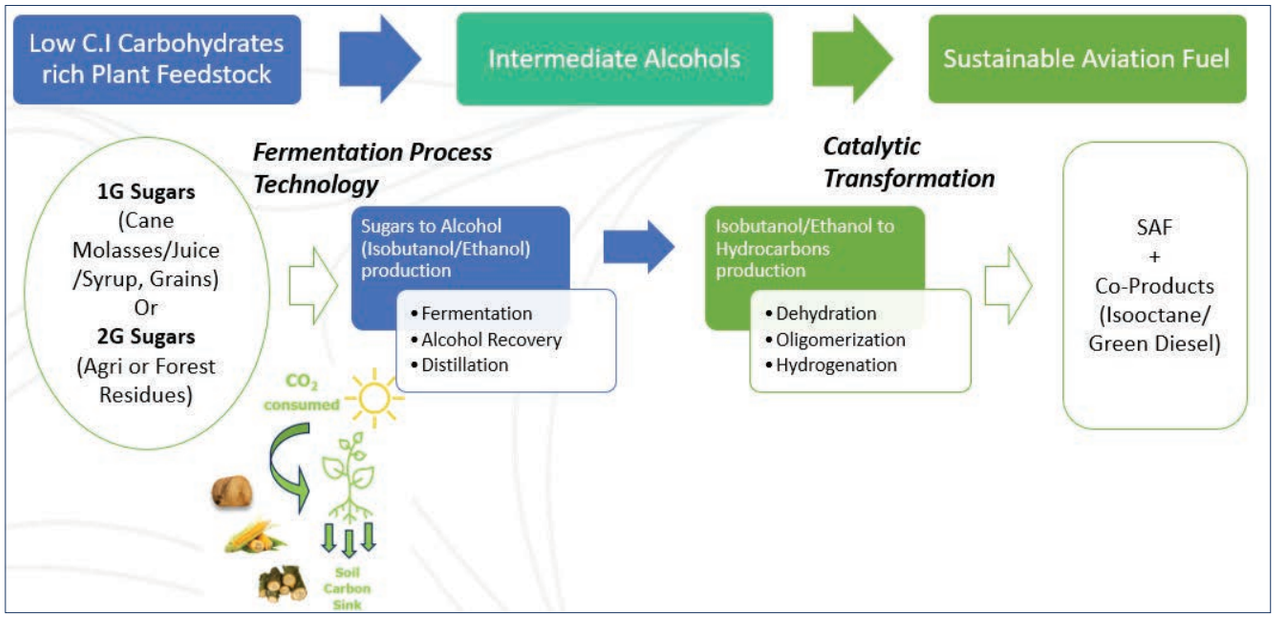
Sustainable Aviation Fuel

The aviation industry, which relies heavily on fossil fuels like Aviation Turbine Fuel (ATF), contributes significantly to global greenhouse gas emissions, with around 1 billion tons annually. To mitigate this impact, the industry is increasingly adopting Sustainable Aviation Fuel (SAF), a renewable alternative that mimics ATF but with cleaner combustion and fewer pollutants.

Fuel	Carbon Intensity (gCO_2e/MJ)
Gasoline	92
Bioethanol (1st generation - from molasses)	31
Bioethanol (2nd generation - from rice straw)	17
Jet A/A1 fuel	89
SAF [from ethanol (sugarcane)]	32.6

India's robust agricultural sector offers abundant feedstocks, such as crop residues, cane molasses, and surplus grains, for producing biofuels like ethanol and SAF, which have a lower carbon intensity than traditional fossil fuels. As aviation evolves, SAF and other biofuels provide a sustainable, eco-friendly way to reduce the industry's carbon footprint. The table below illustrates the lower carbon intensity of biofuels compared to fossil fuels.

Praj Industries has developed an Alcohol-to-Jet (ATJ) technology in collaboration with the Axens for the production of SAF using bio-based feedstock. SAF is produced from ethanol via Ethanol to Jet (ETJ) pathway using this technology. Producing and using SAF in India to reach 10 per cent blend in all domestic flights could significantly boost the economy, adding around USD 2.8 billion to GDP annually from 360,000 tons of SAF. This initiative would raise farmers' incomes,



Alcohol-to-Jet technology

strengthen energy security, create rural jobs, improve waste management, and reduce open-air burning, leading to cleaner skies.

Next-gen Biofuels

Marine Biofuels, and future fuels such as Bio-methanol and Bio-Hydrogen are also key components of Praj's next-generation biofuels portfolio.

Socioeconomic and Environmental Benefits of Biofuels

Biofuels, made from renewable organic resources, offer benefits that go beyond energy production, impacting social well-being, economic growth, and environmental sustainability.

Economic Benefits:

- **Job Creation:** The biofuels industry creates jobs across the entire value chain, especially benefiting rural areas by stimulating local economies.
- **Rural Development:** Biofuel facilities attract investment in rural regions, leading to infrastructure improvements and better access to essential services.

Environmental Benefits:

- **Reduced Emissions:** Biofuels produce significantly lower greenhouse gas emissions than fossil fuels, helping combat climate change and improve air quality.
- **Waste Management:** Converting agricultural residues and waste into biofuels reduces the need for open burning, enhancing air quality and soil health.

Societal Benefits:

- **Energy Security:** Domestic biofuel production decreases reliance on imported fossil fuels, boosting energy independence and reducing supply risks.
- **Foreign Exchange Savings:** By cutting down on foreign oil imports, biofuels help save valuable foreign exchange.

Biofuels offer a sustainable, multifaceted solution that promotes economic growth, improves livelihoods, and reduces environmental impact, contributing to a more sustainable and equitable future.

Challenges and Path Forward

To unlock the full potential of bioenergy, we must overcome key challenges. This necessitates a shift towards non-food feedstocks, fostering waste-to-energy solutions, and safeguarding natural habitats. Collaborative efforts among governments, industries, and research institutions are vital. Investing in research and supportive policies, coupled with a holistic approach that considers social, economic, and environmental factors, is essential for realizing a sustainable bioenergy future.

Conclusion

In the face of escalating climate challenges and India's heavy reliance on fossil fuels, biofuels present a transformative solution. With their potential to reduce greenhouse gas emissions, enhance energy security, and drive economic growth, biofuels, especially advanced options like Sustainable Aviation Fuel (SAF) and Compressed Biogas (CBG), are pivotal in the transition to a cleaner and more sustainable energy future. By embracing biofuels, India can not only reduce its carbon footprint but also pave the way for a more resilient and equitable future. The journey towards sustainable energy is challenging, but with continued innovation, investment, and collaboration, biofuels can lead the way to a cleaner, greener world. ■

Desalination: Water Solutions for India

Despite abundant freshwater resources, India continues to grapple with water shortages. Frequent droughts caused by changing weather patterns have worsened the situation. The ongoing heat wave this summer has led to severe water shortages in many Indian cities. Furthermore, rapid urbanization has resulted in increased water demand and, as a consequence, many cities are facing water supply and distribution problems, further exacerbating the issue of water shortages. Adoption of seawater desalination is proving to be an effective method to address water shortage crisis. **B.B. Singh, Sales Director, Water Systems Division, NSF Asia-Pacific,** shares further insights about this process.

In light of growing water scarcity, it is vital to adopt water conservation and efficient management practices. Key current trends involve water treatment and purification technologies like wastewater reuse, rainwater harvesting and desalination of seawater. In the next 5-10 years, sustainable water reuse and recycling technologies will be essential to fulfill the increasing need for clean water.

Currently, several countries have effectively addressed water scarcity. India could benefit from studying the successful experiences of these countries. One key strategy they leverage is the adoption of seawater desalination technology to secure a reliable source of water.

Desalination is the process of using technology to obtain fresh water with low salt content from seawater for daily use and production. This technique has ancient origins, with people historically using simple heating and condensation methods to obtain fresh water from salt water. Over time, technological advancements have greatly improved this basic thermal desalination process.

Reverse Osmosis Filtration Desalination Technology

Currently, reverse osmosis filtration is the most widely used desalination technology. It involves the use of a semipermeable membrane to separate salt and other impurities from seawater. In this process, seawater is pressurized through a semipermeable membrane, allowing salts and impurities to be filtered out, while freshwater passes through the membrane pores, ultimately resulting in fresh water.

However, reverse osmosis filtration technology also faces some challenges, such as membrane fouling and maintenance issues. The membranes used in reverse osmosis filtration technology may become contaminated and worn, requiring regular cleaning and replacement, resulting in increased maintenance costs. Therefore, the development of more durable membranes is necessary to reduce costs and enhance usage efficiency. Additionally, treating seawater presents another challenge due to the high concentrations of salt, which can have negative environmental impacts when discharged back into the ocean.

Current approaches to overcoming these challenges include:

Pre-Treatment: This is the first step in desalination, which involves removing large particle impurities, sediments, suspended solids, and microorganisms from the seawater. Methods used include carbon filters, microfiltration, and sand filters. This step is crucial to protect the membranes and ensure they do not get fouled.

Pressurization: Seawater is pressurized to a level higher than that of seawater itself, allowing it to pass through the reverse osmosis membrane. This value is usually between 55 and 82 Pa (800 to 1200 psi) (World Resources Institute).

Membrane Filtration: This process involves water passing through a semipermeable membrane,

Desalination technology offers a practical solution by converting abundant marine resources into valuable freshwater resources to fulfill people's daily and industrial water needs.

separating water molecules from impurities such as salt. This allows only water molecules to pass through, while salt and other impurities are left on one side.

Post-Treatment: After the water passes through the semipermeable membrane, essential minerals are added back to adjust the pH of the water for consumption. This is important not only for improving the taste, but also for ensuring that the water meets safety standards.

Thermal Desalination Technology

Thermal desalination is achieved through the processes of evaporation and condensation. The water is heated until it reaches its saturation temperature, causing evaporation while leaving the salt behind. The vapor is then removed and condensed into fresh water using another heat exchanger. It is practical for regions with low-cost energy sources and has the potential for enhanced sustainability and efficiency using solar, hybrid, and geothermal systems in the future, though these methods are still being explored. Additionally, thermal desalination is reliable in treating high-salinity water.

The most common thermal desalination processes are:

Multi-effect Desalination (MED): In this process, seawater is evaporated in one or more (up to 14) stages at a low temperature (<70°C) to produce clean distillate water.

Multi-stage Flashing (MSF): This desalination process distills sea water by flashing a portion of the water into steam in multiple stages using counter current heat exchangers.

Development of New Technologies for Desalination

The two common desalination technologies mentioned above are widely used, but researchers continue to investigate more sustainable desalination methods.

State-of-the-art technology is being utilized at the desalination plant in India. According to a report, the plant uses gravity dual media filters, which are advanced mechanisms that effectively reduce total suspended solids and organic carbon.

To achieve sustainable energy use, efforts are being made to develop and utilize renewable energy sources like wind, solar, and geothermal energy to power reverse osmosis and thermal seawater desalination technologies. Additionally, scientists are actively researching new advanced membrane materials, such as bionic membranes and graphene-based materials, to improve the efficiency of water treatment and reduce pollution levels, thus aiding in the efficient use of water resources and environmental protection.

Furthermore, the integration of artificial intelligence is expected to enhance the effectiveness and reliability of renewable energy desalination systems. By using predictive models, optimization algorithms and advanced control systems, the efficiency and sustainability of these systems can be improved.

The significance and potential of desalination technology for India are clear. India, with its extensive coastline, is facing an increasingly serious shortage of freshwater resources due to population growth and industrialization. Desalination technology offers a practical solution by converting abundant marine resources into valuable freshwater resources to fulfill people's daily and industrial water needs. With ongoing technological advancements and policy support, it is anticipated that India will achieve significant progress in seawater desalination and contribute to the sustainable management of global water resources. ■

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Water & Wastewater Treatment in India: Technologies & Opportunities

Population increase, industrial expansion, and inadequate infrastructure all pose substantial problems to India's wastewater management. A significant volume of home, industrial, and agricultural wastewater is dumped into rivers and bodies of water without proper treatment. This unregulated discharge pollutes the water, degrades the soil, and poses serious health hazards. Proper wastewater management is critical for public health, environmental protection, and long-term water resource sustainability. **Anamika Mani, Manager - Communication and Branding, BDB India Private Limited,** shares detailed insights about water and wastewater treatment market in India.

The India Water and Wastewater Treatment (WWT) market is predicted to expand to over USD 1 billion in 2025, with a compound yearly growth rate (CAGR) of 10 per cent, reaching approximately USD 2 billion by 2030. This market is made up of several different components and divisions, including treatment services, pumps, valves, tanks, automation products and advanced water treatment and disinfection technologies.

Wastewater treatment is a crucial issue in India due to rising urbanization, industrialization, and population increase. It becomes all the more important due to the following factors:

Regulatory Compliance: Adherence to stringent environmental regulations set by bodies like the Central Pollution Control Board and state pollution control boards.

Importance of Industrial Water Treatment

Water Resource Management: Optimizing water use and reducing wastage.

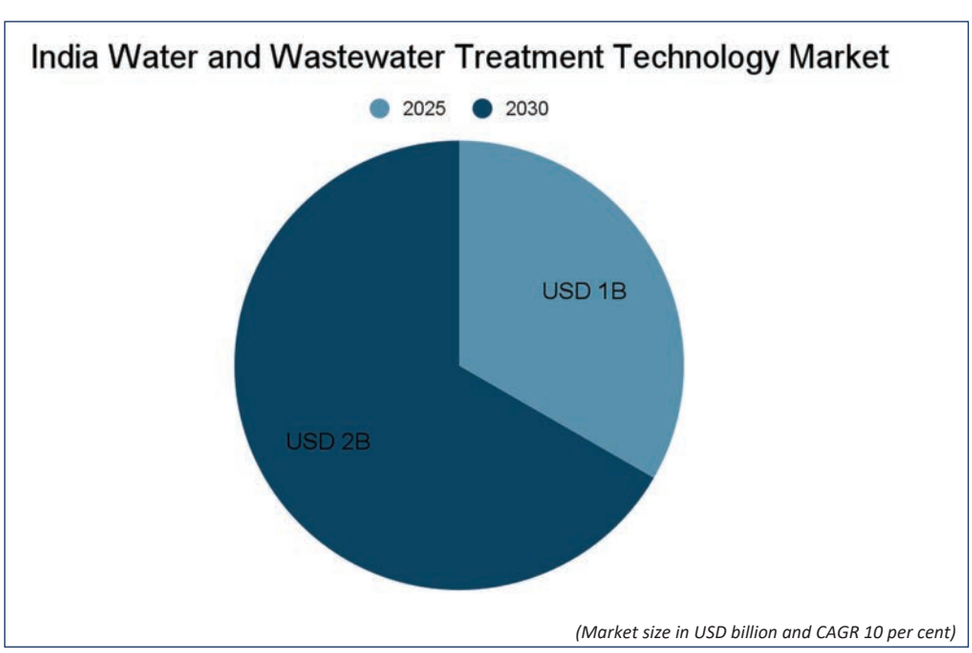
Operational Efficiency: Ensuring smooth industrial processes by providing clean water and managing wastewater effectively.

Environmental Protection: Preventing pollution and safeguarding natural water bodies.

Types of Industrial Wastewater

The various types of industrial wastewater are as follows:

Process Wastewater: Generated from industrial processes such as manufacturing, cleaningm and cooling, it often contains chemicals, heavy metals, and organic pollutants.



(Market size in USD billion and CAGR 10 per cent)

Cooling Water: Used to cool machinery and processes. While it may be less contaminated, it still requires treatment to remove heat and any dissolved substances.

Storm Water Runoff: Water from rain or snowmelt that flows over industrial sites, potentially picking up pollutants from surfaces.

Common Contaminants in Industrial Wastewater

The common contaminants in industrial wastewater are as follows:

Organic Compounds: Including oils, greases, and solvents.

Heavy Metals: Such as lead, mercury, cadmium, and chromium.

Nutrients: Nitrogen and phosphorus, which can cause eutrophication in water bodies.

Suspended Solids: Particles that can clog waterways and harm aquatic life.

Pathogens: Microorganisms that can pose health risks.

Current State of Industrial Wastewater Treatment in India

A brief outlook of the current state of industrial wastewater treatment in India in terms of existing treatment infrastructure; operational efficiency and compliance and enforcement is as follows:

1. Existing Treatment Infrastructure:

Technology Adoption:

- Activated sludge process, anaerobic digestion, and trickling filters are some conventional treatment technologies.
- Advanced treatment technologies like Membrane Bioreactors (MBRs), Reverse Osmosis (RO), and Advanced Oxidation Processes (AOPs) are being increasingly adopted, especially in high-pollution industries.

Capacity and Utilization:

- While there is significant capacity installed for wastewater treatment, actual utilization often lags due to operational inefficiencies.
- Factors such as poor maintenance, inadequate technical expertise, and intermittent operation contribute to underutilization.

2. Operational Efficiency:

- Implementation of continuous monitoring systems helps in maintaining operational efficiency.
- Training programs for plant operators and managers to enhance their technical skills.
- Adoption of energy-efficient technologies and practices.
- Increasing use of automation and Internet of Things (IoT) for real-time monitoring and control.
- Deployment of small-scale, decentralized treatment units in remote industrial areas.

3. Compliance and Enforcement: This includes regulatory framework, enforcement mechanisms and challenges in enforcement.

Regulatory Framework:

- Industry-specific discharge standards set by the Central Pollution Control Board and State Pollution Control Boards (SPCBs).
- Mandatory for industries to obtain Consent to Establish (CTE) and Consent to Operate (CTO) from SPCBs.

Enforcement Mechanisms:

- Regular inspections by SPCBs to ensure compliance with effluent standards.
- Imposition of fines and, in severe cases, closure orders for non-compliant units.
- Increased involvement of local communities and Non-Governmental Organizations in monitoring and reporting violations.

Challenges in Enforcement:

- Limited resources and manpower of SPCBs hinder effective enforcement.
- Instances of administrative inefficiencies can undermine regulatory efforts.
- Ensuring the reliability and accuracy of self-reported data from industries remains a challenge.

Industrial Water Treatment Technologies

The various industrial water treatment technologies available comprise primary treatment, secondary treatment, tertiary treatment, zero liquid discharge and decentralized treatment systems, innovative and emerging technologies and industry-specific technologies. A brief insight into each one:

Primary Treatment: It involves the physical separation

of large particles and solids from wastewater. It includes the following steps:

- **Screening:** Removes large debris such as sticks, rags, and other solids.
- **Sedimentation:** Allows suspended solids to settle at the bottom of a tank.
- **Floatation:** Uses air bubbles to float lighter solids to the surface for removal.

Secondary Treatment: Secondary treatment focuses on the biological degradation of dissolved organic matter such as:

- Utilizes microorganisms in an aeration tank to break down organic matter.
- Wastewater is sprayed over a bed of media where biofilms of microorganisms degrade pollutants.
- Large ponds where air is added to promote microbial activity.
- Sequencing Batch Reactors (SBRs) is a variation of the activated sludge process that treats wastewater in batches.

Tertiary Treatment: Tertiary treatment involves advanced processes to remove remaining contaminants after primary and secondary treatment.

- It Includes microfiltration, ultrafiltration, nanofiltration, and reverse osmosis (RO) to remove fine particles and dissolved salts.
- Uses activated carbon to adsorb organic compounds and pollutants.
- Involves the generation of highly reactive radicals to degrade pollutants. Common Advanced Oxidation Processes (AOPs) include ozone treatment, hydrogen peroxide, and UV radiation.
- Is used to remove specific ions from wastewater, often applied for water softening and demineralization.

Zero Liquid Discharge (ZLD): ZLD is a holistic approach that aims to eliminate liquid waste discharge by recovering and reusing all water within the industrial process.

- Evaporation uses thermal or mechanical means to evaporate water, leaving behind solid residues.
- Crystallization converts dissolved salts into solid crystals for removal.
- RO and Multiple Effect Evaporators (MEEs) are combined systems that concentrate brine and recover water for reuse.

Decentralized Treatment Systems: These are smaller, localized treatment units suitable for individual industries or small clusters. Prefabricated units that offer plug-and-play solutions for wastewater treatment. They use natural processes involving wetland vegetation, soil, and microbial communities to treat wastewater.

Innovative and Emerging Technologies: These comprise electrocoagulation, which uses electrical currents to remove suspended solids, oils, and heavy metals; Advanced bioreactors like Moving Bed Biofilm Reactors (MBBRs) and Membrane Bioreactors (MBRs) offer higher efficiency in treating complex effluents and anaerobic treatment employs anaerobic microorganisms to degrade organic matter, producing biogas as a byproduct. Common technologies include Upflow Anaerobic Sludge Blanket (UASB) and Anaerobic Digestion (AD).

Industry-Specific Technologies: Certain industries require specialized treatment processes due to the unique nature of their effluents. For example, textile industry uses specific treatments like biological treatment, coagulation-flocculation, and advanced oxidation to remove dyes and chemicals. The pharmaceutical industry employs advanced oxidation, membrane bioreactors, and adsorption techniques to handle complex organic compounds and Active Pharmaceutical Ingredients (APIs), whereas the Food and Beverage Industry often uses biological treatment, membrane filtration, and anaerobic digestion to manage high organic load effluents.

India's industrial wastewater treatment sector is evolving with the adoption of advanced technologies and innovative solutions. However, there is still a need for increased investment, capacity building, and regulatory enforcement to achieve sustainable and efficient wastewater management across the country.

Water Treatment Industry: Opportunities

The water treatment industry in India is at a turning point in terms of development and opportunity. The industry offers bright opportunities for companies and investors as the nation struggles with the intricate landscape of industrial water and wastewater management.

Product Market Expansion

The business offers a multitude of opportunities due to the growing demand for efficient water solutions

and infrastructure upgrades, especially in the areas of products, turnkey projects, and services.

Pumps and Valves: The flow and control of water and wastewater are vital functions of pumps and valves, which are basic parts of water treatment systems. The need for high-quality, effective pumps and valves is growing as businesses and governments look to modernize or expand existing treatment facilities. Particularly sought after are innovations in pump technology, such as types that are corrosion-resistant and energy-efficient.

Automation Products: Automation is improving the efficiency and dependability of water treatment processes. Products for automation, such as sensors, control systems, and data analytics software, are necessary for managing and monitoring water treatment operations in real time. The demand for sophisticated automation solutions that can interface with current infrastructure and enhance operational performance is rising as the sector shifts to smart water systems.

Contamination Measurement Device and Chemicals: In industrial water and wastewater treatment, contamination measurement devices are crucial for monitoring and controlling the quality of water used in processes and the effluent discharged. Industrial operations often involve complex water chemistry, with various pollutants that need to be measured and controlled to ensure compliance with environmental regulations and to protect equipment from damage.

Products for Filtration: A crucial step in the treatment of wastewater and water is filtration. Advanced filtration products are in greater demand due to rising water contamination and strict quality regulations. To satisfy the demands of industrial and municipal applications, membrane technologies, activated carbon filters, and other high-performance filtration solutions are crucial.

Turnkey Projects: Turnkey projects are all-inclusive solutions that handle everything from engineering and design to building and upkeep are in high demand. Turnkey projects have a number of benefits such as:

- **Integrated Solutions:** Turnkey companies offer comprehensive services that guarantee the smooth integration of different parts and systems. This all-encompassing strategy aids in streamlining projects and increasing productivity.
- **Time and Cost Efficiency:** Turnkey suppliers who oversee every facet of a project can optimize workflows, cut expenses, and shorten schedules, which attracts clients seeking all-inclusive solutions.
- **Knowledge and Innovation:** Turnkey projects gain from the providers' specific knowledge and experience, since they are able to integrate the newest technologies and industry best practices into their solutions.

Service Opportunities

The wastewater treatment industry provides tremendous opportunities in the service sector through maintenance and improvements and counselling and guidance.

Maintenance and Improvements: The need for maintenance and upgrade services is increasing as technology advances and existing water treatment facilities get older. In order to guarantee the dependability and effectiveness of treatment systems, routine maintenance is essential. Furthermore, businesses with modernization services are well-positioned in the market to integrate new technology and boost performance.

Counseling and Guidance: There is a growing need for consulting services that offer professional advice on system design, operation, and optimization due to the complexity of water treatment systems.

Conclusion

India's water treatment industry presents a vibrant, opportunity-rich environment. Businesses can find great opportunities in supplying cutting-edge items including pumps, valves, automation systems, chemicals, and filtration technologies as the nation continues to tackle its water management issues. Furthermore, chances for expansion and innovation are provided by turnkey projects and service offerings.

Businesses may significantly contribute to the advancement of water treatment techniques in India by following market trends and concentrating on providing premium, long-lasting solutions. The sector is ripe for development and investment as it grows because of the enormous potential for both positive effect and commercial success. ■

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Maximizing Sustainability: Advantages of Zero Liquid Discharge

In an era marked by increasing environmental concerns and stringent regulatory frameworks, industries worldwide are under growing pressure to adopt sustainable practices. One such innovation gaining momentum is Zero Liquid Discharge (ZLD), a process designed to ensure that no liquid waste leaves the boundaries of a manufacturing or industrial facility. Instead, wastewater is treated, purified, and either reused within the facility or safely disposed of as solid waste. The shift towards ZLD offers industries a strategic pathway to reducing environmental footprints while optimizing operational efficiency. **Ajinkya Desai, Sagar Deshmukh** and **Aditya Sharma, Directors, Greenviro Environmental Systems,** share more details about zero liquid discharge.

Water is a critical resource for numerous industries, including power generation, textiles, pharmaceuticals, and chemical processing. However, escalating water scarcity, driven by climate change and overexploitation of natural resources, has intensified the need for responsible water management. Many regions worldwide are facing stricter water discharge regulations, compelling industries to re-evaluate their water use strategies.

Governments and environmental agencies are enforcing tighter wastewater discharge standards, especially in sectors with high water consumption. This has resulted in increased costs for industries, as penalties for non-compliance rise and the need for sophisticated water treatment systems grows. Against this backdrop, the adoption of ZLD systems becomes not only a compliance strategy but also a forward-thinking investment in sustainability.

Benefits of Zero Liquid Discharge

Regulatory Compliance: ZLD ensures that industries meet stringent environmental regulations regarding water discharge. This helps avoid hefty fines, legal

challenges, and reputational damage, positioning companies as leaders in environmental stewardship.

Water Conservation: By recycling and reusing water, ZLD systems drastically reduce freshwater intake, making industries more resilient to water shortages. This is especially beneficial in regions where water resources are scarce, allowing businesses to continue operations without disruptions.

Cost Efficiency: While the initial setup of ZLD systems may be expensive, the long-term benefits include significant cost savings. Reduced reliance on external water sources lowers utility costs, and industries can often recover valuable by-products from the wastewater, such as salts and minerals, which can be sold or reused.

Improved Environmental Footprint: ZLD drastically reduces the environmental impact of industrial operations by minimizing water pollution. This helps industries align with global sustainability goals, contributing to the overall health of ecosystems and communities.

Energy and Resource Recovery: Advanced ZLD technologies now offer energy-efficient solutions that enable industries to not only purify water but also recover energy and materials from the wastewater. This contributes to a circular economy model, reducing waste and promoting resource efficiency.

Role of Water Recycling in Industry Sustainability

Water recycling through ZLD is a game-changer for industries. It not only addresses the issue of water scarcity but also aligns with the growing corporate trend toward sustainability. By treating and reusing wastewater, industries can operate more efficiently, reducing their dependence on natural water sources and decreasing the environmental degradation associated with traditional water extraction methods.

Moreover, industries adopting ZLD technologies often witness improved community relations and enhanced brand reputation. Consumers and stakeholders today expect businesses to take proactive steps toward environmental responsibility. Adopting water recycling technologies like ZLD can demonstrate a company's commitment to sustainability, attracting customers and investors alike.

Conclusion: Strategic Shift Towards Sustainability

In an increasingly resource-constrained world, industries must embrace innovative solutions to maintain operational resilience while reducing environmental harm. Zero Liquid Discharge offers a clear pathway to achieving both goals, transforming wastewater from a liability into a valuable resource. As water scarcity and regulatory pressures intensify, industries that invest in ZLD and water recycling technologies are better positioned to thrive in the future.

Adopting ZLD is more than a compliance measure—it's a forward-looking strategy for industries aiming to reduce costs, conserve resources, and lead the charge in environmental responsibility. ■

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Importance of Chemicals in Water and Wastewater Treatment

Water treatment is a complex process that uses chemistry to ensure that water meets quality standards. For many businesses, wastewater treatment is a necessity. Governments have strict laws and regulations to prevent contaminated runoff flowing into the environment, and causing ecological harm. Thankfully, there is a range of different chemical processes and technological solutions which make treating wastewater safe, efficient, and cost effective. **Mala Mohini, Chief Operating Officer, EnviroWay Bioscience Pvt Ltd,** shares more details about the chemical treatment of wastewater.

Water treatment is a process of making water suitable for its application or returning its natural state. Thus, water treatment is required before and after its application. The required treatment depends on the application. For example, treatment of greywater (from bath, dish and wash water) differs from the black water (from flush toilets). Water treatment involves science, engineering, business, and art. The treatment may include mechanical, physical, biological, and chemical methods. As with any technology, science is the foundation, and engineering makes sure that the technology works as designed. The appearance and application of water is an art.

Chemical Treatment of Wastewater

'Chemical treatment' is an umbrella term that refers to a number of different ways of treating wastewater, and the chemicals used in wastewater treatment vary from method to method. For example, sodium hypochlorite, hydrochloric acid and magnesium hydroxide are used in different chemical treatments.

There are many specific ways of using chemicals to treat wastewater, including:

- Ion Exchange
- Chemical Stabilisation
- Chemical Precipitation
- Chemical Oxidation

Ion Exchange: Hard water is water that has raised mineral content, which can present a number of issues and difficulties. A chemical treatment solution for hard water is ion exchange, which results in the water being softened (eg: lowering the number of minerals present in the water). Positively charged ions are added to the mix by putting sodium chloride salt into the hard water. This causes a chemical reaction where sodium ions are released into the water, breaking up the calcium and magnesium ions that have caused the hardness of the water.

Chemical Stabilisation: This process involves oxidisation also, and is suited for sludge where biological growth is occurring. A large quantity of chlorine — or hydrogen peroxide — is added to the sludge. This slows down the biological growth, and also deodorises the substance. Then, the water can be taken out, and safely rerouted to the environment.

Chemical Precipitation: Chemical precipitation is the most widespread way to get rid of toxic metals that have dissolved into wastewater. A precipitation reagent is added, and the disparate particles take a solid form. These solids can then be filtered out. When choosing a precipitation reagent, people either go with calcium, or a sodium hydroxide water treatment process is used.

Chemical Oxidation: In chemical oxidation, an oxidising agent is added to the wastewater. Electrons travel from the oxidant to the pollution, modifying the structure of pollutants in the water, and making them less harmful. Advanced oxidation is a further step for removing organic compounds that might result as a by-product of the chemical oxidation process. This is achieved through activated carbon absorption, or air/steam stripping.

Chemicals Used in Various Water Treatment Processes

Water is the basis for all life on earth. A person can live without food for weeks but will not survive more than a few days without water. Although the earth has vast natural bodies of water, microorganisms (disease-causing pathogens), high mineral content, pollution can be found in many of them. As a result, an estimated 3.4 million people die annually due to a lack

of access to clean drinking water. Water is a renewable resource. All water treatments involve the removal of solids, bacteria, algae, plants, inorganic compounds, and organic compounds. Removal of solids is usually done by filtration and sediment. Bacteria digestion is an important process to remove harmful pollutants. Converting used water into environmentally acceptable water or even drinking water is wastewater treatment.

The chemicals used in each instance of water treatment depend upon the process utilized. Boiler water treatment and cooling water treatment help to prevent equipment degradation and limit the amount of fresh water needed, thus preserving water. Water purification and wastewater effluent treatment effectively remove contaminants and introduce or return it to the water cycle. In a combination of physical and chemical means, each of these treatments removes suspended solids, viruses, fungi, bacteria, algae, and harmful minerals from water sources making them safe for human usage, equipment and for the environment.

Boiler Water Treatment Chemicals and Solutions

Boiler water treatment is the process of managing water used for hot water heat exchange and steam generation in industrial and commercial steam and hot water heating systems. For boilers to remain in good condition the water needs to be treated with oxygen scavengers, alkalinity builders, and anti-scaling agents. Oxygen scavengers such as sulphite chemicals protect the boiler from destructive chemical reactions and reduce corrosion by passivating various metal surfaces which retards rust and other issues.

To prevent further corrosion, pH levels need to remain high using alkalinity builders, commonly hydroxides, to minimize the amount of acid attack causing thinning or localized corrosion and silica deposition. Often anti-scaling or water softening agents like sodium phosphate or soda ash (sodium carbonate) are used in addition to alkalinity builders to prevent deposition of hardness salts in boiler water. Scaling can cause the boiler to become much less efficient and may eventually cause enough build-up on tubes and other surfaces resulting in possible rupture or overheating.

Cooling Water Treatment Chemicals and Solutions

Cooling water treatment is the process of purifying water in industrial cooling towers. Chemicals used in this process are corrosion and scale inhibitors, algaecides, biocides, and pH adjusters to preserve cooling towers. Chemicals such as copper salts, inhibit algae and other biological growth. To preserve the equipment, bio carbonates are added to remove acidity and phosphates are used to reduce scaling.

Water Purification Chemicals and Solutions

Water purification primarily utilizes chemical disinfectants - chlorine, chloramines, or less commonly, chlorine dioxide. Some communities use a combination of chlorine and chloramines, switching between the two according to variables such as seasons of the year. Chlorine is the most common chemical disinfectant for water sources, including water for drinking, swimming pool use, municipal wastewater use, and industrial water treatment.

Even though chlorine can be toxic to humans as a possible eye, nasal, and respiratory irritant, as well as an acute health threat in fatal doses, the concentration of chlorine in drinking water is so low as to pose little to no threat. First used as a disinfectant in the United States in 1908, chlorine remains the most popular disinfectant and water treatment in the world due to its effective neutralization of bacteria and viruses from surfaces and water sources.

Wastewater Effluent Chemicals and Solutions

Wastewater Effluent (also referred to as 'trade effluent' or 'wastewater') is waste other than that from kitchens, toilets, surface water, or domestic sewage. Produced by industrial or commercial sites, effluent usually flows from the sites directly into the main sewer network. It cannot enter a river, reservoir, stream, or lake unless cleaned and treated first. Contaminants found in effluent include fats, oils, greases, chemicals, detergents, heavy metal rinses, solids, and food waste.

In addition to primary treatment (suspending solids from wastewater through sifting methods as well as aerating the wastewater to oxygenize it), biological treatment can be used to remove nitrogen and phosphorus. Moreover, physical-chemical separation techniques such as filtration, carbon absorption, distillation, and reverse osmosis can be utilized, leaving the water pure enough for the environment. ■

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Biofuels: Feedstock Considerations

We can use the term 'Biorefinery' which necessarily includes biomass, taken as renewable and thus carbon neutral, for diverse applications like bio-energy for power (electric power or steam), conversion to biofuels for use transportation fuels and conversion of biomass to bio based chemicals. There are several feedstocks which are currently used on large commercial basis to produce ethanol, biodiesel and biogas. Agricultural residues, municipal solid wastes are some of feedstocks with very good potential and technologies are in advanced stage to convert these to biofuels. While sugar-based feedstock, sugarcane juice and molasses are main feedstock for ethanol in sugar producing countries like India and Brazil. Corn is feedstock of choice for US and few European countries for bio-ethanol **Dr. D. K. Tuli, Visiting Chair Professor, IITB,** shares insights about biofuels in this in-depth article.

Agricultural residues have been successfully converted to ethanol and several large commercial plants have been established. However, there are problems due to recalcitrant nature of these residues and the cellulosic ethanol so produced is expensive. In order to meet soil fertility only a fraction of, max 30-40 per cent of agricultural residues need to be collected for bioenergy applications like ethanol conversion. Indian biofuel programme has placed emphasis on agricultural residue conversion to cellulosic ethanol. One 100,000 lit per day bio ethanol plant based on rice straw is operational in Panipat refinery and four other similar plants are in various stages of completion. A large plant for bioethanol, based on bamboo, will be operational soon in NE India.

Oil seeds are source of triglycerides and these can easily be converted to biodiesel (FAME) by transesterification process. US and European countries having surplus soyabean / sunflower produce biodiesel on commercial scale. Canola, sunflower, camelina, safflower, and cottonseed are also used for biodiesel production. Used cooking oil and animal fats are also good feedstock for biodiesel and are the cheapest if the proper collection system is in place.

Animal manure, waste food, and agricultural residues are good feed stock for biogas production through anaerobic digestion. Government of India has also launched a very ambitious programme on production of biogas and its compression (CBG) mainly for use as automotive fuels. The CBG development in India has received significant policy support and a scheme was launched in 2018 'Sustainable Alternative Towards Affordable Transportation' (SATAT) to promote the production and utilisation of CBG as an alternative green fuel for the transport / industrial segment. It aims to reduce India's dependence on oil and gas imports by producing CBG using agricultural residue, cattle dung, sugarcane press mud, MSW and organic wastes. Better bio digestor designs and bio gas purification technologies have been developed. Government has set a target of establishing about 5,000 CBG plants with a total production capacity of 15 million tons per annum. Certain issues linked with gas off-take, pricing and right kind of feedstock availability have delayed achievement of scheme objectives but remedial actions have been taken. Research and development efforts have been focused on economical pre-treatment of agricultural residues and development of robust microorganisms for anaerobic digestion.

Technologies for Bioenergy Production

Feedstocks require a conversion process to take diverse biomass raw materials and turn them into

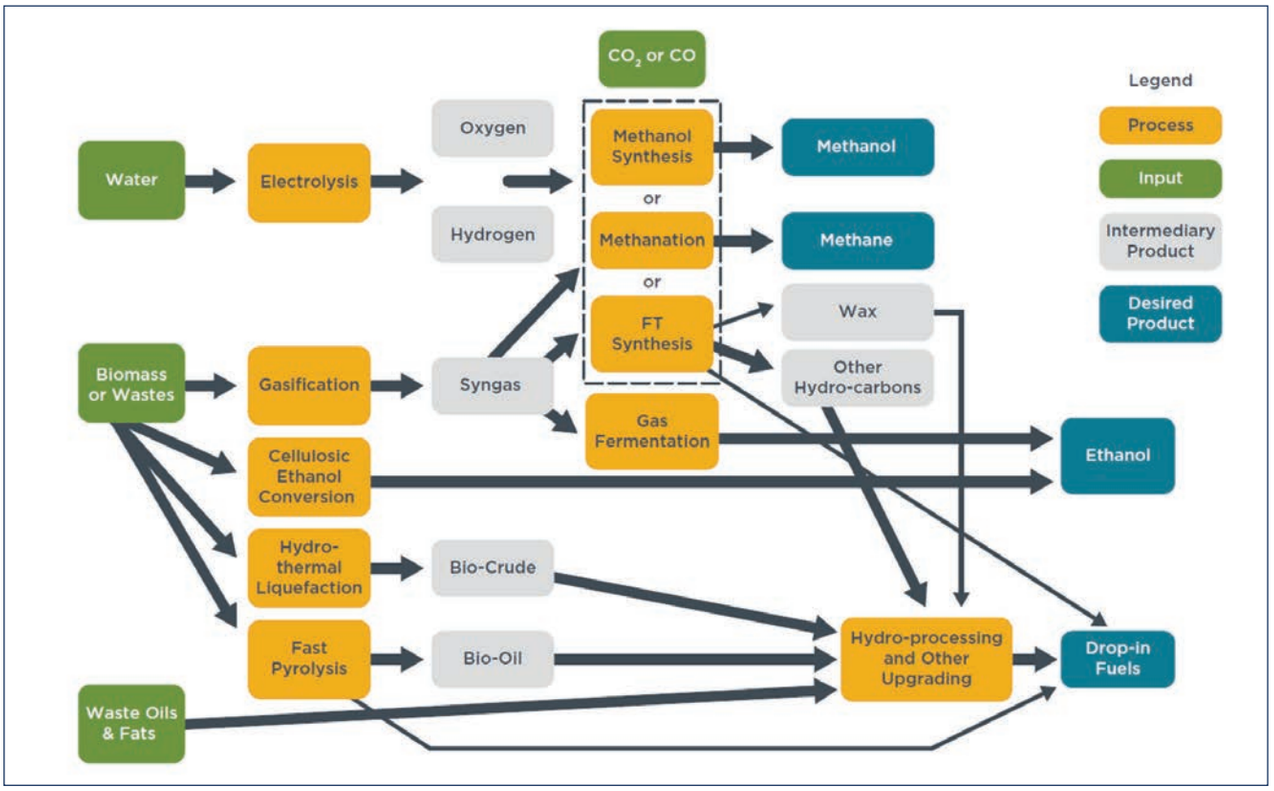

Figure 1: Yellow boxes indicate processes and green boxes represent an input to the process. Blue boxes represent the desired fuel output, whereas grey boxes are intermediary products. Bold arrows indicate primary steps in the conversion process.
(Adopted from: International Council on Clean Transportation, 2019: Advanced Alternative Fuel Pathways: Technology Overview and Status)

useful bioenergy such as heat, electricity, biodiesel, ethanol, biobutanol, methane, and other bioenergy useful products. Two major technology types are thermochemical conversion and biochemical conversion.

In thermochemical methods heating biomass, with or without catalyst and generally in absence of oxygen, leads to various thermos-chemical reactions and creates useful bioenergy products such as gases, liquids, and heat. Examples include direct combustion for heat and power through steam generation, cofiring along with coal in power plants, thermal gasification to produce Syn gas, FT process and pyrolysis. Some of these processes are commercial.

In biochemical processes microorganisms, yeasts, other living organisms and enzymes ferment material such as sugars, starch and proteins and convert them into alcohols or other liquid fuels. Anaerobic digestion of biomass in oxygen void conditions give methane which can be used as transportation fuel in IC engines. Ethanol and butanol fermentation of biomass, called cellulosic alcohols, are already commercialised. All possibilities of biomass conversion and products obtained are shown in Figure 1.

Depending upon the type of feedstock, the bioenergy technologies and their resulting products are classified as first to third generation. First-generation biomass which relies on food crops such as corn, sugar cane, wheat, etc., which has either starch or sugar and these products have been commercialised since last century. Though most of biofuel, ethanol, is currently produced globally by adopting first generation feedstocks, though renewable may not be considered sustainable as these are based on feedstock that are also used as human / animal food. US and few other countries, which are blessed with surplus agricultural land and additionally have smaller population to feed, use corn for producing ethanol. US transport fuel is predominantly gasoline, unlike India which has based majority transport using diesel and currently US gasoline is blended with minimum 10 per cent ethanol.

India, Brazil are sugar producing countries, use sugarcane juice or molasses for producing fuel grade ethanol. Brazil ethanol production is mostly from direct conversion of sugarcane juice, while until last couple of years Indian ethanol production was entirely from the sugarcane molasses which was producing limited quantities of ethanol and hence the gasoline blending was very low. Considering limited availability of ethanol

only from molasses, Government of India has also allowed sugar rich molasses, which was earlier used for secondary sugar recovery, spoiled rice / wheat and direct sugarcane juice (provided country had enough sugar reserve) to ethanol. This has increased supply of ethanol tremendously and country has achieved more than 10 per cent blending with gasoline on all India basis. Several policy support decisions like very appreciable increase in ethanol purchase price by oil marketing companies and creating required storage and blending infrastructure added to achieve large ethanol blending. However, these first generation feedstock, though renewable, are not quite sustainable.

Most biofuel currently uses conventional feedstocks, such as sugar cane, corn and soybeans. Expanding biofuel production to advanced feedstocks is critical to ensuring minimal impact on land-use, food and feed prices and other environmental factors. Sustainability of feedstock for bioenergy production is essential to ensure that its use provide economic, environmental benefits as judged by detailed life cycle GHG emissions. Governmental policy and economic support are generally provided to bioenergy systems which meet sustainability criterion and environmental considerations. Life cycle assessment studies should become the starting point of any bioenergy or development of biofuel technologies. Considering these two factors, EU has renewable energy directives and US renewable fuel standard programme. Change of land use for bioenergy generation is a serious non sustainability factor.

Indian Biofuel Programme

Indian bioenergy / biofuel programme is driven by social, environmental, and large crude import factors. India imports about 87 per cent of its petroleum crude needs with huge outgo of foreign exchange and the continuous availability may pose geo-political risks. Indian Government initiated structured biofuel / bioenergy programme in 2008. First Indian biofuel policy was announced in December 2009 which had targets for both gasoline (Ethanol) and diesel (Biodiesel) blending. The policy called for 5 per cent minimum blending of ethanol in gasoline and increasing this to 10 per cent, however only non-food feedstocks were allowed. Policy had given indicative targets of 20 per cent blending both in gasoline and diesel by 2017. The policy did not meet its objectives primarily due to severe limitation of feedstock both for ethanol and for biodiesel Jatproha-based biodiesel failed to take off due to much lower seed yields and we could not use edible oils as we are short of these. Only 1.53 per cent ethanol could be blended in gasoline in 2013-14 and almost nil biodiesel in diesel.

A comprehensive second biofuel policy was announced in 2018 which allowed wider feedstock use and set ethanol blending in gasoline target of 20 per cent by 2030. Wider basket of feedstock which included sugar rich molasses and grains quickly produced huge quantities of ethanol. Looking at the extraordinary success of this programme, the government amended the policy in June 2022 by advancing the blending

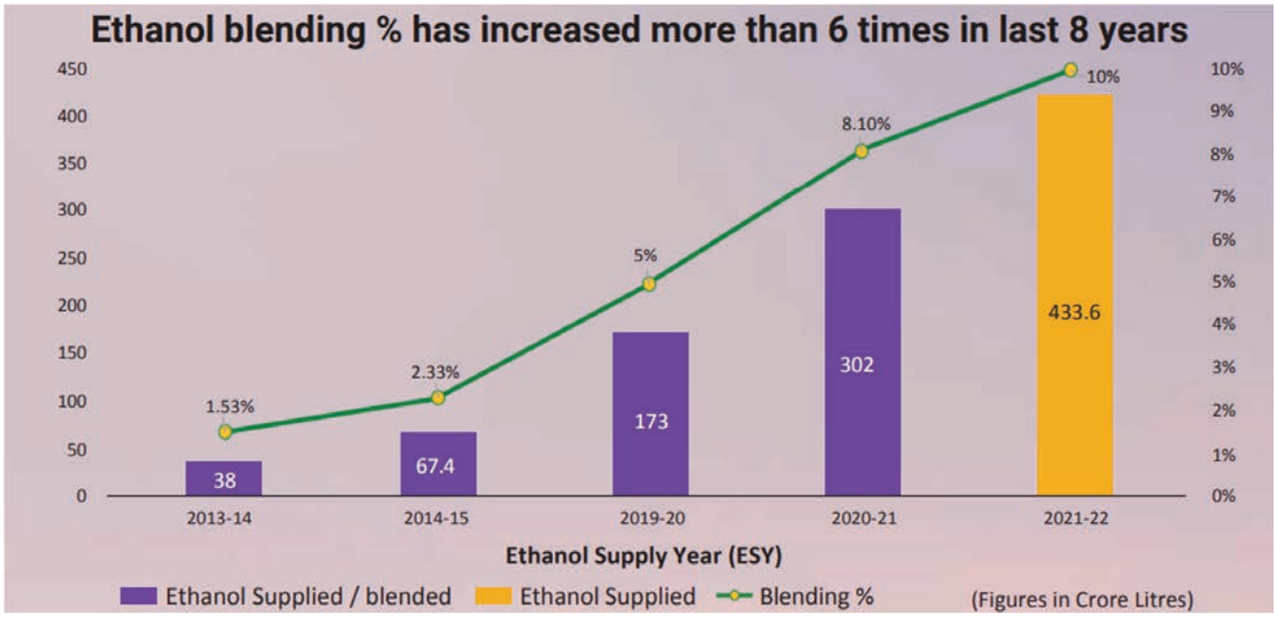

Figure 2: Ethanol blending % has increased more than 6 times in last 8 years.
(Source: Report Aatma-Nirbhar Bharat report by MoPNG)

deadline for 20 per cent blending from 2030 to 2025-26. Ethanol production in India in 2023 was 650 crore lits (6.5 billion lits). India reached ethanol blending of 10 per cent by 2020-21 and OMC paid ₹81,796 crores for ethanol purchase, which supported the farmers and sugar industry. Presently India has 1,380 crores lit ethanol capacity out of which 500 crores is from grains and rest sugar molasses based. India needs about a 1,100 crores lit ethanol in 2025 for 20 per cent ethanol blending and thus needs about 1,700 crore lit ethanol capacity (about 80 per cent capacity utilisation). Figure 2 shows the exponential growth of ethanol blending in gasoline.

For estimation of how much feed stock will be needed to produce the ethanol requirement, we can consider following conversion factors:

Ethanol yield per ton of C-heavy molasses is 225-235 lits; B-heavy molasses 310-330 lits; sugar syrup 330 lits; broken rice 400-420 lits and wheat 370-390 lits. We can see that huge quantity of grains would be needed to produce targeted 500 crores lits ethanol and also a very large sugar source for targeted 20 per cent ethanol blending in gasoline. According to the report of Niti Aayog 'Road map for India for ethanol blending 2020-2025', in year 2025 for 20 per cent blending 165 lakh tons of grain and 60 lakh tons of sugar equivalent will be required. One lit of sugarcane-based ethanol needs 2,680 lits for water in its LCA. Therefore, though renewable but consistent sustainability of 1G ethanol is not very certain.

Second-generation biofuels, by contrast, are derived from plant-based material which are composed of cellulose, hemicellulose and lignin, and are the most abundant renewable resources on earth. However, the potential and ease of ethanol production from these feedstocks is relatively low, as it contains about 15 to 25 per cent lignin, which is refractory in fermentation. Additionally, a pretreatment process should be performed before the saccharification, which is one of the biggest cost factor for commercialization. Second generation ethanol plants have much higher capital cost due to pretreatment and special equipment needed for high solid load handling. In order to overcome the shortcomings of these resources, genetically engineered crops or algae (without lignin components) are classified as third-generation biomass, which merits accelerated commercialization. However, cultivation of algae has lower biomass yields and harvesting / drying involves very large costs. The lipid content of natural algae is generally low and their extraction and conversion to biodiesel has not been economical till now. Some reports on hydrothermal liquefaction of wet algae to biocrude are encouraging.

Ideal Feedstock Criteria

The main factors that will determine the economic feasibility for any feedstock for large scale use in biofuel production are:

- **Cost and availability:** Ideally, feedstock should be inexpensive, have consistent quality, and year-round availability at centralized locations. Should have good storage stability under normal atmospheric conditions.
- Should have composition rich in carbohydrates (Cellulose and Hemi-cellulose). In case of sugar-based feed, it should have higher glucose and lower other sugar isomers. Oil seeds for biodiesel should contain fatty acids in appropriate carbon range and unsaturation.
- Feedstock may not contain impurities or inhibitors affecting the fermentation and enzyme treatment steps. Silica content of rice straw poses issues in its processing.
- Easy to harvest, handle, having lower transportation and storage costs.
- Can be easily densified for transportation.

Availability of Biomass in India for Second Generation Biofuels

In the past, the Indian Institute of Sciences (IISc) Bangalore has conducted biomass resource assessment in two phases, 1998-99 and 2002-04, for the estimation of biomass generation, availability of surplus biomass. The study estimated that the country's biomass availability was at about 500 Million Metric Tonnes (MMT), and the availability of surplus biomass was about 120-150 MMT. Few years later, Technology Information and Assessment Council (TIFAC) carried out another study for the 'Estimation of Surplus Crop Residues in India for Bio-fuel Production' in 2018. The study was restricted to 11 major producing crops of India: Rice, Wheat, Maize, Sugarcane, Cotton, Gram, Tur, Groundnut, Mustard Soyabean, and Castor. These eleven crops were estimated to give 683 MMT of dry biomass during all three seasons. As per the study, the estimated surplus crop biomass was 178 MMT. Few other studies e.g by TERI estimated surplus biomass and there is lot of variation in findings.

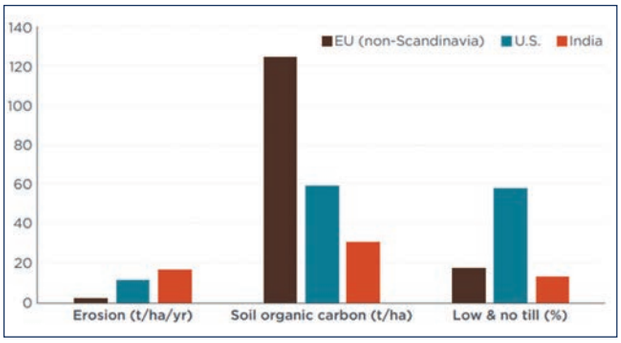

Figure 3: Comparison of erosion rates, soil organic carbon stocks, and rate of zero and reduced tillage in the European Union, United States, and India.

Important considerations for Estimating Surplus Biomass

After harvesting the main crop, a very good part of the biomass needs to be left on the field for soil protection and maintaining enough carbon and soil nutrients. India is more vulnerable to soil fertility loss than the other western countries. Instead of retaining crop residues in place to enhance or maintain soil quality, India already harvests and utilizes unsustainable quantities of biomass for livestock feed and household heating applications. This results in more erosion rates and poor soil fertility. Figure 3 compares the erosion rates, soil organic carbon stocks, and rates of zero and reduced tillage across the European Union, United States, and India. By all three metrics, India is more vulnerable to soil fertility loss than the other regions [N.H. Ravindranath, et al., 'Assessment of Sustainable Non-Plantation Biomass Resources Potential for Energy in India,' Biomass and Bioenergy 29, no. 3 (2005): 178–90].

How much biomass should be removed from field for bioenergy and other uses depends upon the type of crop (Figure 4). Wheat straw is mainly used as animal fodder and hardly any amount is surplus for bioenergy use, after leaving some in field soil enrichment. Rice straw, cotton stalk and pulses are the feed stock which are available even after leaving some on field for soil enrichment.

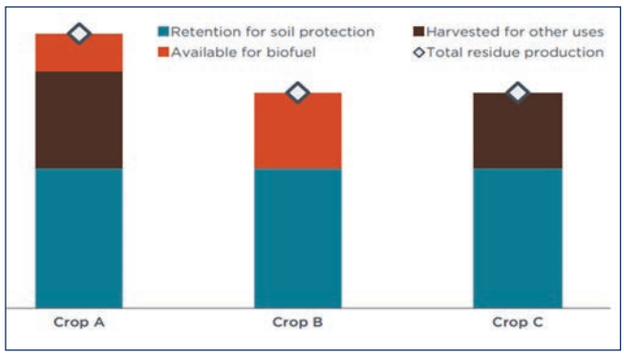

Figure 4: An accepted approach to determining the amount of crop residue available for biofuel production.

Municipal Solid Waste

The diversion of Municipal Solid Waste (MSW) to biofuel production could be particularly impactful in India, as biofuel (biogas) producers can utilize existing MSW collection networks. The majority of MSW in India is disposed of either in the open or in unmanaged managed landfills. As per Ministry of New and Renewable Energy (MNRE), India's per capita waste-generation rate in urban areas is expected to increase from 0.34 kg/day to 0.7 kg/day by 2025, and total MSW generation will reach 165 million tonnes by 2031. MSW can be a good source of anaerobic digestion to produce biogas, however for this segregated digestible material is required. Most Indian cities do not have an effective segregation of MSW leading to mountains of stored MSW. Indore in Madhya Pradesh has shown the way on how to collect the segregated waste material and has several biodigesters working successfully and this factor makes Indore the cleanest city in India.

Conclusion

Bioenergy (biofuels) is essential for India due to social, economic, and environmental concerns. There are several possibilities for bioenergy applications and biogas, bioethanol and biomass based power has seen exponential use in India though biodiesel is yet to pick up. For any successful, economic and sustainable biofuel programme, feedstock is the most critical parameter. Though 1G ethanol in India has seen extraordinary rise in volumes and in all probabilities Government target of 20 per cent blending in gasoline will be met. However excessive dependence on grains and sugar, though renewable has a certain degree of long-term consistent sustainability concerns. There is a strong need of continuing development efforts to lower the cost of production of cellulosic ethanol. All technology options specially biomass gasification for syn gas, biocrude through HTL and pyrolysis needs attention for use of agricultural residues. ■

Author

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Largest Centralized ZLD Plant in Steel Plant

A complete end to end solution for sustainable water solution in steel industry - **B. K. Kumaran, Head – TST & Commissioning, VATECH WABAG Limited,** shares further details in this case study.

Centralized Zero Liquid Discharge Plant – National Mineral Development Corporation (NMDC), Chhatisgarh

Challenge: The disposal of effluent generated from various sources, containing high dissolved solids combined with high organic content in one of the streams, posed a significant challenge due to increasingly stringent regulatory norms. Additionally, the steel plant's daily water consumption was very high, and the scarcity of water resources further intensified the challenge.

Solution: Effluent recycling is considered the most practical solution. The selection of appropriate technology for treating tough effluent is a critical factor. Beyond just treating and recycling the effluent, handling the reject water containing high Total Dissolved Solids (TDS) is also a major challenge. This led to the conception of the Centralized Zero Liquid Discharge (CZLD) project. The effluent recycling plant for the 3.0 MTPA integrated steel plant at National Mineral Development Corporation (NMDC), Nagarnar ensures the comprehensive recovery of all wastewater generated by the plant, which is subsequently recycled and reused as makeup water in the steel production process. Notably, as the largest centralized ZLD plant in the Indian steel industry, our project sets a significant precedent in reducing the sector's reliance on freshwater sources.

Technology: The pre-treatment system includes a High-Rate Solid Contact Clarifier (HRSCC), Dual Media Filter (DMF), Activated Carbon Filter (ACF), UV disinfection system, ultrafiltration system, and Reverse Osmosis (RO), followed by a Multiple Effect Evaporator (MEE).

The CZLD plant was designed, engineered, commissioned, and is operated by VA TECH WABAG LTD at NMDC in Jagdalpur, Chhattisgarh, with Mecon

Characteristics of the effluent to the CZLD is as follows:

Parameters	Units	Design Limit
pH		7.5 – 8.0
Total Suspended Solids	Ppm	625
Total Dissolved Solids	Ppm	11200
Oil & Grease	Ppm	0.1
BOD	Ppm	6.25
COD	Ppm	18.75
Total Hardness as Caco3	Ppm	< 1875
Total Silica	Ppm	< 125

India Limited as the project consultant. The plant has a capacity of 4,320 cubic meters per day, with an MEE capacity of 29,925 kg/hour, and was successfully commissioned in 2023.

This CZLD facility is designed to treat wastewater from 15 distinct sources, including five streams with high levels of total dissolved solids. The treatment process handles complex contaminants such as cyanides, organic pollutants, and oil and grease using a combination of membrane technology and multiple effect evaporation. The plant achieves a 90 per cent water recovery rate, allowing the reuse of treated water as makeup cooling water in the steel production process. Additionally, the MEE crystallizes salts, further enhancing the plant's overall efficiency.

However, a particular stream had Thiyo cyanide of about 600 ppm and Chemical Oxygen Demand (COD) of 800 ppm which posed a huge challenge during commissioning.

Raw effluent from various sources is stored in an equalization tank for homogenization, where mixers are used, and sodium hypochlorite is shock-dosed. The homogenized, chlorinated effluent is pumped into a flash mixer, where lime and dolomite are added to raise the pH and reduce silica content, while coagulant is introduced to aid in solid particle settling. This mixture is then sent to the HRSCC, where silica and TSS are reduced using $FeCl_3$ as a coagulant and polymer as a flocculant.

Final Outlet characteristics of the effluent is as follows:

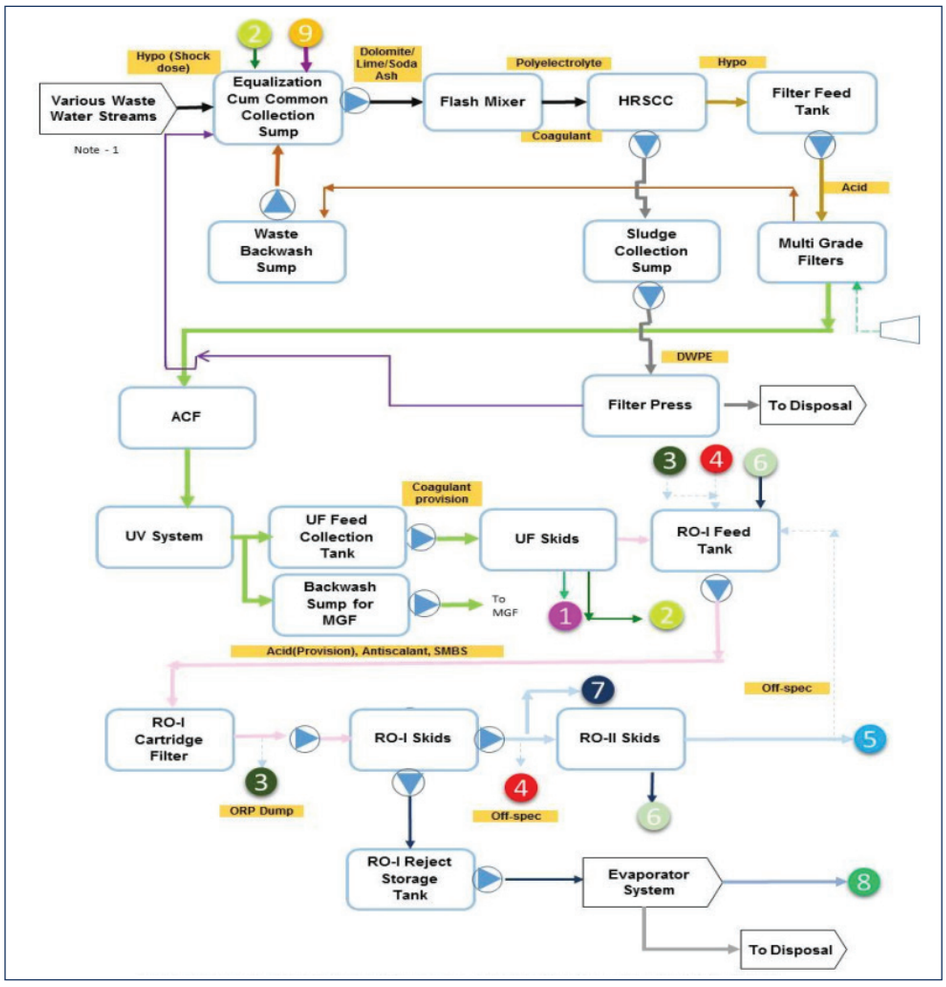
Parameters	Units	Values
pH		7.5 -8.5
Total Dissolved Solids	Ppm	< 425 ppm
Total Hardness as Caco3	Ppm	< 150
BOD	ppm	< 10

The HRSCC-treated water is collected in a filter feed tank and pumped through a Multi-Grade Filter (MGF), with continuous sodium hypochlorite dosing. Clarified water is then passed through the MGF to further reduce suspended solids, and the MGF outlet is fed to an Activated Carbon Filter (ACF), which removes excess chlorine to make the effluent suitable for ultrafiltration (UF).

Sludge from the HRSCC is pumped into a filter press with dewatering polyelectrolyte added for improved efficiency, reducing moisture content to 50 per cent.

Supernatant from the filter press is recycled back to the equalization sump. Waste from the MGF and ACF is collected in a backwash sump, with acid dosing provided at the MGF inlet for pH correction before UF. Effluent from the ACF passes through a UV system for disinfection.

Conditioned effluent is passed through 3 UF skids with vertical membrane configuration to reduce the residual suspended particles, colloids, total organic carbon and further achieve Sustainable Development Index (SDI) < 3. Self-cleaning filters of 200 microns is installed at the upstream of the UF as a guard filter to UF membranes. Ferric chloride was dosed in the UF feed to precipitate the organic content in the effluent and thus filter out in the UF membranes. Fouling on the UF membranes are cleaned through the preset back wash cycles and also by chemical enhanced cleaning using caustic, sodium hypochlorite and citric acid. In addition to this due to the offspec effluent characteristics, oxalic acid is used for Clean in Place (CIP). Backwash water is recycled



back to the HRSCC feed tank while CEB waste was neutralized and pumped into the equalization tank. Hence UF recovery of greater than 90 per cent was achieved.

UF permeate water with SDI less than 3 was further conditioned by antiscalant to enhance the saturation levels of silica and hardness and SMBS to dechlorinate the effluent and passed into sea water RO systems through cartridge filters. Inter stage booster pumps were used to maintain the flux in the RO arrays. RO reject was pumped into the MEE feed tank. First stage RO system had a recovery of 80 per cent. Part of the RO permeate was further passed into a permeate RO skid using brackish water membranes to further reduce the TDS and was blended with RO permeate of sea water membranes RO skid. The blended RO permeate was passed through degasser before pumping back to the steel plant. Second stage permeate RO system had a recovery of 90 per cent. RO reject of the permeate RO skid was recycled back to the RO feed tank of sea water membrane skid.

RO reject is pumped into three stage falling film evaporators which used medium pressure steam to heat the effluent. Titanium tubes were used in the evaporators. The condensate is cooled in the surface condenser and pumped into the final permeate tank. Hence overall recovery of 90 per cent was achieved in the plant.

Highly concentrated slurry from the evaporator is passed through a centrifuge pusher which removes moisture from the slurry and the crystallized salt is stored for disposing to the secured fill. Moisture content in the salt achieved was greater than 80 per cent. ■

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CASE STUDY

Management of Fat Sludge in a Dairy in Circular Economy Mode

This case study highlights how providing anaerobic thermophilic treatment for dairy fat sludge and wastewater treatment plant sludge exemplifies a unique approach to circular economy principles in sludge management**. Dr. Ramesh Daryapurkar, Chairman (India), CleanEdge Resources and Mohit Kale, Senior Manager – Research and Development, CleanEdge Resources**, share details.

The growing recognition of waste as a resource has underscored the importance of sustainability, environmental protection, and economic efficiency. This 'circular economy' approach emphasizes minimizing waste generation through reuse, recycling, and resource recovery. This case study explores a dairy located in a densely populated urban area facing significant odour issues due to the fat sludge produced by its wastewater treatment plant. In response, the dairy established an innovative sludge management plant featuring a Thermophilic Continuous Stirred Tank Reactor (CSTR) anaerobic digester. The biogas generated from this process is utilized for hot water generation, contributing to temperature maintenance and promoting a circular economy. Both the treated liquid and dewatered sludge serve as manure for gardening within the facility.

About Project Site

The sludge treatment facility is strategically situated near a major roadway within the dairy campus, surrounded by residential neighbourhoods. Any unpleasant odour pose a serious risk to the dairy's operations.

About Waste

The sludge generated at the dairy's wastewater treatment plant can be categorized into two types:

- Chemically treated Fat sludge (light grey) from the Dissolved Air Floatation (DAF) unit.
- Bio-chemically treated activated sludge (ranging from light to dark brown).

Pre-project Scenario

Prior to the implementation of the new system, the generated sludge was disposed of in drying beds. This practice resulted in severe odour issues and adversely affected the local air quality. As the organic sludge decayed, it exacerbated the smell, leading to bacterial proliferation and contamination in the surrounding area. These unscientific disposal methods resulted in numerous public complaints and multiple government notices for the dairy.

Waste to Energy Solution

To address these challenges, the dairy sought a sustainable, user-friendly solution for sludge management. CleanEdge Resources designed a state-of-the-art unique fat sludge management plant that

Overview of sludge management plant

operates independently in terms of energy requirements. The sludge digester is capable of processing not only the fat sludge produced by the dairy (25 tons per day) but also the aerobic sludge from the existing wastewater treatment plant (25 tons per day).

Thermophilic Continuous Stirred Tank Reactor (THERMO - CSTR)

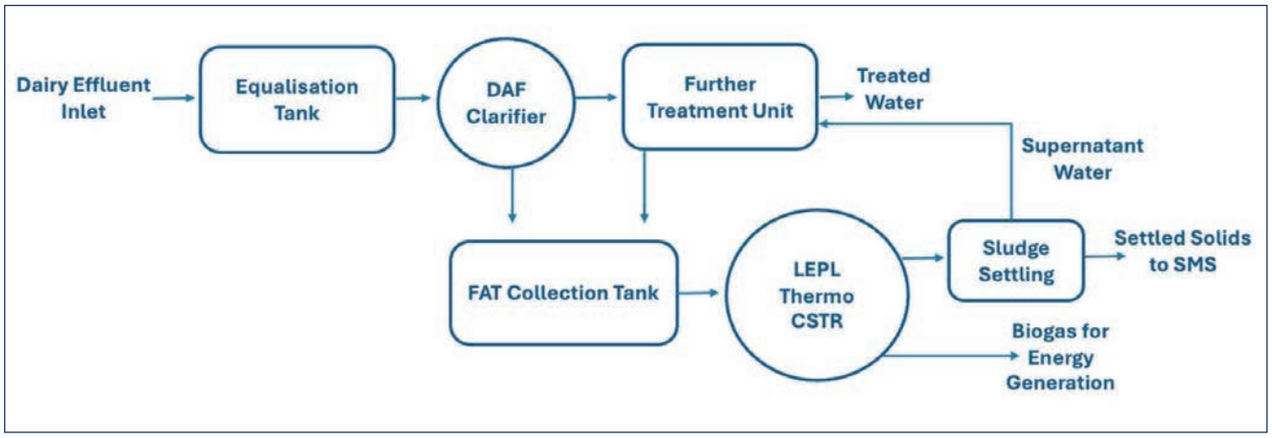
The Thermo-CSTR serves as the core of the sludge management system, transforming foul-smelling fat sludge into neutralized digestate while generating biogas as a green energy source. 21 Resistance Temperature Detectors (RTDs) monitor the temperature within the biodigester to ensure optimal conditions.

Unique Features of Sludge Management Plant

The sludge digester is designed as a thermophilic reactor, operating within a temperature range of 55 ± 2°C, and constructed from state-of-the-art Glass Fused Steel (GFS) bolted tanks. GFS was chosen for its superior safety against any potential adverse effects of the substrate. A notable feature of the plant is the mixing process within the CSTR digester, facilitated by high-pressure ejectors. Liquid flow is drawn from the tank and directed to liquid jet mixing nozzles via a motive pump, where pressure energy is converted into kinetic energy. This creates negative pressure at the nozzle outlet, drawing in ambient liquid. The suction flow is thoroughly mixed with the motive flow in the adjacent mixing section, enhanced by impulse exchange. The drag effect of the exiting mixed flow further increases the mixing efficiency. Additionally, the CSTR digester features a membrane roof that serves as a gas holder to store the generated biogas before it is sent to the hot water generator and other applications.

Benefits of the Project

The Anaerobic Digestion (AD) technology provided by CleanEdge Resources offers a sustainable solution that harmonizes environmental protection, social well-being, and economic development.



Sample of fat sludge (Left), digester outlet water (Centre) and final treated water outlet (Right)

Environmental Benefits

The unscientific dumping of fat sludge in drying beds poses significant environmental challenges, including foul odour, bacterial growth, infection, contamination of the surrounding area, and deterioration of air quality. These major issues have been effectively addressed through Anaerobic Digestion (AD) treatment of both fat sludge and wastewater treatment plant (WWTP) sludge. Currently, the plant achieves excellent reduction of volatile solids (organic content) in the sludge fed to the thermo-CSTR digester. This degradation of volatile solids generates biogas, which serves as a valuable energy resource, meeting the internal energy needs of the plant. The nuisance odours that previously affected nearby residential areas have been completely eliminated.

Social Benefits

Complaints of bad odour have been well addressed. Earlier the dairy plant itself was in jeopardy had this problem not been solved. Smooth operation of dairy now has its own social benefits which can be attributed to the sludge management plant. After project commissioning there was not even a single complaint regarding the bad smell nuisance or any unhygienic condition of operation from the residents nearby.

Economic Benefits

The biogas generated from the plant serves as a renewable energy resource for heating, boiler operations, and electricity needs. Additionally, the treated water is repurposed for irrigation and other processes, contributing to the dairy's overall efficiency.

Conclusion

The dairy industry generates various types of effluents and sludge, with fat sludge presenting critical challenges. Anaerobic treatment, particularly under thermophilic conditions, has proven effective in managing these issues sustainably. The facility's self-sustaining system has not only resolved odour problems but also averted the potential shutdown of operations in a densely populated area. CleanEdge Resources' efforts in transforming waste into a resource showcases the potential for sustainable practices in the dairy industry. ■

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Utilizing Treated Sewage as Water Resource for Power Plants

The Orange Nagpur city with a population of around 2.5 million meets its freshwater demand of more than 600 MLD of water from Pench Reservoir and Kanhan river. Growing population is putting enormous burden on domestic water demand and generating equivalent amount of sewage, which needs additional cost for the treatment. Where domestic water supply is already being challenged by water scarcity and climatic conditions, industrial supply certainly gets affected by it. **Praveen Singh Charan, Senior Manager, SFC Environmental Technologies**, throws more light on the processes and technologies used for sewage treatment to achieve recyclable quality with economic advantages.

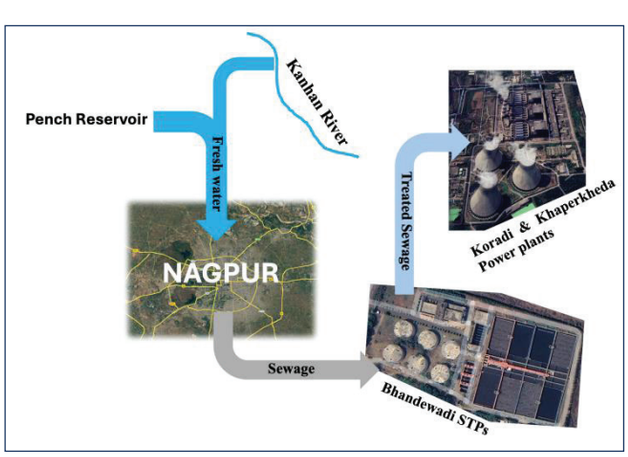
Industrialization affects demographics of any town and impacts the natural resources. Industries and Urban Local Bodies came together to develop a system where treated sewage can be reused by industries. Nagpur generates more than 500 Million Litres per Day (MLD) sewage where 90 per cent of it is being recycled. Sustainable approach like that adopted in Nagpur can certainly ease the incumbrance on the environment.

MAHAGENCO and Nagpur Municipal Corporation (NMC) signed an agreement to treat and reuse wastewater from Bhandewadi Sewage Treatment Plant (STP) to minimize use of fresh water in power plants located nearby Nagpur. 110 MLD treated sewage from stage-1 (130 MLD capacity STP) and 50 MLD treated sewage from stage 2 (200 MLD capacity STP) water is used for Koradi power plant. Also, 40 MLD treated sewage from stage-2 is used for old Koradi power plant; 100 MLD is used for Khaperkheda power plant 130 MLD and 200 MLD STPs are based on cyclic activated sludge technology as biological secondary treatment.

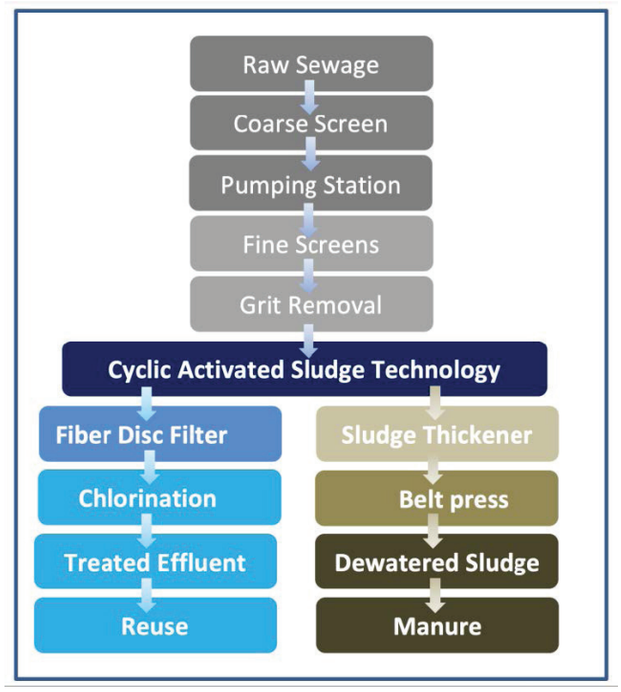
Treatment Scheme

Here we will go into further detail of the 200 MLD capacity STP based on cyclic activated sludge technology, which is a kind of advanced sequential batch reactor. The 200 MLD capacity sewage treatment at Bhandewadi, Nagpur, is now transformed into a water factory. Treated sewage is being reused by MAHAGENCO for their Koradi thermal power plant and Khaperkheda power plant. Various nallahs across Nag river have been intercepted to collect the sewage. Collected sewage at various pumping stations located across the city is being pumped into the primary treatment unit of the STP. Coarse screening has been done at individual pumping stations. Primary treatment includes fine screening, and a grit removal unit is being done at STP.

After primary treatment, sewage is directly taken into cyclic activated sludge technology Sequential Batch Reactor (SBR) basins. There are a total of eight basins provided. Basins are being operated in pairs. Thus, a total of four pairs of basins are there. Biological treatment reduces Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Kjeldahl Nitrogen (TKN) and Total Phosphorus (TP). For aeration has efficiently happened



Nagpur Fresh water uses and wastewater recycling outlines



Process Flow at 200 MLD STP Nagpur

through fine bubble diffusers. Air is supplied by turbo blowers. Treated effluent is further taken into the fiber disc filter for the tertiary treatment where suspended solids are further removed, which ultimately reduces corresponding BOD, COD, TKN and TP, further meeting the requirements of power plant use. Tertiary treated effluent is disinfected with chlorination. Chlorinated treated effluent is pumped to reservoirs where it is used in the thermal power plant processes.

This project was designed for the raw sewage characteristic (pH: 6.8-7.8; BOD: 150 mg/L; COD: 340 mg/L; TSS: 250 mg/L; TKN: 33 mg/L; TP: 4 mg/L), to achieve tertiary treated effluent with characteristics of pH: 6.8-7.8; BOD: <5 mg/L; COD : <100 mg/L; TSS: <10 mg/L; TN: <10 mg/L; TP: <2 mg/L; Ammoniacal Nitrogen: < 1 mg/L; Nitrate Nitrogen: <5 mg/L, Total Coliform: <100 MPN/100ml. This project is efficaciously delivering design outlet quality from last more than 5 years.

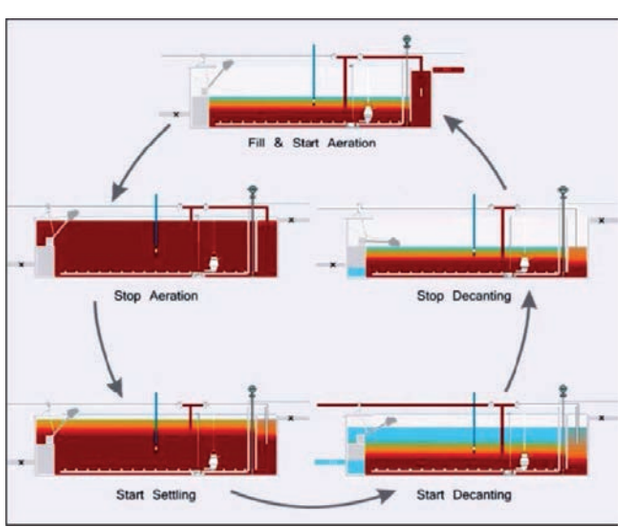
The initiative to utilize treated sewage has been admirable, resulting in significant savings of fresh water. The selection of appropriate technology has not only contributed to overall cost reductions but also led to savings in land use and power consumption

Technology Insights

In this sewage recycling project, three major cutting-edge technologies were used which are: Cyclic activated sludge technology; Fiber disc filter and Turbo blowers. Brief details of these technologies are given below:

Cyclic activated sludge technology: Cyclic Activated Sludge technology is the latest and 4th generation of SBR process. This system specifically refers to the use of variable volume treatment in combination with a biological Selector Zone and Oxygen Uptake Rate (OUR) control, which is operated in a fed-batch reactor mode. The cyclic activated sludge process technology represents a certain technical development of a process philosophy over conventional SBR technology.

Cyclic activated sludge technology basins are complete



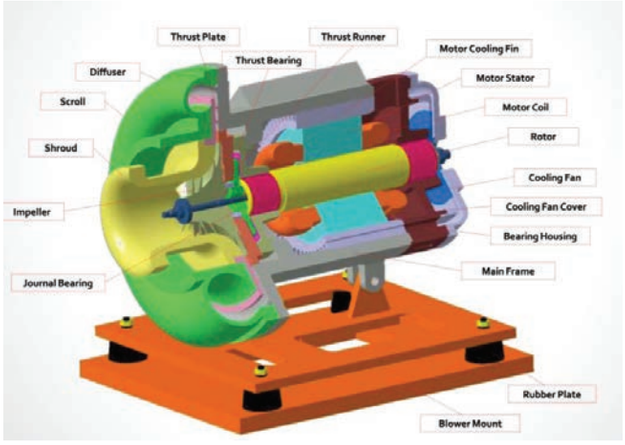
Cyclic Activated Sludge Technology's cyclic operation

with air blowers, diffusers, grid piping, Return Activated Sludge (RAS) pumps, Surplus Activated Sludge (SAS) pumps (SAS), Stainless Steel Decanters, Auto Valves and Programmable Logic Controller (PLC) etc. All cycles will be automatically controlled using PLC-SCADA. The oxygen is supplied through a fixed type of fine bubble diffused aeration system with auto control of oxygen level in levels. The system shall have a Sludge Volume Index (SVI) < 120 for higher settling rates and should be designed in such a way that growth of filamentous bacteria is restricted. Cyclic activated sludge technology furnishes numerous advantages, like outstanding

Fiber Disc Filter

performance, load flexibility, power savings, durability, full automation and substantial land saving.

Fiber Disc Filter: Fiber disc filter is made of polyester fibers. Fibers are piled to enable depth filtration. It is a better media for filtration compared to woven/ non-woven filter media. Disc filter shall comprise single working units, each unit consisting of several high strength and separable discs depending on the capacity. Each disc consists of total 24 filter panels on both sides (12 filter panels/ each side). Each filter disc shall be subdivided into smaller sections to constitute a prefab disc frame (module) to ensure easy replacement and maintenance. The drum shall be round-type and shall have enough area to discharge the treated water



Turbo Blower

without trouble. The material of the fiber media shall be polyester; the filter frame that fixes the fiber media, the disc frame and the cover shall be Acrylonitrile Butadiene Styrene (ABS) resin. Fiber disc filter is a simple alternative to gravity sand filters with many advantages like compact size (low civil cost), very low area footprint, lower power consumption (gravity filtration and low head requirement), continuous filtration (no stoppage for back wash), no need of intermediate pumping, low overall cost and completely automated operation (PLC and SCADA-based).

Turbo Blowers: A turbo blower is a high-speed centrifugal blower with a speed ranging from 25,000 to 40,000 Revolutions Per Minute (rpm) based on the size of the blower. The high speeds are possible because of the innovative air foil bearing technology in which the main shaft rotates virtually in the air without any contact with the surface, making it a more silent and vibration-free machine. A motor is a permanent synchronous magnet motor which is very compact. Blower operation is controlled through the controller with the help of a Variable Frequency Drive (VFD). Blower capacity and head are varied as per the process requirements. The capacity of the blower can be varied between 40 and 100 per cent, providing higher flexibility. These blowers are energy efficient, silent, operate without any vibration, installation and maintenance-friendly.

Summary

The initiative to utilize treated sewage has been admirable, resulting in significant savings of fresh water. The selection of appropriate technology has not only contributed to overall cost reductions but also led to savings in land use and power consumption. Urban local bodies can enhance these sustainable efforts by partnering with industry. Such collaborations can address the rising water demand, support industrial growth, and meet the needs of a growing population. ■

Author

Praveen Singh Charan
Senior Manager
SFC Environmental Technologies Limited

Pioneering Wastewater Treatment for the Chemical Industry

Freshwater is a critical resource for humans, agriculture, and industries. In India, the availability of freshwater is under severe stress due to the rapid increase in population and industrialization. Over-extraction of groundwater, water pollution, and climate change further exacerbate the water crisis. As India aims to become a leading global economy by the end of this decade, and water is essential to growth, innovative approaches to water conservation are essential. The traditional use-and-throw approach to water is no longer sustainable; effective wastewater treatment and reuse are imperative, writes **Balasubramaniam Rajagopal, General Manager - Industrial wastewater, A.T.E. HUBER Envirotech Private Limited.**

Each client in the chemical industry has distinct wastewater characteristics and pain points that require customised solutions. Understanding the current water crisis and aiming to provide sustainable solutions for the chemical and petrochemical industries, Mumbai-based A.T.E. HUBER Envirotech Private Limited (AHET) has developed advanced and cost-effective technologies offering treatments like primary, secondary, biological for wastewater treatment, recycling, sludge management, and Zero Liquid Discharge (ZLD). These technologies are tailored for chemical and petrochemical applications, simultaneously attaining high compliance plus high savings.

A.T.E. HUBER Envirotech, a joint venture between A.T.E., India, and HUBER SE, Germany, has successfully executed more than 300 projects globally, a testimony to its expertise in the field.

Unique Approach

AHET's success lies in addressing the pain points of its clients through its unique IPADS approach – Identifying Pain Areas and Devising Solutions. This approach allows AHET to create tailor-made solutions for each customer.

Additionally, AHET offers unique services such as 'Experts on Call' and 'EnviroCOLA®'. 'Experts on Call' provides expert opinions on wastewater treatment issues, connecting customers with internationally renowned specialists. 'EnviroCOLA®' is a customised cloud-based tool that supports wastewater treatment operators, ensuring smooth plant operations, compliance, and cost savings.

AHET also offers value-added products like bio-boosters, enzymes, and high-performance cultures to enhance plant performance or restore it after upsets.

AHET has designed, manufactured, supplied, constructed, erected and successfully commissioned wastewater treatment plants (ETPs) for many chemical and petrochemicals companies, which are working satisfactorily.

Innovation and Sustainability

The company has made huge investments in R&D and pilot trials, leading to successful wastewater treatment projects. It relies on natural processes, aiming to reduce chemical consumption, sludge generation, and power usage while providing alternative energy sources like

biogas through innovative anaerobic processes. The company's solutions help reduce the overall carbon/ water footprints promoting sustainability in the chemical industry.

Committed to Serve

A.T.E. is a multifaceted engineering group that has served the needs of industrial customers in India for more than 80 years, and HUBER is a world leader in sustainable wastewater solutions and in business for 180 years. Adhering to their common vision, AHET believes that growth is a by-product of a strong value system imbibed and practiced by the company. "We nurture good people and believe in them; people deliver good customer experience, and happy customers help us grow," says Anuj Bhagwati, Head of A.T.E. Group. "At AHET, we will continue to follow this mantra with a suite of technologies and services in our pursuit to create more and more sustainable water infrastructure," he adds.

Some of the company's esteemed customers comprise Sudharshan Chemicals, Novozymes, Indorama Group, Alkyl Amines, Arkema, Unichem, Pidilite, HUBER Ink etc. ■

Author

Balasubramaniam Rajagopal
General Manager - Industrial wastewater
A T E Huber Envirotech Pvt. Ltd.

EVENTS

Chemtech World Expo 2026

Date: 3-6 February 2026

Venue: Bombay Exhibition Centre, Goregaon (E), Mumbai

Details: World meet of the chemicals, petrochemicals, biopharma and process industry in India

Organiser: Jasubhai Media Pvt Ltd
Contact: 022-4037 3636
Email: sales@jasubhai.com
Website: www.chemtech-online.com

Indian Petrochem 2024

Date: 15-16 October 2024

Venue: The Lalit Hotel, Mumbai

Details: It focuses on discussing the latest developments, challenges, and opportunities in the petrochemical sector.

Organiser: Elite Conferences
Contact: +91-22-23851430
Email: info@eliteconferences.com

Website: www.eliteconferences.com

Distillation Experts Conclave Mumbai 2024

Date: 21-22 October 2024

Venue: The Orchid Hotel, Mumbai

Details: The focus of the event is to bring together the global distillation expertise to the South Asian region, providing platforms for engineering personnel from across the chemical, petrochemical, refining, oil & gas, and pharma industries to interact and gain from collective experience.

Organiser: Three Ten Initiative Technologies LLP

Contact: +91 9676611950
Email: prcentral@distillationconclave.com
Website: www.distillationconclave.com

Oil Gas & Power World Expo 2025

Date: 5-7 March 2025

Venue: Hall 4, Bombay Exhibition Centre, Goregaon (E), Mumbai

Details: The 13th edition of 'International Integrated Energy Show' will bring together the stakeholders of energy ecosystem from the up-mid and downstream of hydrocarbon industry, alternate and new energies, power generation, transmission and distribution and allied sectors.

Organiser: Jasubhai Media Pvt Ltd
Contact: 022-4037 3636
Email: sales@jasubhai.com
Website: www.chemtech-online.com

27th Energy Technology Meet

Date: 12-14 November 2024

Venue: The Leela Bhartiya City, Bengaluru

Details: Industry meet for the refining industry.

Organiser: Centre for High Technology
Contact: 9892067088
Email: kulkarni@cht.gov.in
Website: https://www.cht.gov.in

ICC Sustainability Conclave 2024

Date: 5-6 December 2024

Venue: The Lalit Hotel, New Delhi

Details: The two-day event will host senior representatives from Indian and Global companies, government officers, multilateral organizations, chemical industry bodies, and academic experts to discuss trending issues and opportunities in adoption of new technologies and chemistry to reduce the carbon footprint in the Indian chemical industry.

Organiser: Indian Chemical Council
Contact: +91-22-61144000
Email: pallavithakur@iccmail.in
Website: https://iccsustainabilityconclave.org/

29th Fakuma 2024

Date: 15-19 October 2024

Venue: Messe Friedrichshafen

Details: Leading trade event for industrial plastics processing.

Organiser: P. E. Schall GmbH & Co. KG
Email: schur@schall-messen.de
Website: www.fakuma-messe.de

SEPAWA CONGRESS 2024

Date: 16-18 October 2024

Venue: ECC Estrel Congress Center, Berlin

Details: Significant meeting point of the detergents, cleansers, cosmetics and fragrance industry in Europe.

Organiser: SEPAWA Event GmbH
Contact: +49 8281 79940-0
Email: office@sepawa.com
Website: www.sepawa.com

KHIMIA 2024

Date: 21-24 October 2024

Venue: Expocentre Fairgrounds, Moscow, Russia

Details: A meeting place for chemical manufacturers, service providers, suppliers of the latest equipment, materials and technologies, and consumers from all over the world.

Organiser: Expocentre
Contact: +7 (499) 795-37-99
Email: centr@expocentr.ru
Website: www.chemistry-expo.ru

Hydrogen Technology Expo Europe

Date: 23-24 October 2024

Venue: Hamburg Messe Germany

Details: Conference and exhibition focuses exclusively on advanced technologies for the hydrogen and fuel cell industry.

Organiser: Trans Global Events
Contact: +44 (0) 1483 330018
Email: registrations@trans-globalevents.com
Website: www.hydrogen-worldexpo.com

10th ICIS Asian Surfactants Conference

Date: 20-21 November 2024

Venue: Park Royal Collection Hotel, Kuala Lumpur, Malaysia

Details: Driving the future of surfactants downstream value addition through insight and collaboration.

Organiser: Independent Commodity Intelligence Services (ICIS)
Contact: +65 6588 3955
Email: support@icis.com
Website: www.events.icis.com

TURKCHEM EURASIA 2024

Date: 27-29 November 2024

Venue: Istanbul Expo Center

Details: 10th International Fine, Specialty Chemicals, Commodity Chemicals, Petrochemicals, Laboratory, Test-Measurement Equipment, Process and Automation Industry, Packaging, Recycling and Environmental Technologies Exhibition.

Organiser: Artkim Fuarcılık Tic. A.Ş.
Email: sales@artkim.com.tr
Website: www.turkchem.com.tr/2024/

Swing Check Valve from Rappid Valves

Swing Check Valve from Rappid Valves (India) Pvt Ltd is used for preventing back flow to maintain pressure to flow of fluid. It is used in system for low pressure drop across the valve. The size of the uni-directional valve is between 15mm – 350 mm. Body to cover joint is designed to apply a uniform load to the gasket to assure a leak proof seal. Seat ring are seal welded to provide a bubble tight joint. Disc-to-hanger connection allows the disc a controlled movement independent of the hanger to assure proper disc alignment with the seal at closer. The connection is secured by a welded disc nut to prevent disassembly due to vibration and closure impact. Stellited seat ring provides increased resistance to wear abrasion and erosion of the sealing surface. ■

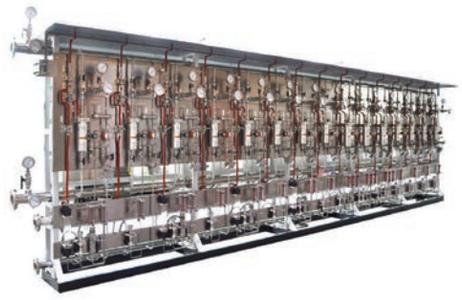
Flameproof Explosion Proof Instrument Enclosure

TRI-FLP Engineers brings in flameproof and explosion proof instrument enclosure as per the IS Standards. The instrument enclosures are mostly installed in the industrial sectors and hazardous environments. The company's enclosure products include industrial enclosure, hazardous area enclosure, electrical enclosure, and many other range of instrument enclosure are available. The technical specification of the flameproof explosion proof instrument enclosure includes epoxy polyester powder coating (paint), cast aluminium alloy LM6 (material of contraction), IP65 IS/IEC60529-1:2001 (Ingress IP protection), zone 1 and zone 2 classification and internal – 01 no external 02 nos earthling. ■

Pfeiffer Vacuum introduces New HiQuad® Neo Mass Spectrometer

Pfeiffer Vacuum combines powerful performance with flexibility and user-friendly operation with its new HiQuad® neo mass spectrometer. The mass spectrometer achieves an exceptionally high measuring speed of up to 125 µs/u. It is distinguished by its outstanding sensitivity and a wide dynamic range. Depending on the application, different mass ranges, rod diameters, ion sources, detectors, interfaces and cable lengths are available for selection. Its properties predestine the HiQuad Neo most particularly for applications in research and development and make it ideal for integrating into analytical systems as well as for cleanliness verification for EUV-lithography. The mass spectrometer is easy to operate with the PV MassSpec software. The integrated sequencer enables easy automated programming of entire measuring procedures. The software also permits automated calibration and tuning. Defining measurement recipes is easy, and it is possible to link the mass spectrometer data to external signals. These features provide an efficient, user-friendly solution for a wide range of applications. ■

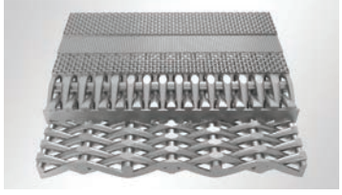
Axis brings in Steam and Water Analysis System



Steam and Water Analysis System (SWAS) from Axis Solutions Private Limited, is an essential system used in various industries to monitor and control the quality of steam and water used in various processes. It is a complete analytical system that is designed to measure and analyze the quality of steam and water at various stages of the process. It consists of several analytical instruments such as conductivity meters, pH meters, dissolved oxygen analyzers, and silica analyzers. Steam can be as hot as 560°C. Pressures can be as high as 250 bar. Samples are at high temperature & pressure. Sample conditioning is required to bring down the temperature & pressure at the desired level. To keep the power plant up and running with minimum erosion and corrosion of the steam turbine, steam boiler, and condenser, SWAS provides exact, precise measurements on all these critical parameters.

SWAS is widely used in industries such as power generation, chemical and petrochemical, pharmaceutical, and food and beverage. The main purpose of using SWAS is to ensure that the quality of steam and water used in the process is within the required parameters. Poor quality steam and water can lead to corrosion, scaling, and other problems that can affect the efficiency of the process and cause equipment failure. ■

POROSTAR®: Metal Wire Mesh Laminated Panels



Porostar filter elements, made from metal wire mesh laminated panels, from the house of Haver & Boecker, consist of a large number of wire mesh layers that are firmly bonded together by diffusion. After initial heat treatment, the mesh laminates are sintered a second time. This duo-sintering technique leads to a firm connection of the layers. The product is available in sheet formats in the standard format 1,200 mm x 1,200 mm up to a maximum of 1,520 mm x 1,900 mm or 1,400 mm x 2,050 mm without a weld seam. As a filter medium, the product enables to achieve foreign particle-free filtration in the range < 1 µm to 200 µm. No particles come loose, even at the maximum operating pressure. Metal wire mesh laminated panels / mesh laminates are used as filter cartridges, in centrifuges and nutsche filter systems and have proven itself for solid-liquid and hot gas filtration in the industries such as chemical and petrochemistry, pharmaceutical, plastics, food, automotive and mechanical engineering, etc. The product is available in the standard version as well as in the special versions - Light, Hiflo and Combi.■

Mechanical Vapour Recompressor from Everest

Mechanical vapour recompressor from Everest Blowers & Vacuum Pumps – An Ingersoll Rand Business, boasts of all internals being coated with special corrosion resistance ENP coating with heat treatment for surface hardness. It has primary and secondary high temperature PTFE seals, on each shaft each end on special steel bush for prolonged life. It has enhanced internal lubrication passage and circulation system. It has a capacity of 200-6000 kg/hr and differential pressure of 100-1000 mBar. The standard accessories that come with the product are MVR common base frame, interconnecting pipe (S.S 304), companion flanges, vibration isolation bellow on suction and discharge, coupling and coupling guard, desuperheating module, pressure gauge and temperature guage at MVR suction and discharge and loading / unloading line + valve. ■

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UPCOMING ISSUE - OCTOBER 2024

Engineering Procurement and Construction – Challenges and Transformation

The EPC segment is significant for the growth of the chemical industry. The October 2024 issue of "Chemical Engineering World," is focused on EPC: Challenges faced by the industry and the transformation the industry is witnessing.

This issue aims to equip professionals with the knowledge needed to stay ahead in a rapidly evolving sector through:
INTERVIEWS with Industry leaders ,
TECHNICAL ARTICLES, CASE STUDIES, PROJECT UPDATES & NEWS

Send Editorial submissions before 18th October 2024 to editorial@jasubhai.com

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ChemTECH WORLD EXPO 2026

SPECIALTY ChemICAL WORLD EXPO 2026

Bio Pharma World Expo 2026

32nd International Exhibition and Conferences

3-6 February 2026

Venue: Bombay Exhibition Center, Goregaon (East), Mumbai, India

Concurrent Events

EPC 2026 | Specialty ChemICAL | Refining & Petro CHEMICALS 2026 | Bio Pharma | Industry AUTOMATION & Control 2026 | PVF | WaterEX WORLD EXPO 2026 | Surface Engineering Coating & Corrosion WORLD EXPO 2026 | Chlor-Alkali World Expo & Conferences 2026

Scope for ChemTECH World Expo 2026

- Plant Machinery & Industrial Consumables
- Engineering Consultants
- OEMs for Chemicals & Pharmaceutical Processing Equipment
- Metals & Metallurgy
- Bioprocessing Equipment
- Construction Services Providers
- Plant Maintenance Services Providers
- Logistics & Supply Chain Solutions Providers
- Instrumentation & Process Control
- Industry Automation (Process & Factory)
- Systems Integration & ERP Solutions Providers
- Water & Waste Water Treatment Consultants
- Environment Solutions Providers
- Waste Management Consultants
- Financial Institutions
- Fire & Safety Solutions Providers
- Material Handling Solutions
- Certification Bodies
- Welding Solutions
- Quality Health & Environment Solutions
- Analytical & Laboratory
- Packaging Materials, Machinery & Systems
- Business Consultants

Scope for Specialty Chemicals World Expo 2026

- Agrochemicals Intermediates
- Adhesives & Sealants
- Agrochemicals & Crop Protection
- Bulk Drugs & Intermediates
- Enzymes
- Colorants, Dyes & Pigments
- Cosmetics & Personal Care Ingredients
- Hygiene & Cleaning Chemicals
- Laboratory Chemicals
- Surfactants
- Water Treatment Chemicals
- Catalysts
- Electronic Chemicals
- Flavours & Fragrances
- Contract Manufacturers

Scope for Biopharma World Expo 2026

- Materials Processing
- Pharma Machinery
- Pharma Ingredients
- Plant Engineering, Process Plants & Equipment
- Laboratory & Analytical Solutions
- Process Measurement & Inspection
- Sterilization & Clean Room Solutions
- Biopharma R&D And Manufacturing
- IT Solutions
- Water & Waste Treatment Solutions

FACT & FIGURES 2024

- 750 EXHIBITORS FROM 15+ COUNTRIES
- 25871 VISITORS FROM 53 COUNTRIES
- SCALE@CHEMTECH World Expo 2024: 60+ GLOBAL CLIMATE TECH STARTUPS FROM 20 COUNTRIES; 40 TECHNICAL PRESENTATIONS
- 8 TECHNICAL CONFERENCES
- 1500+ BUSINESS DELEGATES
- 250+ GLOBAL SPEAKERS
- BRICS WORKING GROUP BRAIN STORMING SESSION
- 2500+ ENGINEERING PHARMA & SCIENCE STUDENTS AT STUDENT OUTREACH PROGRAM FROM 28 STATES & UNION TERRITORIES

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