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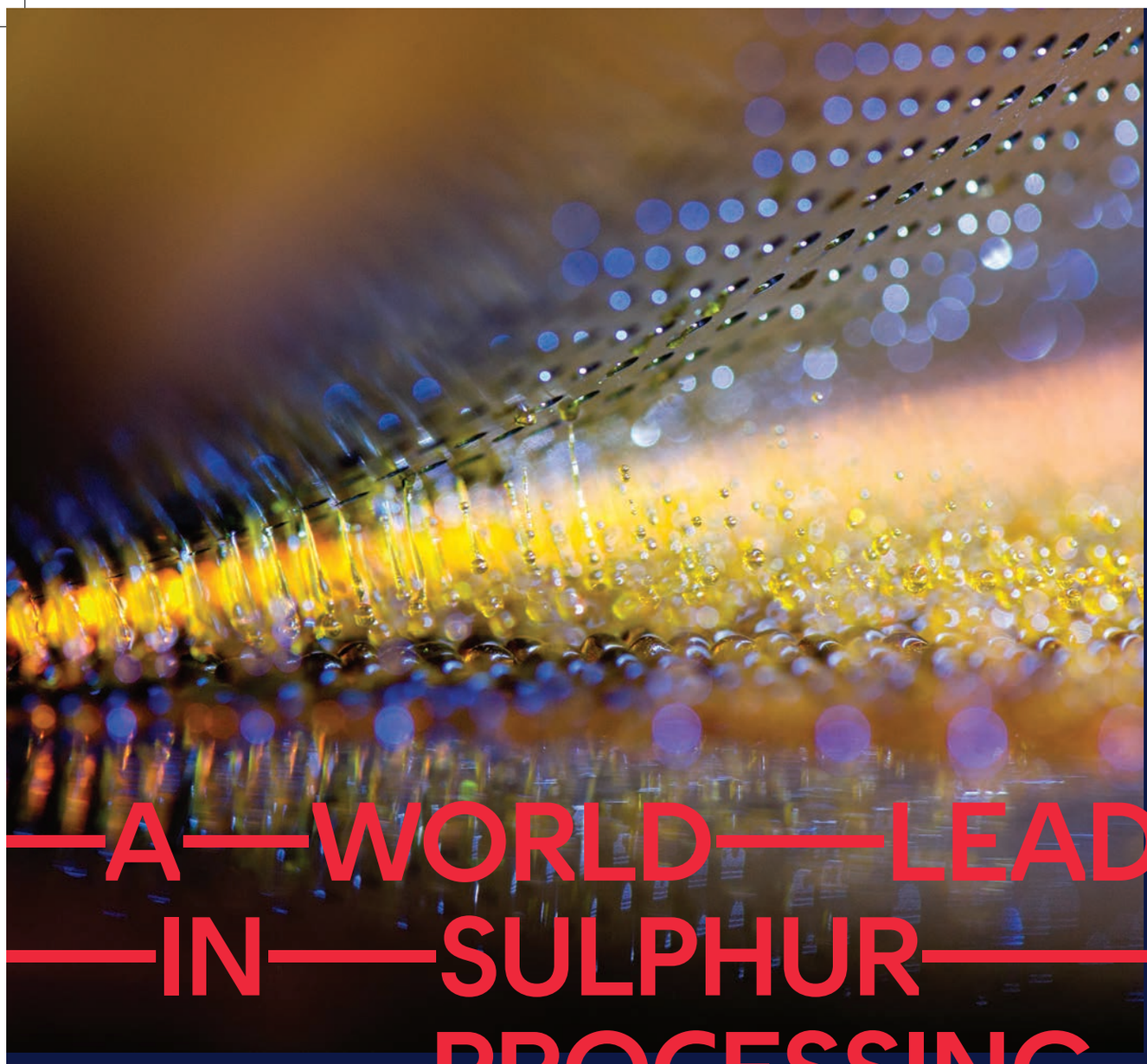

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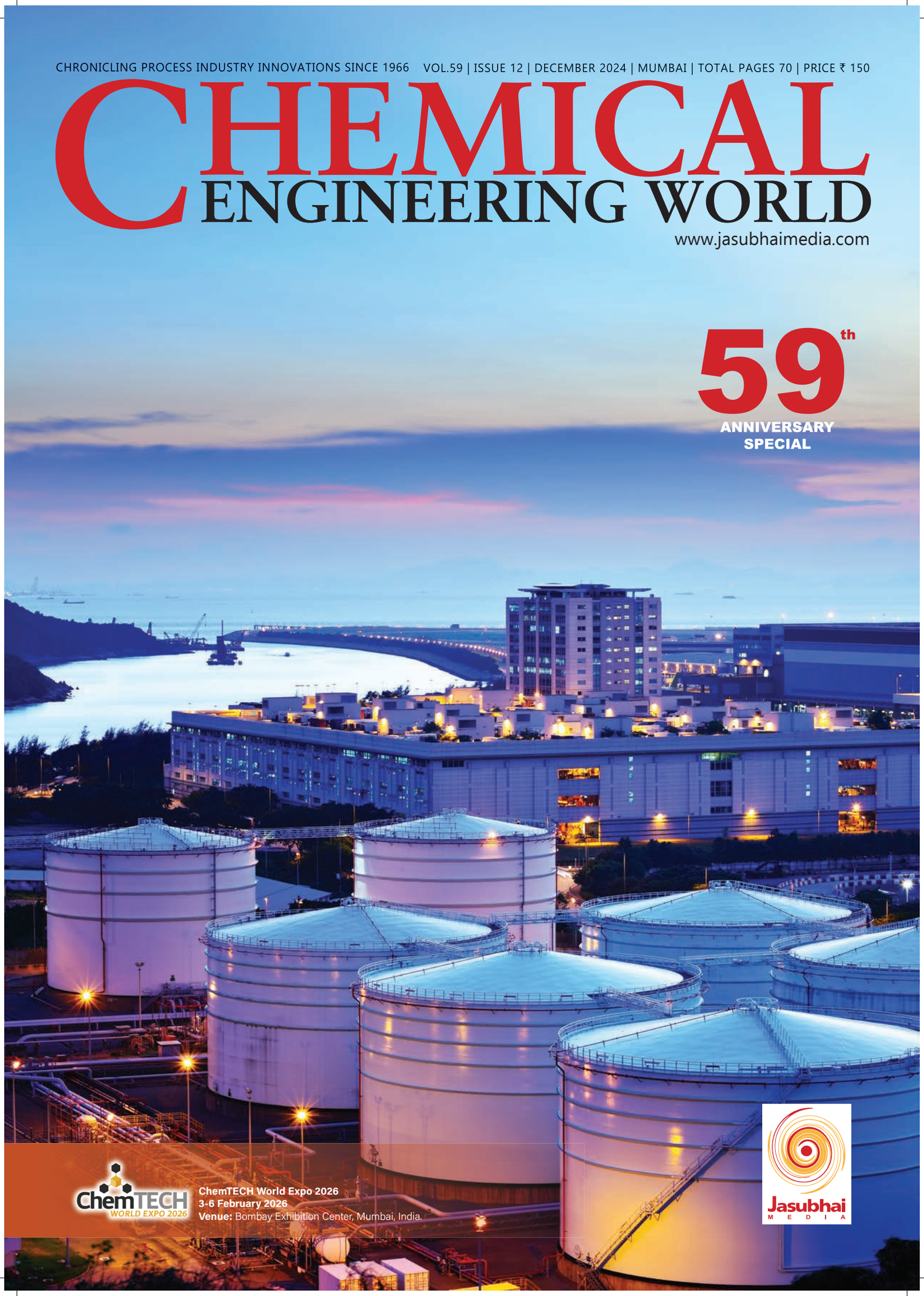

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EDITOR
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Tata Chemicals wins Dual Distinction at CII Summit

New Delhi, India: Tata Chemicals has been recognized with two esteemed awards at the CII Summit on Technology, Intellectual Property, and Industry-Academia Partnerships, celebrating its commitment to innovation and collaboration. The company received two accolades - Winner in the Large Manufacturing Category for Best Trademark Portfolio (2019–24) and Diamond Winner in the Industry-Academia Partnership – Industry Large Category - For fostering innovation through impactful collaborations with universities, addressing industry needs, and advancing cutting-edge research capabilities.

The awards were presented by Dr. R. A. Mashelkar, Padma Vibhushan awardee and Former Director-General of CSIR, during the summit organized by the CII National Committee on Intellectual Property and the CII National Forum on Industry-Academia Partnership for R&D and Innovation.

The Best Trademark Portfolio Award highlights Tata Chemicals' strategic approach to intellectual property management, with a strong focus on protecting and leveraging its trademarks to fuel growth and establish a competitive edge in the global market.

The Industry-Academia Partnership Diamond Award emphasizes Tata Chemicals' dedication to nurturing innovation ecosystems. The company's partnerships with academic institutions have led to transformative solutions that address industry challenges, bridge the gap between theory and practice, and strengthen India's research landscape.

GHCL gets environment clearance for soda ash greenfield plant

New Delhi, India: GHCL, India's leading chemical company, has received environmental clearance from the Ministry of Environment, Forest and Climate Change for its soda ash greenfield project in Kutch, Gujarat. The environmental clearance will help the company start setting up a 1.1 MMTPA soda ash plant over six years at a capital outlay of ₹6,500 crore. Commenting on the environmental clearance, R S Jalan, Managing Director, GHCL Limited, said, "The approval for the new plant of soda ash will play a significant role in achieving India's vision of Green Energy and *AtmaNirbharta*." India, which aims to reach 500 GW of installed capacity of green energy by 2030, will witness a soda ash demand of around 7.0 MTPA. Currently, India produces 3.6 MTPA of soda ash which is merely 6 per cent of the global soda ash manufacturing capacity, Jalan said. The upcoming greenfield project will almost double its production capacities. This forthcoming plant in greenfield will be equipped with ultra-modern technology, with a focus on carbon neutrality by exploring the use of green energy resources. The plant will support the nearby community with CSR and sustainability initiatives, generating direct and indirect employment. It will encourage the setting up of micro, small, and medium enterprises (MSMEs) in the logistics, and packaging material segments, ensuring increased prosperity and economic upliftment of the local communities and facilitating the development of locals.

Jubilant Ingrevia appoints Vijay Srivastava as COO & Whole-time Director

Jubilant Ingrevia has appointed **Vijay Srivastava** as **Chief of Operations & Whole-time Director** of the Company w.e.f. 01 November 2024. Vijay has more than 25 years of experience in Manufacturing across various industries including Petrochemicals, Engineering Polymers, Agro Chemicals, Organic & Inorganic Intermediates. He started his career with UPL and has spent significant time at DuPont in India and abroad. He has also worked with Deepak Nitrite and S.I. Group at various leadership roles. He was appointed as President – Operations for Jubilant Ingrevia Limited w.e.f. 29th March 2022.

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UPL wins Award for Best Patent and Trademark Portfolio

New Delhi, India: UPL, a global leader in sustainable agriculture products and solutions, has been honoured with the Best Patent and Trademark Portfolio Award in the Large - Life Sciences, including Pharma and Agriculture Sciences category, at the Confederation of Indian Industry (CII) Industrial IP Awards 2024 ceremony. The company has received the Best Patent Portfolio award for the 6th consecutive year and the Best Trademark Portfolio award for the 4th time, underscoring its unwavering commitment to innovation and excellence in intellectual property (IP) management.

UPL currently holds over 2,500 granted patents and about 4,300 pending applications, showcasing its robust IP portfolio. UPL's trademark portfolio has over 17,000 registered trademarks and about 13,000 pending applications across the globe.

Reliance acquires 21% stake in Wavetech Helium, Inc.

Mumbai, India: Reliance Finance and Investments USA LLC, a step-down wholly owned subsidiary of Reliance Industries, has entered into a stock purchase agreement with Wavetech Helium, Inc. (WHI) and subscribed to 21 per cent stake of WHI for an aggregate consideration of USD12 million. WHI was incorporated on July 2, 2021 in United States and started its commercial operations in CY 2024. WHI is a U.S. helium gas exploration and production company engaged in the acquisition, exploration, and development of properties to produce helium gas from underground reservoirs. Helium is used in medical applications, scientific research, aerospace and aeronautics, electronics, fibre optics etc. Further, given the growth expected in AI and Datacentres, helium demand for semiconductor manufacturing is expected to increase. The acquisition is part of the company's strategy to expand its exploration and production business in low carbon solutions.

Hind Rectifiers incorporates subsidiary company

Mumbai, India: Hind Rectifiers Limited has incorporated a wholly owned subsidiary company - Hirect FZ-LLC, in the Ras Al Khaimah Economic Zone (RAKEZ). The paid-up capital is AED 125,000/- (One Hundred and Twenty-Five Thousand Dirhams). Suramya Nevatia, Chairman & Managing Director (CEO) of Hind Rectifiers Limited has been appointed as Manager and Director in Hirect FZ-LLC.

The company will deal in power generation, transmission & distribution equipment trading, heavy equipment and machinery spare parts trading, electronic card wholesale industrial plant equipment and spare parts trading, wholesale of non-ferrous metal main products trading.

Hirect FZ-LLC is set up as a separate entity and a subsidiary of Hind Rectifiers Limited to become more customer-focused and leverage the growth opportunities in the international market. Hind Rectifiers Limited will own 100 per cent equity interest in Hirect FZ-LLC.

Dinesh Mahur appointed on the Board of Directors of Hindustan Zinc Ltd

Hindustan Zinc Limited has received the order from the Ministry of Mines, Government of India informing the appointment of **Dinesh Mahur, Joint Secretary, Ministry of Mines as Government Nominee Director (Non-Executive)** on the Board of Directors in place of Dr Veena Kumari Dermal, Ex-Joint Secretary, Ministry of Mines. Dinesh Mahur is also inducted as a member of the Stakeholder Relationship Committee & Sustainability and ESG Committee. Dinesh Mahur, aged 54 years, Joint Secretary, Ministry of Mines handles policy, legislation and critical minerals in this Ministry.

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Hindustan Zinc announces energy savings of over 0.8 million GJ in just 1 year

Udaipur, India: Hindustan Zinc Limited, India's largest and the world's second largest integrated zinc producer, has announced cumulative energy savings of over 0.8 million Gigajoules (GJ) in FY 24. For context, this quantum of energy savings could power over 70,000 Indian households around the year. The company also announced the expansion of its renewable power delivery agreement (PDA) to 530 MW (capacity includes earlier signed PDAs) following approvals in the last Board meeting. This will increase the overall renewable energy contribution to over 70 per cent of total power requirement by 2026. Hindustan Zinc has already signed power delivery agreements to source 450 MW round the clock renewable power.

Waaree sets up subsidiary in Australia

Mumbai, India: Waaree Energies Limited has incorporated a new wholly-owned subsidiary in Australia by the name of Waaree Renewable Energies Australia PTY Limited. The wholly owned subsidiary will be a related party of the company and other subsidiaries. This subsidiary will focus on renewable energy business in Australia.

Godavari Biorefineries secures exclusive license agreement with Catalyxx Inc

Mumbai, India: Godavari Biorefineries Limited (GBL), a pioneer in renewable chemicals and biofuels, has announced the signing of a strategic international license agreement with Catalyxx Inc. This partnership grants GBL exclusive rights to leverage Catalyxx's cutting-edge technology for the conversion of ethanol to for up to 30,000 tons of biobutanol and other higher alcohols in India and selling globally. Godavari will in the first phase, construct and operate a state-of-the-art facility designed to produce 15,000 metric tons of biobutanol and higher alcohols annually.

Praj eyes opportunities in multiple sectors

Pune, India: Praj Industries is eyeing opportunities in multiple sectors including sustainable aviation fuel (SAF), biopolymers and the Energy Transition and Climate Actions (ETCA). The company is expecting to triple its revenues by 2030. Dr. Pramod Chaudhari said, "The energy transition & climate actions (ETCA) sector which has a global potential and contains segments like blue and green hydrogen, green ammonia and west to energy solutions is expected to drive the growth. Globally, the energy majors are likely to invest close to ₹25 lakh crore in the clean energy sector by 2030, whereas the traditional oil and gas market will continue to attract new investments to the tune of ₹21 lakh crore in the next 10 years' time on the global front." "This will lead to the significant demand for modularization solutions for setting up plants in the above-mentioned sectors. To cater to this demand, Praj has developed strong engineering capabilities in modularization and has set up a dedicated advanced manufacturing facility at Mangalore in Karnataka with an investment of about ₹400 crore spread across 123 acres of land, this plant can deliver revenues in the range of ₹2,000-2,500 crore annually at the optimum level," Dr Chaudhari added. "The CORSIA agreement for the use of Sustainable Aviation Fuel (SAF) has opened a door to the new opportunities for Praj as India has set the target of blending 1 per cent by 2027 and 2 per cent by 2028. Atul Mulay, President, Bioenergy Business, said, "The current revenues of Praj are close to ₹3,400 crore annually, and we have a goal to reach ₹10,000 crore by the year 2030. Currently, share of exports is around 29 per cent; going forward, we are looking at increasing it to 50 per cent by 2030." ■

Thermax inducts Arun Unni as a member of Senior Management of the company

Arun Unni has been inducted as the **Business Unit Head, New Energy & Strategy and member of Senior Management** of **Thermax Limited**. Unni has 23 years of experience across strategy consulting, energy transition, and sustainability, with leadership roles in top-tier firms and major corporations. He began his career in 2001 at Arthur Andersen, later moving to KPMG, where he honed his consulting expertise. His expertise spans M&A, Technology Partnerships and Operational Transformation Projects.

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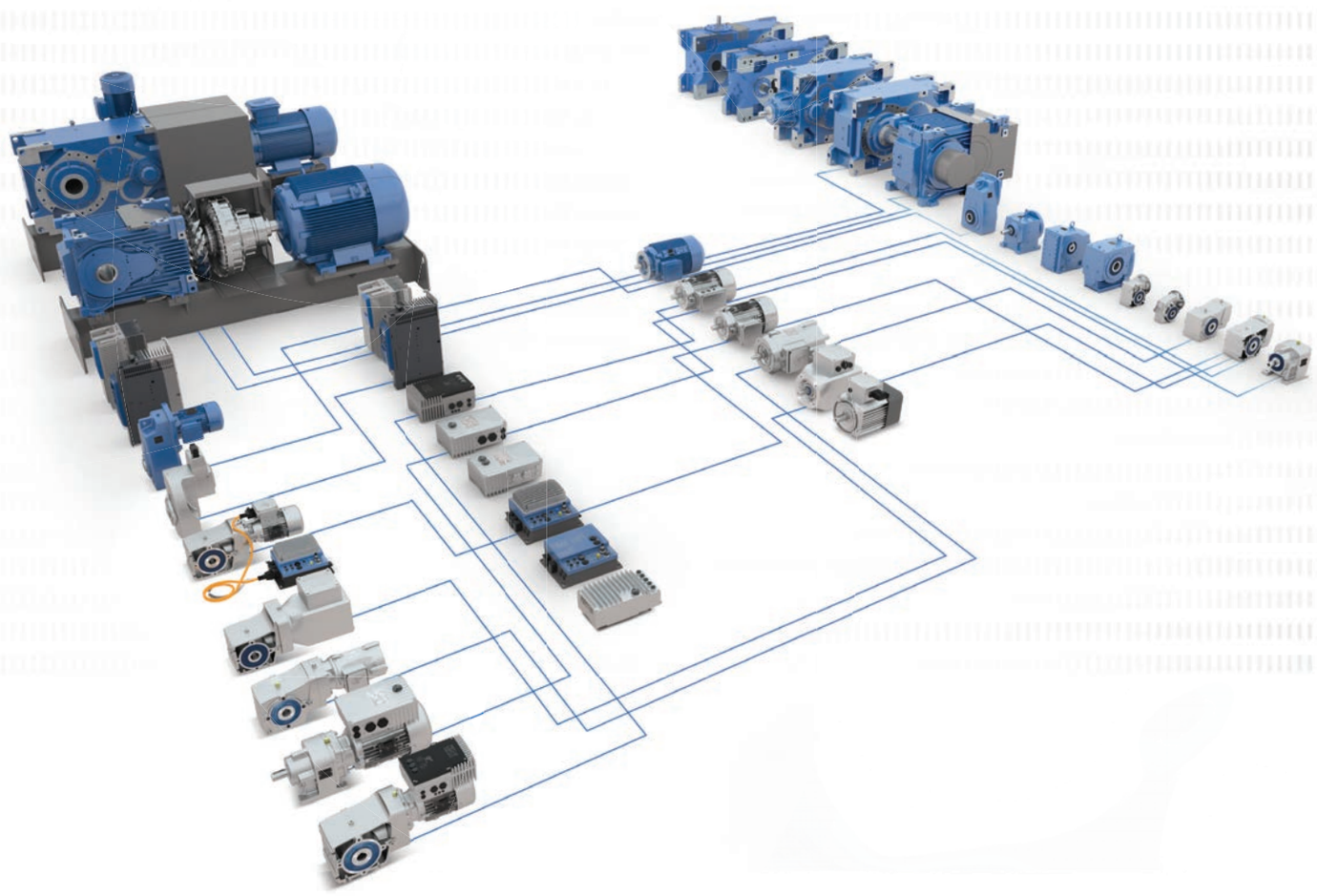

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PROJECT UPDATES

POWER

Company: NTPC

Project: The Board of Directors of the Company, has accorded investment approval for three thermal power projects.

Details: 1. Nabinagar Super Thermal Power Project - Stage-II (3x800 MW) - ₹29,947.91 crore.

2. Gadarwara Super Thermal Power Project - Stage-II (2x800 MW) - ₹20,445.69 crore.

3. Telangana Super Thermal Power Project - Phase-II (3x800 MW) - ₹29,344.85 crore.

FERTILIZERS

Company: Coromandel International Limited

Place: Kakinada, Andhra Pradesh, India and Ankleshwar, Gujarat, India

Project: Coromandel International Limited has approved capital projects with an investment outlay of around ₹800 crore.

Details: ▪ Enhancement of granulation capacity by 7.5 lakh tons per annum for manufacture of complex and unique fertilisers at Kakinada, Andhra Pradesh, and

- Setting up of a state-of-the-art multi-product plant for manufacture of recently off-patented fungicides at Ankleshwar, Gujarat and
- Phosphoric acid plant with a capacity of 650 Tons Per Day (TPD) and sulphuric acid plant with a capacity of 2,000 TPD at a cost of ₹1,000 crore.

RENEWABLE POWER

Company: Waaree Energies Limited

Project: Waaree Energies Limited has received an order for supply of solar modules upto 1 GW from a renowned customer engaged in the business of owning, developing and operating renewable power projects in India.

Details: The supply of solar modules is scheduled to commence in FY 2024-25 and FY 2025-2026.

STEEL

Company: JSW Group & Korea's POSCO Group

Project: Integrated Steel Plant

Details: JSW Group (JSW), one of India's fastest-growing conglomerates, has signed a Memorandum of Understanding (MoU) with Korea's POSCO Group (POSCO) for the development of an integrated steel plant in India with an initial capacity of 5 million tonnes per annum.

SPECIALTY CHEMICALS

Company: PCBL Chemical Limited

Project: Brownfield Expansion - specialty chemical capacity

Details: Commissiong of second and final phase 20,000 MTPA of 40,000 MTPA specialty chemical capacity at Mundra Plant, Gujarat done recently. With this, the combined manufacturing capacity of the company is 7,90,000 MTPA.

SOLAR ENERGY

Company: Waaree Forever Energies Pvt Ltd

Project: Development of Solar power plant in Madhya Pradesh

Details: Waaree Forever Energies Private Limited, a wholly owned subsidiary of Waaree Energies has received Letter of Award for the development of 170 MW Solar power plant in Madhya Pradesh, from Rewa Ultra Mega Solar Limtied. The solar power plant will enable the generation and transmission of clean energy via the Inter-State Transmission System (ISTS). The project will supply renewable energy to Madhya Pradesh Power Management Company Ltd and Indian Railways.

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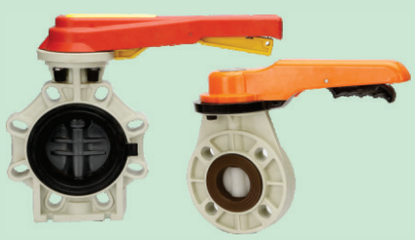

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End Connection: Socket/Flange

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End Connection: Socket/Flange

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Material: PPH/UPVC/CPVC/PVDF
End Connection: Socket/Flange

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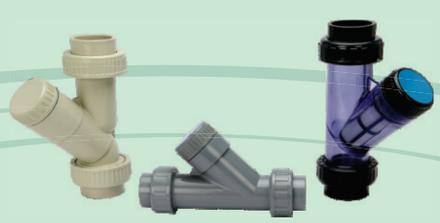

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End Connection: Socket/Flange

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End Connection: Socket/Flange

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End Connection: Socket/Flange

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PROJECT UPDATES

BIO-ENERGY

Company: Godavari Biorefineries Limited

Project: Investment in a New Corn/Grain Based Distillery to Enhance Ethanol Production

Details: The company plans to invest approximately ₹130 crore in a new 200 KLPD corn/grain-based distillery to its existing operations, enhancing flexibility through dual-feedstock capability.

CHEMICALS

Company: INEOS, GNFC

Place: Bharuch, Gujarat, India

Project: INEOS and Gujarat Narmada Valley Fertilizers & Chemicals Ltd (GNFC) sign a Memorandum of Understanding to build a new world scale Acetic Acid unit in India.

Details: The 600kt Acetic Acid plant will be built at GNFC's site in Bharuch, Gujarat, India. The two companies have held a technology partnership for close to 30 years but will now establish a new joint venture which will manage bringing this project to market, currently forecast in 2028.

YARN

Company: Indian Oil Corporation Limited

Project: Yarn Project

Details: Indian Oil Corporation Limited Board has accorded investment approval for setting up of a Yarn Project consisting of 900 TPD Continuous Polymerization (CP) unit with downstream units of Draw Textured Yarn (DTY), Fully Drawn Yarn (FDY), Polyester chips and associated facilities at Bhadrak (Odisha) at an estimated cost of ₹4,382.21 crore through (50:50) Joint Venture with MCPI Pvt. Ltd. with IndianOil's equity contribution of ₹657.33 crore.

REFINERY

Company: Hindustan Petroleum Corporation Ltd

Project: Lube Modernization and Bottoms Upgradation Project at Mumbai Refinery

Details: This project would increase the Lube Oil Base Stocks (LOBS) production from current 475 KTPA to 764 KTPA with production of superior grade Group 11+ and Group III LOBS. Additionally, there would be increase in Bitumen production by approximately 487 KTPA with upgradation of Fuel Oil to Bitumen. The estimated cost of this project is ₹4,679 crore with a mechanical completion schedule of 36 months and 3 months for commissioning from the date of Board approval.

SPECIALTY CHEMICALS

Company: Himadri Speciality Chemical Limited

Project: First commercial plant and expansion of specialty carbon black line

Details: Himadri Speciality Chemical Limited is setting up its first commercial plant with a 40,000 MTPA capacity for LFP Cathode Active Material. The plant is scheduled to be operational by Q3 FY27. The second project - expansion of a new speciality carbon black line - with a 70,000 MTPA capacity is set to be completed by Q3 FY26.

BATTERY ENERGY STORAGE SYSTEMS

Company: Reliance NU Suntech Private Limited

Project: Solar Energy Project and Battery Energy Storage System

Details: Reliance Power Limited subsidiary, Reliance NU Suntech Private Limited, received the Letter of Award from Solar Energy Corporation of India (SECI) for its proposed solar 930 MW and 465 MW/1860 MWh Battery Energy Storage System (BESS) projects. The project will see the largest deployment of grid storage batteries at a single site, not only in India but also in Asia, besides China.

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Dr. R. A. Mashelkar receives 51st Honorary Doctorate

Dr. R. A. Mashelkar received his 51st honorary doctorate from Assam Royal Global University, Guwahati (2024); 50th honorary doctorate during the 8th Convocation of the Academy of Scientific and Industrial Research and the 49th Honorary Doctorate from Deakin University, Australia.

Dr. Raghunath Anant Mashelkar, known for his scientific research, received the 51st Honorary Doctorate from Assam Royal Global University, Guwahati (2024).

On 23rd November 2024, he was conferred with his 50th Honorary Doctorate during the 8th Convocation of the Academy of Scientific and Industrial Research at the hands of Dr. Jitendra Singh, India's Minister of Science and Technology and Minister of Earth Sciences. This follows on the heels of his recent 49th honorary doctorate from Deakin University, Australia. With this, Dr. Mashelkar has passed the record held by any Engineer in India, namely that of 48 Honorary Doctorates received by the late Dr. A.P.J. Abdul Kalam.

Dr. Raghunath Anant Mashelkar is known for his world-class scientific research in polymer science and engineering, for his transformative national research institution leadership, for his pioneering different movements such as evolving global systems for traditional knowledge protection, helping create strong yet balanced IPR systems, inclusive innovation movement based on the concept of Gandhian Engineering that he pioneered. He has been an influential thought leader in shaping Science, Technology and innovation policies in post-liberalised India.

He has made pioneering contributions to the rheology of complex fluids, non-Newtonian fluid mechanics, diffusional phenomena in structured polymeric systems and polymer reaction engineering. His work in mechanistic analysis, synthesis and some breakthrough applications of novel stimuli-responsive polymers has received worldwide accolades. His latest work on supramolecular therapeutics is as novel as it is impactful.

Dr. Mashelkar has been propagating a culture of innovation and a balanced intellectual property rights regime for over four decades. Dr. Mashelkar has previously served as Director General of the Council of Scientific and Industrial Research. ■

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GUEST COLUMN

Indian Chemicals Industry: Challenges & Growth Opportunities

Khushbu Lakhotia
Director
India Ratings & Research

The Indian chemicals industry has witnessed challenging times in the past 1.5-2 years, given the soft global demand and oversupply in most value chains leading to high channel inventories affecting offtake. This in turn has led to a sharp fall in prices across chemicals, affecting profitability. Some signs of recovery have been seen in 1HFY25 and a moderate improvement is likely in FY26. The medium-to-long term fundamentals of the Indian chemical industry, however, remain intact, with a growing domestic demand and medium-term export opportunities likely to drive growth.

With the robust GDP growth over the past 3 years, India's domestic chemical demand has been better than most major economies. With consumption demand gradually getting broad-based and a pick-up in infrastructure spending after a slowdown in 1HFY25, domestic chemical demand is likely to witness a healthy growth in 2025. Chemicals are used almost across sectors including textiles, pharma, auto, plastics, paints, agriculture, FMCG, paper, construction, etc. While some of these sectors like textiles, pharma witnessed softness in the past few quarters, they are expected to recover in the near-term.

However, despite a healthy domestic demand, the fortunes of India's chemical sector remain linked to the global chemical industry which has a significant bearing not only on the exports and the prices of various chemicals but also the ability of Indian chemical companies to tap the domestic growth as a weak global demand typically leads to an increase in imports into India.

Chemical production fell in most large economies of the world in 2023 owing to a weak demand coupled with an influx of imports as production in China rose almost 10 per cent year-on-year (y-o-y). While weakness continues, some signs of recovery were seen in 2024, with a few of the economies registering low-to-mid single digit growth in 7M2024. 2025 is likely to witness a modest recovery in demand led by economic growth,

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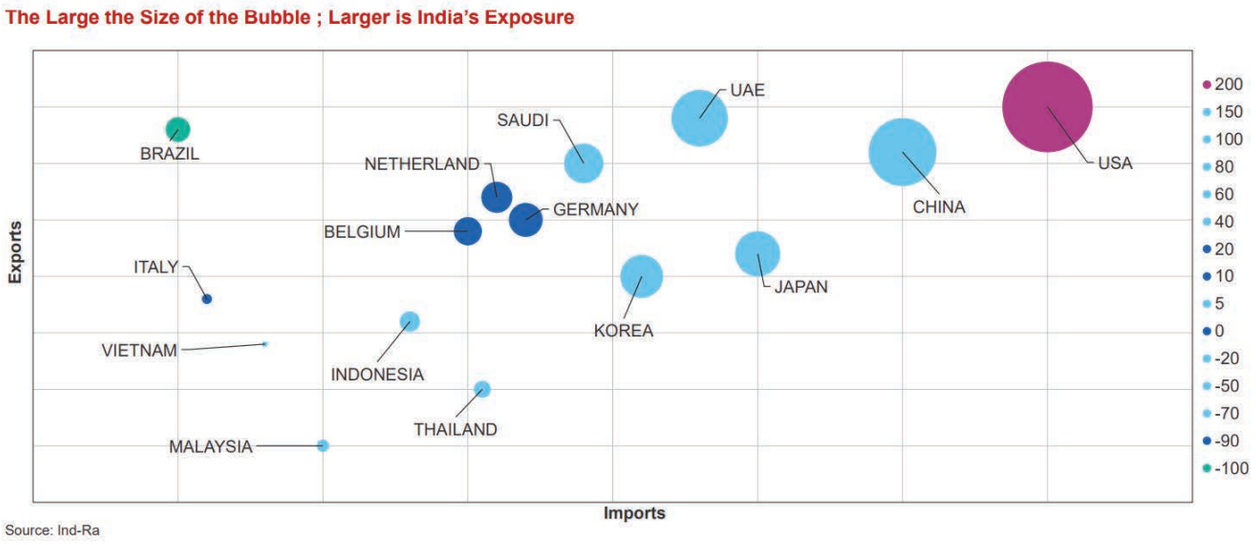

Figure 1: Geo-Political Risks: What to Watch Out For?

restocking and a likely reduction in policy rates and easing of inflation. China, which is the single biggest driver of the global chemical market, could witness a modest recovery in 2025 as a sizeable destocking in 2024 and government stimulus measures lead to some recovery in demand although a continued weakness in Chinese property sector would weigh on the demand. Among other key markets, demand in the US is likely to remain soft with some slowdown in household consumption and economic growth. The worst is likely to have been over for Europe and we expect to see capacity rationalization in the region given the continued slowdown.

With the global slowdown in demand, FY24 saw chemical imports into India rise to their highest level in at least about a decade and a further year-on-year increase was witnessed in 1HFY25. With the current global demand-supply backdrop, import threat continues to loom over Indian chemical companies given that India is a large and growing consumption centre. Further, risks could arise from the US-China tariff war given these are the two largest chemical exporters in the world and additional US tariffs on China and any retaliatory action by China could redirect their exports into other countries including India. The US and China are also India's largest chemical trade partners.

After a sharp increase in FY22, India's chemical exports weakened with global demand hit harder and an influx of Chinese chemicals in key consuming countries. After being the second largest exporter of agrochemicals in 2022, India slipped to the third position in 2023. While the China+1 benefit has not played at the expected pace, India's medium-to-long term exports prospects remain healthy as large players look to gradually de-risk their supply chains away from China and Europe. Some of this is evidenced in the letters of intent received by Indian specialty chemical companies even though the slowdown has taken a toll on the volumes in the segment. However, most specialty chemical players continue to invest in scaling up the value chain, albeit the investment pace has reduced amid the weak cash flows.

Capex, which was around 7-11 per cent, of the revenue is likely to come down by a few basis points over FY25-FY26 as companies wait for the added capacities to ramp and cash flows from existing businesses to recover. Specialty chemicals are typically more capital intensive compared to commodity chemicals compared to commodities where capacity additions are typically lumpy and aimed typically at import substitution.

At a broader level, technology and product development could continue to be one of the key constraints that India may face compared to China. The R&D spends of Indian players typically ranges between low-to-single digit of revenue (often less than 1 per cent for commodity chemicals and rarely more than 5 per cent for specialty chemicals), significantly lower than large global players. India needs to increase R&D spends for a better long-term readiness to increase its global market share.

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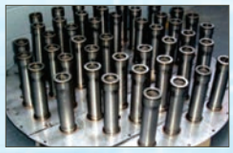
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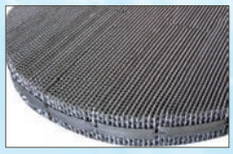
Multi-Cyclones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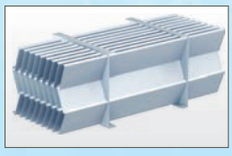
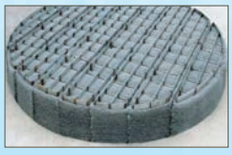

Vane Pack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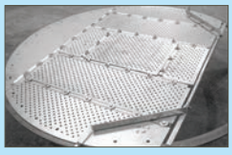
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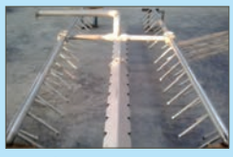
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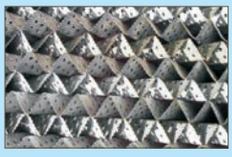
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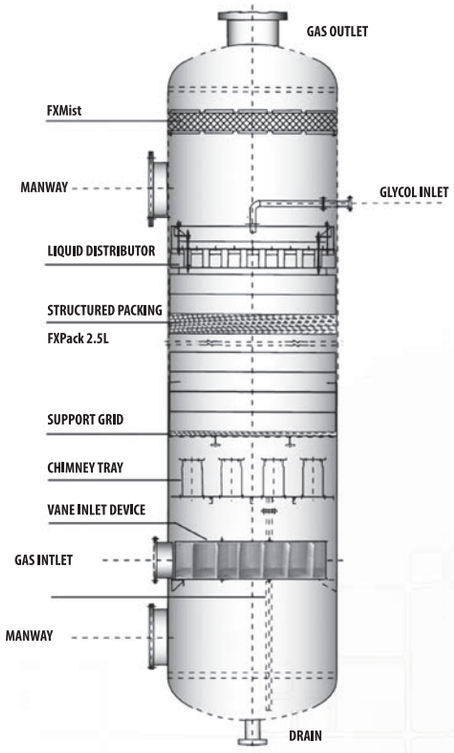

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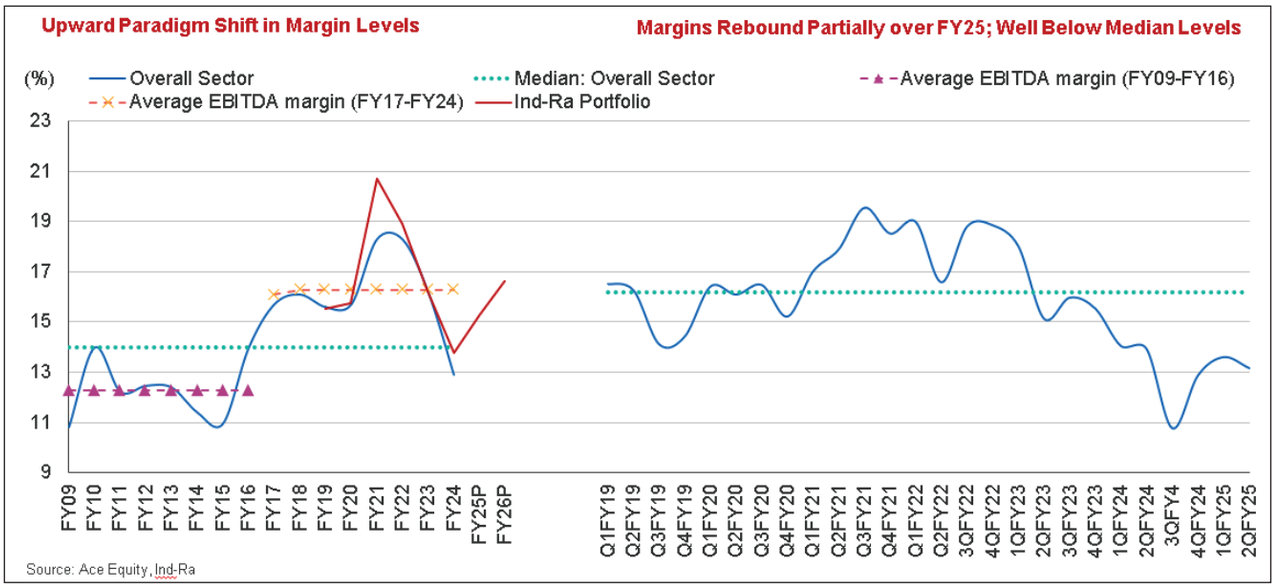

Figure 2: Recovery from Bottom of Cycle Margins by FY26

chemical companies witnessed a decline of around 10 per cent y-o-y in the revenue in FY24 as the global weakness led to a sharp decline in prices of most chemicals. Some signs of recovery were seen in the interim results of FY25, wherein listed entities recorded a y-o-y growth in both1Q and 2Q led by an increase in volumes even as prices remained subdued. The trend is likely to continue in 2HFY25 too. FY26 is also likely to witness a similar mid-to-high single digit, driven by some recovery in both demand and prices but remain lower than the median growth of low-teens over the cycle.

EBITDA margins hit a cyclical high in FY22 as prices shot up given the post-covid recovery in demand and supply chain disruptions. This was followed by a moderation in FY23 and a sharp fall in FY24 as the secular fall in prices led to inventory losses in most segments. After hitting a multi-year low in 2HFY24, margins have witnessed some recovery to 13-14 per cent in 1HFY25 on volume growth and reduction in inventory losses in many cases, but they remain lower than the mid-cycle levels of 15-17 per cent. We expect profitability to gradually move back to the mid-cycle levels over FY26-FY27, but geo-political developments remain a key monitorable. However, on the positive side, the mid-cycle EBITDA margins that used to be around 12-13 per cent over FY09-FY16 have moved up to 15-17 per cent over FY17-FY24 with even the downcycle registering around 13 per cent in FY24.

Despite a healthy domestic demand, the fortunes of India's chemical sector remain linked to the global chemical industry.

The performance across various chemical segments has been far from uniform. The margin profile of specialty chemical companies has witnessed less volatility given their higher ability to pass on fluctuations in input prices with a lag of about a quarter. Agrochemical has been one of the worst hit, with extremely high channel inventory emanating from the large stocking in anticipation of a large demand post lockdown, coupled with the high interest rate environment globally, drying up demand over FY24-1HFY25.

However, with a gradual moderation in inventory, restocking demand is likely to result in some recovery in the segment in FY26 even as the elevated interest rate environment could mean that the 'new normal' inventory level would be lower. Most large chemicals witnessed significant deleveraging over FY21-FY22 which created headroom to absorb 1-2 years of weakness although certain segments witnessed weakness. As a result, while the net debt/EBITDA levels have risen nearly across the board, financial health remains comfortable. About 80 per cent of the sector entities had interest coverage above 1.5x, close to the decadal medians. However, a delay in recovery beyond FY26 could gradually affect the liquidity buffers. ■

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Chemical Process Engineering in Advancing the Chemical Industry

In today's competitive and environmentally conscious world, Chemical Process Engineering (CPE) stands as a transformative force for the chemical industry. This multidisciplinary domain, merging the principles of chemistry, physics, and engineering, while focusing on designing, optimising and integrating processes, CPE drives efficiency, safety, and sustainability in chemical manufacturing. The transition from an era of experience-driven processes to a data- and core science and engineering-led approach is no longer optional; it is imperative. This article explores the applications and critical importance of chemical process engineering, its contribution to sustainable development, and its potential to transform India's chemical landscape.

As global competition intensifies, nations like China have demonstrated how the strategic adoption of CPE can revolutionise manufacturing capacity and dominate world markets. For India, embracing CPE is not merely a strategic option but an urgent necessity to enhance its competitiveness, particularly in batch manufacturing plants, while meeting sustainability goals.

Chemical Process Engineering: Cornerstone of Modern Manufacturing

Chemical process engineering forms the foundation of modern industrial processes, ensuring that raw materials are converted into valuable products in an efficient, cost-effective, and environmentally responsible manner. Its applications span across all the chemical manufacturing sectors such as petrochemicals, pharmaceuticals, agrochemicals, and specialty chemicals amongst others. By integrating advanced tools like computational modelling, process simulation, and control systems, CPE ensures:

- **Efficiency Enhancement:** By optimising reaction conditions and process design, CPE ensures higher yields and reduced resource consumption. According to the International Energy Agency, process optimisation has reduced energy use in global chemical plants by 30 per cent on average.
- **Improved Safety:** Advanced hazard analysis and real-time monitoring have significantly reduced industrial accidents. A Deloitte study highlighted a 40 per cent drop in safety incidents in facilities adopting advanced process control.
- **Sustainability:** By designing eco-friendly processes, CPE minimises emissions and waste while promoting renewable feedstocks.

To put this into perspective, China's rapid ascent to become the global leader in chemical manufacturing exemplifies the power of CPE. Between 2015 and 2022, China's share of global chemical exports grew from 22 per cent to 34 per cent, driven by widespread adoption of energy-efficient technologies, automation, and sustainable practices. Furthermore, Chinese chemical plants have utilised advanced distillation technologies to reduce energy consumption by 25–40 per cent, far surpassing global benchmarks. India, by comparison, lags significantly behind. With its chemical plants consuming 40–60 per cent more energy than global standards, the lack of CPE integration is a critical bottleneck that must be addressed urgently.

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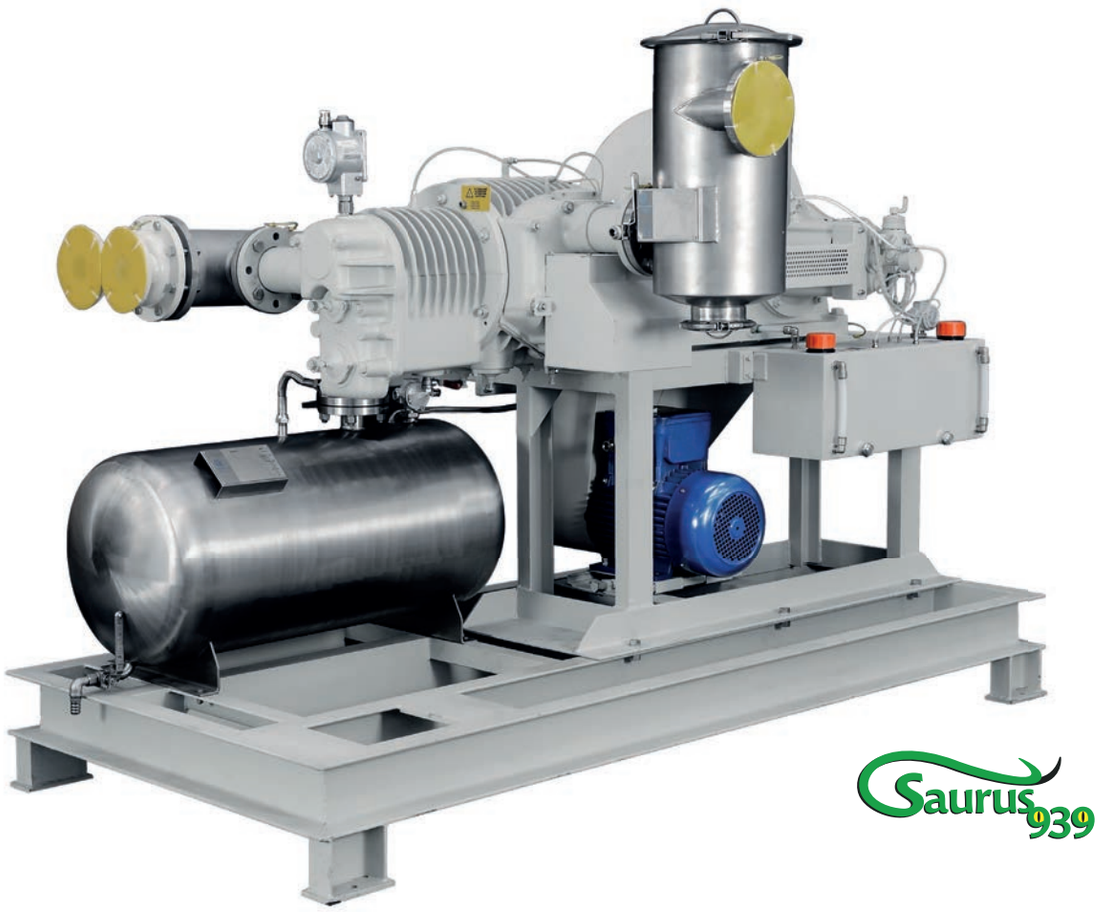

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global greenhouse gas emissions. CPE plays a crucial role in transitioning this industry towards sustainability by integrating energy efficiency, waste reduction, and renewable feedstocks into core manufacturing processes.

How CPE Drives Sustainability

- **Energy Optimization:** Process intensification technologies such as heat integration and catalytic enhancements drastically reduce energy requirements. For instance, advanced heat integration systems have cut energy use in chemical plants by up to 30 per cent, according to the American Chemical Society. BASF's use of similar systems saves 60 lakhs tonnes of CO_2 annually and cuts raw material usage by 20 per cent.
- **Circular Economy Solutions:** Through solvent recovery and chemical recycling, industries can minimise waste while reusing valuable resources. Dow Chemical reports that advanced recycling techniques reduce process waste by 10 per cent annually.
- **Sustainable Feedstocks:** CPE facilitates the transition to bio-based and renewable raw materials, reducing dependency on fossil fuels.

Global chemical manufacturers have been a frontrunner in integrating sustainability into chemical manufacturing. Its closed-loop recycling systems and solvent recovery initiatives have set benchmarks globally. For example, the chemical sector in China now recycles 70 per cent of solvents used in batch manufacturing, compared to the global average of 50 per cent. These measures have helped China reduce emissions from chemical plants by 15 per cent over the last decade, while also maintaining cost competitiveness.

India's chemical industry, on the other hand, contributes nearly 18 per cent of the country's industrial CO_2 emissions and struggles with inefficiencies in waste management. By adopting CPE, Indian manufacturers could reduce emissions by 25 per cent and water consumption by 40 per cent, according to a FICCI study.

India's Urgent Need for Chemical Process Engineering

India's chemical industry, valued at approx. ₹19,23,471 crores in 2023, is projected to reach ₹25,42,120 crores by 2030. However, this growth is impeded by inefficiencies, environmental concerns, and a lack of advanced technologies.

Challenges Hindering Progress

High Energy Intensity: Indian chemical plants consume significantly more energy than their global counterparts.

Safety Deficiencies: Industrial accidents in India are 30 per cent more frequent than in developed countries.

Outdated Practices in Batch Manufacturing: Batch plants, especially in pharmaceuticals and specialty chemicals, suffer from inefficiencies due to reliance on manual processes and legacy systems.

Statistical Context

- A NITI Aayog report suggests that implementing CPE could save India approx. ₹42,365 crores annually through energy savings alone.
- Process improvements in batch manufacturing could enhance cycle times by 25 per cent and reduce costs by 30 per cent, according to PwC.

While experienced professionals have traditionally driven India's chemical industry, the complexity of modern processes demands the expertise of specialised chemical process engineers. They bring advanced knowledge of process optimisation, modelling, and integration that goes beyond intuition or experience.

Cutting-Edge Process Developments

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reactors significantly reduce energy and material inputs. Studies show that microreactors can cut energy use by 40 per cent and reduce reaction times by up to 90 per cent.

- Real-time process control using automated feedback loops has reduced product variability by 15–20 per cent, improving product quality and minimising waste.

AI and Machine Learning

AI-enabled systems optimise reactions, predict maintenance needs, and control emissions. A Deloitte study highlights a 20–30 per cent reduction in downtime for plants using AI-driven control systems.

Energy Optimisation and Integration

Heat recovery and cogeneration technologies have drastically improved energy efficiency. For example, Reliance Industries' Jamnagar refinery saves approx. 847 crores annually through heat integration, reducing CO_2 emissions by 30 lakhs tonnes.

By adopting such technologies, Indian chemical manufacturers can not only enhance productivity but also align with global benchmarks, as demonstrated by China's strategic investments in similar innovations.

Road Ahead: Bridging Gap with Global Leaders

India's chemical industry is at a pivotal juncture. While the potential for growth is immense, failure to integrate chemical process engineering could result in missed opportunities, environmental non-compliance, and diminishing global competitiveness.

Policy Support: Strengthen incentives for adopting energy-efficient and sustainable technologies.

Skill Development: Establish training programmes to equip professionals with expertise in advanced process engineering.

Technology Adoption: Leverage global best practices in process optimisation, automation, and sustainability.

Global Perspective

While China has shown how CPE can transform a chemical sector into a global powerhouse, other nations like Germany and South Korea also offer lessons. Germany's chemical sector has reduced emissions by 38 per cent since 1990 through process integration, while South Korea's focus on batch process optimisation has improved manufacturing flexibility and cost efficiency.

India must adopt a similar strategic approach. According to TERI, achieving global benchmarks in process efficiency could double India's share in the global chemical market from 3 per cent to 6 per cent by 2030, unlocking an additional ₹847.3 lakh crores in revenue.

Conclusion

Chemical process engineering is the cornerstone of modern chemical manufacturing, driving efficiency, safety, and sustainability. Nations like Japan, Germany, China, etc have demonstrated its transformative potential, achieving global dominance through strategic adoption of advanced processes.

For India, integrating CPE is no longer a choice but a necessity. The stakes are high, with opportunities to boost productivity, reduce environmental impact, and enhance global competitiveness hanging in the balance. By embracing CPE, particularly in batch manufacturing plants, India can bridge the gap with global leaders and secure a sustainable, prosperous future for its chemical industry.

The time for action is now. Chemical process engineering is not just the solution to India's industrial challenges—it is the pathway to its industrial renaissance. ■

Author

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Engineering Procurement & Construction: Transformation & Challenges

Engineering, Procurement & Construction (EPC) firms are critical in executing large-scale infrastructure projects across sectors like oil and gas, chemicals, and renewable energy. These companies simplify management for clients by taking full responsibility for project delivery. However, the industry faces obstacles like talent shortages, regulatory pressures, and market volatility, which necessitate adopting transformative strategies. This article explores these issues and demonstrates how businesses can spearhead digital transformation while upholding their dedication to worker welfare and safety.

EPC contracts, often called turnkey contracts, obligate the contractor to deliver a complete facility to the client, who only needs to 'turn the key' to start operations. By combining duties into one organization, this model makes project management easier for clients. Important elements of EPC contracts consist of:

- **Engineering:** Involves detailed design and planning.
- **Procurement:** Securing all necessary materials and equipment.
- **Construction:** Actual building and installation processes.

The contractor assumes full responsibility for executing the task on schedule and within budget, which, if improperly managed, can result in serious risks. These contracts also help clients de-risk projects by combining responsibilities and risks, guaranteeing more efficient execution.

Current Challenges in the EPC Industry

Market Volatility: The EPC sector is highly susceptible to fluctuations in commodity prices, especially in oil and gas. Such volatility can lead to unpredictable project costs and timelines, complicating financial forecasting and project management.

Sustainability and Regulatory Compliance: Meeting environmental laws while ensuring sustainable practices is becoming imperative. This often requires investing in new technologies that may not provide immediate financial returns.

Complex Project Management: Large-scale projects involve numerous stakeholders across various locations, increasing the risk of miscommunication and delays. Managing logistics, regulatory requirements, and diverse teams can be overwhelming.

Talent Acquisition and Retention: The industry faces a significant skills gap, particularly in emerging fields such as data analytics and digital technologies. Attracting and retaining skilled professionals is crucial for maintaining competitiveness.

Integration of Digital Technologies: While digital transformation offers numerous benefits, integrating new technologies with existing systems poses significant hurdles. Resistance from employees accustomed to traditional methods can hinder successful implementation.

Digital Transformation: A Necessity

Digital transformation is essential for EPC firms aiming to enhance operational efficiency and remain competitive. Businesses can optimize processes throughout the project lifecycle by utilizing cutting-edge technologies like block chain, cloud computing, artificial intelligence

(AI), machine learning (ML), and the Internet of Things (IoT). Notably, these technologies offer a chance to rethink processes, fix inefficiencies and generate new sources of income.

Benefits of Digital Transformation

Digital transformation provides EPC firms with numerous advantages in the way they operate and add value. Digital tools automate core processes (engineering design, procurement, project management, etc.) which leads to enormous operational efficiency. Furthermore, cloud-based platforms help eliminate errors and minimize delays among the stakeholders. AI and ML can be used to make data-driven decisions and this helps firms forecast possible future challenges, thereby being proactive in tackling the challenges. With IoT devices, real-time monitoring helps provide enhanced safety and control of its quality by tracking assets and resources while construction is ongoing. Additionally, digital transformation offers opportunities for new businesses, and therefore, EPC firms can think of new businesses whether it is through innovative models or markets. Leveraging their data and industry experts, they can offer value-added services such as asset management and maintenance, which makes them stronger competitors.

Challenges in Digital Transformation

Despite its clear benefits, digital transformation faces several barriers:

Unclear Definitions and Goals: The term 'digital transformation' can be ambiguous. Companies must establish a clear vision aligned with their strategic objectives to ensure successful implementation.

Cultural Resistance: Employees might be resistant to adopting new technologies because existing processes are comfortable. The secret to changing this is to foster a culture that welcomes change. Creating a change-embracing culture is essential to overcoming this hurdle.

Dynamic Environments: EPC projects are evolving in nature, and demand agile solutions to adapt to unpredictable regulatory changes, market shifts, etc.

Talent Development: EPC companies need to invest in training programs to fill the skill gap by teaching their workforce digital skills, as well as promoting a culture of continuous learning.

Embracing Digital Transformation

Adopting digital transformation is pivotal for encouraging efficiency and innovation across the project lifecycle. To improve project delivery in industries like chemicals, hydrocarbons, and renewable energy, our team actively invests in digital solutions. We expedite project execution by implementing digital twins, remote monitoring systems, and cloud-based collaboration platforms. For example, using cutting-edge tools like 3D modeling greatly increases design efficiency while emphasizing sustainability by reducing carbon emissions and energy use. Predictive maintenance using AI also aids in the analysis of machinery data to proactively address possible failures.

Future Outlook

Through digital transformation, the EPC industry will be able to adjust to the shifting market conditions and determine its future. With increasing global infrastructure demands and government investments, we can capitalize on these trends. EPC businesses may prosper in an unpredictable environment by embracing digital transformation and implementing best practices. Our approach exemplifies how focused technology investment can enhance operational efficiency while maintaining safety, with zero accidents reported in its extensive portfolio of projects. Even though the road ahead is full of potential obstacles, it also provides unprecedented possibilities to those who are willing to change the engineering procurement construction landscape. ■

Author

A. K. Tyagi
Founder-Chairman & Managing Director
Nuberg Engineering Limited

“Digitalization should be viewed as a strategic necessity”

S. SUNIL KUMAR
Country President
Henkel Adhesive Technologies India

Industrial Internet of Things (IIoT), Artificial Intelligence (AI) technology and digitalization are driving a fundamental shift in manufacturing. Today, companies are increasingly implementing Industry 4.0 technologies for streamlining process flow and achieving efficiency in manufacturing processes. In an exclusive interview with *Chemical Engineering World*, **S. Sunil Kumar, Country President, Henkel Adhesive Technologies India,** shares his opinion about the growing importance of digitalization and what role will it play in the future.

What according to you are the advantages of digitalization? How can the industry further leverage the potential of digitalization?

India has immense potential to emerge as a global manufacturing powerhouse, driven by government initiatives, infrastructure development, and a focus on sustainability. The country is strategically positioning itself in key sectors such as electronics, renewable energy, and pharmaceuticals, enhancing its competitiveness and innovation in the manufacturing ecosystem. Initiatives like the Make in India campaign aim to elevate the manufacturing sector’s contribution to GDP to 25 per cent by 2025 and create 100 million jobs, reflecting a strong commitment to transforming India’s industrial landscape. With the manufacturing sector valued at USD400 billion in 2020 and projected to reach USD1 trillion by 2025, digitalization is set to play a crucial role in unlocking this potential.

Digitalization offers significant advantages, including increased operational efficiency, enhanced data analytics, and improved customer engagement. At Henkel, we have deployed Industry 4.0 based smart factory system at our Kurkumbh and Chennai manufacturing sites. These facilities employ end-to-end digitalization to ensure transparency and traceability, promoting built-in quality through automated workflows. Through smart technologies, we optimize resource use, improve accuracy, and enhance productivity.

Automating processes and utilizing real-time data allows companies to streamline operations, reduce costs, and make informed decisions. Industries can

further integrate digitalization by adopting advanced technologies such as artificial intelligence (AI) and machine learning (ML), creating a culture of innovation, and enhancing collaboration across supply chains. Organizations must make digital literacy a cornerstone of their strategic initiatives, with dedicated investments in comprehensive workforce training programs. Through systematic implementation of these frameworks, companies can enhance operational excellence while simultaneously accelerating their innovation capabilities. This aligned approach positions enterprises to achieve sustainable competitive advantages in an increasingly dynamic business environment.

How would you describe the digitalization journey at Henkel?

Digitalization is a decisive element of our strategic framework for purposeful growth, at Henkel. It helps us drive our sustainability initiatives, innovative technologies and solutions. Thereby, creating added value for our customers.

Henkel India's Adhesive business is leading the digitalization transformation in the manufacturing sector through its Smart Factory System and a strong focus on sustainability. By integrating advanced technologies such as the Industrial Internet of Things (IIoT), SCADA systems, and AI, Henkel enhances operational efficiency and product quality while minimizing downtime.

The company's commitment to sustainability is evident in its initiatives to monitor energy and water consumption using real-time data analytics, enabling proactive resource management. Additionally, Henkel aims to achieve a paperless factory by digitizing workflows, which reduces waste and improves efficiency.

We are committed to empowering our customers in anticipating and mitigating disruptions through predictive analytics. Our LOCTITE Pulse range of IoT solutions, for example, utilizes sensors to capture data on equipment health, enabling predictive maintenance and minimizing downtime. By leveraging data-driven insights, we enable our customers to proactively address challenges and optimize their operations, ensuring uninterrupted service and enhancing customer satisfaction.

Embracing customer-centricity not only navigates challenges but also fuels innovation and growth. Our Customer Experience Center is designed to inspire

"At Henkel, we have deployed Industry 4.0 based smart factory system at our Kurkumbh and Chennai manufacturing sites. These facilities employ end-to-end digitalization to ensure transparency and traceability, promoting built-in quality through automated workflows. Through smart technologies, we optimize resource use, improve accuracy, and enhance productivity."

our team members and external stakeholders to collaborate and co-create groundbreaking solutions to solve the challenges faced by the industry. It leverages digitalization to improve knowledge sharing, enhance collaboration, increase efficiency and promote open dialogue.

Our Supply Chain team has introduced an integrated Service Cloud, which enables the entire Customer Service team to provide an amazing customer experience by improving customer service efficiency across channels.

What are some of Henkel's future plans in terms of digitalization?

Henkel plans in digitalization are focused on advancing its transformation through deeper integration of cutting-edge technologies like artificial intelligence (AI), machine learning (ML), augmented reality (AR), and 3D printing. These technologies will play a pivotal role in advancing Henkel's Industry 4.0 initiatives, driving both operational efficiency and innovation. According to an Indian non-governmental trade association and advocacy group that primarily serves the Indian technology industry, over two-thirds of Indian manufacturers are projected to adopt digital transformation initiatives by 2025.

One of the key focus areas for Henkel is enhancing supply chain transparency and agility. By implementing smarter, interconnected systems, Henkel aims to optimize real-time decision-making and modernized production processes. This will enable the company to not only meet the growing demand for customized solutions but also align more closely with sustainability goals.

In line with these digital initiatives, Henkel plans to further invest in smart factory technologies, making manufacturing processes more responsive and adaptive. This includes the development of systems that allow for real-time monitoring, predictive maintenance, and optimization of production cycles. By leveraging AI and IoT, Henkel intends to enhance its predictive capabilities, minimize equipment downtime, and maximize resource utilization, all of which will support more sustainable and cost-effective operations.

Additionally, Henkel is committed to leveraging data analytics to improve customer experiences. The company plans to develop more interconnected systems that will provide deeper insights into customer needs and enable faster, more personalized solutions. Real-time data and advanced software tools will empower Henkel to accelerate product development cycles and improve customization, giving it a competitive edge in a rapidly changing market.

Could you throw more light on the initiative of embracing Industry 4.0 across your manufacturing facilities? How will this initiative help in the future growth of the company?

Henkel is actively embracing Industry 4.0 across its manufacturing facilities to transform operations through advanced technologies such as automated guided vehicles (AGVs), robotics, and data-driven analytics. This integration creates interconnected systems that enhance production efficiency and quality control. By making use of real-time data from sensors on production lines, Henkel continuously monitors and optimizes processes, leading to reduced energy consumption and minimized waste. This approach not only boosts sustainability but also drives cost savings, which are essential for the company's long-term growth.

Henkel's digitalization extends beyond automation, embedding technology into the core of manufacturing operations. In India, for instance, the company is implementing end-to-end digitalization that integrates raw material quality data and process parameters into seamless workflows, enhancing decision-making and operational precision. By incorporating systems like SCADA (Supervisory Control and Data Acquisition) and PLC (Programmable Logic Controllers), Henkel has achieved significant automation and improved resource utilization.

In the future, smart factories will enable Henkel to enhance productivity through autonomous decision-making and predictive maintenance, minimizing downtime. As the industry evolves towards Industry 5.0, the focus will shift to improving human-machine collaboration through technologies like artificial intelligence (AI), augmented reality (AR), and virtual reality (VR). These advancements will further enhance operational efficiency and adaptability in production systems. Additionally, integrating circular economy principles into manufacturing processes will align with Henkel's sustainability goals, reducing environmental impact while supporting future growth.

What message would you like to share with the industry peers to encourage them to adapt digitalization?

Digitalization should be viewed as a strategic necessity for long-term success rather than just a technological upgrade. Embracing digital technologies is essential for driving operational efficiency, promote innovation, and enhancing resilience to market fluctuations. In today's fast-paced environment, the ability to adapt quickly to shifting customer needs and market dynamics is a significant competitive advantage. By integrating digital solutions across the supply chain, businesses can unlock new levels of agility and create greater value for customers.

Investing in digital transformation today empowers organizations to streamline workflows, use resources more efficiently, and improve decision-making. This approach not only drives sustainable growth but also positions companies for success in an increasingly competitive and digitally driven landscape. Digitalization is about future-proofing our businesses, ensuring they remain resilient and relevant.

As we advance in digital transformation, it is crucial to prioritize cybersecurity. Protecting our digital assets is more important than ever. Maintaining a clear separation between IT (Information Technology) and OT (Operational Technology) networks is vital to safeguard critical operational systems from potential threats. Additionally, investing in employee training ensures that teams are not only skilled in using digital tools but also equipped to identify and respond to security threats.

By embracing digitalization thoughtfully and responsibly, we can progress securely while keeping an eye on sustainable growth. ■

Biosurfactants: The Next Frontier in Sustainable Chemical Solutions

Vishal Sharma
Executive Director and CEO
Godrej Industries Chemicals

Wherever the work, whichever the industry, the voice for sustainability is being taken increasingly seriously today. The world, which has been driven by synthetic chemicals from non-renewable resources, is on the lookout for sustainable alternatives. In the realm of surfactants, or surface-active agents, a class of versatile and ubiquitous ingredients used in everything from shampoos to dyes and from foods to nanoparticles, this search has an answer in what are called biosurfactants.

Biosurfactants, unlike their synthetic counterparts, are produced naturally by microorganisms and are under constant attention due to their faster biodegradability, low toxicity, ecological acceptability and availability from renewable sources, and now even waste material as feedstock. Biosurfactants have become attractive microbial products in the emerging biotechnology industry due to their advantages over synthetic surfactants in terms of environmental sustainability, global public health, and the concerns of industries to produce environmentally friendly goods.

Scrutiny over Synthetic

The world of surfactants wasn't always synthetic. For centuries, cleaning agents, the primary surfactants going back in history, were made using vegetable oils and animal fats. Then, starting in the early 1900s, research breakthroughs and the rapid evolution of the petroleum industry gave synthetic chemicals-based surfactants a runway for fast growth.

Synthetic surfactants dominate today's world, with their ability to perform reliably and variably. The fact that they can be produced at scale also means they have been highly cost-effective compared to other alternatives.

But over the last few decades, they have come under increasing scrutiny over environmental safety, health, and sustainability issues. In fact, in the last half-century, governments worldwide have increasingly become concerned about these issues, the evidence of which can be seen in the numerous laws enacted to control toxic chemicals, ensure clean water, and so on. The industry has responded to this in three ways, essentially: one, by improving products and processes; two, by eliminating problematic substances; and three, by developing safer alternatives.

Safe and Useful

Biosurfactants are part of the third kind of response. They have similar chemical structures to surfactants, complete with a 'water-loving head' and an 'oil-loving tail.' And they, like any other surfactant, can reduce the surface tension of a liquid or the interfacial tension between a liquid and a solid. The similarities end there. Biosurfactants stand out from their other surfactant counterparts because of their origin (living microorganisms such as bacteria, fungi, yeasts, marine microbes, among others). They have more complex structures than synthetic ones and, therefore, unique properties. More importantly, studies show a propensity for biodegradability; that is, they break down quickly and naturally and have much lower toxicity. Their ability to operate in extreme conditions - at high temperatures, in highly saline environments, and across the pH range - has also been studied.

The production process for biosurfactants happens at low temperatures, without the use of toxic catalysts by a so called biotransformation which is a biological clean production process. These advantages have resulted in the commercialization of a number of microbial biosurfactants. These numerous advantages make them useful in industries such as agriculture, food, mining, medicine, and nanotechnology. It is also important to differentiate biosurfactants and bio-based surfactants. While biosurfactants are made from renewable resources/waste and through an enzymatic or fermentation process, the bio-based surfactants are made from renewable resources/waste and through classical-synthetic-chemical processes.

Biosurfactants have come a long way since the first of them, Surfactin, was isolated in 1968. Since then, several biosurfactants have been discovered.

- Glycolipids
- Lipopeptides
- Phospholipids
- Polymeric biosurfactants

While they have a lot of growth potential, in a world that increasingly leans toward sustainable solutions, at this point, they constitute only a tiny segment of the overall surfactants market. While biosurfactants offer several advantages compared to their non-bio counterparts, their market share is < 4 per cent. For instance, a report by Expert Market Research estimated the global size of the biosurfactants market in 2023 to be USD2.61 billion while another report by the same agency gave the overall surfactants market size that year to be USD50.59 billion.

Living Complexity

The journey from the lab to the market, as the commercialization process is often dubbed, is ridden with challenges. To achieve consistent and high production of biosurfactants, various factors need to be considered such as strain selection, growth conditions, purification methods, and fermentation techniques. All these factors lead to a major challenge of relatively high cost of production. It is much easier and cost-efficient to manufacture synthetic surfactants than biosurfactants.

Why so? One reason is that the microorganisms, which are the origin of these surfactants, aren't static substances. They are living entities and, therefore, respond to their environment and any stimuli and undergo changes. They are complex. Creating conditions for large-scale production and processing with the fermentation process is complex, too.

The natural yield is low and is accompanied by a longer cycle time for fermentation. A significant cost item is substrate costs, or in other words, the cost of the feedstock. Moreover, at the industry scale, everything from maintaining consistency in product quality to optimising conditions for processing multiplies the complexity.

New Strains, New Gains

Researchers have been working to overcome these challenges for some time now. For one, there is a definite move toward using low-cost, renewable raw materials, including agricultural byproducts and waste (sugar cane molasses as a low-cost substrate for rhamnolipid production, for example), which have plenty of carbohydrates and nitrogen. Used Cooking Oil (UCO) and food waste is another feedstock used to produce bio-surfactants recently.

Technological advancements such as bioprocess optimization, genetic engineering, and improved downstream processing techniques are driving innovation in the biosurfactant market, leading to enhanced product quality and cost efficiencies.

Similarly, work is going on toward improving better production processes, and developing high-yield strains of microorganisms via genetic engineering to increase the yield. These have market implications.

For instance, developments in fermentation and bioprocess engineering have made biosurfactants more competitive than before. Two of the glycolipid based surfactants has gained attention in this context. The highest productivity reported for sophorolipids is 3.7 g L^{-1} h^{-1} and Rhamnolipids is 1.54 g L^{-1} h^{-1}. For a large scale industrial production, higher productivity is very important and hence the traction in the development research of glycolipids.

The future promises to bring the benefits of new technologies such as artificial intelligence and gene editing tools, which could even mean custom-made biosurfactants. With a possible scaling up, costs could also come down, making biosurfactants more competitive from a current 6X-10X of synthetic surfactants to 1.5X-2X.

Project Sustainability

In the immediate term, while research continues to find new opportunities for the industry, business challenges remain. Also, the complexity of adaptability to evolving regulation cannot be overlooked. But with the world leaning toward sustainability, biosurfactants are poised to grow. Market research firm MarketsandMarkets projects the bio-surfactants market size to grow from USD1.2 billion in 2022 to USD2.3 billion in 2028, a CAGR of 11 per cent.

Special mention has to be made about their enhanced role going forward in environmental protection as they reinforce remediation of water, soil and overall environmental health, pharmaceuticals, and agriculture. Biosurfactants can be useful in cleaning up oil spills, treating groundwater, contributing to more effective antibiotic drugs, and helping to eliminate chemical fertilisers. While biosurfactants could outperform synthetic counterparts in certain areas, it is important that the production cost and the volume of production be optimized further. The profitability and commercial viability depend heavily on the feedstock. Development (shift) towards secondary feedstocks and enhanced productivity with refined process flow will make biosurfactants more viable. With proper optimization, balance between performance-economy-sustainability can be achieved. Sustainability is no longer just a buzzword, it is a need of the day and biosurfactants offer huge sustainable benefits. ■

Technological Transformation Challenges in the EPC Industry

The rapidly changing technological scenario has led the Engineering Procurement and Construction (EPC) firms to witness significant challenges, ultimately creating the need to leverage the use of innovative technologies. This article highlights the transformative potential of digital technologies in overcoming these challenges and highlights strategies for navigating the complex data management landscape in the EPC sector.

As projects grow in complexity and scale, the pressure on EPC companies to enhance efficiency of projects, reduce costs, and meet tighter deadlines for such projects has intensified. The adoption of digital tools such as Building Information Modeling (BIM), digital twins, cloud computing, and AI-driven analytics is revolutionizing the way projects are designed, executed, and managed. However, there are significant factors that may hinder this transformation shift moving forward.

Catering to Client Requirements

The infrastructure sector witnessed a significant surge in private investments in 2022. This increase was mainly due to post COVID-19 recovery and strong growth of a few industry verticals including renewable energy, power transmission, and digital infrastructure. This trend has further led to the increase in client requirements, thus making the EPC industry highly competitive, over recent years.

The nature of client requirements has also changed, with the key concern being reducing turnaround time of projects without compromising on quality or cost. This, in turn, has created a need among EPC firms to continuously innovate in meeting or exceeding client expectations.

Challenges

- **Increased competition:** While the push for faster delivery leads to a race among firms to adopt modern technology, adopting modern technology without a proper time frame for pilots and testing often results in oversights that affect quality and compliances.
- **Budget constraints:** Clients are not only expecting quick turnarounds but also demand cost-effective solutions, and any technological transformation in a project can end up restraining project budgets.

Tips to Address Challenges

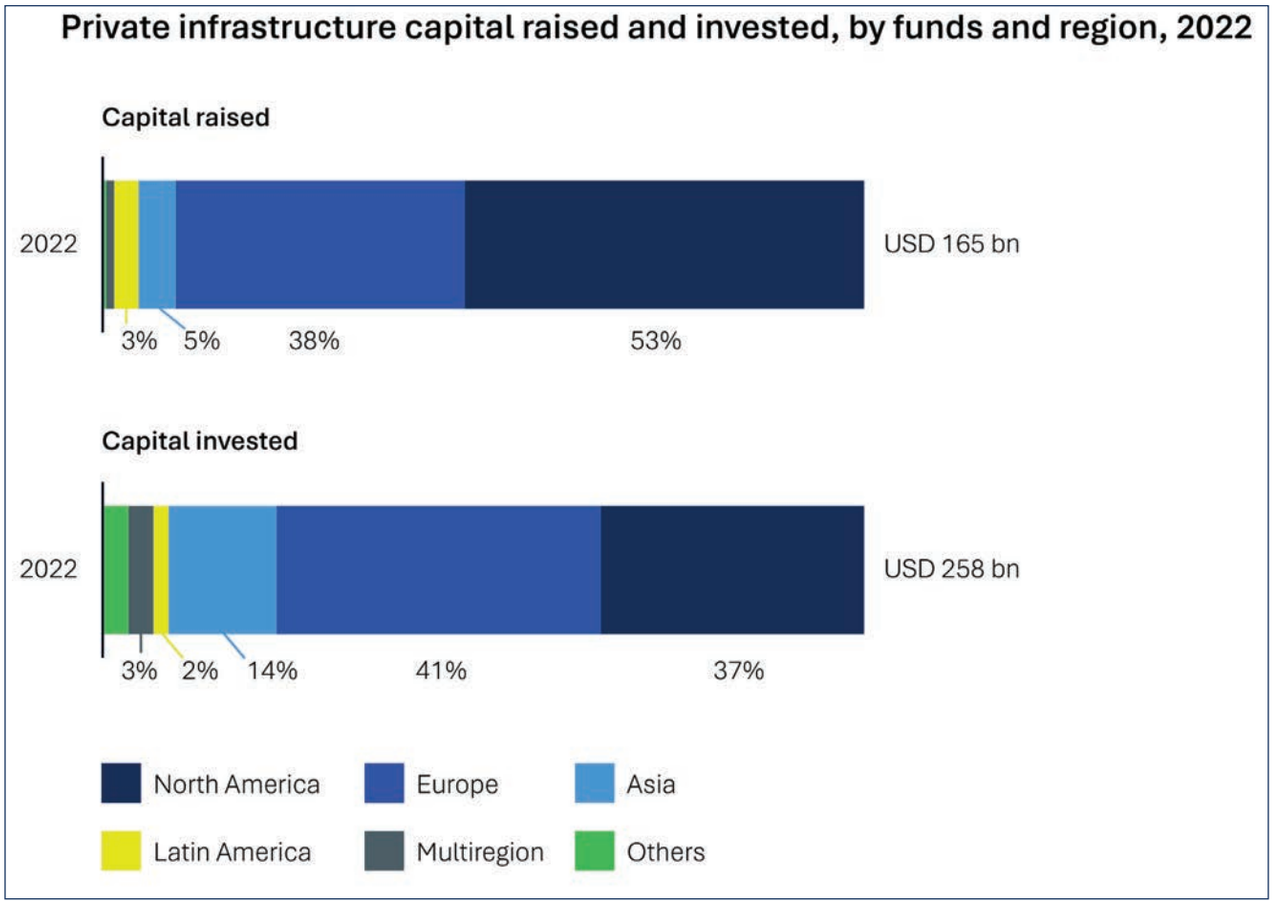
- **Adopt Agile methodologies:** Implementing agile project management practices can help teams respond more swiftly to changes and client expectations. It also can help with adoption of new technologies during project executions.
- **Invest in modular constructions:** Utilizing modular construction techniques allows for prefabrication off-site, reducing on-site construction and labor costs.

Handling Large Quantity Data

Engineering and construction companies produce billions upon billions of bytes of data daily. Collecting, handling and managing the same can be overwhelming.

Challenges

- **Data silos:** Tons of data is generated daily and stored in different systems, making it inaccessible.
- **Inadequate data management:** Without a proper data strategy, many organizations struggle to derive actionable insights from their data.



Source: Global Infrastructure Hub, 2023 Infrastructure Monitor Report

Tips to Address Challenges

- **Establish a centralized data platform:** Implementing an integrated platform that consolidates data from various sources can streamline access and analysis.
- **Utilize data governance frameworks:** Developing robust data governance policies can help preserve data integrity, boost security and confirm compliance.

Adoption of Digital Transformation

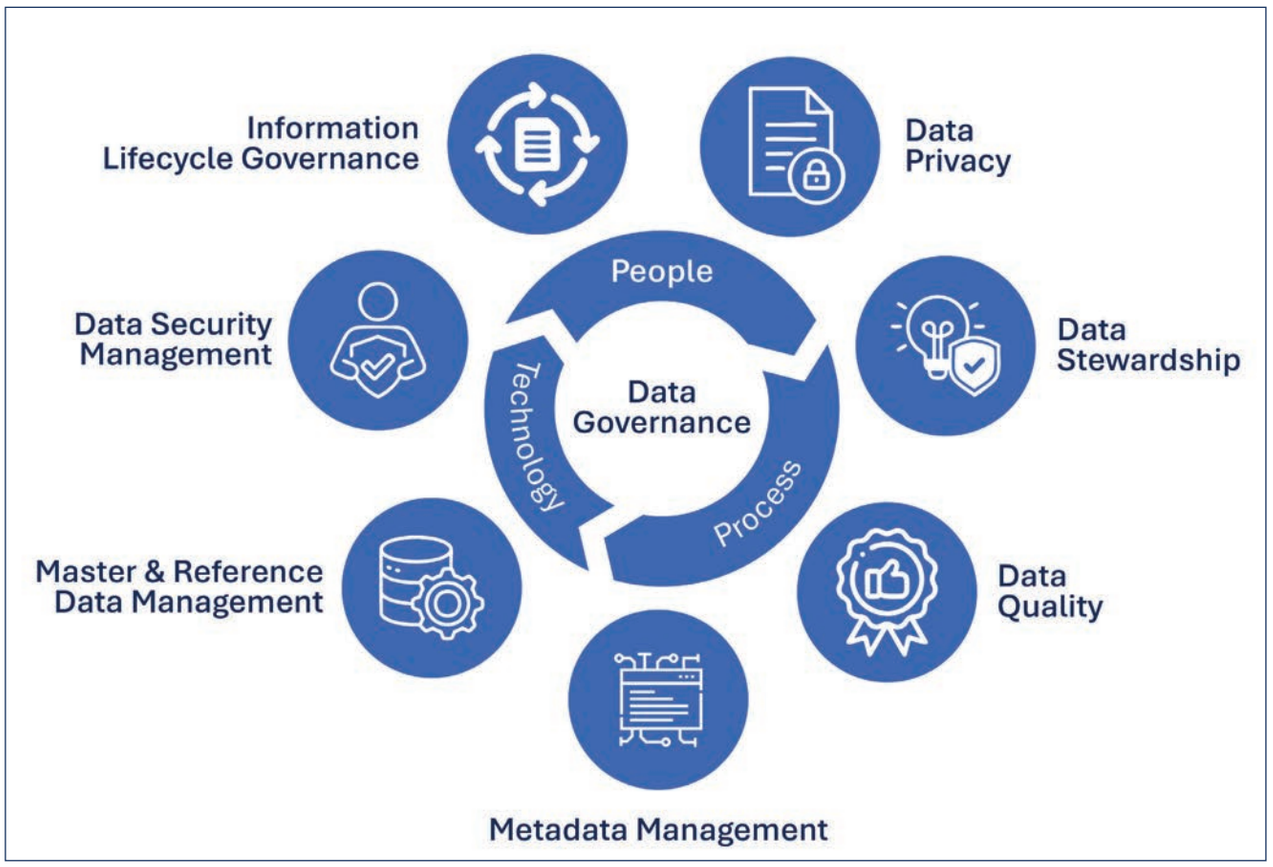
According to The Future of Jobs Report 2023 published by World Economic Forum, "Technology adoption, big data, cloud computing and AI feature highly on the likelihood of adoption. More than 75 per cent of companies are looking to adopt these technologies in the next five years. The digital transformation journey is fraught with challenges. Many EPC organizations face resistance to change, inadequate IT infrastructure, and lack of strategic vision for implementing new technologies."

Challenges

- **Cultural resistance:** The employee mindset plays a huge role in implementing digital transformation changes. For instance, introducing new technology can create resistance towards its adoption and other behavioral adversities in employees.
- **Insufficient investment in Information Technology:** Many organizations underestimate the importance of investing in IT infrastructure, which can hinder digital transformation efforts.

Tips to Address Challenges

- **Foster a culture of innovation:** Encourage a companywide mindset that embraces change and innovation to boost technology adoption.
- **Develop a clear digital strategy:** Create a road map that outlines specific goals, timelines, and resource allocation for digital initiatives.



Data Governance Structure

- **Adoption of AI analytics and RPA technology:** Artificial Intelligence (AI) and Robotic Process Automation (RPA) are emerging as game changers in the EPC industry that can streamline operations, reduce costs, and enhance decision-making processes.

Skill Gap of Experienced and Qualified Resources

The rapid evolution of technology has created a significant skill gap in the EPC industry. The Future of Jobs Report 2023 mentions, "up to 60 per cent of workers in the engineering sector lack the skills necessary to leverage new technologies effectively. Employers estimate that 44 per cent of workers' skills will be disrupted in the next five years. Cognitive skills are reported to be growing in importance most quickly, reflecting the increasing importance of complex problem-solving in the workplace."

Challenges

- **Retirement of experienced workforce:** This leaves a void in leadership and specialized skills.
- **Insufficient training programs:** Many organizations do not have adequate training and development programs to upskill their workforce.

Tips to Address Challenges

- **Implement continuous learning programs:** Encourage employees to engage in continuous professional development by offering training in emerging technologies. Reward employees bringing out new technology's trends.
- **Collaborate with educational institutions:** Partnering with universities and technical schools can help EPC firms develop tailored training programs that align with industry needs. ■

Author

Vishal Sankpal
Assistant General Manager, Technology & Innovation - Oil, Gas & Chemical Group
Burns & McDonnell Engineering India Limited

Role of Biotechnology in Wastewater Treatment

Biotechnology is the most natural solution for cleaning organic contaminants in the environment and by using this technology today we can move towards cleaner and safer water tomorrow.

Water pollution found in rivers in the cities is the result of domestic waste disposal. Domestic wastewater contains high organic matter, composed of 65 per cent protein, 25 per cent carbohydrate and 10 per cent fat, while the inorganic material is salt and metal. There is also ammonia from urine and faeces produced by human waste. The Government is constructing Sewage Treatment Plants to control water pollution due to domestic waste, in order to maintain the quality of water flowing into the river.

Conventional waste water treatment processes used in Sewage Treatment Plant consists of a combination of physical, chemical and biological processes and operations to remove solids, organic matter and sometimes nutrients from wastewater. It is done in three steps, viz., Preliminary Treatment, Primary Treatment and Secondary Treatment.

Preliminary Treatment

The preliminary treatment involves collection and screening of sewage. The primary treatment contains oil and grease trap for removal of oil and grease, equalization tanks to homogenize the peak loads and the pollutant loads before entering the aeration tanks for secondary treatment.

Biological treatment of domestic sewage in wastewater is must before it enters in the river streams as it plays a major role in the removal of contaminants through the use of selective microorganisms. These especially cultured microbes degrade the organic waste into smaller particles. During the process of microbial metabolism enzymes are secreted which further help in the digestion of the waste material. The end product of the biological reaction is CO_2 and water.

Secondary Treatment

The secondary treatment involves the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes. Aerobic biological treatment is performed in the presence of oxygen by aerobic microorganisms (principally bacteria) that metabolize the organic matter in the wastewater, thereby producing more microorganisms and inorganic end-products (principally CO_2, NH_2 and H_2O).

Biodegradation of domestic wastewater using a consortium of bacteria (indigenous and non-indigenous) is a biological wastewater treatment method that is effective and efficient and is derived from processes occurring naturally in nature. The biological treatment process for decomposition of the organic wastes consists of controlling the environment required for optimum growth of the microorganisms involved. Bioremediation process is a proven technology and the same is highly useful in immediate redressal of the pollution issues of existing sewage treatment plant, lakes and ponds, drains falling directly in the rivers, choked pipelines, decomposition of organic sludge with enhanced performance of anaerobic digestor.

Bacteria that are used have the ability to decompose organic matter, such as being able to degrade cellulose, lipids, and proteins. An indigenous microbe normally present in domestic waste is the genus Bacillus, Aerobacter, Nitrobacter, Nitrosomonas and Saccharomyces. Nitrosomonas is able to reduce ammonia.

Advantages of Biological Products

The multiple benefits by using biological products are as follows:

- Wastewater treatment for improving water quality and its effective recycling
- Bio-remediation of waste water
- Substantial reduction in Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD)

and other parameters

- Odour reduction
- Reduce sludge volume
- Reduce operating costs
- Reduce energy consumption, labour cost and sludge management expense
- Employment of environment friendly process

EnviroWay products contains the maximum strains of required bacteria found in cow dung and activated sludge. Several times sourcing fresh cow dung, its transportation and handling costs are expensive than required quantity of our product. Activated sludge are at times unhealthy for treatment because of large quantity of dead bacteria or the filamentous growth bacteria not required for treatment, in that case we advise for improving the bacterial strength. Feeding both the required and not required bacteria is also expensive.

Role of Enzymes

Enzymes are large biological molecules responsible for the thousands of chemical inter-conversions that sustain life. They are highly selective catalysts, greatly accelerating both the rate and specificity of metabolic reactions, from the digestion of food to the synthesis of DNA. Most enzymes are proteins although some catalytic RNA molecules have been identified.

Use of Biotechnology

Through the effective use of biotechnology, the following benefits can be established:

- Destruction of organics along with oxidation of a wide variety of organic compounds, resulting in reduction of BOD, COD and Total Suspended Solids (TSS).
- Odour reduction due to greater degradation of odour-causing compounds (H_2S, mercaptans, amines, volatile fatty acids, etc.).
- Increase in system reliability and efficiency due to operational flexibility to handle a wide range of flows and wastewater characteristics.
- Faster upset recovery by addressing the problems of slow biomass recovery created due to abnormal variations in flow or characteristics of the wastewater, which can detrimentally affect a biological treatment system.
- Decreased environmental liabilities by constantly maintaining the better quality of treated water.
- Sludge reduction through increased biological activity on biodegradable solids resulting in reduced sludge treatment, handling, transportation and disposal cost.
- Substantial reduction in electricity consumption through effective management of Dissolved Oxygen (DO) in aeration tank.
- Foam reduction due to degradation of surfactants and de-stabilization of filamentous bacteria.
- Improved solid settling by destabilizing filamentous organisms.
- Other benefits include improved nitrification (ammonia removal), polymer reduction, greater oxygen transfer efficiency, and less costly alternative to retrofitting plants in some cases.

Optimization of the current system plus addition of biological products or micronutrients helps in stabilizing and increasing the efficiency of the biomass resulting in better quality of treated water. Successful bio-augmentation requires total system management. If the microbiological population can be viewed as a workforce, then the biological process consultant is responsible for keeping the workforce productive. A critical part of the success of a bio-augmentation program is proper application.

Because every system is unique, it is essential that products are properly applied. Bio-augmentation programs should be implemented with the help of surveying the total system, assessing the best solution to the problem and documenting the impact of the program. Simply dumping a product into the influent is not bio-augmentation. The purpose of bio-augmentation is to facilitate a gradual shift in the microbial population, not to totally replace the existing biomass.

Total system management requires in-depth understanding of waste plant operation and design, in addition to environmental microbiology. ■

Author

Mala Mohini
COO
EnviroWay Bioscience Pvt. Ltd.

Specialty Chemicals: Enhancing Competitiveness for Sustainable & Value Generative Business Solutions

The landscape of the specialty chemicals industry is undergoing rapid transformation driven by advancements in various technologies, including green chemistry, biotechnology, and nanotechnology. These innovative methodologies offer more efficient and sustainable approaches to product design and manufacturing. Furthermore, the market dynamics are being influenced by robust regulatory frameworks and proactive initiatives aimed at fostering sustainability, such as international chemicals management strategies that prioritize environmental conservation.

Specialty chemicals comprise a diverse range of chemical compounds specifically engineered to meet distinct functional or performance requirements across various industrial sectors. These compounds are characterized by their unique formulations and high purity levels, serving as critical components in the production of numerous final goods, including electronics, agrochemicals, personal care products, and pharmaceuticals. The inherent properties of specialty chemicals make them indispensable for enhancing product effectiveness, durability, and overall performance. Specialty chemicals play a pivotal role in enhancing the performance, longevity, and environmental sustainability of a wide array of end products, aligning with the increasing consumer demand for efficacy and superior quality.

The growing emphasis on the adoption of green specialty chemicals is largely due to an intensified focus on environmentally friendly formulations, the use of renewable resources, and the implementation of cleaner production techniques.

The heightened concern for sustainability, has emerged as a significant driver of change within the industry. Consequently, there is a concerted effort to embrace green chemistry principles aimed at minimizing waste output, reducing energy consumption, and lowering harmful emissions. This has led to a growing prevalence of bio-based feedstocks, recyclable and compostable materials, and energy-efficient production methodologies.

Several key trends and innovations are currently shaping the future trajectory of the specialty chemicals market.

- **Technological Integration in Manufacturing:** In parallel with these sustainability efforts, the integration of digital technologies within chemical production is revolutionizing both the manufacturing and marketing aspects of specialty chemicals. The advent of Industry 4.0 – characterized by the modern era of production automation – has facilitated a more agile, effective, and cost-efficient manufacturing environment. The incorporation of artificial intelligence (AI), the Internet of Things (IoT), and advanced data analytics enables businesses to automate various processes, enhancing operational efficiency.

- **Effective use of Algorithms for supply chain:** Firms are now leveraging predictive maintenance techniques and real-time monitoring systems to optimize equipment utilization, thereby minimizing the likelihood of breakdowns and production downtimes. The pace of compound design and the prediction of chemical behavior in practical applications have also accelerated, thanks to advanced AI algorithms that streamline innovation timelines and improve formulation precision. Additionally, the increasing demand for traceability and transparency in supply chains has led to growing adoption of technology within the specialty chemicals industry.

- **Various applications of Speciality Chemicals:** The functional applications of specialty chemicals are expanding rapidly in sectors such as medicine, electronics, and automotive industries, all of which demand high-performance materials characterized by exceptional durability and enhancement attributes. For instance, the automotive sector is placing a greater emphasis on lightweight adhesives and materials tailored for electric vehicles (EVs), while smart materials are being utilized in the healthcare field for innovative diagnostic tools and advanced drug delivery systems. Specialty coatings, nanomaterials, and polymers have gained popularity due to their ability to deliver superior performance while minimizing resource consumption.

- **Rise of sustainable products:** As the industry evolves, there is a noticeable shift towards the utilization of renewable materials in the manufacturing of specialty chemicals, sparking a surge in demand for renewable energy sources. Companies are implementing greener production techniques, such as enzymatic and catalytic processes, which are designed to be more environmentally sustainable and efficient compared to conventional methods.

- **Epichlorohydrin:** Epichlorohydrin, a key chemical compound, is primarily transformed into bisphenol A glycidyl ether, which serves as a crucial building block in the production of epoxy resins. Beyond its role as a foundational element for epoxy, epichlorohydrin also acts as a precursor to a variety of monomers utilized in the creation of different resins and polymers, showcasing its versatility in the chemical industry. Epoxy resin is widely recognized for its exceptional insulating properties, making it a preferred choice in windmill, automotive, aerospace, electrical and electronic applications where protection is paramount in challenging and hazardous environments. Industries such as chemical manufacturing, deep-sea exploration, and aerospace heavily rely on epoxy resins to safeguard their equipment and components from extreme conditions.

- **CPVC Resin - foundation for today's economic growth:** The growing residential and infrastructure sector play a pivotal role in driving the demand for Chlorinated Polyvinyl Chloride (CPVC) pipes, which are increasingly essential for a wide array of applications. The applications include for plumbing in residential and commercial places and also has huge potential in fire sprinkler systems, and various types of process piping. As industries expand and urban infrastructure develops, the need for reliable and durable piping solutions has surged. In addition, there is a rising awareness among consumers regarding the quality and safety of water, contributing to a significant demand for corrosion-resistant pipes. This demand aligns with the growing concerns over waterborne contaminants and the overall health implications of poor water quality.

In light of the global shift towards circular economies, manufacturers of fine chemicals are actively reassessing their waste management strategies and resource utilization practices. A circular economy transcends traditional product and process design paradigms by emphasizing continuous resource use, remanufacturing, and the critical aspects of reuse and recycling. Innovative solutions such as waste-to-chemicals technologies and closed-loop recycling systems are enabling businesses to recover valuable resources from waste disposal streams, thus promoting sustainable practices within the industry. Additionally, chemical upcycling has emerged as a promising area within material chemistry, where discarded low-value raw materials are repurposed into valuable high-end products. ■

Author

Yash Chitnis
Sales - Head
Epigral Limited

The Imperative for EPCs to Invest in Decarbonization

For Engineering, Procurement and Construction companies, reimagining execution strategies with digital solutions will empower project teams in this digital age and bridge potential skillset gaps, driving greater flexibility, scalability, and innovation while staying aligned with the fundamentals of project execution.

"The measure of intelligence is the ability to change."
Albert Einstein

In today's dynamic landscape, the term "change" feels inadequate to describe the profound transformation underway. The energy, chemical and Engineering Procurement and Construction (EPC) industries are being reshaped by the dual imperatives of ensuring energy security and achieving ambitious energy transition goals. Within this context, the capital project sector faces the daunting task of balancing sustainability objectives with the practical realities of financial risk tolerance, workforce constraints, supply chain challenges, environmental compatibility, and community engagement. EPC companies must address short-term energy demands to meet global consumption growth, simultaneously positioning themselves for long-term energy transition projects that are rapidly gaining momentum. In this context, it is important to explore how energy leaders are leveraging digital strategies to navigate these shifts and drive progress across the energy sector.

Investing in sustainability

Sustainability and energy security represent two priorities confronting today's EPC firms and the broader capital projects sector. These forces, compounded by economic growth, market volatility, and shifting geopolitical dynamics in Asia, South Asia and Global South, have created a complex opportunity landscape.

New influences have accelerated a step change in reshaping strategies as investment funds increasingly prioritize sustainability initiatives, activist investors gain influence, and governments offer regional green incentives to drive environmental progress. At the same time, increasing energy efficiency, ensuring operational excellence, and safeguarding asset reliability remain critical priorities to combat escalating costs, maximize profitability, and maintain economic stability in a competitive global market.

As these priorities grow increasingly urgent, strategic decisions on resource allocation will be pivotal for an EPC's long-term success. This includes investing in workforce development through hiring or training expertise in key target markets such as hydrogen, electrification, and LNG, where demand is poised for substantial growth. Equally important is determining which segments of the asset lifecycle — whether design, construction, operation, or maintenance — should be prioritized for the integration of digital solutions. These foundational objectives are not just about optimizing current operations but also about creating a stable financial footing to support the transition to greener, more sustainable technologies.

The most successful EPC firms will have leaders that adjust business models periodically, integrate digital tools with workforce training continuously, and continually improve collaborative communication with clients, thereby fostering innovative partnerships to achieve excellence while addressing market needs.

Changing the way EPCs work

The evolving landscape demands a fundamental shift in the way EPCs approach their work, addressing not only technological gaps but also the critical need for reskilling teams. The key challenge today lies in transforming how projects are executed to meet the demands of a rapidly changing industry. Traditional project schedules are too lengthy and costly to satisfy the aggressive net-zero targets set by clients, and many EPCs lack the digital infrastructure needed to support a digitally native workforce. As global volatility continues to strain resources and timelines, workflow flexibility protected with database management and performance

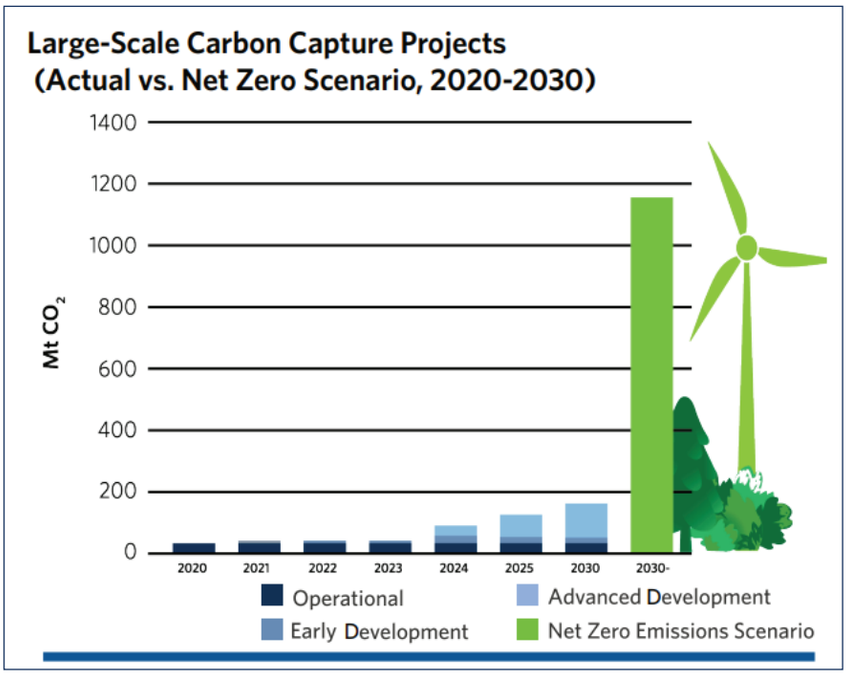


Figure 1: Actual carbon capture projects currently in pipeline for 2030 vs number to achieve net-zero (source: IEA).

engineering solutions to ensure data integrity and asset optimization will support the economics for final investment decision greenlight.

Embracing digital infrastructure also supports new tactics in digital project execution. Value engineering practices, lessons-learned and best practices are incorporated, documented and integrated from project to project allowing for rapid, repeatable designs. Systematic processes to analyze project designs leveraging collaborative workflows enhanced by industrial AI enables a self-optimizing plant approach. Best applied during the early stages of a project, the profitability margins increase and the benefits snowball throughout the lifecycle of the asset.

An analysis by the International Energy Agency (IEA) makes the compelling case that there are too few capital projects in the pipeline today relative to those needed to meet global climate goals. To meet these targets, the award rates for energy efficiency and energy transition capital project contracts must accelerate and be supported by new project execution strategies (see Figure 1).

Evolving traditional project methods and facilitating additional capital project investments to meet sustainability demands must be supported through critical changes on various fronts. In addition to new digital execution approaches, it is essential that the industry is strengthened through regulatory frameworks, financing and tax incentives, as well as new market players and partnerships – forged by industry veterans. Pacific Rim partnerships, such as the Korean – Malaysian Shepherd CCS Project, are requiring and being enabled by these approaches.

It is up to senior management and subject matter experts to successfully navigate any challenges. In the short term, efforts may focus on enhancing energy efficiency, integrating bio-feedstocks, and fitting carbon capture units on existing facilities. Meanwhile, a strategic long-term outlook is essential for driving progress in transformative areas such as electrification, hydrogen adoption, and advanced recycling.

Economic feasibility is increasingly influenced by a range of external factors that add complexity to decision-making. These include the uncertainty of forecasting future carbon taxes, the availability and structure of carbon credits and offsets, and the varying scope of renewable energy and bio-feedstock incentives offered by governments and regulatory bodies. Additionally, manufacturing-related risks associated with implementing new low-carbon processes pose significant challenges, particularly as companies strive to scale these technologies while maintaining cost competitiveness. Understanding and integrating these dynamic factors into project planning is essential for EPCs and owner operators to ensure long-term viability and alignment with sustainability goals.

Digital solutions can optimize early design phases, reducing overall engineering and construction costs, schedules and risks. Strategic use of these innovative digital solutions achieves improved replication of repeatable, best-available designs, modular versus stick-built analysis and Advanced Work Packaging (AWP) to expedite construction. Advanced model-based estimation provides better visibility into economic and projection execution costs earlier in the capital allocation process, reducing cost uncertainty.

This is a prime example, where digital solutions and new ways of working are crucial. Integrated workflows between process designs and cost engineering (see

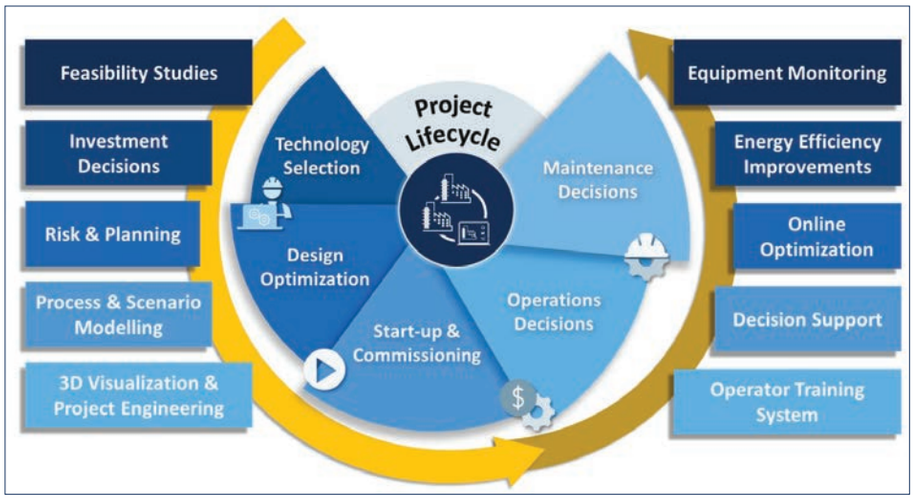


Figure 2: Sample digital workflow of asset lifecycle

Figure 2), that enable optioneering and risk assessment at very early feasibility stages become strategic differentiators for EPCs. Collaborative workflows also ensure the optimal flow of information and avoid duplication of work.

Another area of challenge is regulatory uncertainty. Better transparency and ease of auditing, both of which are facilitated by digital execution project approaches such as decision support and equipment monitoring, will assist project leaders in navigating the regulatory ambiguities and changes.

EPCs that succeed in improving economic feasibility and enhance concurrent collaborative workflows will emerge as leaders and define the industry's future.

Major takeaways for EPC leaders

Industry players have been demonstrating progress in their digital approaches to the current round of sustainability projects. For example, Air Products and Chemicals employs digital twin models using AspenTech tools to create models representing operation status of hydrogen plants, and thereby monitor performance across multiples sites from one location and identify options for improved individual plant performances and operating strategies. The projected financial benefits are estimated to be over USD 1M per year.

ExxonMobil uses a combination of process modeling, conceptual estimating and conceptual 3D layout solutions from AspenTech to greatly accelerate its process-select phase of projects, enabling them to reduce from-end project timetables by an estimated 30 per cent to 50 per cent.

Overall, the opportunity to play a leading role in reducing the Green Premium on the pathway to net zero carbon is here. Digitalization of the capital projects business will be a key contributor. To achieve geopolitical, financial, and social goals, investments will accelerate. The companies that will emerge as the big winners are those that look for step changes in project delivery methods to fast-track schedules, reduce costs and mitigate risks to eliminate the Green Premium over those that look for conventional incremental changes. Companies that successfully implement advanced adoption of digital solutions to optimize energy utilization, emissions management, and process control will steer the EPC industry, as it completes a digital transformation.

Future market leaders will be those EPCs that embed sustainability results into all capital project bids and execution strategies. However, there are significant hurdles that remain, primarily revolving around developing the proven capability and expertise to conduct sustainability projects and mitigate future risks. As the industry evolves, the ability to balance innovation with execution will be critical. It is only a matter of time before viable innovations emerge and disrupt the market we see today. ■

Authors

Ron Beck
Senior Industry Marketing Director
Aspen Technology, Inc

Judith Ponniah
Industry Marketing Director
Aspen Technology, Inc

Co-generation plant at Travancore Titanium Products Limited: An energy efficient project

In this article, Energy Management Centre (EMC), Kerala, shares details about the first energy efficiency project, that has been funded through the Kerala State Energy Conservation Fund (KSECF), for the implementation of a co-generation plant at Travancore Titanium Products Limited, which is one of the leading manufacturers of Anatase Grade Titanium Dioxide in India.

Travancore Titanium Products Limited (TTPL), a public sector company under the Government of Kerala, has its own Sulphuric Acid Plant (SAP) for captive consumption for the manufacturing of titanium dioxide. The plant has a design capacity of 300 Ton Per Day (TPD) of 98.5 per cent acid. Burning of Sulphur is an exothermic reaction producing huge quantum (297 kilo Jule/mol) of heat. This waste heat is recovered as steam by using a waste heat boiler in SAP.

The SAP produces around 1.15 MT of super-heated steam at 32 kg/cm^2 and 33^{0}C per MT of sulphuric acid produced. This super-heated steam is utilized in steam turbines which drives Boiler Feed Water (BFW) pump and the turbo air blower. The output steam at 7 Kg/cm^2 is de-superheated to 17^{0}C. The remaining superheated steam is passed through a Pressure Reducing De- Super heater (PRDS) to 7 Kg/cm^2 at 17^{0}C. The reduction in pressure through PRDS liberates substantial energy wastage which can be effectively utilized for power generation through Micro Steam Turbine and Cogeneration.

Figure 1: Co-generation plant at Travancore Titanium Products Limited.

As per the energy audit report, a potential for power generation in Sulphuric Acid Plant was identified. The company in consultation with EMC decided to proceed with the project. Accordingly, EMC conducted a feasibility study and the power generation potential was identified as 108 Kwh per hour when the acid plant operates at 270 TPD production rate. A feasibility report was prepared by EMC in June 2020 and the TTPL Board of Directors approved the project in November 2020.

Accordingly, TTPL published the e-tender for the supply, installation and commissioning of the turbo generator and Green Secure Power Systems Pvt Ltd, executed the work and commissioned the project on 26th June 2024. During performance test, the power obtained is as shown in Table 1.

The cogeneration plant is designed to operate at a sulphuric acid production rate of 270 tons per day or higher. However, the average acid production during the operational period of the cogeneration plant, was recorded at only 210 tons per day. This reduced acid production has resulted in lower steam availability for power generation. Consequently, under such conditions of minimal steam

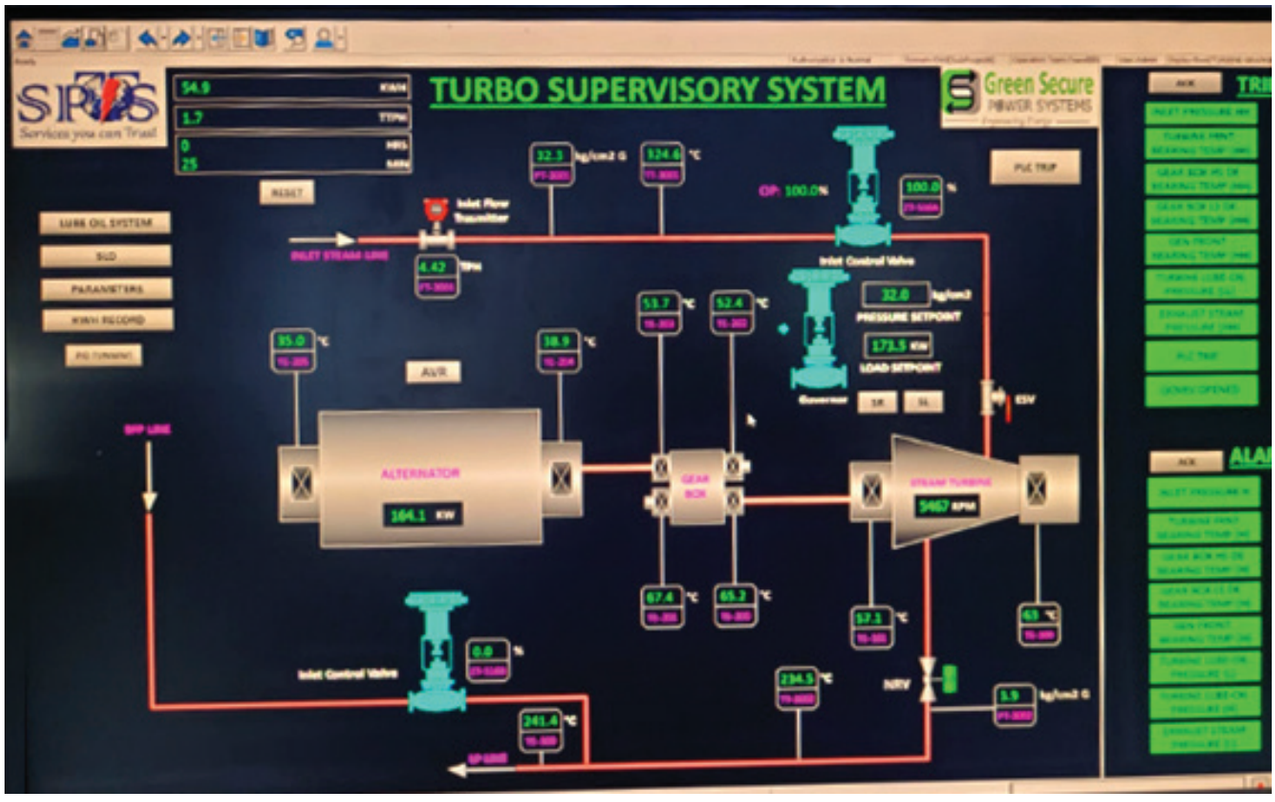


Figure 2: SCADA system of Turbo Supervisor System of Co-generation plant.

availability, the turbine's power output fluctuates and remains limited. The power output corresponding to a production rate of 210 tons per day will be low. However, TTPL managed to produce above 0.1 MU of electricity through the co-generation till date.

	Inlet Pressure Kg/cm²	Inlet temp °C	Outlet pressure Kg/cm²	Outlet Temp °C	Steam flow rate TPH	Power generation in kW
During performance test	32	330	3.5	240	4.4	173

Table 1: Power obtained during performance test from Travancore Titanium Products Limited.

About KSECF

Energy Management Centre has been administrating the Kerala State Energy Conservation Fund (KSECF) for promoting energy efficiency project funding in the state. The KSECF is a fund that can be used to meet the expenditure for energy efficiency improvement projects for implementing the provisions of Energy Conservation Act 2001. Through KSECF, EMC shall provide financial assistance against suitable bank guarantee for prospective energy efficiency projects.

The applicants for financial assistance have to remit Administration charges of 5 per cent of the total project cost to avail this fund. The interest rate is 4 per cent and 2 per cent (simple Interest) for the private companies and Government/ Public/Cooperatives respectively with a repayment period is for 5 years. Priority is given for the projects in the range of 10-50 lakhs in order to increase the number of energy efficiency projects. The repayment capacity of the applicant shall be examined or scrutinized by evaluating the financial statement of the applicant of the past three years. ■

Author

Anoop Surendran
Energy Technologist-B
Energy Management Centre - Kerala

The Future of Bioplastics : Focus on Polyhydroxyalkanoate

Since the mid-20th century, plastic production has surged to over 460 million metric tons annually, reshaping industries and modern life.[1] Yet, this convenience comes at a steep cost—these plastics are made from non-renewable, fossil fuels and only about 9 per cent of plastic waste is recycled around the world each year, with billions of tons accumulating in landfills and oceans.[2] Efforts to reduce, reuse, and recycle are vital but insufficient to curb the growing plastic crisis. To truly transform the future of plastics, we need innovative, biobased materials that can be made from non-toxic, renewable feedstocks, and support more circular solutions. One such breakthrough is polyhydroxyalkanoate (PHA), a biodegradable, compostable and biobased polymer poised to redefine the lifecycle of plastics from how they are made to how they are thrown away.

The first PHA, poly (3-hydroxybutyrate) was discovered in 1926 by the French scientist Maurice Lemoigne during his work with the bacterium Bacillus megaterium[3]. A PHA is a unique polymer made from annually renewable feedstocks that have sequestered carbon dioxide into sugars that are processed through large-scale fermentation. The sugars are fermented the same way you would ferment hops to make beer, but instead of beer, the microorganisms produce PHA that is recovered and turned into a functional polymer that can be used for a wide variety of applications. The raw materials for PHA are sugars sourced from plants, including sugar cane, tapioca, corn, or, in the future, cellulosic biomass. As a natural polymer, PHA offers an attractive alternative to petrochemical-based materials, such as polyolefins and polystyrene, that are used to make plastic products. It works well as a modifier to other polymers or biopolymers, increasing bio-based content, accelerating biodegradation, and improving the functional properties of resin and finished products.

PHAs are readily biodegradable in various environments, including marine and soil settings as well as industrial composting facilities. Because PHAs are compostable, they can be used to create certified compostable food packaging and serviceware that helps divert more food scraps away from landfills and into compost. Food scraps degrading in landfills are the third largest source of human-generated methane

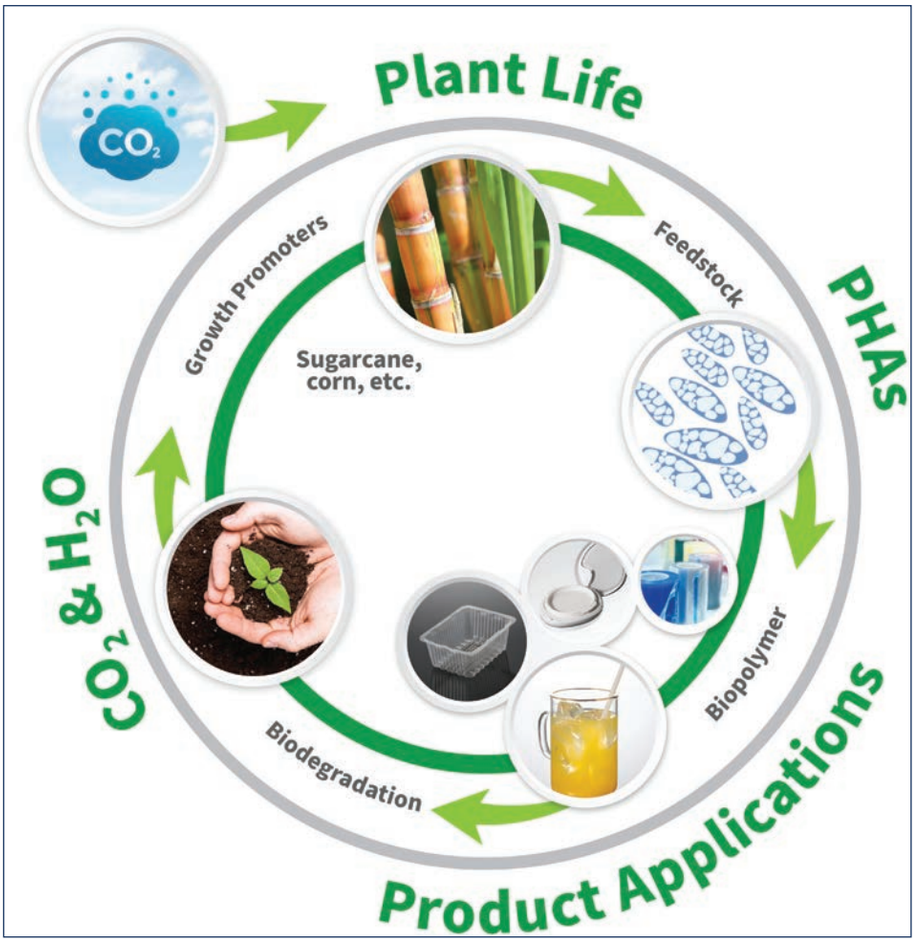


Chart 1: Bio-circle diagram *(Credit: CJ Biomaterials).*

emissions in the US. However, in compost, food scraps and compostable packaging breakdown and become part of a nutrient-rich soil amendment that improves soil's health, biodiversity, and carbon sequestration capability. In the US, access to industrial composting facilities that process food waste is growing quickly with the number of households with access to food waste collection growing by 49 per cent from 2021 to 2023 — from 10.0 million to 14.9 million households .[4]

Environmental conditions, such as temperature and pH, and PHA properties, likewise monomer type, molecular weight, crystallinity, and surface area, directly influence the degradation rate of PHAs. In the environment, PHAs are observed to have a relatively fast degradation mostly via microbial activity.[5] Therefore, if products made entirely with PHA are littered, they will biodegrade naturally, leaving behind no persistent microplastics or long-term impacts to the environment. This is why PHAs offer a safer, and more circular alternative to incumbent fossil-based plastics. At the beginning of life, PHAs accelerate the decoupling of materials from fossil fuels like oil or natural gas, instead using plants to capture and sequester atmospheric CO_2 into sugars that can be used to produce PHA. At the end of life, products made with PHA-modified biopolymers biodegrade into CO_2 and water, which are ultimately sequestered into compost or returned to the atmosphere to be used by plants again. (See Chart 1.)

Improving Functional Properties of other Biopolymers

During the past 50 years, extensive research and many development projects have been dedicated to the ever-growing class of PHAs.[6] To date, the number of known PHA monomers has increased to more than 150, including unsaturated and aromatic monomers.[7]

Amorphous PHA is a more recent innovation. It is a tough, ductile, pliable material that offers fundamentally different performance characteristics than the crystalline or semi-crystalline forms of PHA that currently dominate the market. Amorphous PHA (aPHA) is a thermoplastic material that can be compounded with other biopolymers and processed into various applications including fibers and nonwovens for hygiene products, flexible and rigid food packaging, foams, straws, and injection molded cutlery or profiles.

Significant progress has been made over the last 20 years in using biopolymers to reduce the use of fossil-based plastics and address the accelerating levels of plastic waste on our planet. Polylactic acid (PLA), in particular, has made significant inroads, and it is the biomaterial of choice for the plastics industry. The challenge PLA faces is that it is very brittle, stiff, and

can be slow to compost, limiting its usefulness for certain applications.

The aPHA biopolymer works well as a modifier to PLA as well as other polymers or biopolymers and can be used to increase bio-based content, accelerate biodegradation, and improve functional properties of resins and finished products. For example, in rigid food packaging, aPHA improves the impact resistance of polylactic acid (PLA) thermoforms so they can be used in automated food packaging systems while maintaining high levels of biobased content and passing 3rd party compostability testing. aPHA also improves the softness of spunbond PLA nonwovens by 40 per cent, which is a critical attribute for nonwovens used as the topsheet, or layer that touches the skin, in diapers.

Furthermore, aPHA increases the rate of composting of PLA and other biobased polymers. Like PLA, aPHA is certified by the Biodegradable Products Institute (BPI) as industrially compostable. But, unlike PLA, it is also TÜV OK-certified biodegradable in soil and marine environments and also certified for home compost. These properties that make PHA biodegradable under a wider range of conditions are what help improve the compostability of PLA as well.

Using aPHA as a modifier can have a significant impact on the market. Global production capacity of PLA was approximately 675,800 tons in 2023,[8] and that is not enough capacity to begin replacing fossil-based plastics at scale. A conservative estimate is that half a million tons of PLA needs to be produced to satisfy market demand. Looking beyond PLA to all biopolymers (PBAT, PBS, PBST, etc.), European Bioplastics estimates that total global production capacity of bioplastics will eclipse 7.4 million tons by 2028[9] which is barely 2 per cent of the greater incumbent plastics market. The full portfolio of PHAs, from amorphous to semi-crystalline, will be needed to expand the functional capabilities of all biopolymers so that more applications and products can transition away from fossil-based plastics to safe, low carbon, biobased materials with extended capabilities for compostability and biodegradability.

Looking Ahead

The crisis the world is facing, from climate change to plastic waste demands immediate action and innovative solutions. From governments to brands to consumers, we are seeing unprecedented attention being paid to how plastics impact all aspects of the environment. PHAs represent a critical step forward to ensure we are able to meet the challenge of implementing a low carbon, fully circular bioeconomy for materials. As fully biodegradable, bio-based polymers, PHAs address the limitations of traditional plastics and even other bioplastics, offering a truly circular solution. With advancements like amorphous PHA, the potential for widespread applications is growing—from enhancing the performance of existing biopolymers to enabling home-compostable packaging solutions.

In addition to its environmental advantages, a cohesive regulatory framework is also essential for PHA to have an impact. While initiatives like California Senate Bill 54[10] represent significant progress, there are gaps in implementation that hinder the scalability of compostable materials. For example, the National Organic Program (NOP) standards, which restrict compostable packaging inputs for organic agriculture, create unintended roadblocks for advancing compostability. Updating these standards to reflect modern materials is critical to achieving alignment across industries and reducing dependency on landfills. Collaborative regulatory efforts, such as working with the National Organic Standards Board (NOSB) to revise these outdated standards, are key to addressing systemic challenges and ensuring compostable products achieve their highest value by aiding in the diversion of food scraps away from landfills and into compost.

The future of PHA and its ability to address plastic pollution depends on its scalability and its industry adoption as a replacement for conventional plastics. Achieving commercial scale production is difficult for newer biobased materials competing against the economics of fossil-based polymers where the production and value chain has been optimized over the last 60 years. However, despite the challenges, PHA manufacturers are seeing greater interest from the market, securing investments, and justifying re-

investment economics that will support the ongoing scale up of the industry. Recently, Mango Materials, a producer of PHAs in California, received funding via a USD26.9 million investment from BioMade to facilitate point-of-need production for biodegradable plastic replacements while enabling decentralized production of materials.[11] In April 2024, CJ Biomaterials announced additional capacity at its manufacturing facility in Pasuruan, Indonesia, specifically to expand production of both its aPHA and scPHA biopolymers.[12] The biotechnology company, RWDC, then announced an additional investment in June 2024 that will support construction of their new PHA manufacturing expecting to break ground in 2025.[13] While certainly challenges remain, the ongoing investment in PHA capacity and capabilities will underpin growth in the biopolymers market in 2025.

By integrating PHA into packaging, consumer goods, and industrial applications, manufacturers and brands can continue the journey to reducing the negative impact of plastics on our climate and environment. With increasing global capacity for bioplastics and ongoing innovations in PHA technology, the vision of a sustainable, circular bioeconomy is firmly within our reach. ■

Author

Max Senechal
Chief Commercial Officer
CJ Biomaterials

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XtraFlo™ DRA: For Sustainable Pipeline Transportation of Crude Oil & Petroleum Products

Xtraflo™ DRA is a groundbreaking additive that significantly reduces drag in pipelines, enabling more efficient and sustainable transportation of petroleum products. Commercially available through Indian Oil Corporation Limited (IOCL) licensee Dorf Ketal Chemicals India Pvt Ltd, Xtraflo™ DRA has gained widespread adoption among pipeline operators in India due to its superior performance and cost-effectiveness.

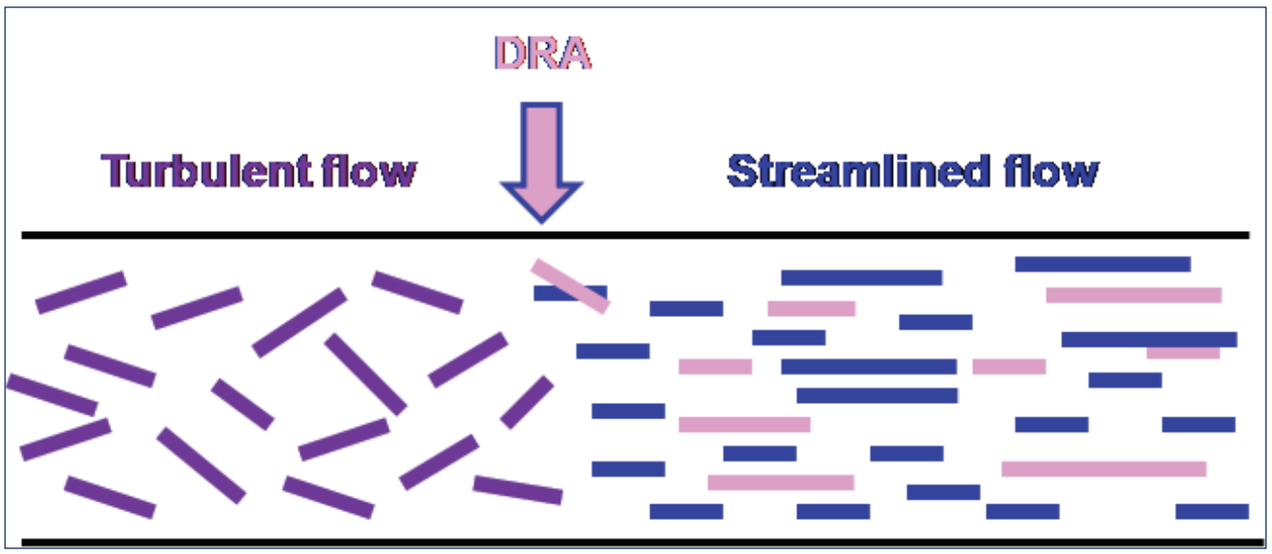
Dr. Gurmeet Singh
DGM
IOCL R&D Centre

Dr. Alex Pulikottil
ED (PC&CAT)
IOCL R&D Centre

Drag Reducing Additives (DRA) are formulations containing ultra-high molecular weight poly (alpha-olefins) along with other components, which enable oil and pipeline industries to reduce the frictional pressure within the flow of a pipeline or conduit. DRAs, due to their unique comb-like structure with pendant groups attached to ultra-long hydrocarbon chains, reduce energy dissipation caused by turbulence. These DRAs have ultra-high molecular weight polyolefins, molecular weight ranging from 10 to 20 million Daltons, which enable the decrease in the amount of energy lost due to turbulent formation in pipeline transportation. These are the niche products that have been extensively patented by a few global players.

Till 2021, the DRA consumed within the country was 100 per cent imported, predominantly from the USA. Apart from IOCL, the other major pipeline operators in India, Hindustan Petroleum Corporation Limited (HPCL), Bharat Petroleum Corporation Limited (BPCL), and HPCL-Mittal Pipeline Limited (HPCL-MPL), are consuming DRA.

Considering the importance of this guarded product, IOCL embarked upon indigenization of this technology. In the ensuing journey, IOCL developed, patented, and successfully commercialized its Drag Reducing Additive (DRA) technology by licensing it to Dorf Ketal Chemicals India Pvt Ltd, a leading multi-national Indian company, for manufacturing in India and worldwide supplying against royalty to IOCL in 2021.

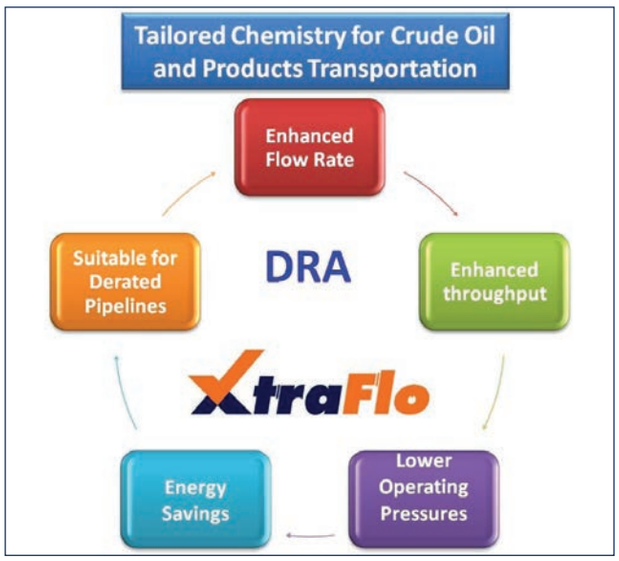


Pictorial representation of the DRA action

Main Features of IOCL XtraFlo™ DRA Technology

IOCL's development of DRA is a pioneering achievement, marking the first successful development of this technology within India and possibly in developed countries. The effective replacement of imported DRA with domestically produced XtraFlo™ DRA is evident in the significant increase in sales of XtraFlo™ DRA from ₹25.27 crore in FY22 to ₹63.72 crore in FY23 and further to ₹105.32 crore in FY24.

The successful domestic production of XtraFlo™ DRA has triggered a spiraling effect, marked by reduced costs, improved logistics, and enhanced product availability. As a result, adoption by pipeline operators, including IOCL, BPCL, HPCL, and HPCL-MPL has steadily increased. Building upon this success, IOCL is committed to further deepening import substitution and expanding market penetration. Imports have already dropped to a mere 4.8 per cent in FY24 from 100 per cent in FY20.



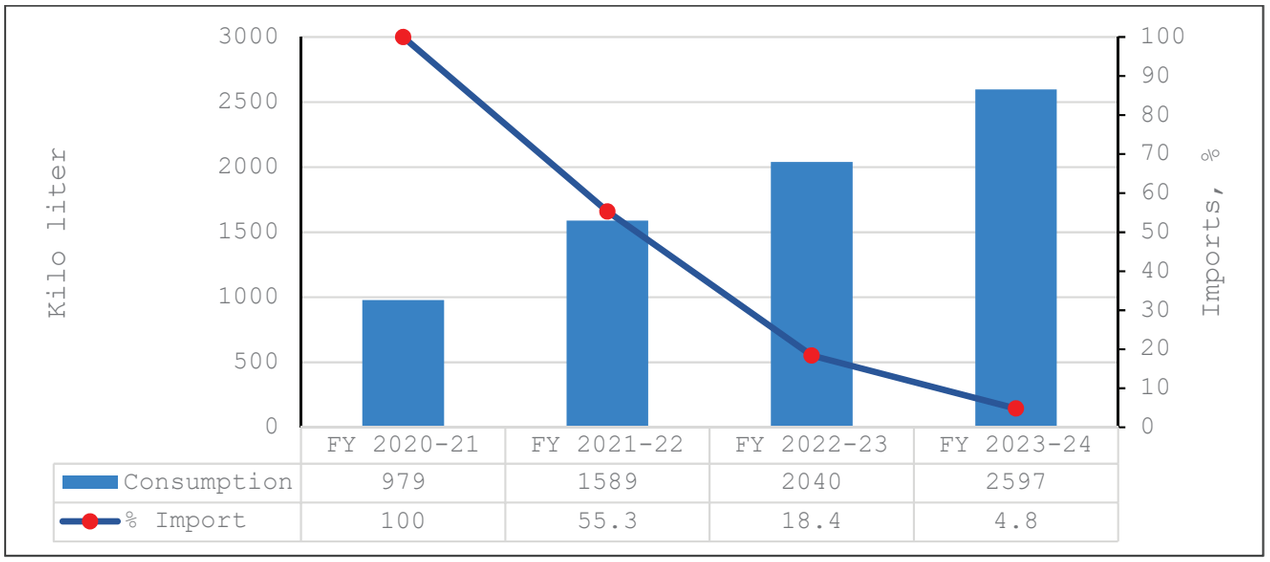
Main Features of IOCL XtraFlo™ DRA Technology

Energy Savings & Green House Gas Reduction

With the usage of XtraFlo™ DRA, saving on the cost of energy (power and fuel) on account of reduced operational cost per ton of hydrocarbon transported can be achieved, i.e., enhanced throughput within the existing operational setup or by shutting down pumps at intermediate booster stations. Energy (power and fuel) savings translate to approximately ₹106 crore for 2023-24 for the IOCL pipeline network. Lower energy consumption due to DRA usage is estimated to reduce CO_2 emissions by 56,800 MT CO_2 annually for the IOCL pipeline network. These figures are expected to nearly double on a national basis, including BPCL, HPCL, and HPCL-MPL. Thus, the use of XtraFlo™ DRA is contributing significantly to environmental sustainability.

Environmental Impact

The product has been developed to be environmentally benign and non-hazardous. There is zero generation of effluent in the process, making it highly sustainable. It reduces pipeline pressures while maintaining the same throughput, enabling the utilization of degraded pipelines. This eliminates the need for new pipelines, thus providing a sustainable solution to the old assets



Total Consumption (in KL) and Import (%) of DRA in India

and saving on CAPEX on account of the requirement of new pipeline assets and road/rail transportation.

Innovative Technologies & Processes

Production technology for producing such a high molecular weight polymer was established for the first time in India. The technology involved overcoming mass and heat transfer challenges while handling high-molecular-weight polymers and their dispersion. A bulk polymerization process was developed to avoid the usage of solvents and make the process sustainable while achieving >95 per cent conversion levels. The technology for obtaining the final formulation was developed and established by converting bulk ultra-high molecular weight poly (alpha-olefins) into dispersible form. This stable dispersible form was suspended in a special formulation to produce the industrially usable DRA product.

Drop-in Technology

The technology has been designed and developed such that no additional hardware over a conventional system is required for usage of XtraFlo™ DRA. The ease of XtraFlo™ usage and comfort of dosing have been the main focus during the formulation development.

Additionally, opportunities are being explored to expand XtraFlo™ DRA's applications, capitalizing on its potential for energy savings and greenhouse gas reduction for hydrocarbon transportation. ■

Revolutionary membrane less flow battery

Amazon is trialing a new battery technology for its energy storage needs in co-operation with the Swiss battery start-up, Unbound Potential, a participant of the Amazon Sustainability Accelerator.

Unbound Potential has developed a membrane-less redox flow battery that, unlike conventional lithium-ion batteries, does not require any critical raw materials, has a longer shelf life and is significantly more cost-effective for stationary applications. The pilot location and launch timeframe is currently being scoped.

Unbound Potential's energy storage solution addresses Amazon's challenge of limited solar energy utilisation due to 24/7 operations, enabling the transition to off-grid fulfilment centres powered entirely by renewable sources. Potentially, the start-up can help provide long-duration energy storage that meets the energy intensive needs of Amazon's logistics operations.

Throughout the pilots, Amazon's subject matter experts will work closely with the start-ups, offering feedback, troubleshooting assistance, and opportunities to refine their technologies to ensure they work smoothly in their respective placements. Upon completion, Amazon will assess the environmental impact, financial viability, and overall effectiveness of the pilot to determine whether any can be scaled across other sites as part of a long-term partnership.

Says Justine Mahler, Sustainability Director, Amazon, "By providing a real-world testing ground for unique and cutting-edge technologies, we are not only reducing our environmental impact but also creating a blueprint for more sustainable practices across industry."

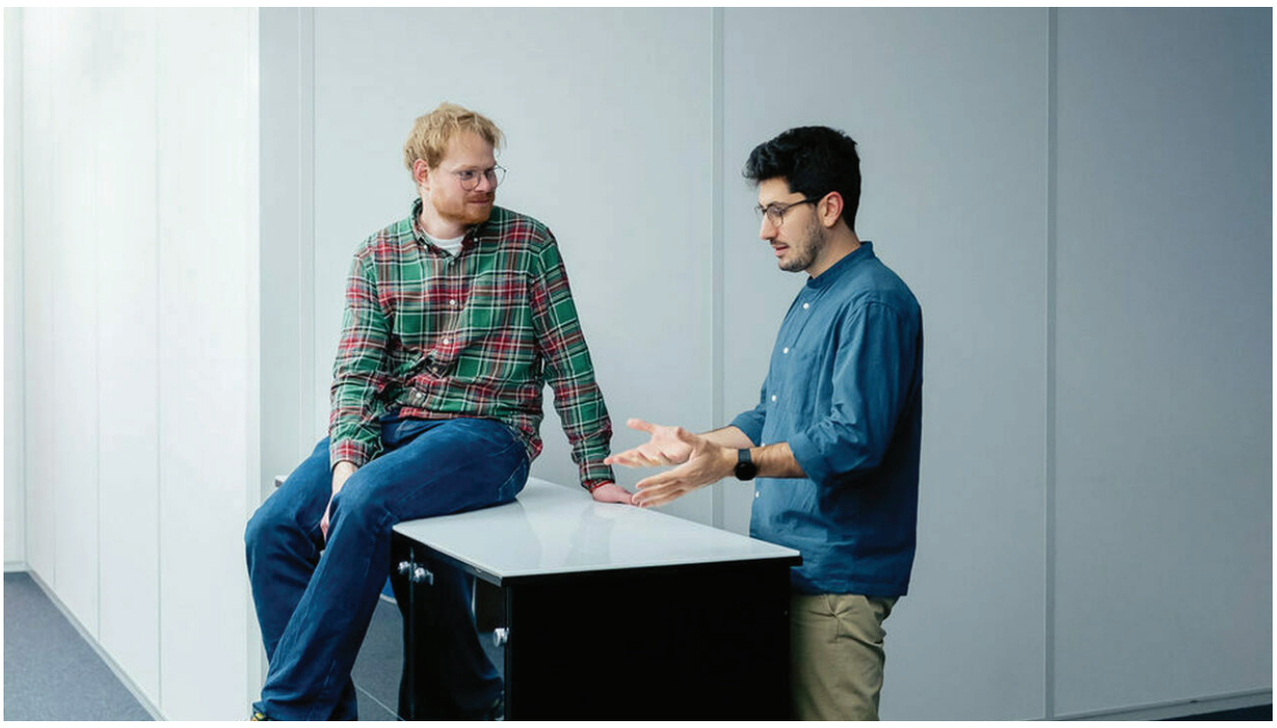
David Taylor, CEO of Unbound Potential, says, "There could be no better partner for our market entry than this pilot with Amazon. The benefits of our battery solution can potentially fit perfectly with Amazon's storage needs."

Technical Advantages

Sharing more details about the new technology in an exclusive interview with *Mittravinda Ranjan*, David Taylor, CEO, Unbound Potential, elaborated on the specific technical advantages, of the membrane-less redox flow battery both - in comparison to the traditional lithium-ion as well as other redox flow battery technologies.

He said that cost and supply chain are the major advantages of the new redox flow battery technology as compared to traditional lithium-ion battery technology. "Technologies, which do not decouple power end capacity are ultimately limited by the costs of the peripheral system, which have to be scaled together with the cells. Besides, the components of our systems are simple and can be produced anywhere. These are much more scalable than shipping cells from Gigafactories," he added.

Explaining the advantages of the new technology as compared to traditional Redox Flow battery technologies, Taylor said, "The first advantage is simplicity. Without a membrane, the material selection, machining and assembly of cell stacks becomes simpler and thus way more scalable and affordable."



David Taylor (L), Co-Founder and CEO with Emilio Del Re (R), Co-Founder and Managing Director, Unbound Potential.

"The second advantage is Platform solution. Our system is flexible to be used with different active species," he noted.

Unique Feature

The design of Unbound Potential's solution differs fundamentally from other redox flow batteries. Instead of using a membrane, the ion exchange is controlled by non-miscible electrolytes. This makes the battery more durable and requires 90 per cent fewer sealing surfaces, and in contrast to lithium, flow batteries do not pose a fire hazard. Therefore, the usual minimum distances for potential risk factors are not required. The technology is becoming more efficient as it is scaled up to industrial-sized energy storage systems, such as those required by Amazon.

The elimination of the membrane contributes to improved performance, durability, and cost-effectiveness. "Our cells have lower flow resistance, less weight, less components. This increases the robustness of the system as a whole, and saves cost on capex and opex," added Taylor.

Applications

Besides the logistics sector, the redox flow battery technology is applicable for renewable power generation, grid stability services and energy arbitrage (In front of the meter) and self-consumption optimization, peak shaving and back-up power (behind the meter). "As we can freely adapt power and capacity and our system is non-flammable and has a fast response time, we can suit the needs of various use cases," explained Taylor.

Future

Talking about the future plans and the role of contributing to a greener future, Taylor said, "We are using organic active species, instead of mined materials and are targeting to reach 20k cycles, about 3x more than Li-batteries." ■

Overcoming Challenges in the Industrial Valve Industry

Micro, Small, and Medium Enterprises (MSMEs) are integral to the industrial ecosystem, especially in specialized fields like industrial valve manufacturing. At TSflo, a leading producer and marketer of industrial valves — including Gate, Globe, Check, and Ball valves—we have gained valuable insights into the unique challenges MSMEs face in meeting the rigorous demands of industries such as chemical and process engineering. This article explores these challenges and provides an overview of how MSMEs like TSflo tackle them while maintaining excellence and innovation in their offerings to the Chemical Engineering sector.

Meeting Stringent Quality Standards

Chemical, petrochemical, and pharmaceutical industries require industrial valves that perform reliably under extreme conditions, including high temperatures, corrosive environments, and variable pressures. For MSMEs, meeting these stringent quality standards and obtaining certifications like API, ISO, and CE can be financially and operationally demanding.

At TSflo, we have prioritized quality by investing in state-of-the-art manufacturing techniques and rigorous quality control processes to ensure compliance with international standards. While such efforts are crucial for market acceptance, they place a significant strain on the limited resources of smaller enterprises.

Keeping Up with Technological Advancements

The industrial valve sector is rapidly advancing, with trends pointing toward automation, smart valves, and new materials. For MSMEs, adopting these technologies is vital for staying competitive, yet the associated R&D costs and technical expertise requirements can be prohibitive.

TSflo has addressed this challenge by collaborating with research institutions and leveraging government programs aimed at fostering innovation among MSMEs. These partnerships have enabled us to develop cost-effective, high-performance valve solutions. However, the broader MSME sector continues to struggle with limited access to such opportunities.

Competing with Large-Scale Manufacturers

MSMEs often face stiff competition from well-established multinational corporations and large domestic manufacturers. These larger players benefit from economies of scale, advanced production capabilities, and substantial marketing budgets, allowing them to offer competitive pricing and dominate market share.

To differentiate ourselves, TSflo focuses on delivering customized solutions, quick turnaround times, and exceptional customer service. By tailoring our products to the specific needs of chemical and process industries, we have built a strong and loyal client base. However, the competitive pressures in the market remain a constant challenge.

Financial Constraints and Cash Flow Issues

Financial challenges are a recurring concern for MSMEs, particularly in capital-intensive industries like valve manufacturing. High raw material costs, coupled with delayed payments from customers, often result in cash flow problems. Additionally, significant investments in equipment, certifications, and workforce training further stretch financial resources.

TSflo has managed these issues through careful financial planning, strategic supplier relationships, and leveraging government support programs for MSMEs. However, timely financial assistance and faster customer payment cycles would greatly benefit the sector as a whole.

Shortage of Skilled Labor

Manufacturing industrial valves requires a skilled workforce proficient in complex machining, quality assurance, and product development. MSMEs often struggle to attract and retain such talent due to their limited ability to offer competitive salaries and training opportunities.

TSflo has addressed this challenge by investing in training programs and partnering with technical institutes to create a pipeline of skilled professionals. Although this approach has been successful for us, many MSMEs still face a persistent skills gap that hampers their growth.

Navigating Supply Chain Challenges

The supply chain for industrial valve manufacturing is complex and susceptible to disruptions. MSMEs are particularly vulnerable to fluctuations in raw material availability and pricing. Global events such as the COVID-19 pandemic and geopolitical tensions have further compounded these issues.

To mitigate these risks, TSflo has diversified its supplier network, maintained strategic inventory levels, and established strong relationships with reliable suppliers. While these strategies have proven effective, they require substantial effort and resources that are often out of reach for smaller players.

Managing Regulatory and Policy Complexities

The regulatory environment for MSMEs in manufacturing is often challenging, with complex compliance requirements related to environmental standards, taxation, and trade policies. Navigating these regulations can be daunting for smaller businesses with limited administrative capacity.

For example, while the Export Promotion Capital Goods (EPCG) license offers cost advantages, it introduces procedural complexities that can delay operations. TSflo has worked to streamline compliance processes, but MSMEs would benefit from simplified regulatory frameworks tailored to their capabilities.

Establishing Market Presence

Building a strong market presence is essential for MSMEs competing in the industrial valve industry. However, limited marketing budgets and resources often restrict their ability to reach potential customers effectively.

TSflo has leveraged digital marketing, industry trade shows, and technical knowledge-sharing platforms to enhance our visibility and credibility. These efforts have helped us establish a strong foothold in the market, but many MSMEs struggle to achieve similar results due to resource constraints.

Transitioning to Sustainable Practices

The global push for sustainability has added pressure on MSMEs to adopt eco-friendly manufacturing processes and materials. While this transition is necessary and beneficial, it requires significant investments that many MSMEs find challenging to afford.

TSflo is committed to sustainability and has implemented measures to reduce waste, improve energy efficiency, and explore environmentally friendly materials. Nonetheless, widespread adoption of sustainable practices across the MSME sector will require more robust support from policymakers and industry stakeholders.

Conclusion

The industrial valve industry presents vast opportunities for MSMEs, particularly in serving the chemical and process engineering sectors. Despite the challenges, MSMEs like TSflo continue to demonstrate resilience and adaptability. By embracing innovation, fostering strategic partnerships, and utilizing government initiatives, we have managed to navigate hurdles and deliver value to our clients.

To unlock the full potential of MSMEs, collaborative efforts from policymakers, financial institutions, and industry leaders are essential. Tailored policies, accessible financing, and workforce development initiatives can empower MSMEs to thrive and contribute significantly to the industrial ecosystem.

As the Chemical Engineering sector evolves, MSMEs will remain crucial drivers of innovation, competition, and customised solutions. With the right support, these challenges can be transformed into stepping stones for growth and success. ■

Author

Abhishek Parmar
Director
TS Flow Controls Private Limited

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METTLER TOLEDO is a leading global manufacturer of precision instruments. The company is the world's largest manufacturer and marketer of weighing instruments for use in laboratory, industrial and food retailing applications. The company also holds top-three market positions for several related analytical instruments and is a leading provider of automated chemistry systems used in drug and chemical compound discovery and development. In addition, the company is the world's largest manufacturer and marketer of metal detection systems used in production and packaging. Additional information about METTLER TOLEDO is available at www.mt.com. ■

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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
- **8** TECHNICAL CONFERENCES
- **250+** GLOBAL SPEAKERS
- **1500+** BUSINESS DELEGATES
- **2500+** ENGINEERING PHARMA & SCIENCE STUDENTS AT STUDENT OUTREACH PROGRAM FROM 28 STATES & UNION TERRITORIES
- SCALE@CHEMTECH World Expo 2024: 60+ GLOBAL CLIMATE TECH STARTUPS FROM 20 COUNTRIES; 40 TECHNICAL PRESENTATIONS
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Taj Building, 3rd Floor, 210, Dr. D N Road, Fort, Mumbai – 400 001, INDIA.
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