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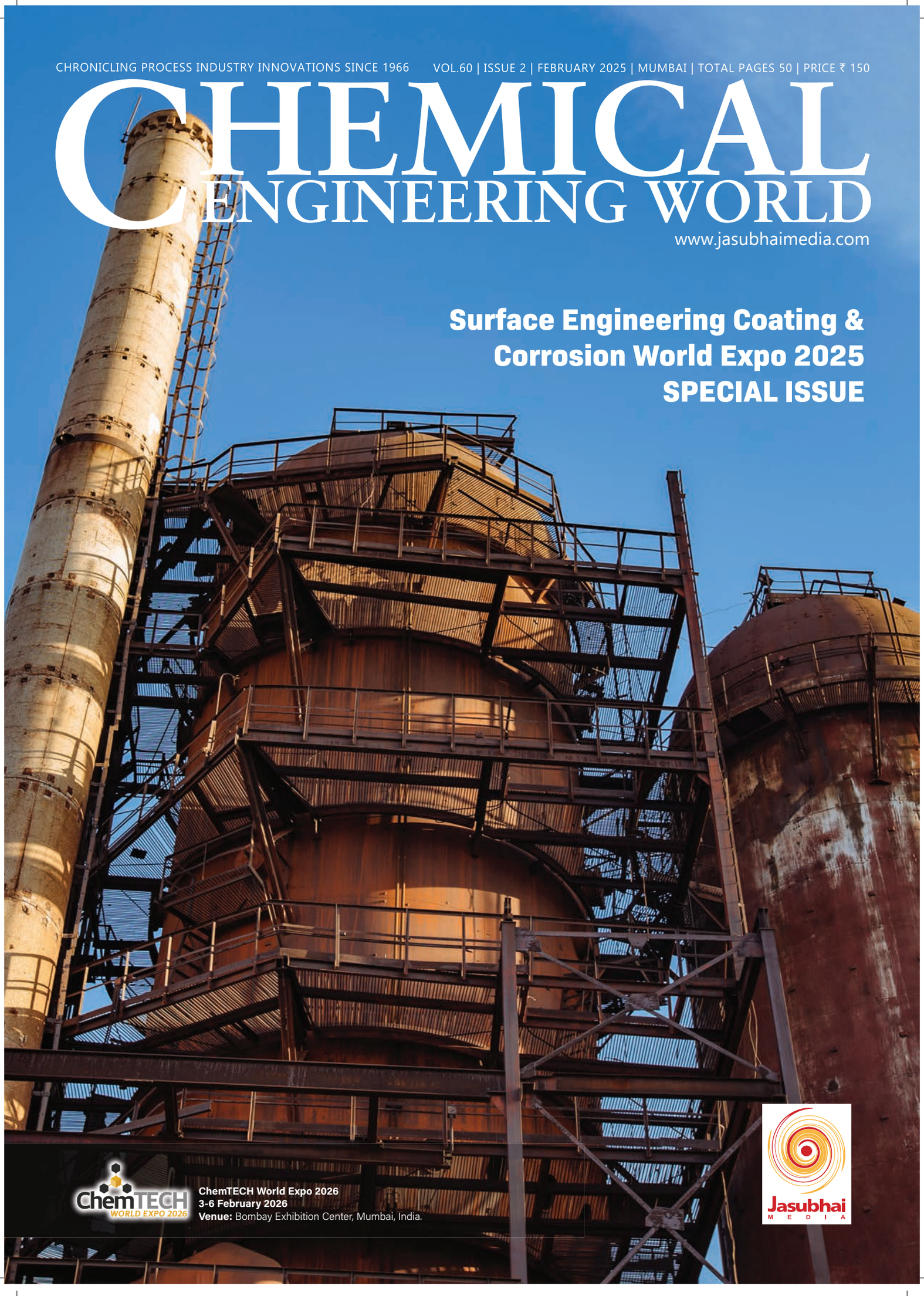

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PI in S&P Global Sustainability Yearbook for 2nd consecutive year

Gurugram, New Delhi: PI Industries Ltd. (PI), an agri-sciences leader, has again been recognised in the S&P Global Sustainability Yearbook 2025, marking its second consecutive inclusion in this prestigious global ranking. This achievement underscores PI's commitment to sustainability-driven innovation, ESG excellence, and long-term value creation. The S&P Global Sustainability Yearbook is one of the world's most respected benchmarks for corporate sustainability performance. It is based on the S&P Global Corporate Sustainability Assessment (CSA), an independent and rigorous evaluation covering over 13,000 companies globally. For the 2025 edition, more than 7,690 companies were assessed, and only 780 companies secured a place in the Yearbook, including 51 from India.

Kansai Nerolac Paints announces Q3 results FY 2024-2025

Mumbai, India: Kansai Nerolac Paints Limited (KNPL), one of the leading paint companies in India, has announced its unaudited results for the third quarter of the financial year 2024-25. For the quarter, the company declared net revenue of ₹1842.2 crores, a growth of 1.5 per cent over the corresponding quarter of the previous year. EBITDA was at ₹246.9 crores, a growth of 2.9 per cent over the same quarter of the previous year. PBT before exceptional items was at ₹228.1 crores, a growth of 7.2 per cent over the same period of the previous year. For the nine months net revenue was ₹5756.3 crores, growth of 0.4 per cent over the same period of the previous year. EBITDA was at ₹796.3 crores, a growth of -5.6 per cent over the same period of the previous year. Commenting on the results, Anuj Jain, Managing Director, Kansai Nerolac Paints Ltd, said, "The company continued to see good growth in Paint+ products, projects, wood coatings and construction chemicals. Demand in decorative was impacted due to higher inflation leading to lower spend on discretionary products and tight liquidity. We are seeing a gradual recovery in demand. In automotive growth was better than market, based on several internal initiatives. Performance coatings registered strong growth due to a good order pipeline. The various strategic initiatives undertaken have led to a better than market performance across all businesses. Going forward it is expected that the recent budget announcements will help improve the consumption cycle which would positively impact demand." The size of domestic paint industry is estimated at around ₹75,000 crores as of March 2024. The good growth in infrastructure, core sector as well as automobile and real estate is likely to have a positive effect on the overall demand of paint for the industry in the long run.

Eveready Industries India announces Q3 & 9M FY25 results

Kolkata, West Bengal: Eveready Industries India Ltd. (EIIL), a household name in batteries and Flashlights, with an emerging presence in lighting, has announced its financial results for the third quarter and nine-months ended December 31, 2024. Growth was primarily driven by robust performance in batteries and flashlights. Alkaline batteries continued to demonstrate strong momentum, while Carbon Zinc showed healthy sign of recovery. Similarly, rechargeable flashlights delivered traction, led by improved sales across a wider portfolio. Growth in the lighting segment saw moderation due

Kansai Nerolac Paints appoints Pravin D. Chaudhari as MD

Pravin D. Chaudhari has been appointed as Managing Director, for a term of three years with effect from 1st April, 2025, subject to approval of the shareholders of the company. Anuj Jain, Current Managing Director, will take early retirement from the services of the company on 31st March, 2025. With over 30 years of experience across functions, Chaudhari has a stellar career building B2C and B2B businesses. Joined as a trainee in 1993, he was appointed as an Executive Director of the company in 2008. In 2018, he moved to Pidilite Industries. In 2023, he rejoined Kansai Paint Co., Ltd (KPJ), promoter company of Kansai Nerolac Paints Limited, as an Executive Officer. He is currently the Executive Officer, Head of India business and Deputy Chief of R&D/Procurement Unit, at Kansai Paint Co., Ltd (KPJ).

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to continued value erosion coupled with competitive activity and pricing. Total Batteries sales grew by 12.2 per cent during the quarter. Carbon zinc Batteries sales grew 7.6 per cent on low base of same quarter last year while Alkaline battery volume surged 100 per cent during the quarter, propelling market share to 11 per cent in Q3 FY25, a significant increase from 6%+ in the prior year. To sustain this momentum, we are strategically expanding our retail footprint in the focussed markets to drive consumer led growth.

PPL to invest ₹4,000 crore over five years

Paradeep Phosphate Ltd and Government of Odisha executives during signing of Memorandum of Understanding

Bengaluru, Karnataka: Paradeep Phosphate Limited (PPL), a leading fertilizer manufacturer, has signed a Memorandum of Understanding (MoU) with the Government of Odisha for an investment of ₹4000 crore. PPL will invest ₹4000 crore over five years to increase the Phosphatic Fertiliser Manufacturing capacity in both intermediate and final products including Port/ Jetty and infrastructure development. This will escalate the employment capacity directly between 100-150 and indirectly between 700-1000. Alongside, this strategic investment will increase production capacity, reduce environmental impact, and contribute to agricultural growth. The company aims to be self-sufficient in fertiliser production and to improve crop yields, farmer prosperity and soil health. The MOU was signed between Hemant Sharma, IAS, Addl. Chief Secretary, Department of Industries, Government of Odisha and Suresh Krishnan, MD & CEO, Paradeep Phosphates Limited. Subhendra Kumar Nayak, Special Secretary, Department of Industries; Bijoy Kumar Biswal, Chief Financial Officer, PPL and Sudhi Ranjan Mishra, Head-Corporate Affairs, PPL were present during the event.

Epigral Limited Q3FY25 PAT jumps 110% to ₹104 crore

Mumbai, India: Epigral Limited (Epigral), India's leading integrated chemical manufacturer, has announced its financial results for the quarter ended December 31, 2024. The company posted a robust Profit After Tax (PAT) growth for Q3FY25 at ₹104 crore, a jump of 110 per cent as compared to ₹ 49 crore in Q3FY24. The quarterly revenue rose by 37 per cent to ₹649 crore as against ₹ 474 crore recorded in Q3FY24.

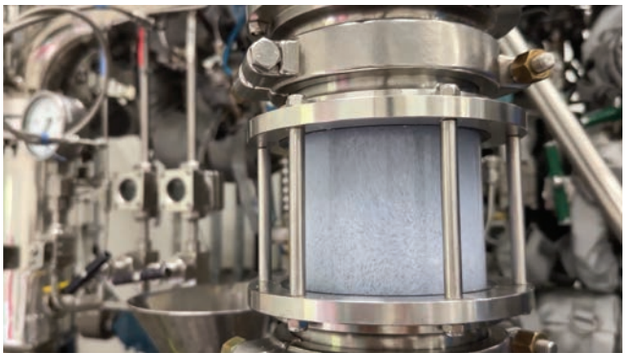
Commenting on the results Maulik Patel, Chairman and Managing Director, Epigral, said, "Epigral's revenue grew by 37 per cent in nine months of FY2025 on account 15 per cent growth in sales volume from Derivatives business and high value products. The diversification strategy of our company has played a key role in witnessing consistent and stable growth in this subdued demand scenario. Revenue contribution from Derivatives business stood at 54 per cent for 9MFY25 vs 44 per cent in 9MFY24."

Sales volume grew 15 per cent YoY, it majorly comes from Derivatives and Specialty business. Capacity utilization stood at 82 per cent in 9MFY25 vs 76 per cent in 9MFY24. Realizations dropped for all the products in 9MFY25 vs 9MFY24, except for caustic soda.

Balram Singh Yadav re-appointed as MD of Godrej Agrovet Limited

The Board of Directors of Godrej Agrovet Limited, based on the recommendation made by the Nomination and Remuneration Committee, has approved re-appointment of Balram Singh Yadav as the Managing Director of the company. The current tenure of Balram Singh Yadav as the Managing Director of the company is upto April 30, 2025. The re-appointment is for a further period commencing from May 1, 2025 upto August 31, 2025, subject to approval of the Shareholders. Balram Singh Yadav is the Managing Director of Godrej Agrovet Limited (GAVL) and also serves as Managing Director of Godrej Foods Limited. He has been the Chairman of CLFMA of India (twice), an Association of Livestock Industry. In addition, he is a Director of numerous entities, including, ACI Godrej Agrovet Pvt. Ltd. (Bangladesh), Creamline Dairy Products Limited (Hyderabad), Astec LifeSciences Limited and Godrej Cattle Genetics Private Limited (Mumbai).

thyssenkrupp Uhde & Novonesis launch uhde® enzymatic esterification



thyssenkrupp Uhde enzymatic esterification fluid bed

Essen, Germany: thyssenkrupp Uhde, a major chemical technology solution provider, in partnership with Novonesis, partner and pioneer in enzymatic technology, has announced the launch of their joint offering: uhde® enzymatic esterification. This ground-breaking technology bears the potential to revolutionize ester production by significantly reducing energy consumption and enhancing product quality through environmentally friendly biocatalysis, at a competitive cost-in-use of the enzyme. Esterification plays a crucial role in the oleochemical value chain by converting natural fatty acids into the corresponding esters. These bio-based and bio-degradable esters are then utilized in a wide range of day-to-day products for food, personal care, household care and technical applications.

The new enzymatic esterification process developed by thyssenkrupp Uhde leverages Novonesis' bespoke enzymes as catalysts, replacing traditional chemical catalysts such as inorganic acids or metal-based catalysts. This innovative approach operates at significantly lower temperatures, resulting in substantial energy savings and a reduction in greenhouse gas emissions by up to 60 per cent. Additionally, the process has an inherently safer design due to the absence of chemical catalysts and lower operating temperatures.

The proprietary reactor design and enzyme technology ensure high performance, leading to minimized side reactions and reduced waste by up to 60 per cent. This not only raises the quality of the final product but also opens the door to the creation of completely new products, allowing businesses to expand their portfolios and enter new markets.

The proprietary design of the enzyme bed allows up to 30 circulations per hour which ensures efficient and cost-effective production. Thus, the enzymatic esterification process is optimized for short reaction times, resulting in competitive enzyme cost per ton of product, higher annual production, and superior product quality.

"Our collaboration with thyssenkrupp Uhde brings together the expertise of our two companies and has enabled us to create an innovative technology solution for production of low-carbon esters. We will collaborate closely with thyssenkrupp Uhde to commercially deploy this new technology," said Hans Ole Klingenberg, Vice President, Global Marketing, Industrial & Household care solutions of Novonesis.

Suvamoy Saha reappointed as MD of Eveready Industries India

Suvamoy Saha has been reappointed as Managing Director of Eveready Industries India Limited for a period effective from 8th March 2025 till 30th September 2025, subject to approval of shareholders.

Saha is a Fellow Chartered Accountant from the Institute of Chartered Accountants of India and a B.Com (Hons) graduate from Calcutta University. After beginning his career with a short spell at Price Waterhouse, he joined Eveready and has since contributed to the organization in diverse capacities, including finance, information technology, quality management, sales and marketing, and general management. He was appointed as a member of the Board in 2004, and he has been serving as the Managing Director of the company since March 2022.

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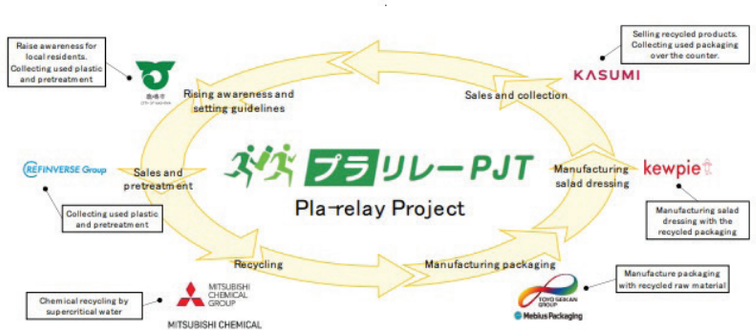
Mitsubishi & Partners join hands for plastic recycling

Japan, Tokyo: Kashima City of Ibaraki Prefecture, REFINVERSE, Inc., Mitsubishi Chemical Corporation, Toyo Seikan Group Holdings Ltd., Kewpie Corporation, and KASUMI CO., Ltd, have entered into a six-party comprehensive partnership agreement with an objective to promote closed-loop recycling of plastic packaging in Ibaraki Prefecture. In this pilot project, each of the six partners will pass materials onto the next partner to promote the recycling of plastic through the supply chain. Dubbed the 'Pla-relay Project,' it is the first closed-loop recycling of packaging project in Japan that leverages the unique strengths of a local government, a waste collecting company, a chemical manufacturer, a packaging manufacturer, a food manufacturer and a supermarket. As the recycling of plastic packaging and containers is essential to achieve a sustainable society, local governments, manufacturers, and retailers are promoting a variety of recycling projects.



'Pla-relay Project,' is the first closed-loop recycling of packaging project in Japan

Executives during the signing of the comprehensive partnership agreement

In this project, the parties will develop a circular model to chemical recycle caps and inner plugs of salad dressing bottles, items that are used in daily life. Caps and inner plugs of salad dressing bottles will be collected experimentally at public elementary schools in Kashima City and REFINVERSE will collect and perform the pretreatment of the used caps. Mitsubishi Chemical will then convert the pretreated caps into raw material for chemicals at its new chemical recycling plant, which will in turn be transformed into plastic resins at Japan Polypropylene and Japan Polyethylene. Mebius Packaging, a subsidiary of Toyo Seikan Group, will mold the plastic resin into caps and plugs for bottles, which Kewpie will use in their salad dressing bottles. Finally, KASUMI will sell the finished products at its Kashima Stadium Store, returning the plastics into the hands of the residents of Kashima City.

Ram Mehrotra appointed as CBO - Decorative Sales at Kansai Nerolac Paints

Ram Mehrotra has been appointed as Chief Business Officer - Decorative Sales (CBO) of Kansai Nerolac Paints. Mehrotra has over 30 years of experience in sales, marketing, and business leadership. He was serving as the Senior Vice President (Sales & Marketing) at Astral Limited, where he was overseeing the business development and brand strategy for the paints vertical. Before joining Astral, Mehrotra had a long and successful tenure with Kansai Nerolac Paints Ltd, where he served for over 25 years in various key positions, including Vice President (Sales & Marketing).

Sudarshan Chemical reports 27% YoY growth in Consolidated EBITDA

Pune, India: Sudarshan Chemical Industries Limited, the third largest pigment player globally, has announced its financial results for the third quarter of FY25, showcasing a significant year-on-year growth in profits. The company achieved a 27 per cent growth in consolidated EBITDA before exceptional expenses at ₹79 crore.

Sudarshan Chemical's Q3FY25 consolidated income reached ₹666 crores, a 18 per cent increase compared to the third quarter last year, reflecting the eighth consecutive quarter of sales growth. With an expanding presence in over 80 countries, Sudarshan Chemical is leveraging its comprehensive product portfolio to meet the demands of high-growth markets, particularly in specialty segments such as coatings, plastics, inks, and cosmetics.

Commenting on the third quarter earnings, Mr. Rajesh Rathi, Managing Director of Sudarshan Chemical Industries Ltd., said, "The steady growth in our EBITDA and profitability is a result of our commitment to operational excellence and strategic expansion, and we remain confident about sustaining the overall momentum ahead."

Asian Energy Services reports strong 9MFY25 performance

Mumbai, India: Asian Energy Services Limited specialising in servicing the energy and mining sector, has announced unaudited financial results for the quarter and nine months ended 31st December 2024. In 9MFY25, the company achieved a total revenue of ₹249.6 crores, a 34 per cent growth compared to 9MFY24; for 9MFY25, EBITDA stood at ₹34.6 crores with a margin of 13.9 per cent, reflecting a substantial improvement YoY. PAT for 9MFY25 reached ₹19.6 crores, an increase of 81 per cent as compared to same period last year. The company's revenue from operations reached ₹249.6 crore in 9MFY25, marking a 34 per cent growth over 9MFY24, with a robust YoY improvement in EBITDA to ₹34.6 crore and EBITDA margin to 13.9 per cent. During the quarter, the company secured a new order from Assam Gas Company Limited for supplying compressor station on Build, Own, Operate, and Transfer (BOOT) basis for 3 years and valued at ~₹200 crore exclusive of GST. Asian Energy Services Limited (AESL) offers end-to-end services which extend across the entire upstream value chain. AESL's service offerings comprises Integrated Oil & Gas services including 2D and 3D Seismic Geographical Data Acquisition, Operations and Maintenance of Onshore and Offshore Oil and Gas Production Facilities, production enhancement services and Mining services including supply and installation of Material Handling Plants and Rapid Loading Systems. ■

Ashish Gaikwad appointed as Managing Director-Designate at Praj Industries

Praj Industries has announced the appointment of **Ashish Gaikwad** as Managing Director-Designate, effective February 3, 2025. Gaikwad will succeed Shishir Joshipura, CEO & MD, who will complete his tenure on June 30, 2025. To ensure a seamless transition, Gaikwad will work closely with Joshipura and the leadership team over the coming months, ensuring continuity of Praj's strategic priorities. Gaikwad brings over 34 years of experience in industrial automation, digitalization, process technology, renewable energy transition, artificial intelligence, and autonomous manufacturing. He holds a Bachelor of Engineering (Honors) in Electrical & Electronics from BITS Pilani, India. Before joining Praj Industries, he successfully led Honeywell Automation India Ltd. as Managing Director for over seven years.

ONGC and bp sign contract to enhance production from Mumbai High

New Delhi, India: Oil and Natural Gas Corporation Limited (ONGC) and bp have signed a contract under which bp will serve as the Technical Services Provider (TSP) for the Mumbai High field, India's largest and most prolific offshore oil field. ONGC will retain ownership and operational control of the field. Under the terms of the contract, bp will receive a fixed fee for a period of two years for its deployed personnel, followed by a service fee linked to incremental oil and gas production. bp will work in close collaboration with ONGC to stabilize the field's current production decline and restore it to a robust growth trajectory. Leveraging its extensive experience in managing some of the world's largest oil fields, bp will optimize oil recovery at Mumbai High by conducting comprehensive reviews of subsurface models, implementing system optimizations, and enhancing reservoir management practices. bp will assemble a team of technical experts to commence work by March 2025. In support of this initiative, both companies have already established a Senior Management Team and a Joint Management Team to ensure seamless project execution.

ONGPL to acquire 100% stake in Ayana Renewable Power

Executives during the signing of the share purchase agreement

New Delhi, India: ONGC NTPC Green Private Limited (ONGPL), a 50:50 joint venture between ONGC Green Limited (OGL) and NTPC Green Energy Limited (NGEL), has signed a Share Purchase Agreement (SPA) to acquire a 100 per cent equity stake in Ayana Renewable Power Private Limited (Ayana). The agreement was signed with National Investment and Infrastructure Fund (NIIF), British International Investment Plc (BII) and its subsidiaries, and Eversource Capital. The transaction is valued at ₹195 billion (USD 2.3 billion). Ayana, a leading renewable energy platform, has approximately 4.1 GW of operational and under-construction assets, strategically located across resource-rich states. Its portfolio is backed by high-credit-rated off-takers such as SECI, NTPC, GUVNL, and Indian Railways.

This acquisition marks ONGPL's first strategic investment since its inception in November 2024. The deal aligns with the broader vision of its parent companies— ONGC and NTPC—to achieve net-zero targets by 2038 and 2050, respectively. ONGPL will now leverage Ayana's platform for further expansion and growth. NIIF has played a pivotal role in scaling Ayana as one of India's premier renewable energy platforms, supporting the Government of India's vision for clean energy transition. Established by BII in 2018, Ayana attracted investments from NIIF and Eversource Capital in 2019, expanding its portfolio across solar, wind, and round-the-clock (RTC) projects while achieving best-in-class ESG ratings.

BPCL finalizes first LNG sourcing contract

Mumbai, India: Bharat Petroleum Corporation Limited (BPCL) has finalized its first Liquefied Natural Gas (LNG) sourcing contract linked to the Henry Hub Index. The contract is designed as a medium to long-term agreement, allowing BPCL to broaden its LNG sourcing portfolio and thus ensure competitive and dependable gas supplies to cater to India's escalating energy needs. LNG deliveries under this contract are slated to begin in Calendar Year (CY) 2025. This agreement marks BPCL's LNG sourcing contract linked to Henry Hub, enhancing energy security and market competitiveness. Speaking about the agreement, G. Krishnakumar, Chairman & Managing Director, BPCL, remarked, "Our agreement with ADNOC Trading is a significant step in securing a stable and cost-effective LNG supply. Diversifying our sourcing with a Henry Hub-linked contract strengthens India's energy security and supports its transition to cleaner energy."

Tecnimont, Paradeep municipality & NITK - Surathkal launch biogas plant project

Executives during the launch of the one-ton biogas plant project at Paradeep Municipality, District Jagatsinghpur, Odisha

Mumbai, India: Tecnimont Private Limited (TCMPL), the Indian subsidiary of Tecnimont, Paradeep Municipality and the National Institute of Technology of Karnataka Surathkal (NITK) held the groundbreaking ceremony for the one-ton biogas plant at Paradeep Municipality, District Jagatsinghpur, Odisha. This biogas plant is part of TCMPL Corporate Social Responsibility's initiatives, being executed under a tripartite agreement in collaboration with the Paradeep Municipality, the District Administration of Jagatsinghpur, and the NITK. The project aims to set up a small-scale facility to produce biogas to be used as cooking gas by using food and vegetable waste as feedstock, effectively closing the waste-to-resource loop. The plant is expected to be operational within the next 12 months to serve local communities. The project also emphasizes educational benefits, building on a pilot phase at the NITK campus that provided foundational training for students. The plant will serve as a model for innovative solutions to manage organic waste while actively engaging university students in practical learning experiences. Speaking about the project, Prof. B. Ravi, Director of NITK, stated, "NITK has been actively exploring sustainability initiatives on our Surathkal campus, supported by the MAIRE group. We have 500 kg biogas plant operating at NITK supported by TCMPL. We are delighted to scale up this experience to Paradeep, thereby contributing to Odisha's green energy objectives. We aspire for this project to inspire students, budding entrepreneurs, and other corporations to harness the vast potential of renewable energy.

PTC to build aerospace-grade Titanium Sponge manufacturing facility

Bhubaneswar, India: PTC Industries, a leader in advanced manufacturing and materials technology, has announced the signing of a Memorandum of Understanding (MoU) with the Government of Odisha for an intent to establish an aerospace-grade Titanium Sponge manufacturing facility in the state. This initiative will position PTC (and its subsidiary Aerolloy Technologies) as one of the very few companies in the world with an integrated Titanium manufacturing value chain - spanning from the production of Titanium Sponge, Titanium alloy ingots, forged billets, rolled bars, rods, sheets, plates, and precision castings.

Titanium Sponge is the fundamental raw material required for manufacturing Titanium alloys, which are indispensable in aerospace, defence, and advanced industrial sectors. At present, only a handful of countries, including the United States, Russia, Kazakhstan and Japan, have the capability to produce aerospace-grade Titanium Sponge. India, despite having the third-largest reserves of Titanium ore in the world, has long been dependent on foreign nations for the production of Titanium Sponge and its downstream aerospace-grade products. This places India at a significant strategic disadvantage, creating a dependency on international suppliers for critical defence and aerospace applications. With this initiative, PTC Industries and Aerolloy Technologies intend to place India in this elite

group, securing an uninterrupted domestic supply of this strategic material. With the establishment of a Titanium Sponge manufacturing capability, PTC Industries will move further towards its vision of Parity and global leadership in the production of critical metals and components for aerospace, defence, and high-performance industrial applications. The proposed establishment of the Titanium Sponge facility in Odisha aligns with the Government of India's Make in India and Aatmanirbhar Bharat initiatives, further solidifying India's position as a global hub for advanced materials manufacturing. The Government of Odisha has played a pivotal role in facilitating this strategic investment, offering a conducive industrial ecosystem, policy support, and infrastructure incentives. Odisha's rich natural resources, skilled workforce, and progressive policies have been instrumental in attracting high-value manufacturing projects such as this.

Speaking on the occasion, Sachin Agarwal, Chairman & Managing Director, PTC Industries, said, "This MoU signifies an important step towards strengthening India's Titanium industry. With Odisha's support and our technological expertise, we aim to build a fully integrated Titanium manufacturing ecosystem that can cater to the evolving needs of global aerospace and defence industries. We appreciate the proactive efforts of the Government of Odisha in facilitating this opportunity and look forward to exploring the potential of this investment."

JSW wins MDO contract for 2 copper mines

Mumbai, India: The USD24 billion JSW Group – one of India's fastest-growing conglomerates – has made a significant expansion into the mining of non-ferrous metals sector by winning the Mine Operator & Developer (MDO) contract of two blocks of copper mines in Jharkhand from the state-owned Hindustan Copper Limited (HCL).

The project involves operationalizing the two mines and setting up of a copper concentrator plant, with the total capital investment estimated to be ₹2,600 crore. On full-scale ramp up, the mines will have an ore capacity of 3 MTPA. The mines are expected to become part operational in the second half of financial year 2026-27 (H2 FY27).

The JSW Group secured the MDO contract through a competitive bidding process of the copper mines of HCL for 20 years and further extendable for next 10 years. Under the terms of the agreement, JSW will be responsible for the development of mines through capital expenditure and operational management including installation of concentrator plant of same capacity. In return, HCL will provide technical support and receive a percentage of the revenue generated.

Parth Jindal of JSW Group, said, "Venturing into non-ferrous metals, particularly copper, is a strategic move for the JSW Group. The increasing demand for copper in sectors such as electric vehicles (EVs), renewable energy infrastructure, construction, electronics, telecommunications and healthcare presents a significant opportunity. India is currently a major importer of copper concentrate; therefore, by developing domestic copper resources, we aim to support the country's industrial growth and reduce dependency on imports."

HMEL, Emerson to co-develop solutions for energy value chain optimization

Emerson and HMEL executives during signing of Memorandum of Understanding

Noida, India: HPCL-Mittal Energy Limited (HMEL), a leading India petrochemical and refining company, and Emerson, an industrial technology leader delivering advanced automation solutions, are joining forces to optimize enterprise operations across HMEL's refining, petrochemicals and sustainable fuels complex. The collaboration will leverage Emerson's industrial automation portfolio, including artificial intelligence and machine learning technologies, to enhance HMEL's production outputs while ensuring reliability,

safety and sustainability goals are met. HMEL is a digital-first organization, operating one of the most modern Integrated Refinery-Petrochemical Complex 'Guru Gobind Singh Refinery' at Bathinda, Punjab. Emerson will provide a real-time industrial data platform to bridge the gap between industrial OT and enterprise IT environments, providing connectivity and contextualization to operational data from multiple sources. It will also provide AspenTech's multi-unit dynamic optimization solutions to help improve margins and achieve sustainability goals by integrating planning, scheduling and advanced process control in a closed loop and by end-to-end demand forecasting, planning and scheduling across the oil-to-chemical value chain. The collaboration also includes Emerson's DeltaV™ control system, latest measurement offerings and pioneering electronic marshalling technology. "Process automation has been at the heart of HMEL's strategic vision for building a smart enterprise. We are thrilled to partner with Emerson to develop innovative automation solutions that will boost digital transformation at HMEL," said Mr. Prabh Das, MD & CEO, HMEL. "Our partnership with Emerson aligns with our mission to create an interconnected and intelligent enterprise that delivers maximum value across the energy value chain." The two companies signed the Memorandum of Understanding during India Energy Week 2025 in New Delhi. Prabh Das, MD & CEO, HMEL and Roel Van Doren, Group President, Emerson were present during the signing ceremony by Mr. Manu Sehgal, VP – Strategy and Feedstock Supply Group, HMEL and Anil Bhatia, Vice President and Managing Director of Emerson India, along with senior members from both the companies.

PCBL Chemical to set up acetylene black plant in India

Kolkata, West Bengal: PCBL Chemical Limited has signed a technology transfer agreement with Chinese company Ningxia Jinhua Chemical Co. to produce acetylene black in India. Acetylene black is a high-end conductive grade chemical with applications in high voltage power cables, Li Ion batteries, EV charging, semiconductor packaging and conductive plastics, paints and coatings applications. PCBL is planning to set up its 1st acetylene black plant in India to meet the fast-growing demand of Indian Battery industry and export to the global battery, semiconductor and conductive markets. PCBL has recently set up a Joint Venture company, Nanovace Technologies Ltd to develop nano-silicon products to be used in anodes of Li-Ion batteries. The pilot plant at PCBL Palej site will be ready in the next few months.

Lanxess inaugurates India Application Development Center

Lanxess India Application Development Center

Mumbai, Maharashtra: German specialty chemicals company Lanxess has inaugurated its India Application Development Center (IADC) in Thane, Mumbai, strengthening its innovation and customer service capabilities.

The IADC underscores LANXESS' strategic focus on India as a key market and innovation hub, enhancing the company's ability to deliver high-value, specialized solutions tailored to local needs. In a first step, it integrates expertise from two key businesses in India: Lubricant Additives (high-performance additives and additive systems, synthetic base fluids and ready-to-use lubricants) and Material Protection Products (antimicrobial, disinfection, and preservation solutions). Customers will for example benefit from advanced studies of friction and wear of lubricants, the synthesis and testing of new materials and the evaluation of the antimicrobial performance of paints, emulsions, and other water-based chemistries. ■

Support for the 'Make in India' initiative to empower domestic manufacturers

Mr. Anand V S,
Managing Director, NOCIL Limited

"With the Union Budget 2025-26, the Indian government has reaffirmed its commitment to simplify and enhance the ease of doing business this is expected to have a positive impact on attracting investments. The emphasis on infrastructure development, with an allocation exceeding ₹11 lakh crore, will significantly enhance supply chain resilience and the growth of direct and indirect sectors.

A strong push on the demand side through the personal income tax changes in a fiscally responsible manner is expected to boost consumption and is expected to have a positive impact for rubber chemicals.

Support for the 'Make in India' initiative will empower domestic manufacturers to increase their market share and export potential, helping to position India as a global leader in chemicals. Overall, these measures are expected to drive growth in the sector and contribute positively to India's economic goals."

A strong foundation for sustained economic expansion, energy security & industrial development

Dr. Kapil Garg, Managing Director, Asian Energy Services Limited

"We applaud the Government and Hon'ble Finance Minister, Smt. Nirmala Sitharaman on presenting a favourable budget for the manufacturing and infrastructure segment. The announcement to invest in urea production capacity in Namrup, Assam is an excellent move since Assam's abundant natural gas resources will not only benefit Oilmax in the long term but also open up significant natural gas demand in the region. This strategic initiative aligns with the government's broader vision to drive industrial growth in eastern India while bolstering self-reliance in fertilizer production.

The budget's robust focus on expanding waterway and canal infrastructure is set to transform industrial logistics, particularly for sectors like oil, gas, and petrochemicals. The creation of a substantial Maritime Development Fund and the expansion of regional connectivity through enhanced schemes will further streamline transport and trade, integrating remote areas into the national economy.

Key duty exemptions on critical minerals such as cobalt, lithium-ion battery scrap, lead, and zinc are poised to strengthen domestic manufacturing. The allocation for research, development, and innovation will accelerate advancements in energy efficiency aims to secure long-term energy stability.

The policies should attract private sector participation and foreign direct investment in energy projects, will enhance India's energy security and reduce import dependency.

Furthermore, the reduction in income taxes and the rationalization of TCS and tax exemptions are expected to boost household spending power, fueling broader economic demand. Power sector reforms that incentivize improved electricity distribution and intrastate transmission capacity will further ensure a stable and efficient energy supply. The substantial provision of interest-free loans to states for capital expenditure underscores a strong commitment to long-term infrastructure development.

For MSMEs, increased investment and turnover limits will empower small and medium enterprises to scale up, innovate, and expand their global competitiveness, especially as they contribute significantly to India's exports. Mining sector reforms, along with policies for recovering critical minerals from tailings, will further reinforce resource independence.

By promoting energy storage, grid modernization, and expanding strategic oil reserves, the government is laying the groundwork for a resilient, diversified energy mix. Export incentives and policy measures to integrate India into global energy markets will further enhance the country's positioning as a key player in the sector.

Overall, this budget lays a strong foundation for

sustained economic expansion, energy security, and industrial development. It creates a growth-oriented policy framework that will generate long-term value for industries such as oil, gas, and energy, while driving India's journey toward a more self-reliant and sustainable future."

A Strategic Step to Viksit Bharat, with Growth & Fiscal Balance

Vishal Sharma, Executive Director and Chief Executive Officer, Godrej Industries (Chemicals)

"In our journey to Viksit Bharat, the budget proposals announced today effectively triggers domestic consumption, production, and capability development across both urban and rural sectors. The focus on enhancing agricultural productivity and targeted support for specific cash crops will significantly boost farming incomes. Combined with tax slab modifications at the lower end, the resulting increase in spending power of the consumers will be highly impactful.

The nuanced credit facilities for the MSME sector, along with the emphasis on enhanced upskilling opportunities for the young workforce, have the potential to be game-changers. Strengthened education facilities from high school onwards are a vital step toward building a capable and future-ready population.

While more could have been done on customs duty rationalization and funding for technology and R&D, the controlled fiscal deficit target of 4.4% reflects a balanced approach. With strong execution and efficient delivery of programs, our GDP growth target of 6.5-7% is well within reach—and with some luck, perhaps even higher."

The strategic approach fosters a pro-business environment

"The Union Budget 2025, with its emphasis on inclusive development, accelerated growth, and private sector investments, marks a pivotal moment in strengthening India's industrial and economic foundation. The rationalization of customs tariffs will enhance India's global competitiveness, particularly benefiting manufacturers, while the focus on MSMEs—crucial contributors to India's GDP and exports—will empower them to diversify offerings and expand internationally. The strategic and forward-thinking approach fosters a pro-business environment that encourages both FDI and domestic investment.

Mr. S Sunil Kumar, Country President, Henkel Adhesive Technologies India

The ambitious 100 GW nuclear target represents a bold commitment to sustainable growth, driving investments in infrastructure, technology, and human capital, while positioning India as a leader in clean energy on the global stage. Honourable Finance Minister Nirmala Sitharaman has also emphasized the government's commitment to strengthening the domestic electronics equipment industry, creating significant opportunities for youth. The government's emphasis on skill development across industries, particularly in the nuclear and footwear sectors, will not only create thousands of jobs but will also build a robust workforce prepared to meet future challenges. With the footwear sector alone employing over 4 million people, the focused scheme will drive significant job creation and enhance India's position in the global supply chain. Lastly, the restructuring of income tax slabs will enhance disposable income, providing greater purchasing power to consumers. By directly benefiting the middle class, this policy will act as a catalyst for broader consumption, supporting businesses and driving momentum across key sectors."

Budget reinforces India's commitment to a sustainable future

Ms. Tanya Singhal, Industry expert in Renewable Energy, Founder of Mynzo Carbon & SolarArise

"The 2025 Union Budget reinforces India's commitment to a sustainable future by fostering clean tech manufacturing, expanding nuclear energy capacity, and investing in renewable energy solutions. Initiatives to boost domestic production of solar PV cells, EV batteries, and electrolyzers

will accelerate our transition to a net-zero economy. The announcement of a Nuclear Energy Mission and support for Small Modular Reactors mark a bold step towards energy security and decarbonization."

Budget 2025 will strengthen India's manufacturing & energy transformation

Dr. Bijal Sanghvi, Managing Director, Axis Solutions

"Union Budget 2025 will drive and strengthen India's manufacturing and energy transformation with a strong push for "Make in India". Targeting 100 GW of nuclear energy by 2047 is a welcome move for a sustainable future. With a ₹20,000 crore outlay for small modular reactors in Nuclear Power, the budget accelerates clean energy adoption. Power sector reforms, export promotion, and policy incentives will strengthen industrial growth, ensuring Atma-Nirbharta, innovation, energy security and transition. Investing in people through skill development programme will build a future-ready workforce, positioning India as a global power- house in manufacturing, sustainability, and technological advancement."

A significant boost to the country's recycling industry

Mr. Makarand Kulkarni, CEO, revalyu Resources

"We are very thrilled to see that the government has demonstrated its commitment to climate-friendly development in the country through the establishment of National Manufacturing Mission, which will also support Clean Tech manufacturing in the country. This initiative will strengthened the domestic value addition, while fostering a robust ecosystem for key sustainable technologies, including solar PV cells, EV batteries, motors and controllers, electrolyzers, wind turbines, high-voltage transmission equipment, and grid-scale batteries. Additionally, the government's move to incentivizing urban sector reforms related to governance, municipal services, urban land, and planning will provide a significant boost to the country's recycling industry, driving sustainable growth and resource efficiency."

Renewed focus on manufacturing marks a transformative shift

Mr. Sanjay Choudhari, Chairman, SBL Energy Limited

"The government's renewed focus on manufacturing and energy security marks a transformative shift for India's industrial landscape. The National Manufacturing Mission under the Make in India initiative is a timely and much-needed move that will strengthen small, medium, and large industries. We see this as a crucial step toward building a robust supply chain for mining and infrastructure, enhancing domestic production of critical materials, and reducing import dependency.

The Nuclear Energy Mission, with its ambitious target of 100 GW capacity by 2047, is a bold move toward energy transition. The ₹20,000 crore investment in small modular reactor R&D and incentives for capacity augmentation will create opportunities for energy-intensive industries, including mining and explosives. Reliable and scalable power sources are fundamental to driving industrial growth, and this initiative is a step in the right direction. At SBL Energy, we are optimistic about these developments and look forward to leveraging these opportunities to contribute to India's self-reliance in mining, energy, and industrial explosives."

Budget reinforces India's position as a global manufacturing and export hub

Ms. Smitha Shetty - Regional Director APAC - Achilles Information Ltd

"Achilles welcomes the Indian government's FY25 budget, which reinforces India's position as a global manufacturing and export hub. Increased MSME credit limits and expanded classification will drive industrial growth, job creation, and innovation. Investments in clean technology manufacturing — solar, EV batteries, and wind turbines — mirror global sustainability trends, strengthening supply chains. Maritime and shipping sector incentives will enhance trade competitiveness. However, robust supply chain due diligence and ESG compliance are vital to mitigate risks. While this budget lays a strong foundation, its execution will determine India's success in becoming a self-reliant, globally competitive manufacturing powerhouse."

A balanced approach to strengthening India's energy sector

Mr. Rakesh K. Jha, Partner, Energy Sector Solutions, Sustainability and ESG, BDO India

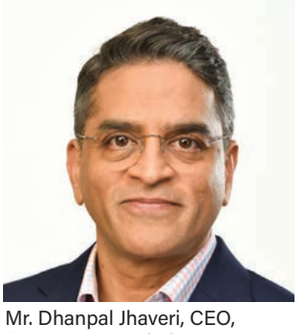
"The Union Budget 2025 takes a balanced approach to strengthening India's energy sector by addressing financial, infrastructure, and manufacturing challenges. It prioritizes DISCOM reforms, transmission expansion, and renewable energy growth while reducing costs for solar and battery storage through lower duties and enhanced PLI incentives. The focus on green hydrogen, nuclear energy, and domestic manufacturing signals a long-term vision for energy security and self-reliance. While these measures create a strong foundation for India's clean energy transition, their success will depend on effective implementation, regulatory clarity, and sustained financial support to ensure long-term impact."

A significant step toward strengthening India's technological landscape

Mr. Gaurav Sahay, Practice Head - Technology & General Corporate, Fox Mandal & Associates LLP

"The Union Budget 2025-26 takes a significant step toward strengthening India's technological landscape by prioritizing AI, deep tech, and digital education. The establishment of AI Centers of Excellence, alongside the expansion of IITs, will foster a robust ecosystem for innovation and skill development. Additionally, the government's focus on supporting deep tech startups through dedicated funding will accelerate advancements in AI, blockchain, and clean energy. These initiatives reaffirm India's commitment to becoming a global leader in emerging technologies, driving both economic growth and digital transformation. The Government should look at gaining an AI sovereignty as against US and China already present there."

Proposals emphasize the government's commitment to fostering sustainable growth



Mr. Dhanpal Jhaveri, CEO, Eversource Capital

"The Union Budget is a critical blueprint for India's future, and this year's proposals emphasize the government's commitment to fostering sustainable growth and boosting foreign investment. With an increased focus on green finance, infrastructure, and digital innovation, including a 33% increase in budget allocation for infrastructure development to INR 10 lakh crore, the budget aligns with Eversource Capital's vision of driving impactful investments that contribute to both economic and environmental well-being. We are optimistic that these initiatives will create a conducive environment for greater private sector participation and elevate India's position as a global leader in sustainable development, especially with the green finance market expected to grow at a CAGR of 24% over the next 5 years."

Increased infrastructure will directly allow steel sector to increase production output

Mr. Brij Bhushan Agarwal, Vice Chairman and Managing Director, Shyam Metalics

"As Budget 2025 plans revolve around national growth and getting new opportunities, it brings new initiatives like The National Manufacturing Mission while greatly focusing on the Public-Private Partnerships (PPP). Similarly, it aims to strengthen the manufacturing section of India, thus improving policies with the help of governance systems, making sure 'Make in India' remains a priority. Public-Private Partnership on the other hand aims to use the expertise and spending of the private sector in society's benefit by quickening the construction of major projects like roads, bridges and urban development areas.

This plan will not only attract investment and increase the demand for steel which plays an imperative role in infrastructure development, but will also increase the industrial activity in the region. In order to attain the set future vision, The Steel sector needs to evolve towards safer and more advanced methods of production. Increased infrastructure will directly allow the steel sector to increase its production output. These changes will enhance the economy of India, along with making the country more competitive on an international scale."

Budget 2025 significantly advances India's renewable energy sector

Mr. Shekhar Singal, Managing Director, Eastman Auto & Power Ltd

"The Union Budget 2025 significantly advances India's renewable energy sector with the launch of the Clean Tech Mission, focusing on Solar PV, EVs, and Batteries, alongside the National Manufacturing Mission. The announcements underscore the government's dedication to strengthening 'Make in India' and becoming Aatmanirbhar in generation as well as storage of clean energy. This approach aims to reduce import reliance and build a robust domestic industry.

From a Solar and Last Mile e-mobility category perspective, the budget with reduction in the BCD for cells and modules prioritizes scaling up of the domestic manufacturing capacities for key components for Solar. The addition of 35 capital goods related to Lithium batteries for EV reduces capital expenditure for setting up manufacturing plants thereby stimulating growth.

These strategic measures set India on a path to achieve its 500 GW renewable energy target by 2030, paving the way for energy independence and a cleaner more sustainable future."

Budget 2025 prioritizes India's infrastructure and manufacturing sectors

Nikhil Mansukhani, Managing Director, Man Industries Ltd. (Steel Pipes)

"The Union Budget 2025 prioritizes India's infrastructure and manufacturing sectors with strategic initiatives like the National Manufacturing Mission and 'Make in India,' aimed at enhancing domestic production capabilities. The ₹1.5 lakh crore interest-free loan for infrastructure and PPP projects will improve logistics, reduce bottlenecks, and boost multimodal connectivity, which is crucial for industries such as steel, oil & gas, and heavy engineering.

The introduction of Bharat Trade Net and easier export credit access will streamline international trade, making Indian manufacturers more competitive in global supply chains. However, to fully capitalize on these opportunities, it is essential to ensure faster execution, sector-specific incentives, and continuous policy support. With India's manufacturing sector set to contribute 25% of GDP by 2030, these initiatives are key to driving long-term growth and positioning India as a global manufacturing leader." ■

Future of Chemical Recycling: Innovative Potential of Glycolysis Technology

Dr. Vivek Tandon
Founder
Revalyu Resources

Dr. Ajay Amrutkar
Assistant General Manager - Research and Innovation
Revalyu India

Chemical recycling of Polyethylene Terephthalate has emerged as a pivotal method for generating recycled PET (rPET) for various applications including food-contact and non-food contact applications (textiles). Various chemical recycling methods studied include, glycolysis, methanolysis, hydrolysis, aminolysis and enzyme-assisted. As early as 2004, Revalyu Recycling India Limited pioneered the use of glycolysis as the preferred approach for further innovation and large-scale adoption of chemical recycling of PET.

Chemical recycling of polymers can be simply defined as a process consisting of a sequence of:

- De-polymerization of polymer to generate an intermediate,
- Purification of intermediate to remove non-desired molecules and
- Re-polymerization of intermediate to obtain recycled polymer.

Chemical recycling of Polyethylene Terephthalate (PET) has emerged as a pivotal method for generating recycled PET (rPET) for various applications including food-contact and non-food contact applications (textiles). Removal of non-PET molecules present in the PET waste stream and certain volatiles formed during recycling is essential to meet the stringent standards, especially for food-contact applications. Chemical recycling, by its very virtue, offers an ability to efficiently separate non-PET molecules and provide an access to high purity rPET which can be used as a direct substitution for conventional PET made from fossil fuels.

Polyethylene Terephthalate (PET) flakes

Various chemical recycling methods studied include, glycolysis, methanolysis, hydrolysis, aminolysis and enzyme-assisted. Most of these methods have been performed on a lab-scale while a few have been attempted on pilot or large scale. Each of the methods differ in:

- The reactants, catalysts, conditions, and reactors needed for de-polymerization reaction
- Purification methods needed to obtain high purity monomers or intermediates (and rPET subsequently)
- Recovery and reuse of reactants and catalysts
- Environmental impact of the process
- Overall cost

Amongst these various de-polymerization methods, glycolysis stands out as it can be performed with relatively milder reactants and conditions. The overall environmental impact of the process and costs are lower. As early as 2004, Revalyu Recycling India Limited (erstwhile Polygenta Technologies Limited) pioneered the use of glycolysis as the preferred approach for further innovation and large-scale adoption of chemical recycling of PET.

Innovation and Growth of Glycolysis of PET

The scientific literature has extensively reported glycolysis of PET based on lab-scale experiments. While the studies were useful, revalyu determined that glycolysis was one of the few depolymerisations technology which could offer quality, cost and easy scalability allowing it to compete head to head (and eventually replace) conventional fossil manufactured PET. Large-scale adoption would require solving key challenges while ensuring a delicate balance between cost, quality, scale, and environmental impact. The pioneering innovations that revalyu developed over the years are:

Glycolysis Process Optimization: Our Process Innovation Team developed a unique reactor design and process conditions that enabled us to perform glycolysis with substantially less glycol than typically reported in the literature. While the lower glycol usage is a significant achievement in itself, another ground-breaking innovation developed by revalyu team is that the glycolysis is performed without any catalyst and at atmospheric pressures. Less glycol, no catalyst and atmospheric pressure conditions have enabled us to obtain depolymerized intermediate with lower amounts of energy, providing significant positives to the environmental impact of the process. The process is simple and scalable as it involves only two raw materials: PET waste and glycol.

Development of suitable and scalable purification methods: The success of recycling lies in the closeness of quality between recycled polymer and virgin polymer. This in-turn depends on ability to remove non-desired molecules (contaminants). PET waste comes with a variety of non-PET molecules (PVC, BoPP, BoPET, adhesive, inks, process aids, dyes, pigments, metals, dirt, etc). A single purification method is not sufficient to remove these various contaminants. Revalyu developed suitable purification methods at various locations along its chemical recycling process to remove specific set of contaminants in each method. This customized and contaminant-centric approach enabled removal of most of the contaminants in a cost-effective manner enabling access to high purity rPET.

Recovery and reuse of glycol: The glycol used to de-polymerize PET is generated as a by-product in the re-polymerization step (condensation polymerization) of chemical recycling. Revalyu's proprietary innovation of performing glycolysis with small amounts of glycol provided an opportunity to design systems capable

revalyu's glycolysis recycling plant in Nashik, India.

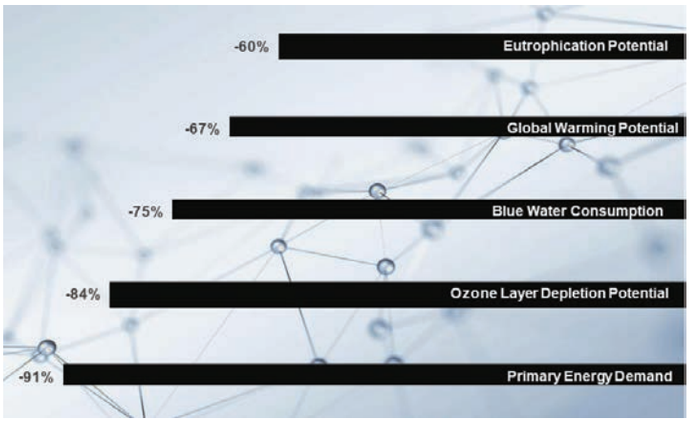


Figure 1: Life Cycle Analysis (LCA) of revalyu process (performed in 2018) through independent third party due diligence

of recovering glycol. Our Process Innovation Team designed effective unit operations to recover, purify and reuse ≥ 96 per cent of the glycol used in the process. This 'closed-loop usage of glycol' enables us to perform chemical recycling with lower energy and raw material usages ultimately leading to positive impact on environmental parameters and cost.

These strategic innovations and process optimizations were a result of development of deeper understanding of glycolysis process, stepwise evaluation from lab-scale to pilot-scale to large-scale, leveraging simulation tools for better design and thorough analytical characterization of various intermediates.

The new knowledge generated as a result of years of R&D set the foundation for our capacity expansion.

De-bottlenecking Unit Operations: A critical aspect of our capacity enhancement involved de-bottlenecking various unit operations within our chemical recycling process. This included optimizing operations such as separation, mixing, and conversion. These improvements have been instrumental in incrementally increasing our plant's capacity from an initial 12 TPD (tons per day) to 20 TPD, then to 27 TPD, 35 TPD, and ultimately reaching 120 TPD. 0ur site in Nashik, India has a total production capacity of over 280 tonnes per day.

Scale-Up with Advanced Simulations: Leveraging advanced simulation methodologies, we have rigorously tested every single step of our recycling process. These simulations demonstrated the feasibility of scaling our operations up to an impressive 120 TPD. We started an ambitious project of designing and setting up two plants of 120 TPD each in Nashik, India in the year 2022. Successful commissioning and production of high purity rPET at 120 TPD in September 2024 has proved the scalability of revalyu's process paving the way for future growth and enhanced sustainability.

Key Value Propositions of Chemical Recycling Process

Versatility to the Plastic Waste Feedstock: PET is a widely used plastic in a broad range of everyday articles such as bottles, textiles, and films. Revalyu's process of controlled de-polymerization complemented with suitable purification methods provides an opportunity to recycle the PET waste of variety of forms such as bottles, textiles, and films.

Broader and Customized Product Offerings: The monomeric-intermediate generated by the controlled de-polymerization step provides a platform to produce materials for variety of applications. For example, the re-polymerization step performed on the purified intermediate is a typical condensation polymerization and once repolymerised the product can be used as a direct replacement of fossil based PET. This customization capability allows revalyu to meet diverse market needs of rPET. This enables revalyu to practice 'circularity' and 'sustainability' at scale.

Positive LCA Metrics: Life Cycle Analysis (LCA) of revalyu's innovative chemical recycling process demonstrated significantly positive environmental impact of the process. Figure 1 below shows significant reduction in all the key LCA metrics achieved with revalyu process.

revalyu's rPET-based products are low carbon footprint materials that enable organizations in the polymer and material science domain achieve their environmental and sustainability goals (ESG) in a reliable and cost-effective manner. ■

revalyu Resources plant in Nashik, India.

Alleima Sanicro® 35: Improving Productivity & Safety at an Indian Refinery

Materials innovations have been one of the key enabling factors in technological advancements in all industries. Refinery and Petrochemical complexes are one such area where materials have enabled the implementation of more efficient processes over the last several decades. This case study describes one such example where Alleima's award-winning material innovation – Sanicro® 35, a super-austenitic stainless steel, ensured safe and uninterrupted operations by reducing production downtime in a hydrogen generation unit at an Indian refinery.

Hydrogen is one of the most important molecules in refineries and enables increased efficiency, improved product quality, and reduced emissions. Hydrogen is used in hydrocracking, catalytic reforming, hydrotreating, desulfurization, etc. These processes convert low-value feedstocks, such as heavy crude oils and residues, into high-value products. This means that hydrogen generation is a crucial process in refineries, and any disruption in a Hydrogen Generation Unit (HGU) can have cascading effects on several other processes in a refinery, causing significant operational delays, reduced production efficiency, and potential financial losses. Ensuring a reliable and efficient hydrogen generation process is therefore critical to maintaining refinery performance and meeting market demands.

A few years ago, an Indian refinery enhanced the capacity of its HGU to meet the increased demand for hydrogen. However, this expansion led to a higher heat load on the parallel heat exchangers, which used seawater to cool the syngas. Consequently, the heat exchanger tubes, made of Alloy 400, began experiencing frequent leakages. Following the HGU revamp, operations were disrupted multiple times, with 16 tube leakage incidents reported between 2021 and 2023. A failure investigation revealed that the Alloy 400 tubes failed due to the under-deposit pitting corrosion (as seen in Figure 1) on the tube's inner surface exposed to seawater. The root causes of failures were identified as higher shell side temperature of 80-90°C and low cooling water velocity.

Figure 1: Inner surface of the failed Alloy 400 tubes showing pits and thick greenish scale

During one of the retubing requirements, the refinery faced challenges due to the exponential rise in nickel prices, making it impossible to source for Alloy 400

Figure 2a: Super duplex stainless steel tubes failed prematurely by pitting corrosion

tubes. As a temporary fix, super duplex stainless steel tubes (not supplied by Alleima) available in the

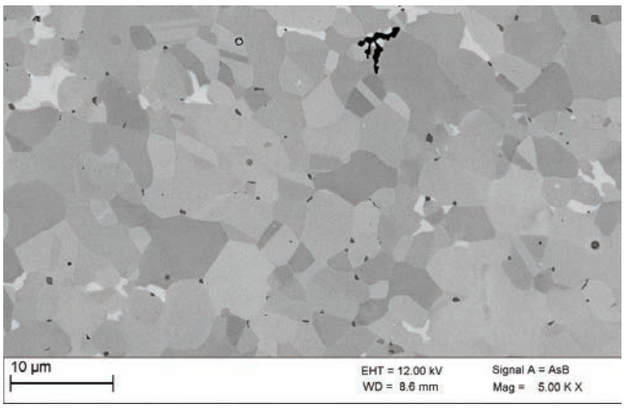


Figure 2b: Microstructure showed the presence of undesired intermetallic sigma phase (bright) and sub-micron-sized Chromium nitrides (dark). The initiation of corrosion can be seen in the microstructure.

refinery's stock were installed to keep the exchanger operational. However, these tubes unexpectedly failed within just four months of installation. While super duplex stainless steel is a borderline choice for such process conditions, failure this early was unexpected.

An investigation of these tubes was conducted at Alleima R&D in Pune, India, and revealed that these tubes failed by pitting corrosion, driven by the presence of undesired intermetallic sigma phase and chromium nitrides. The microstructure of duplex stainless steel alloys should ideally contain approximately 50 per cent ferrite and 50 per cent austenite phases. The presence of sigma phase and chromium nitrides is a manufacturing defect. The failure occurred due to inadequate process control during production and poor quality assurance, as basic corrosion tests should have detected this issue. This episode highlights the importance of selecting a reliable tube manufacturer.

After carefully evaluating the failure mechanism of Alloy 400 tubes and the associated process conditions, Alleima recommended Sanicro® 35 for this application. Sanicro® 35 is a super austenitic stainless steel developed for extremely corrosive environments.

The Pitting Resistance Equivalent number (PRE), calculated as PRE = %Cr + 3.3%Mo + 16%N, is an empirical measure to rank the corrosion resistance of steels against pitting in chloride-bearing environments. Sanicro® 35, with its high levels of Cr, Mo and N in achieves a remarkably high PRE value of 52. This high

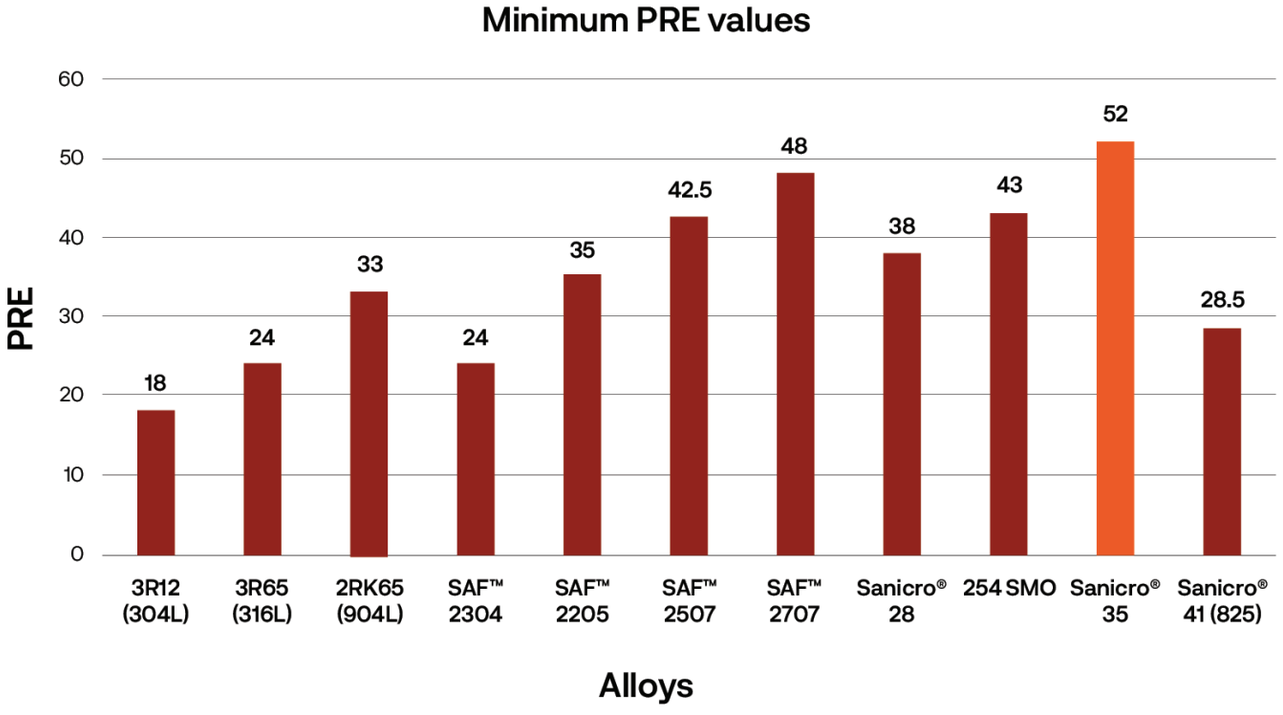


Figure 3: Comparing minimum PRE values across alloys.

C	Mn	P	S	Si	Cr	Ni	Mo	Cu	N	Fe
0.030	1.2	0.030	0.020	0.5	27	35	6.5	0.4	0.3	Remainder

Table 1: Sanicro® 35's chemical composition (nominal) %

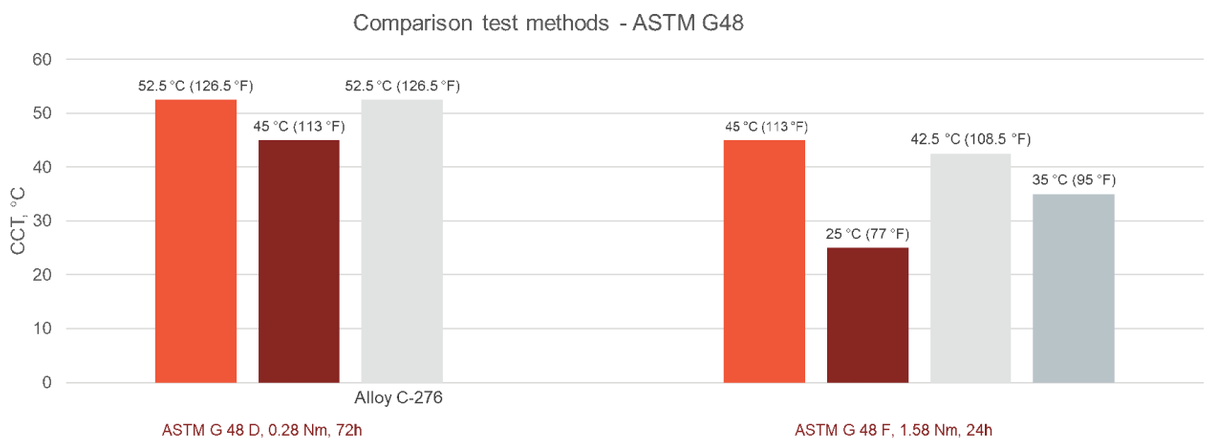


Figure 4: Comparative corrosion test results (ASTM G48).

	Sanicro® 35		Alloy 625	
Seawater condition	**Pitting**	**Crevice**	**Pitting**	**Crevice**
30 °C Natural	Passed	Passed	Passed	**Corrosion**
45 °C Chlorinated (0.5 ppm Cl)	Passed	Passed	Passed	Passed
80 °C Chlorinated (0.5 ppm Cl)	Passed	NO TEST	Passed	NO TEST

Table 2: Seawater corrosion test results.

PRE value signifies exceptional resistance to pitting corrosion resistance.

Figure 3 shows that Sanicro® 35 has the highest PRE value compared to the commonly used stainless steel, highlighting its superior performance in demanding conditions.

The empirical comparison of PRE translates into the experimentally measured Critical Crevice Corrosion Temperature (CCT) data for key alloys. CCT is the temperature above which an alloy has a risk of crevice corrosion under standardized testing conditions. The experimental data shows that Sanicro® 35 performs at least at par with C-276 and outperforms Alloy 625 and 254SMO. This underscores Sanicro® 35's exceptional performance-to-cost ratio compared to higher-cost nickel alloys.

The other direct and more conclusive data supporting the suitability of Sanicro® 35 for this application comes from the corrosion testing conducted in actual seawater. Table 2 presents the corrosion test results of Sanicro® 35 compared with Alloy 625 in seawater under various conditions. Chlorine dosing is used to counteract the harmful corrosive effects of microbiological activity in seawater, which results in bio-fouling.

Based on the above test results, Sanicro® 35 was selected as the construction material for the HGU process gas cooler tubes. One of the two heat exchangers with Sanicro® 35 tubes was installed in June 2023 and has been operating safely and uninterrupted for 1.5 years. Because of this grade change, the refinery has estimated a lifecycle cost saving of more than ~ ₹20 crores, excluding the maintenance man-hours. The upgrade of tubes in the second heat exchanger is expected to take place soon. ■

Author

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Alleima

Mettler Toledo TGA 2: A Cutting-Edge Thermogravimetric Analysis Tool

Thermogravimetry (TGA) is an essential analytical technique used to study the thermal properties of materials by measuring their weight changes in response to temperature variations. The Mettler Toledo TGA 2 stands out in the field, offering fast and accurate results tailored to a diverse array of applications in industries ranging from plastics and pharmaceuticals to ceramics and building materials

Key Features and Benefits of TGA 2

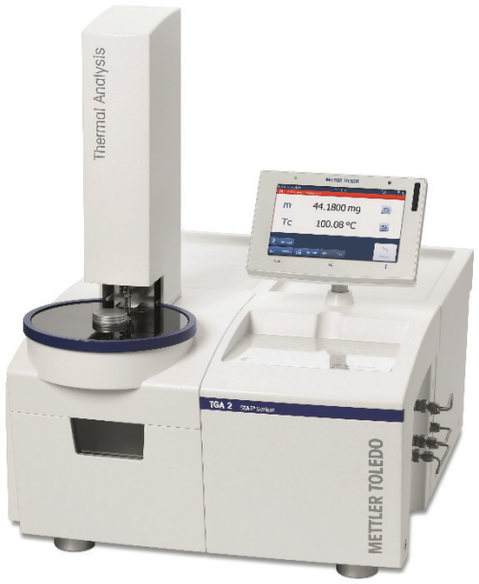
The TGA 2 is equipped with an ultra-micro balance that reflects Mettler Toledo's leadership in balance technology. Its ability to measure very low minimum weights on 5-gram balances ensures precise and accurate sample characterization, enhanced by high resolution that allows for sub-microgram measurements across its entire weighing range.

One of the hallmark features of the TGA 2 is its robust, factory endurance-tested sample robot, designed for efficient and reliable operation around the clock. With the convenience of OneClick™ functionality, users can initiate experiments quickly and simply, streamlining routine operations. The built-in gas flow control allows for sample analysis in controlled atmospheres, while automatic buoyancy compensation accelerates the path to accurate results.

The TGA 2 also features a modular design, protecting your investment by adapting to both current and future analytical needs. Moreover, Mettler Toledo offers comprehensive support services, ensuring users have access to professional assistance whenever needed.

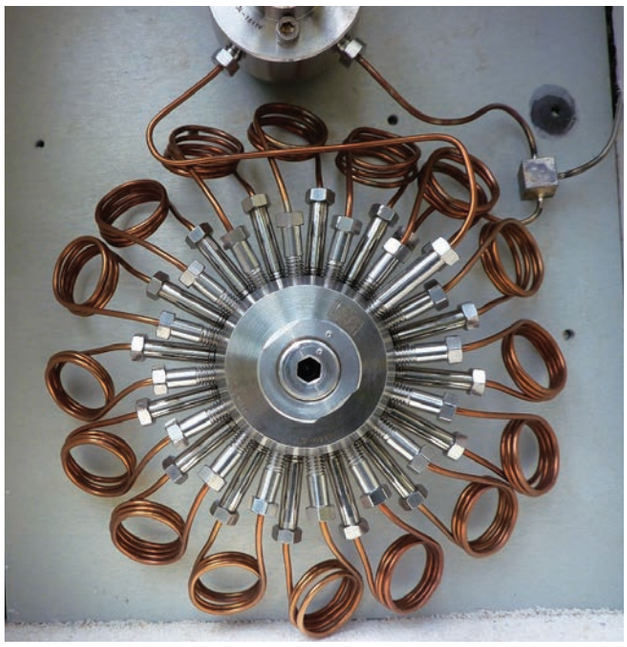
Reliable Automation: A Year-Round Workhorse

Incorporating sophisticated automation capabilities, the TGA 2's sample robot ensures reliable operation 24 hours a day. Coupled with STARe software, the automation is enhanced by the unique FlexCal™ calibration concept, which selects the appropriate adjustment parameters automatically, and facilitates result evaluation without manual intervention.



The design includes a unique feature that eliminates weight changes before measurement. The sample robot can efficiently remove the protective crucible lid or pierce hermetically sealed aluminum crucibles just prior to measurement, minimizing potential mass changes. This ensures that the integrity of the sample is maintained throughout the entire analytical process.

The TGA 2 accommodates a wide range of crucibles, made from various materials and available in volumes from 20 to 900 µL, providing versatility for different applications.



Hyphenated Techniques: Enhanced Insights from Every Experiment

To gain deeper insights into material properties, the TGA 2 can be coupled with a variety of instruments, including humidity generators, mass spectrometers, FTIR spectrometers, and GC/MS systems. This hyphenation capability allows for simultaneous TGA-EGA analysis, enabling quantitative compositional analysis and material identification all in a single run.

With reference databases available, users can readily identify gaseous decomposition products, offering a more comprehensive understanding of the thermal events occurring within the sample.

A Versatile Tool for Diverse Applications

The TGA 2 is designed to operate over an extensive temperature range — up to 1100°C — making it an exceptionally versatile tool for characterizing physical and chemical properties of materials. By leveraging Mettler Toledo's leading micro and ultra-micro balances, the TGA 2 provides rapid and reliable data essential for research, development, and quality control across numerous industries, including:

- **Plastics:** Evaluating polymer content and thermal stability.
- **Building Materials:** Assessing moisture and filler content.
- **Minerals:** Investigating thermal decomposition processes.
- **Pharmaceuticals:** Analyzing oxidation stability and solvent identification.
- **Foodstuffs:** Determining moisture content and thermal properties.

Conclusion

The Mettler Toledo TGA 2 is an invaluable asset for laboratories seeking to enhance their analytical capabilities. With its fast and accurate results, reliable automation, and versatility across various applications, it plays a crucial role in advancing research and quality control efforts in diverse fields. Whether you are exploring the thermal properties of a new polymer or ensuring the quality of a pharmaceutical product, the TGA 2 is equipped to deliver insightful data that drives innovation and ensures quality.

About Mettler Toledo

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. ■

For more information
https://www.mt.com/us/en/home/products/Laboratory_Analytics_Browse/TA_Family_Browse/ta-instruments/thermal-analysis-system-TGA-2.html

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Sustainable Energy – Reducing CO_2 Emissions in LNG Plants

Liquefied Natural Gas (LNG) offers a transitional solution to cleaner energy amidst the shift towards net zero carbon emissions. While LNG is cleaner than coal or oil, CO_2 emissions from its production must be mitigated. **Prakash Ray, Engineering Group Supervisor – Process and Aruna Vaidya, Deputy Project Manager, Bechtel,** present a promising avenue for reducing carbon capture from gas turbine exhaust, essential for achieving net zero targets by 2050.

Liquefied Natural Gas (LNG) and its Importance to Net Zero

Natural gas is a 'traditional' source of energy that is already used for a range of functions, from heating our homes and businesses to cooking and transport. But the fact that it's a fossil fuel means there's a limit to how long we can continue to rely on it. As the world moves towards net zero carbon emissions and renewable energy sources, LNG may be the 'clean' fossil fuel that's best-placed to help transition to a carbon-free future. LNG is created by transforming natural gas into a liquid state, by cooling it to -161oC (-259 0F). The process reduces it to 1/600th of its original un-liquified volume and to half the weight of water. LNG produces 40% less carbon dioxide (CO_2) than coal and 30% less than oil, which makes it the cleanest of the fossil fuel. It does not emit soot, dust or particulates and produces insignificant amounts of Sulphur dioxide, mercury and other compounds considered harmful to the earth's atmosphere. Clear, odorless, and colorless, LNG is typically 85 to 95% methane, which contains less carbon than other forms of fossil fuels. It also contains tiny amounts of ethane, propane, butane and nitrogen; the exact composition varying depending on its source and processing.

Source of CO_2 Emission in LNG Plant:

A series of LNG plants were built around the world in the 1960s and 1970s. Many of these plants, especially larger ones (1 MTPA and above), use gas turbines for the refrigeration compressors in the liquefaction process. While LNG is a cleaner energy alternative, LNG production process can still create emissions from fuel gas combustion, flaring and venting, fugitive emissions and plant upsets. This creates multiple sources of greenhouse gas emissions in the LNG production chain. CO_2 emissions at an LNG liquefaction facility can be categorized into two primary sources:

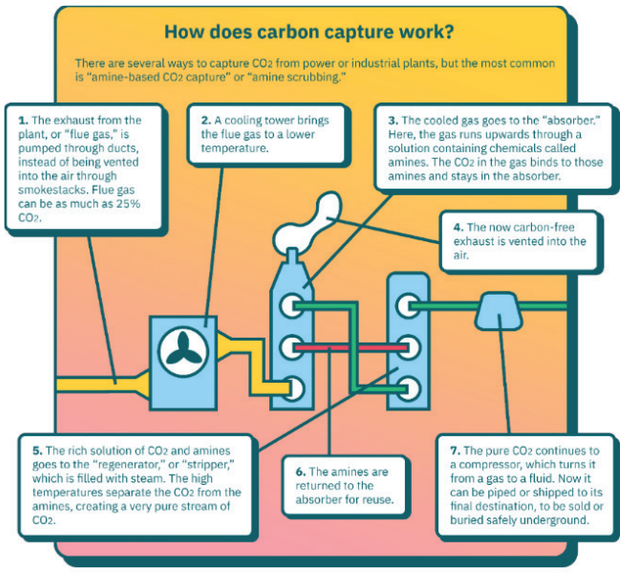
- CO_2 vented during upstream pretreatment to remove acid gases
- CO_2 released in the gas turbines exhaust used to drive the liquefaction process

Capturing and sequestering the CO_2 in the feed is already possible with well-proven technologies. A typical acid gas removal unit Acid Gas Removal Unit (AGRU) for LNG already separates CO_2 from the natural gas feed using an amine-based absorption process. The CO_2 stream from AGRU can be compressed for sequestration to reduce CO_2 emission from LNG plant.

The other prime candidate for reducing carbon emission from LNG plants is the Gas Turbine Exhaust.

Methods of CO_2 Reduction

Among the two prime locations of CO_2 emission from LNG plant discussed in the above section-B,



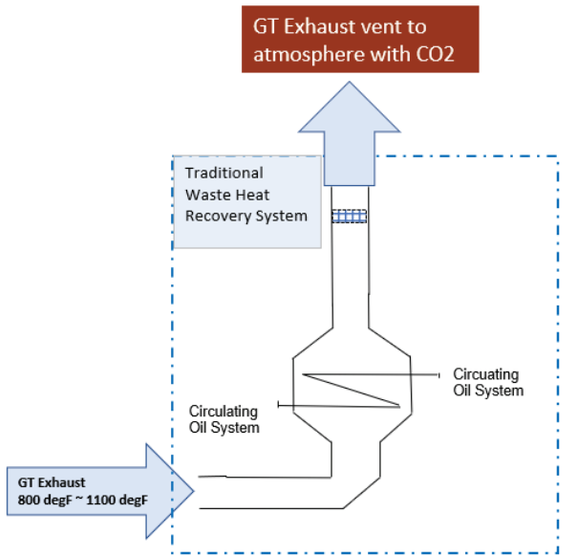
this section described CO_2 capture from Gas Turbine exhaust. Methods of CO_2 reduction from Gas Turbine exhaust can be classified as pre-combustion and post combustion. Pre-combustion CO_2 capture employs de-carbonization of fuel before it is combusted. Post-combustion CO_2 capture involves CO_2 capture from flue gas.

The main focus for LNG plant is post-combustion CO_2 capture from Gas Turbine Exhaust.

The CO_2 reduction process from Gas Turbines exhaust involved three major steps.

Gas Turbine Exhaust Cooling

The turbine exhaust temperature is generally in the range of 800o F to 1100° F. Traditionally, the heat from



Gas Turbine (GT) Exhaust gas is recovered through Waste Heat Recovery system to cater the heat duty requirement of the LNG process consumers. In this process, Exhaust gas is cooled up to approximately 700-800° F.

As, the Carbon Capture Process needs GT Exhaust to be at ambient temperature (Approximately 100o F), a large cooling duty of GT Exhaust gas from nearly 700-800o F to 100o F is required prior to the Carbon Capture process.

It is possible to utilize multiple options (e.g., cooling water, circulating heat transfer fluid, direct contact cooling, indirect cooling etc.) for cooling the turbine exhaust. The recovered heat can be used in other areas of the plant for process heating and power generation. The GT Exhaust cooling can be performed in two stages.

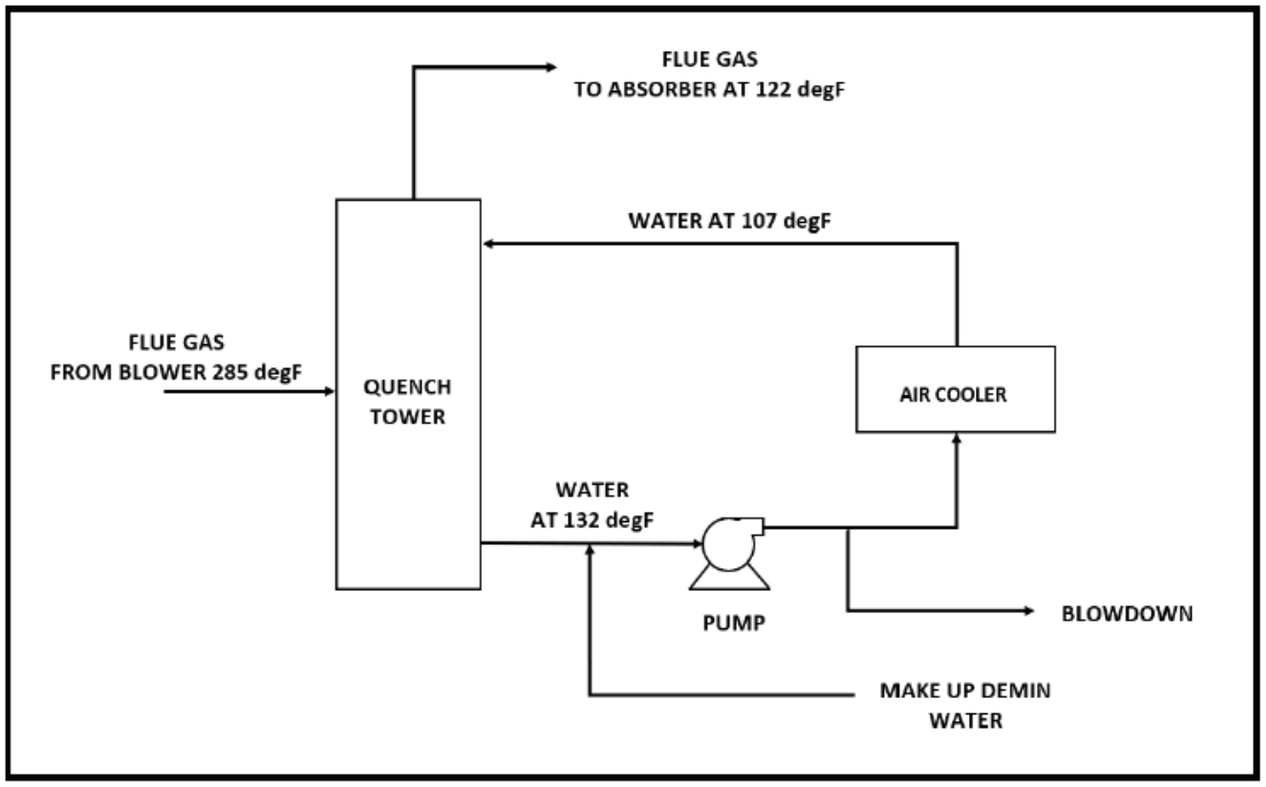
First Stage Cooling: In the first stage cooling high temperature Gas Turbine Exhaust can be cooled to nearly 200°F to 300°F to produce Power. A steam cycle or Organic Rankine Cycle (ORC) can be used to produce power from the high temperature gas.

Power generation through steam and ORC has its advantage and disadvantages. Selection between a steam cycle and ORC cycle need to be studied depending on the multiple factors of the plant as listed below.

- Steam can be used for the heating requirement of the carbon capture process which will provide advantage of a steam cycle compared to ORC.
- The ORC loop will require a circulating heat transfer oil to transfer heat from the Gas Turbine Exhaust to the ORC fluid.
- Steam system will require multiple auxiliary equipment to manage condensate, water requirement, dosing etc. An ORC loop can work like a package within its boundary.
- Steam system may produce higher power generation than an ORC loop.

Selection for flue gas cooling between a steam system and Organic Rankine Cycle (ORC) can be decided depending on the above factors.

Second Stage Cooling: Flue gas from the 1st Stage Cooling will be further cooled in the 2nd stage cooling to meet the required temperature of the Carbon



Capture process. A quench column with direct contact circulating water can be applied for the (GT) Exhaust gas second stage cooling.

A schematic drawing of a quench column process is shown below with a representative temperature of the different streams.

Carbon Capture Process

There are multiple technology and open-art process for carbon capture from Gas Turbine Exhaust. Most of technologies work with circulating solvent with Absorber column, Regenerator column with solvent heating and cooling. Some of the leading processes are listed below.

KM-CDR Process by MHI: "KM CDR Process™" is a CO_2 capture technology that can handle a variety of exhaust sources and a wide range of volumes, from small to large plants. This technology recovers more than 90% of the CO_2 contained in the target gas (with a purity of more than 99.9% by volume). The technology and the solvent used in this process is proprietary of MHI.

OASE Blue by BASF: BASF has developed the OASE®blue Technology for capturing CO2 from flue gas streams originating from coal, and gas fired power plants, fired heaters and other process streams. The OASE®blue solvent is a proprietary amine solution. The technology and the solvent used in this process is proprietary of BASF.

BASF Gas Treating Excellence provides CO_2 capture solutions that support applications ranging from enhanced oil recovery (EOR), urea production and food grade CO_2 production facilities. The OASE® technology portfolio has a wide range of solutions that can be tailored to the meet customer-specific needs to provide a high purity CO_2 product available for commercial utilization.

Open-Art MEA: Recent research on CO_2 capture is focusing on the optimization of CO_2 absorption using amines (mainly Monoethanolamine—MEA). CO_2 capture from flue gases using MEA has been widely demonstrated, and the basic feasibility of the process and general trends for capture performance, energy consumption and so on are not in doubt. The Open-Art MEA Plant consists of a number of unit operations, which have been designed individually based on open art principles and then combined into a generic amine scheme.

CO_2 Compression and Dehydration

CO_2 capture from the carbon capture process is generally at gas stage, low operating pressure (10 to 50 psig), saturated with water and at ambient temperature.

The CO_2 stream will be transported and injected as a liquid or a dense-phase supercritical fluid. Independent of the method used to capture the CO_2, it remains central to compress carbon dioxide. For CO_2 transportation and storage, CO_2 must be compressed to minimize the volume the CO_2 occupies so that its flow rate through the pipeline can be maximized and to pressurize it enough that it can overcome the pressure of the reservoir into which it is being injected.

One of the most remarkable characteristics of CO_2 is its low critical temperature of 31.1°C (88 0F), which causes CO_2 compression systems work partly below and partly above the critical pressure of 73.8 bara (1070.4 psia). CO_2 in its supercritical state is neither liquid nor gas but instead exhibits properties of both.

The CO_2 stream from carbon capture process are captured at low pressure and water saturated at the regeneration pressure and temperature. As the fluid is compressed up to the necessary injection or disposal pressure (or potentially for EOR usage or other receipt point), some water will begin to condense. However, depending on the composition, operating conditions, and specifications, this fluid may require supplemental dehydration. CO_2 gas, when combined with water, will produce hydrates (at elevated pressures), as well as produce an acidic aqueous phase contributing to corrosion concerns. While corrosion concerns can usually be countered with proper materials selection and corrosion monitoring programs, this is often costly and impractical depending on the process scheme, injection receipt points, and design considerations.

To remove the water from the CO_2 stream a supplementary dehydration unit is generally integrated with the compression process.

A Triethylene glycol (TEG) dehydration process is common for CO_2 Dehydration process. There are other technologies to remove water e.g. DexProTM process, Molecular Sieve process. Irrespective of the Dehydration technologies, the CO_2 dehydration process is generally located in-between the two Compressor stages where water saturation with CO_2 is minimum.

Conclusion

Natural gas in the form of LNG will play an important role in the energy transition, but its contribution to global greenhouse and climate change, gas emissions must be reduced to an absolute minimum. To limit global warming, it is critical to lower greenhouse gas emissions like CO_2 from industrial facilities around the world by deploying carbon capture and storage (CCS) at these facilities.

Upcoming LNG Plants have already started working on the Carbon Capture from Gas Turbine Exhaust. These investments in upcoming carbon capture projects in LNG plants will have to be stepped up substantially to help achieve the ambition of net zero anthropogenic greenhouse gas emissions by 2050. ■

Article Courtesy: Bechtel India
Published earlier in CEW March 2024

Navigating the Nexus: Addressing Antimicrobial Resistance in Water Sources

As advancements in water purity continue, the looming threat of antimicrobial resistance (AMR) becomes increasingly urgent. The unveiling of the Antimicrobials Filter Cartridge marks a significant breakthrough in water purification technology, specifically aimed at tackling AMR compounds. **Pavithra Ravindran, CMO, Biznustek Systems Pvt. Ltd.,** underscores this innovation as vital for safeguarding public health, combating superbugs, and confronting the escalating issue of water contamination.

The Water Purification Technology market has been making significant strides over the last few decades. However, amidst this pursuit of water purity, a silent threat looms large: antimicrobial resistance (AMR) and the proliferation of superbugs. This global challenge has sparked an urgent need for innovative solutions that not only purify water but also address the complex issue of AMR.

In response to the urgent need for effective solutions to combat antimicrobial contamination in water sources, Antimicrobials Filter Cartridge has been introduced by (BSPL). This revolutionary filtration device represents a significant leap forward in water purification technology, specifically engineered to address the complex challenge of antimicrobial resistance (AMR). Unlike traditional filters that primarily target physical impurities. The cartridge utilizes advanced filtration technology to selectively remove a wide range of antimicrobial contaminants, including antibiotics and antimicrobials, from water.

The Growing Threat of Antimicrobial Resistance

Antimicrobial resistance is a phenomenon characterized by the ability of microorganisms—such as bacteria, viruses, parasites, and fungi—to withstand the effects of antimicrobial drugs, including antibiotics. This resistance arises from various factors, including the overuse and misuse of antibiotics in healthcare, agriculture, and the environment. As a result, once-treatable infections are becoming increasingly difficult—and sometimes impossible—to cure, leading to prolonged illness, higher healthcare costs, and elevated mortality rates.

Superbugs: A Looming Public Health Crisis

Compounding this issue is the emergence of superbugs—resilient pathogens that have evolved to resist multiple antibiotics. These superbugs pose a formidable challenge to public health, undermining the efficacy of conventional treatment methods and exacerbating the global burden of infectious diseases.

The threat of a superbug pandemic looms large, fueled by interconnected factors such as global travel, antimicrobial misuse, and inadequate infection control measures. As superbugs continue to proliferate and evolve, the urgency of developing effective strategies to combat AMR becomes increasingly apparent. In this context, the role of water contamination in the dissemination of superbugs cannot be overlooked. Water sources contaminated with antimicrobial residues provide a conducive environment for the transmission and proliferation of resistant pathogens, contributing to the amplification of AMR on a global scale.

The Role of Water Contamination in AMR

Water contamination plays a significant role in the proliferation of antimicrobial resistance. Antibiotics and other antimicrobial compounds can enter water sources through various pathways, including agricultural runoff, pharmaceutical manufacturing, and improper disposal of medications. Once in the environment, these antimicrobial agents can exert selective pressure on microbial populations, driving the emergence and spread of resistant strains. Additionally, wastewater treatment plants may not adequately remove antimicrobial residues, allowing them to persist in the environment and contribute to the development of AMR.

Antimicrobials Filter Cartridge

In response to the urgent need for effective water filtration solutions, Biznustek Systems Pvt. Ltd. (BSPL) has developed the Antimicrobial Filter Cartridge—a revolutionary technology designed to combat antimicrobial contamination in water sources. Unlike traditional filters that primarily target physical impurities, such as sediment and debris, the Antimicrobial Filter Cartridge employs advanced filtration technology to selectively remove antimicrobial compounds, including antibiotics and antimicrobials, from water.

At the heart of the Antimicrobial Filter Cartridge lies its sophisticated filtration matrix, which utilizes a combination of physical, chemical, and biological processes to neutralize antimicrobial contaminants. This multifaceted approach ensures that water passing through the cartridge is thoroughly purified, with antimicrobial residues effectively removed to levels below detectable limits.

Characterised by:

- Advanced Filtration Technology: The Antimicrobial Filter Cartridge utilizes state-of-the-art filtration mechanisms to selectively target and eliminate antimicrobial contaminants, ensuring unparalleled water purity and safety.
- Sustainability and Eco-Friendliness: The technology is committed to environmental stewardship, prioritizing the use of eco-friendly materials and manufacturing processes in the production of the Antimicrobial Filter Cartridge. This pledge not only minimizes the ecological footprint of the cartridge but also contributes to a healthier planet for future generations.
- Public Health Impact: By removing antibiotics and antimicrobials from water sources, the Antimicrobial Filter Cartridge plays a crucial role in safeguarding public health and combating AMR. By mitigating the spread of resistant pathogens, the cartridge helps protect vulnerable populations from the devastating consequences of antimicrobial-resistant infections.
- Cost-Effective Performance: Engineered for durability and efficiency, the Antimicrobial Filter Cartridge offers long-term cost savings by reducing maintenance requirements and operational costs. Its robust construction ensures reliable performance over extended periods, providing consumers with peace of mind regarding the quality and safety of their drinking water.

Applications and Market Potential

The Antimicrobial Filter Cartridge has a wide range of applications across various sectors, including residential, commercial, and industrial settings. From household water purification systems to municipal water treatment plants, the cartridge can be seamlessly integrated into existing infrastructure to enhance water quality and safety. Additionally, its compatibility with a diverse range of filtration systems makes it a versatile solution for addressing antimicrobial contamination in diverse water sources.

In terms of market potential, the demand for antimicrobial filtration technologies is expected to surge in the coming years, driven by increasing awareness of waterborne health risks and growing concerns about antimicrobial resistance. As consumers and policymakers alike prioritize water quality and safety, the Antimicrobial Filter Cartridge is poised to emerge as a leading solution for addressing these critical needs.

Conclusion

Daunting challenges posed by antimicrobial resistance and water contamination, the Antimicrobial Filter Cartridge represents a beacon of hope—a testament to human ingenuity and innovation. By harnessing advanced filtration technology, BSPL is paving the way for a future where clean and safe drinking water is accessible to all. As the global community continues to grapple with the complex interplay of environmental, societal, and public health factors, the Antimicrobial Filter Cartridge stands as a symbol of collective efforts to resolve and build a healthier, more sustainable world for generations to come. ■

Article Courtesy: Biznustek Systems Pvt. Ltd.
Published earlier in CEW March 2024

Avoiding Downtime with Proactive Maintenance

According to leading AI-powered predictive maintenance provider, Senseye, large plants lose an average of 323 production hours a year, adding that one hour of downtime can cost up to $532,000. Manufacturers cannot afford extensive periods of downtime, so proactively maintaining equipment is key to continuous production. Here Clive Jones, managing director of global UK-based thermal fluid supplier Global Heat Transfer explores how businesses using thermal fluid can prevent equipment failures with proactive maintenance.

Heat transfer systems and fluids can be challenging to maintain because once introduced to the pipes, fluid is invisible and therefore difficult to visually monitor. As a result, issues with the fluid may go unnoticed until there is a chemical blending failure, temperature inconsistencies, or extensive pipe damage.

Fluid degradation

Chemical reactions occur at high temperatures that thermal fluids must maintain for prolonged periods. Over time, operating for long periods at these temperatures can cause the fluid to degrade, due to oxidation and thermal cracking. These processes produce contaminants, such as carbon, which will start to build up inside the pipes and negatively impact heat transfer efficiency.

Regular sampling

General maintenance

Taking accurate measurements

Regular sampling enables businesses to proactively monitor fluid condition. Maintenance engineers can gain accurate representations of the fluid's condition by taking samples at regular intervals from a hot, closed and circulating system. After sending a sample to a thermal fluid expert for analysis, plant managers can use the data to find any changes in fluid, such as carbon level, and intervene if adaptations to the maintenance programme are needed.

Incorrect sampling may give inaccurate flash point results, which can have dangerous consequences. Unless the fluid samples are collected when the oil is hot and circulating, the results may reveal artificially high flash point values. Incorrect sampling can lead to the inaccurate conclusion that the fluid is safe and does not require attention, or that systems need to be wrongly shut down.

Businesses may not have the in-house expertise to fix and maintain the heat transfer system, so they can invest in a thermal fluid expert to carry out the relevant tests and service needed to help extend boiler lifespan. Most thermal fluid specialists offer companies a seven-point test to determine the overall condition of the fluid. This test is sufficient, but some companies also offer more extensive analysis with eleven-point tests. These look at the sample in greater detail to ensure the results completely reflect reality.

Light ends removal kit

The curve

Engineers can also use sampling to predict the lifespan of fluid, using data to monitor condition over time and detect trends. For example, as a fluid reaches the end of its lifespan, there is a gradual curve that drops off sharply, referred to by specialists as 'the degradation curve.' This sudden change in the quality of thermal fluids is one of the reasons why regular and preventative maintenance is so important.

At the beginning of this curve, plant managers can dilute the degraded fluid, by topping up the system as a cost-effective and durable option to return to optimal productivity. This is no longer an option when the condition of the fluid has significantly deteriorated. Instead, plant managers must flush and clean the system, prior to refilling it with fresh heat transfer fluid as a long-term solution.

Automating fluid sampling

Operating a system efficiently and continual monitoring are the best methods for extending thermal fluid maintenance. Embracing digital technologies is one way that businesses can improve proactive maintenance. For example, many industries have benefitted from installing Industry 4.0 technologies that monitor machine performance. Traditionally, engineers have only sampled fluid manually, but the rise of Industry 4.0 technologies could change how engineers carry out thermal fluid management.

Light ends removal

Carbon is not the only cause of fluid degradation, as hydrocarbon chains break under high temperatures light ends are produced, lowering the flash point of the fluid and making it more flammable at lower temperatures. If samples show that light ends are forming rapidly, it indicates that the heat transfer fluid is not venting properly, allowing temperatures to rise. The build-up of light ends can be prevented by using a light ends removal kit (LERK), which removes light ends as they form.

Engineers temporarily install a LERK to eliminate volatile light ends in the fluid. Light ends are collected when the hot thermal fluid flows through the distillation vessel and the gaseous light ends are collected in the liquid phase of the condenser. The light ends are either drained automatically or manually from the system.

Light ends can be managed on a more regular and automated basis by permanently installing a LERK on a new or existing system. Businesses can choose to install LERKs that use gravity to return the oil to the circuit or opt for a new range of active, floor mounted, LERKs that employ a frequency-controlled pump. ■

Article Courtesy: Global Heat Transfer
Published earlier in CEW February 2023

Driving India towards Net Zero: Exploring Decarbonization Technologies including CCUS

Decarbonization is a critical global goal, and many countries across the world have set their emission reduction targets towards a more sustainable, pollution-free environment. India is one of the major nations to set ambitious objectives and is taking big strides towards meeting them.

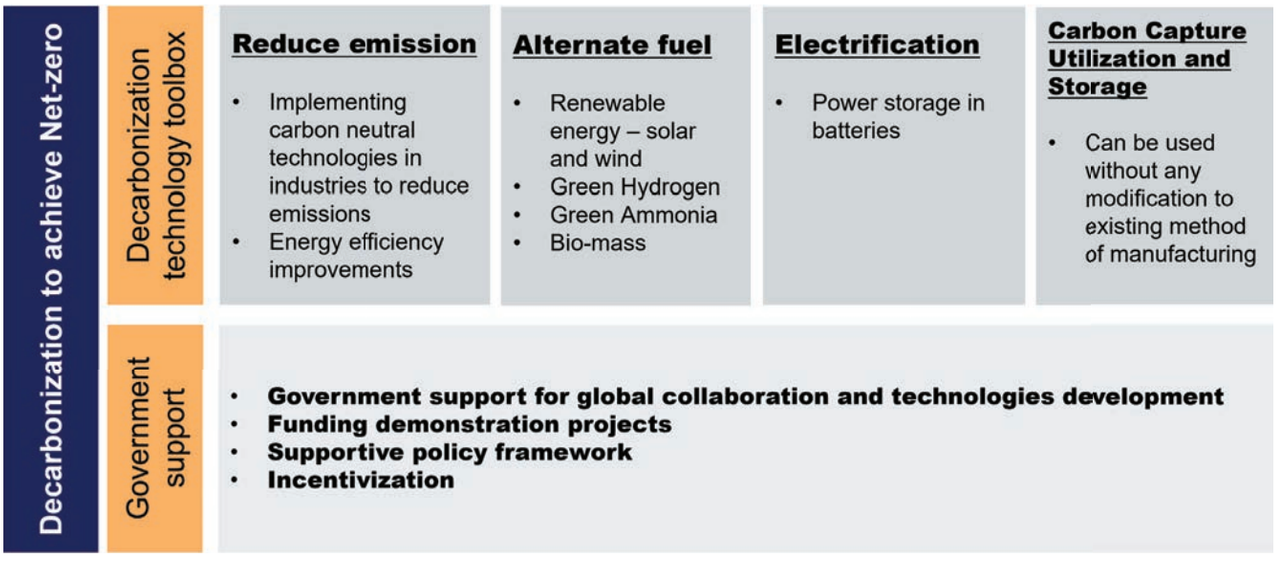
In the broader effort towards net-zero, there are various decarbonization tools available on the market. This article will draw on **Aker Solutions'** extensive CCUS experience highlighted by **Vishal Pawar, Head of Department – Process & SAE and Vinay Parab, Senior Manager – Process Subject Matter Expert – Carbon Capture** to explore a selection of technologies and assess their adoption, as well as commercial availability, enquiry flux, prospects and role in ongoing projects.

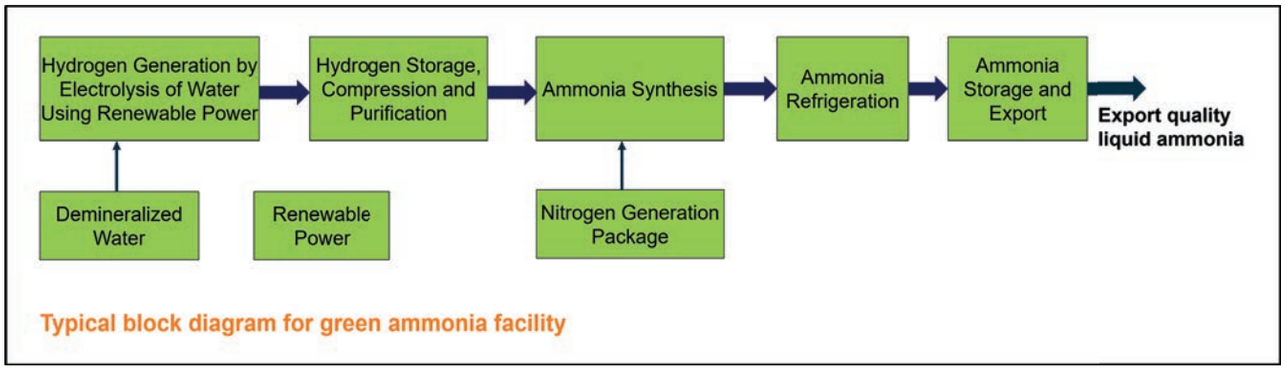
Decarbonization Toolbox

There is no single approach that can be adapted to reach net-zero. Emitting industries should select the appropriate option from the decarbonization toolbox by reviewing feasibility and commercial availability.

In India, renewable energy, electrification, power storage in batteries, green hydrogen, green ammonia, and blending hydrogen in natural gas are expected to be key to reduce emissions from the power sector. With innovations in the production of green hydrogen and its wide range of applications in refinery fired heaters, and the steel and transport industries, hydrogen is considered as a 'green energy carrier' and a critical decarbonization tool. Similarly, ammonia produced from green hydrogen has the potential to reduce emissions from the fertilizer industry.

Hard-to-abate industries contribute to one-third of total carbon emissions. CCUS can play a vital role in cutting these emissions, based on the approach and learnings from countries that are further along in their net-zero journey.





Typical block diagram for green ammonia facility

Green Hydrogen

Green hydrogen refers to the production of hydrogen by water electrolysis using renewable power. It is emerging as a feasible option due to technological innovations in electrolysers, electricity generation from renewables, and a variety of hydrogen applications. The Government of India is taking various measures to facilitate the transition from fossil fuel to green hydrogen / green ammonia.

Water electrolysis is a process used to split water into hydrogen and oxygen using electricity. There are three main types of electrolysers, alkaline electrolysers, polymer electrolyte membrane (PEM) electrolysers and solid oxide electrolysers.

Among these, alkaline electrolysers have the most developed technology. Potassium hydroxide solution, which operates at a temperature range of 80-90°C and 1-30 barg pressure, is primarily used as electrolyte for these.

Hydrogen production facilities using alkaline electrolyser technology typically consist of an alkaline electrolyser, hydrogen gas separator, gas cooler and electrolyte circulation system. Alkaline electrolysers have a longer operating life than PEM electrolysers.

In PEM electrolysers, a solid sulfonated polystyrene membrane is used as a electrolyte. It operates at a temperature range of 50-80°C and requires a higher quality of demineralized water than alkaline electrolysers.

Solid oxide electrolysers operate at a high temperature range of 700-850°C and use water in the form of steam. They operate with high efficiency, but the technology is less mature than the other two options.

Green Ammonia

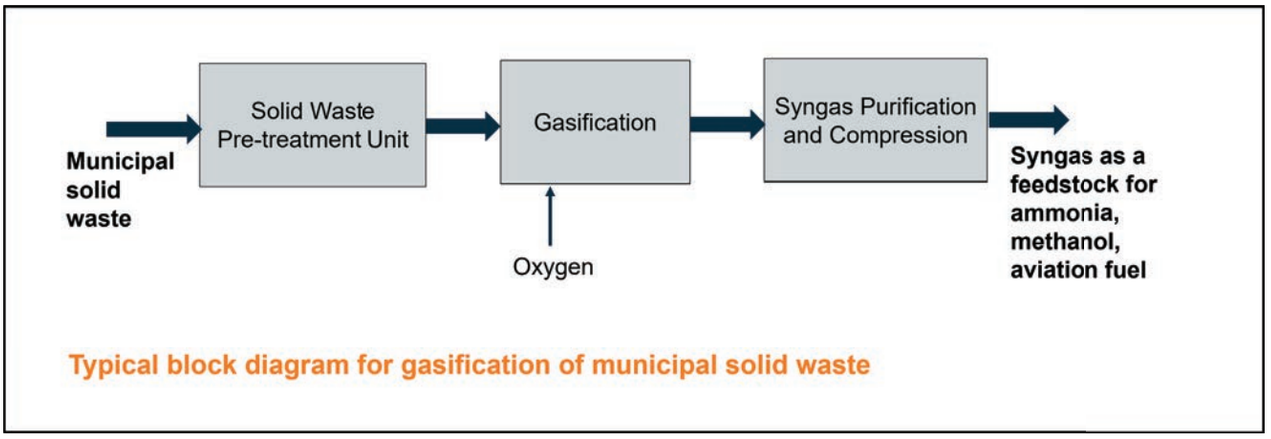
The traditional steam methane reforming process for manufacturing ammonia causes carbon dioxide emissions. In the green ammonia process, hydrogen is produced by water electrolysis, with the power requirement for electrolysis and plant operation being produced from renewables and eliminating carbon dioxide emissions.

The hydrogen generated from electrolysis reacts with nitrogen from an air separation unit in the ammonia synthesis package to produce ammonia. Hydrogen produced from electrolysers needs to be purified to remove oxygen and meet the ammonia synthesis loop quality requirement.

It is possible that the renewable power being used may not be available continuously throughout the day and year. In such a scenario, there are various engineering solutions to ensure uninterrupted production of green ammonia. Taking this into consideration, the hydrogen storage facility should be sufficiently sized to provide the required quantity of hydrogen continuously for ammonia synthesis. Also, provision for energy storage using batteries or 'pump hydropower' should be made for continuous supply of renewable power.

Gasification of Municipal Solid Waste

Municipal solid waste poses an environmental and health hazard if not treated properly. The usual method in India and many other countries is landfilling, dumping grounds or incineration. However, these contribute to carbon emissions in the form of methane and carbon dioxide. The operational model for capturing the emitted carbon dioxide is in an early stage of development.



Typical block diagram for gasification of municipal solid waste

Globally, steps are being taken to develop technologies for converting solid wastes into sustainable products through green routes. One of the processes is gasification of waste in a controlled oxygen process to produce syngas, which can form a significant building block for producing chemicals like methanol, ammonia and aviation fuel through various proven technologies.

To initiate, incubate and implement gasification and downstream processes requires continuous research, development of prototypes and scale-up of models to build commercial level plants. This can surely be a sustainable tool for decarbonization at source.

Carbon Capture, Utilization and Storage (CCUS)

CCUS is an important and well-known tool available for carbon dioxide emitting industries that have exhausted their options to meet emission reduction targets. It can be used without making any modifications to the existing production technology and method.

Considering India's rapidly growing energy needs, dependence on fossil fuels is likely to continue for the generation of affordable and reliable baseload power. Carbon intensive industries such as steel, cement, oil and gas, refineries, petrochemicals, chemicals and fertilizers are critical to the continued growth of the Indian economy. CCUS has an integral role to play in the decarbonization of these industries.

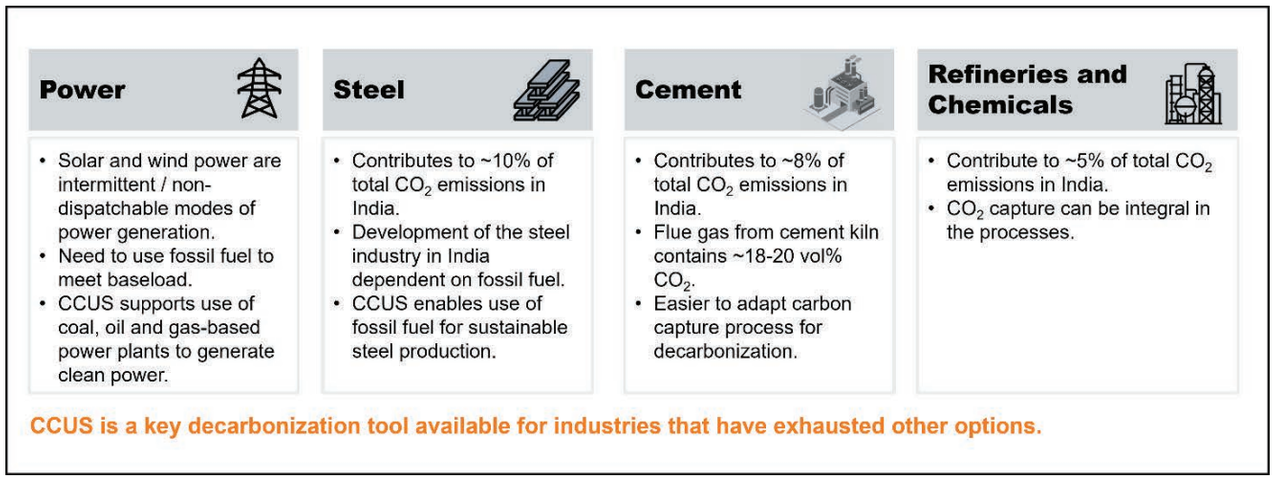
CCUS will also support the transition from blue hydrogen to green hydrogen by accelerating the demand and creating technologies and infrastructure for production, storage and transportation of hydrogen.

Chemical solvent-based post combustion carbon capture process:

There are different types of commercial-scale carbon capture technologies available, depending upon carbon dioxide concentration and pressure of the gas stream. Among these, chemical solvent-based technologies are widely developed and commercially available.

Process description

In chemical solvent-based post-combustion capture processes, the flue gas is first cooled and pre-treated



CCUS is a key decarbonization tool available for industries that have exhausted other options.

in the quencher to remove acid gases from the flue gas stream. The pre-treated flue gas enters the absorber, where the solvent absorbs carbon dioxide from the flue gas by a chemical bond. The cleaned flue gas is vented to the atmosphere.

The solvent containing the captured carbon dioxide is removed from the absorber bottom and sent to a stripper. The stripper is heated with steam to release the carbon dioxide from the solvent before it is returned to the absorber. The released carbon dioxide is compressed, dried and / or liquefied, depending on the end use.

Impurities from the flue gas will accumulate in the solvent over time. A small slipstream of the solvent is routed to a reclaimer to purify the solvent and reduce solvent loss.

Solvent selection: The amine-based gas sweetening process is popular in oil and gas, and refining facilities to remove impurities like hydrogen sulphide and carbon dioxide from the product gas stream. However, these amines have limitations in the post-combustion flue gas carbon dioxide capture process. The effect of post-combustion components from flue gas on the solvent performance should be taken into consideration while selecting the absorption solvent.

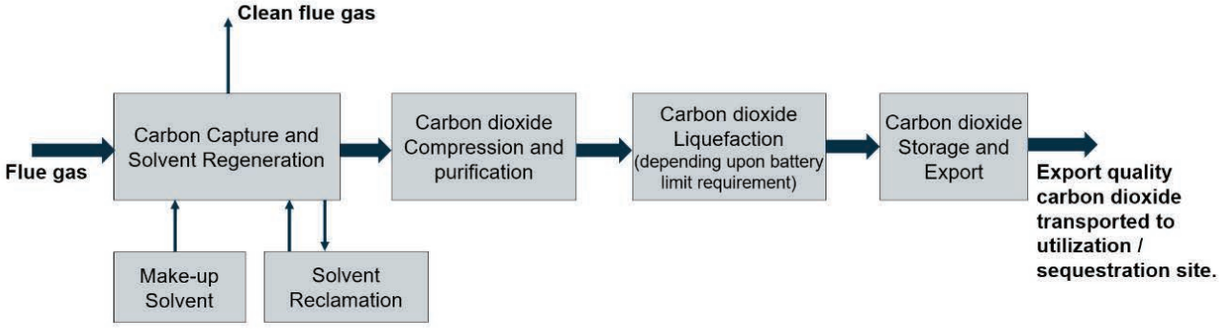
The carbon capture process should be energy efficient, economical, and most importantly HSE friendly to make it acceptable to the industry and society. The key element to make the capture plant economically sustainable is the choice of the most robust solvent to absorb the carbon dioxide from flue gas. Robust solvents ensure low solvent degradation, which has benefits like low solvent makeup, low emissions and low demand of reclamation, hence saving significant operational costs.

Design innovation – heat integration: The process of carbon capture, compression, conditioning, liquefaction, and transport is energy intensive, and every effort should be made to reduce energy requirements. Heat integration within the process and with the balance of the facility wherein the capture plant will be installed can be a challenge to engineering companies and is key for acceptable design.

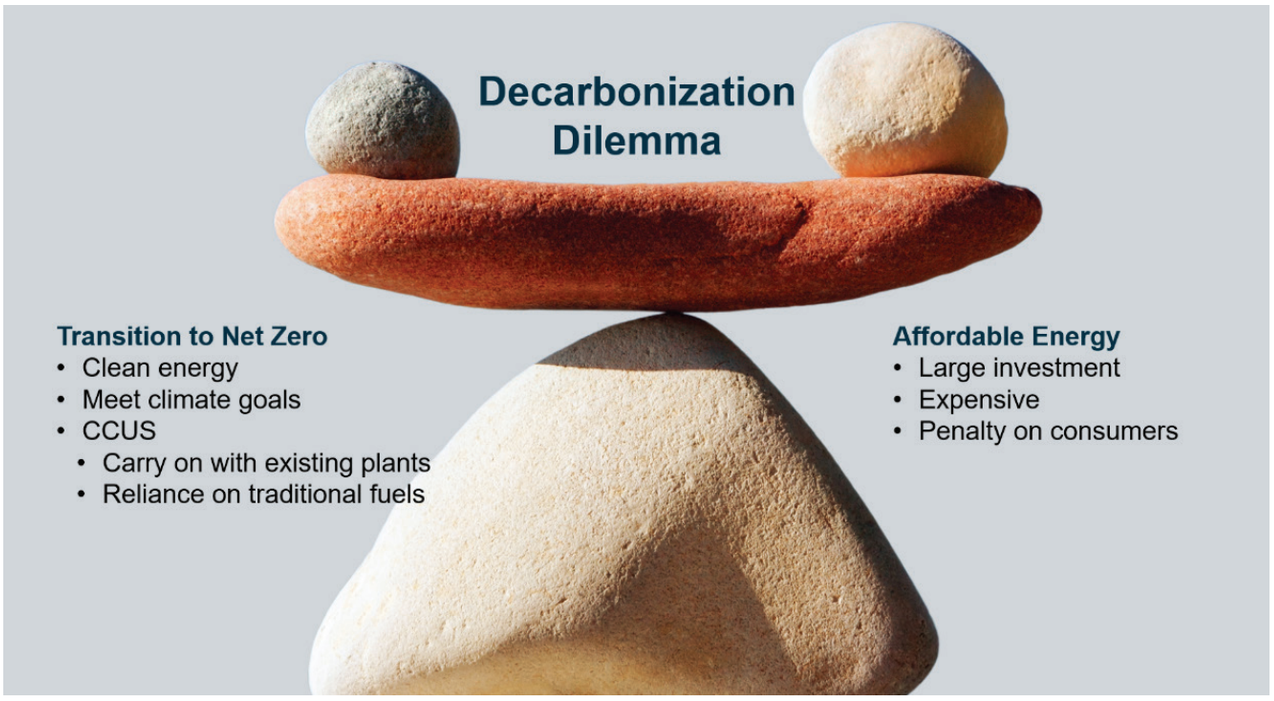
Sequestration of captured carbon dioxide: Carbon dioxide utilization technologies can provide a wide variety of opportunities to convert the captured carbon dioxide to value-added products which have a ready market in India. However, it has a limited capacity to contribute to meeting net-zero. For India to realize the net-zero mission, it requires mainly permanent sequestration of captured carbon dioxide supported by value-based utilization.

If geological sequestration is to be realized at a commercial scale, the facilities need to be able to handle several million tons of carbon dioxide. It is vital to develop a hub and cluster concept to make this feasible. Multiple industrial emitters of carbon dioxide can then share common infrastructure for collection of captured carbon dioxide from the emitting industry's battery limit, transportation and gathering facilities and the setup for further sequestration. It supports reduction of unit cost for carbon capture and storage (CCS) due to economies of scale.

Globally, a number of hub and cluster projects are being studied and developed. Aker Solutions has worked on various facilities which are part of such



Typical block diagram for carbon capture facility



a concept, including Norway's pioneering Longship project and Net Zero Teesside in the UK.

We believe that similar concepts should be initiated in India to enhance application of CCS as a decarbonization tool. Government support is required for source-sink mapping, identification of fields for carbon dioxide injection and developing the necessary network.

Conclusion

Decarbonization in India needs a stepwise approach to reach net zero emissions by 2070. Renewable energy, electrification, green hydrogen, green ammonia and CCUS will play a vital role. The immediate focus should be on the transfer of proven technologies and adapting them at commercial scale. CCS has a critical role to play, and hub and cluster development is vital to make its use feasible. Government support is required for developing carbon dioxide storage infrastructure in India.

The decarbonization dilemma for developing economics like India is to maintain a balance between transition to net-zero and generating affordable energy for the country's development.

A methodology involving adoption of various decarbonization technologies, global collaboration to implement them and government initiatives such as incentivization, funding demonstration projects and supportive policy framework is the key to India achieving its decarbonization goals. ■

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