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CHEMICAL ENGINEERING WORLD
RNI REGISTRATION NO. 11403/1966

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SALES
Godfrey Lobo
Chandrahas M Amin
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Single Copy Price: ₹ 150/-
Annual Subscription: ₹ 1620/-, Foreign: USD 180

Registered Office: 26, Maker Chambers VI, 2nd Floor,
Nariman Point, Mumbai 400 021, INDIA.
Tel.: 022-4037 3737 Fax: 022-2287 0502
E-mail: sales@jasubhai.com

PLACE OF PUBLICATION
JASUBHAI MEDIA PVT. LTD.

210, Taj Building, 3rd Floor, Dr. D. N. Road, Fort,
Mumbai 400 001, Tel: +91-22-4037 3636

Printed and published by Mr Hemant K. Shetty
Address: 406-D, The Karachi Citizens Co-Op Hosg Soc Ltd.,
Juhu Varsova Link Road, Andheri West, Mumbai - 400053.

Printed at The Great Art Printers
25, Unique House, S A Brelvi Road, Fort, Mumbai 400 001.

Editor: Ms. Mittravinda Ranjan, 3rd Floor, Taj Building, 210,
Dr. D N Road, Fort, Mumbai 400 001.

Published from Jasubhai Media Pvt .Ltd. 3rd Floor, Taj Building,
210, Dr. D N Road, Fort, Mumbai 400 001.

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FORM IV

Statement about ownership and other particulars about newspaper **CHEMICAL ENGINEERING WORLD** to be published in the first issue every year after the last day of February

1.	Place of Publication	Mumbai
2.	Periodicity of its Publication	MONTHLY
3.	Printer's Name	HEMANT K SHETTY
	Nationality	INDIAN
	[1][(a) Whether a citizen of India?	YES
	(b)If a foreigner, the country of origin]	NOT APPLICABLE
	Address	406-D, Karachi Citizens CHS, Juhu-Versova Link Road, Andheri (West), Mumbai – 400 053.
4.	Publisher's Name	HEMANT K SHETTY
	Nationality	INDIAN
	[1][(a) Whether a citizen of India?	YES
	(b)If a foreigner, the country of origin]	NOT APPLICABLE
	Address	406-D, Karachi Citizens CHS, Juhu-Versova Link Road, Andheri (West), Mumbai – 400 053.
5.	Editor's Name	MITTRAVINDA RANJAN
	Nationality	INDIAN
	[1][(a) Whether a citizen of India?	YES
	(b)If a foreigner, the country of origin]	NOT APPLICABLE
	Address	3rd Floor, Taj Bldg., D N Road, Fort Mumbai 400 001
6.	Names and Addresses of individuals who own the newspaper and partners or shareholders holding more than one per cent of the total capital	JASUBHAI MEDIA PVT LTD. 26, Maker Chambers VI, Nariman Point, Mumbai 400 021 Maulik Jasubhai Shah (1100, Shanudeep, 10, Altamount Road, Mumbai 400 026), Maulik Business Services Pvt. Ltd & Jasubhai Business Services P Ltd., (26, Maker Chamber VI, Nariman Point, Mumbai 400 021

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MGL drives conversation on sustainability at Oil Gas & Power World Expo 2025

Mahanagar Gas Limited's exhibit at Oil Gas & Power World Expo 2025.

Mumbai India: Mahanagar Gas Limited, one of the largest city gas distribution (CGD) companies in India, recently participated in Oil, Gas & Power World Expo 2025 in Mumbai. The 13th edition of this international integrated energy tradeshow had participation from across the energy ecosystem and allied sectors. As a part of the expo, Ashu Shinghal, Managing Director, Mahanagar Gas Limited participated in a high-impact panel discussion on "City Gas Distribution: Growth Challenges & Pitfalls" where he highlighted the immense scope for investment, innovations and growth in natural gas sector and discussed challenges like high reinstatement charges, and infrastructure development in rural areas, as well as the need for uniform policy for the CGD sector. The panel, moderated by Abhinandan Dutta, Director, One Consulting Fuels & Resources Strategy & Operations, PwC India, also featured distinguished leaders - Sandeep Jain, Executive Director (Gas), Indian Oil Corporation Limited; Kapil Jain, Executive Director, Marketing (Retail LNG), GAIL Limited and Rajesh K C Dwivedi, Area Head, Govt. & Institutional Business, HDFC Bank.

Ashu Shinghal (extreme right), Managing Director, Mahanagar Gas Limited, while participating in a panel discussion on City Gas Distribution: Growth Challenges & Pitfalls.

Commenting on MGL's participation at Oil Gas & Power World Expo 2025, Ashu Shinghal, Managing Director, Mahanagar Gas Limited said, "Platforms like Oil Gas & Power World Expo are instrumental in bringing the industry together and opening dialogue for innovation and overall development of the energy sector. As one of the pioneers in City Gas Distribution, Mahanagar Gas Limited remains committed to expanding the reach of sustainable energy solution and fostering innovation. Our participation reflects our commitment, alongside the industry, to shaping policies, embracing new technologies, and collaborating with stakeholders to drive the sector's growth."

Mahanagar Gas Limited's exhibit at the event featured their leap into Liquefied Natural Gas (LNG), Electric Vehicles (EV), Indigenous battery cell manufacturing for Electric Vehicles (EV) and Compressed Biogas (CBG) along with their diverse sustainability initiatives.

Subramanian Sarma elevated as Dy MD & President of L&T

The Board of Directors of Larsen & Toubro have announced the elevation of **Subramanian Sarma** from **Wholetime Director & President, Energy to Deputy Managing Director & President** of the company with effect from 2nd April 2025. The Board has also decided to extend his term to 3rd Feb 2028 subject to shareholder's approval in the upcoming AGM.

A graduate in Chemical Engineering, Sarma completed his master's from IIT Mumbai. A seasoned professional, he has over 40 years of experience, with 30 years being in the Middle East. During his career span, Sarma has handled the complete Oil & Gas value chain across various geographies. He was appointed on the Board of L&T in August 2015.

Hindalco unveils new identity

Mr. Satish Pai (L), Managing Director, Hindalco Industries Ltd and Mr. Kumar Mangalam Birla, Chairman, Aditya Birla Group, during the unveiling of Hindalco's new identity (in the background)

Mumbai, India: Hindalco Industries Ltd., the metals flagship of the Aditya Birla Group, has unveiled a bold new brand identity, marking its transformation from a materials supplier to an engineered solutions provider. The refreshed identity underscores its role as a co-creator and problem solver, shaping the future of industries such as electric mobility, renewable energy, energy storage, semiconductors, and high-end electronics. The brand identity was unveiled by Aditya Birla Group, Chairman, Kumar Mangalam Birla in the presence of industry leaders, policymakers, and business partners.

Speaking at the launch, Mr. Kumar Mangalam Birla, Chairman, Aditya Birla Group, said, "Today, Hindalco is a mini conglomerate in itself, with 52 plants across 10 countries producing a diverse portfolio of high-quality products that contribute to the global economy. We are committing ₹45,000 crore across aluminium, copper, and specialty alumina businesses to deliver both upstream and next-generation high-precision engineered products".

The new Hindalco brand logo, featuring a bold and dynamic 'H,' represents forward momentum and reinforces the company's role in shaping India's industrial and sustainable future. This transformation is not just about advanced materials, it is about cultivating innovation, attracting top talent, and fostering a high-performance culture that drives continuous progress.

Satish Pai, Managing Director, Hindalco Industries Ltd., added, "This marks a pivotal moment in Hindalco's journey as we transition from a metals manufacturer to an innovation-driven solutions provider. The new brand identity, ENGINEERING BETTER FUTURES, reflects our core principles: Sustainability, Circularity, Durability, and Precision Engineering. These pillars form the foundation of our transformation, ensuring we create a lasting impact for generations to come."

Henkel publishes sustainability report for 2024

Düsseldorf, Germany: Henkel has published its

Dr. Shivkumar Kalyanaraman assumes charge of CEO of ANRF

Secretary Department of Science and Technology (DST) Professor **Abhay Karandikar** who was acting as Chief Executive Officer (CEO) of Anusandhan National Research Foundation (ANRF) handed over the charge to Dr. Shivkumar Kalyanaraman who has been appointed CEO. With this, Dr. Shivkumar assumes charge of the CEO of ANRF which aims to seed, grow and promote research and development (R&D) and foster a culture of research and innovation throughout India's universities, colleges, research institutions, and R&D laboratories. Dr. Shivkumar who earlier held the post of Chief Technology Officer (CTO), Energy Industry, Asia at Microsoft is a Distinguished Alumnus Awardee of IIT Madras & Ohio State University (2021). He is also a Fellow of the IEEE (2010), Fellow of Indian National Academy of Engineering (2015), ACM Distinguished Scientist (2010), Microsoft Gold Club (2024) and Technology Review TR100 young innovator (1999).

sustainability report for 2024 today. The company has advanced further, especially in the areas of climate protection and circular economy, but also in social issues. Already this year, Henkel voluntarily reports in line with the content-related requirements of the European Union's new Corporate Sustainability Reporting Directive (CSRD) and its European Sustainability Reporting Standards (ESRS).

"We have made great progress and delivered tangible improvements in sustainability over the past year – across all areas of our sustainability strategy," said Carsten Knobel, CEO of Henkel. "Even in challenging times, we stand by our fundamental values: through our products, processes, and contribution to society, we are committed to a more sustainable world. This is also reflected in our net-zero roadmap aimed at reducing our greenhouse gas emissions by 90 per cent by 2045."

By the end of last year, Henkel had reduced CO2 emissions in its production per ton of product by 64 percent compared to the base year 2017 and increased the energy purchased from renewable sources to 47 percent.

Henkel also set Net-Zero targets last year, which cover a larger part of the value chain than its climate targets before. By 2045, Henkel aims to reduce its absolute scope 1, 2 and 3 greenhouse gas (GHG) emissions by 90 percent. As short-term climate targets, Henkel plans to reduce its absolute scope 1 and 2 GHG emissions by 42 percent and its absolute scope 3 GHG emissions by 30 percent by 2030 (compared to 2021). The new targets have been validated by the Science Based Targets Initiative (SBTi), a climate change organization that supports companies in setting GHG reduction targets that are in line with the Paris Climate Agreement. By the end of 2024, Henkel had reduced its scope 1, 2 and 3 GHG emissions by 20 percent (compared to 2021).

To further decarbonize the value chain and better capture CO2 emissions in the supply chain (scope 3), Henkel accelerated its engagement program for its global suppliers last year. It collects emissions data and defines specific measures to reduce emissions.

BPCL and Refroid Technologies launch India's First Indigenous Liquid Coolant

Mumbai, India: Bharat Petroleum Corporation Limited (BPCL), a premier energy company in India, has teamed up with Refroid Technologies, a leader in liquid cooling solutions, to introduce India's first Make in India liquid coolant specifically formulated for next-generation AI-driven and sovereign data centers. This innovative development signifies a major advancement in promoting energy efficiency and sustainability within India's expanding digital infrastructure. The new liquid coolant developed by BPCL and Refroid Technologies provides a state-of-the-art solution, improving cooling efficiency, decreasing Power Usage Effectiveness (PUE), and reducing carbon emissions. By co-developing this liquid coolant, BPCL becomes the first Indian energy company to take this initiative, solidifying its dedication to innovation and environmental stewardship. "BPCL is honoured to take the lead in implementing and advancing this pioneering initiative," said Shubhankar Sen, Executive Director, BPCL. "We are proud to contribute to a solution that aligns with global environmental goals, supports AI and sovereign

Baker Hughes appoints Ahmed Moghal as CFO

Baker Hughes Company announced that **Ahmed Moghal,** a highly experienced finance leader who currently serves as chief financial officer (CFO) of Industrial & Energy Technology (IET) business, has been appointed CFO of the company, effective immediately. Prior to IET, Moghal held senior positions in various business and corporate roles. In this role, he succeeds Nancy Buese, who, by mutual agreement with the company, ceased to serve as CFO.Lorenzo Simonelli, Baker Hughes chairman and chief executive officer, said, "The news we are announcing today reflects the substantial progress Baker Hughes has made in executing our strategic transformation. Reflecting on the financial successes achieved during Horizon 1, we drove record results last year while taking key actions across the Company to significantly expand margins." With Moghal's appointment, Buese will move to a strategic adviser role and will depart the company on April 30, 2025.

data initiatives, and strengthens India's position as a technology leader," he added.

Sumitomo Chemical to sell chemically-recycled acrylic resin to electronics and automotive companies

Tokyo, Japan: Sumitomo Chemical will begin selling its polymer material polymethyl methacrylate (PMMA) made from methyl methacrylate (MMA) monomer produced through chemical recycling. LG Display Co., Ltd. of South Korea and Nissan Motor Co., Ltd. of Japan have decided to use this chemically-recycled material for their products. Sumitomo Chemical will accelerate the implementation of chemical recycling in the MMA supply chain as an industry leader.

In 2022, Sumitomo Chemical constructed a new pilot facility for the chemical recycling of PMMA at its Ehime Works located in Niihama City, Ehime Prefecture, Japan. It has also implemented such initiatives as a joint project with Niihama City to recycle PMMA protective partition panels, which are used for reducing the spread of droplets, in the area, as well as providing its chemically-recycled PMMA as raw material for the acrylic jewelry sold by Star Jewelry Co., Ltd.

In addition, Sumitomo Chemical has received third-party certifications, such as the ISCC PLUS* certification, and is making efforts to globally implementing practical recycling systems using the mass balance approach.

Sumitomo Chemical will provide its chemically recycled PMMA produced in mass production facilities for applications that require high quality, such as electronics and automotives. The Company will start selling the product to LG Display as raw material for light guide plates used in backlight units for liquid crystal displays and to Nissan Motor as raw material for lenses used in vehicle headlights.

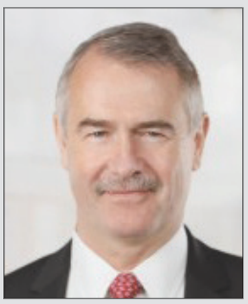
LANXESS introduces Vulkanox HS Scopeblue for Sustainable Tire Production

Mumbai, India: LANXESS' new rubber additive Vulkanox HS Scopeblue supports tire manufacturers in producing more sustainable, longer-lasting tires and in achieving their sustainability goals. The antidegradant from the specialty chemicals company is the sustainable variant of the proven antioxidant Vulkanox HS (TMQ), which tire manufacturers use to effectively protect their products from adverse effects of oxygen and heat. The additive is also characterized by low volatility and low migration tendency.

Compared to the conventionally manufactured product, the carbon footprint of Vulkanox HS Scopeblue is more than 30 percent lower. This is achieved by using biocircular acetone and renewable energy in production. The mass-balanced product is manufactured in an ISCC PLUS-certified plant in Germany. Since the overall chemical structure of the product remains unchanged, no modifications to the tire manufacturing process are required and customers can use Vulkanox HS Scopeblue as drop-in to produce more sustainable tires.

The additive is marketed under the LANXESS Scopeblue label, which stands for products with a particularly low carbon footprint or a high proportion of circular raw

AkzoNobel nominates Dr. Hans-Joachim Muller to Supervisory Board

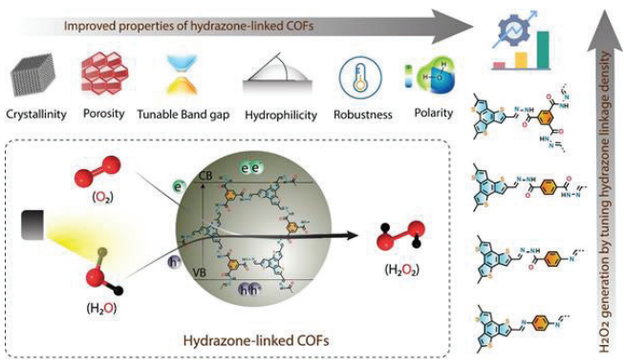


AkzoNobel has announced the nomination of Dr. Hans-Joachim Müller to the company's Supervisory Board. The appointment will be put to shareholders for approval at the Annual General Meeting on April 25, 2025.

Commenting on the nomination, Ben Noteboom, Chair of AkzoNobel's Supervisory Board, said, "With Hans-Joachim joining, we look forward to continuing to create long-term value for all our stakeholders. He brings a wealth of knowledge in science and experience in the chemicals industry. We wish him every success in his new role." Dr. Müller is currently Chair of the Supervisory Board of TIB Chemicals AG and a member of the Supervisory Board of Lanxess AG.

materials. "With Vulkanox HS Scopeblue, we have developed another product that enables our customers to manufacture tires more sustainably and meets the growing demand for sustainable and environmentally friendly materials," says Dr. Holger Graf, head of the Functional Tire Additives business line at the LANXESS Rhein Chemie business unit. "With this antioxidant, we extend the lifetime of tires while reducing their ecological footprint."

Scientists to develop green and efficient synthesis of hydrogen peroxide



Sustainable synthesis and versatile applications of hydrogen peroxide

New Delhi, India: Researchers have found an efficient, less energy-intensive, and environmentally friendly way of synthesizing hydrogen peroxide, a chemical that is crucial to the industry for disinfection, paper bleaching, and so on.

Hydrogen peroxide (H_2O_2) is a versatile oxidizing agent that is widely used in environmental disinfection, chemical synthesis, paper bleaching, and fuel cells. In addition, the growth of this market is driven by the increasing awareness of disinfection, the rise in the number of surgeries, the prevalence of hospital-acquired infections, and so on. Currently, over 95% of H2O2 is produced industrially using the anthraquinone oxidation process, which is very energy intensive, expensive and produces many hazardous chemicals as by-products.

Scientists are therefore looking for an environmentally friendly and economical strategy to produce H2O2 from renewable resources with minimal environmental impact. In this context, a new class of porous and ordered polymers with modifiable catalytic sites and light-harvesting properties in visible range, called covalent organic frameworks (COFs), have emerged as promising photocatalysts.

Researchers at S. N. Bose National Centre for Basic Sciences, Kolkata, an autonomous institute under the Department of Science and Technology (DST), have designed and prepared a series of COFs having good water affinity through careful control of the hydrazone linkage density and studied their effect on the photocatalytic performance for H_2O_2 generation. It was observed that the hydrazone-linked COFs provide abundant docking sites for water and oxygen, thereby promoting water oxidation reaction (WOR) and oxygen reduction reaction (ORR) - two main pathways for photocatalytic H_2O_2 generation.

As a result, the hydrazone-linked COF exhibited exceptional photocatalytic H_2O_2 production without external sacrificial electron donors when irradiated with a 40 W blue LED (λ = 467 nm). Interestingly, a significant amount of H_2O_2 (550 µmol g-1 h-1) was also produced under sunlight irradiation, which outperforms most organic photocatalysts under similar conditions, thus demonstrating a clean and sustainable pathway.

Furthermore, as-synthesized hydrazone-linked COFs can generate H_2O_2 up to 21641 µmol g-1 h-1 using an aqueous benzyl alcohol solution (water: benzyl alcohol = 90:10) by preventing the degradation of H_2O_2. This strategy of using a mixture of water-benzyl alcohol solution will be helpful in developing a continuous flow reactor for the sustainable production of H_2O_2 and will reveal a laboratory-to-industry technology transfer for the benefit of mankind.

India to Lead the World in Green Hydrogen: Union Minister Shri Pralhad Joshi

New Delhi, India: Union Minister for New and Renewable Energy, Shri Pralhad Joshi, said that India is striving to becoming a global leader in green hydrogen production and utilization. Speaking at the flag-off ceremony of India's first fleet of hydrogen-powered truck trials in New Delhi, the Minister highlighted the transformative vision behind the National Green Hydrogen Mission (NGHM) and the country's strides towards energy independence.

Union Minister Shri Pralhad Joshi emphasized that, under the leadership of Prime Minister Shri Narendra Modi, India has positioned itself at the forefront of the global green energy transition. With an allocation of ₹19,744 crore, the National Green Hydrogen Mission aims to

establish India as a key player in hydrogen production, storage, and application across various sectors. He noted that India has already made remarkable progress, awarding 4,12,000 TPA of Green Hydrogen production and approving 3 GW of electrolyser manufacturing capacity per annum. Additionally, seven pilot projects have been launched across transportation, shipping, steel, and storage, alongside the publication of 88 standards to ensure safety and scalability.

Looking ahead, the Minister outlined India's ambitious 2030 targets, which include producing 5 million metric tons (MMT) of Green Hydrogen annually, installing 60-100 GW of electrolyser capacity, and adding 125 GW of renewable energy capacity dedicated to hydrogen production. These initiatives are expected to help reduce 50 million metric tons of CO_2 emissions annually, save ₹1 lakh crore in imports, and attract investments worth ₹8 lakh crore.

Nouryon becomes first Nordic supplier to launch low-carbon hydrogen peroxide

Jennie Malker, Vice President of Research and Development, Renewable Fibers Nouryon

Dublin, Ireland: Nouryon, a global specialty chemicals leader, has announced the launch of Eka® HP Puroxide™, a new low-carbon hydrogen peroxide product. As the first company in the Nordics to offer this solution, Nouryon provides customers in the pulp and paper, mining, and water treatment end markets with a solution to significantly reduce their Scope 3 greenhouse gas emissions.

At Nouryon's sodium chlorate and hydrogen peroxide manufacturing facilities, processes are closely linked to manufacture a hydrogen peroxide product with a low-carbon footprint. This synergy enables Nouryon to offer a regional hydrogen peroxide product that reduces the carbon footprint by up to 90 per cent compared to natural gas steam reforming processes.

Eka® HP Puroxide™ is produced using fossil-free hydrogen, sourced from Nouryon's chlorate production and oxygen from the air, resulting in a very low carbon footprint. Unlike traditional methods that use natural gas, Eka® HP Puroxide™ relies solely on fossil-free hydrogen gas and is produced in Sweden exclusively using renewable electricity.

"We are proud to be the first in the Nordics to launch a hydrogen peroxide product with a very low carbon footprint. This Eco-Premium Solution is designed to help our customers achieve their emission reduction targets by reducing their Scope 3 emissions. This represents a significant step forward for both traditional and new hydrogen peroxide customers in Europe and a major step forward in reducing environmental impact," said Jennie Malker, Vice President of Research and Development, Renewable Fibers at Nouryon.

OMV and ADNOC to create USD 60+ bn global polyolefins champion

North America: OMV and ADNOC have announced the signing of a binding agreement for the combination of their shareholdings in Borealis and Borouge into Borouge Group International. ADNOC has also entered in a share purchase agreement with Nova Chemicals Holdings GmbH, an indirectly wholly owned company of Mubadala Investment Company P.J.S.C. for 100 per cent of Nova Chemicals for an enterprise value of USD13.4 billion. ADNOC and OMV have also agreed that upon completion of the combination, Borouge Group International will acquire Nova Chemicals further expanding its footprint in North America.

Once fully operational, Borouge 4 is envisaged to be retransferred to Borouge Group International at the end of 2026 at cost, estimated to be approximately USD 7.5 billion. When combined, the three highly complementary world-class businesses will create the fourth-largest global polyolefin group with equal shareholdings by OMV and ADNOC.

The acquisition of Nova Chemicals, a North American-based polyolefin producer and a leader in advanced packaging solutions and proprietary technologies, will further strengthen Borouge Group International's presence across the Americas and increase its exposure to advantaged feedstock. Borouge Group International will be uniquely positioned to create value and generate superior through-cycle shareholder returns, supported by synergies and a strong pipeline of organic growth projects. ■

Thermax partners with OCQ for high-performance chemicals

Ashish Bhandari (L), Managing Director and CEO, Thermax Limited and Francisco Fortunato (R), Founding Partner, OCQ Group, during the signing of the agreement.

Pune, Maharashtra: Thermax Chemical Solutions Private Limited, a wholly-owned subsidiary of Thermax, has entered into an exclusive shareholder's agreement with Oswaldo Cruz Química Indústria e Comércio Ltda (OCQ), one of the leading chemical companies in Latin America producing resins and polymers. Thermax will hold a majority 51 per cent stake in this new company, while OCQ will have a 49 per cent share.

The new entity will be responsible for manufacturing, trading, marketing and selling OCQ formulated materials by leveraging Thermax's existing resources, infrastructure and extensive customer base. To accommodate the new operations, Thermax will adapt its existing industrial plant at Jhagadia, Gujarat, India, and establish the first production line to manufacture acrylic resins.

Commenting on this partnership, Ashish Bhandari, Managing Director and CEO, Thermax Limited, said, "OCQ is a leading company in its space, and partnering with them will help us manufacture and deliver high-performance chemicals to a wide range of industries. Initially, production will focus on acrylic resins—widely used in the paint, adhesives, infrastructure, textile and waterproofing industries. In the future, the plant will expand to include polyester and alkyd resins, among others. This step marks the beginning of our venturing into a new line of business within the chemical range of solutions."

The new entity will strengthen Thermax's chemical portfolio, which currently includes ion exchange resins, water treatment chemicals, oil field chemicals, and construction chemicals.

Ormecon to set up new manufacturing plant in Assam

Dr. Arindam Adhikari (Extreme left), Founder-Director, Ormecon Pvt Ltd, during the signing of the MoU with Government of Assam.

Pune, Maharashtra: Ormecon Pvt. Ltd. recently signed MoU with Government of Assam for setting up of manufacturing plant in Tinsukia, Assam for production of electrically conductive polymer based materials for various applications, mainly high performance anticorrosion primer.

Dr. Arindam Adhikari, Founder-Director, Ormecon Pvt Ltd, said, "Conductive polymers based coatings have emerged as a powerful and safe replacement for hexavalent chromate as well as zinc rich primers for corrosion protection, due to their reversible redox properties and conductivity. Various studies show that these coating systems have the ability to out-perform even the best conventional anticorrosion coating systems available."

Ormecon is planning to set up one manufacturing plant in Assam to cater to the needs of the customers of North East India and South East Asia. On choosing Assam as the manufacturing hub, Dr Arindam said, "The present government's focus on infrastructure development in Northeast India along with the ongoing infrastructure development projects in the South East Asian countries was a plus. In addition having a long coast line of about 2,34,000 km with many national and international sea ports, plus the infrastructure surrounding these ports and along the coastline presents a significant opportunity for high-performance anticorrosion primers."

"If Act East policy of Government of India is implemented, manufacturers will gain access to a larger customer

base in Southeast Asia and a huge market will open up for Indian manufacturers, particularly for manufacturers based out of North East India. Assam, being strategically located will emerge as a key economic powerhouse, and will position itself as a strategic gateway between India and South East Asia driving long-term prosperity. It therefore holds strategic importance for setting up a manufacturing plant, ensuring accessibility to both domestic and international markets," he added.

Ormecon Pvt Ltd, established in 2018, is an innovation driven enterprise engaged in R&D and manufacturing of high quality electrically conductive polymers for environmental friendly high performance anticorrosion primer and other applications such as EMI Shielding, RADAR absorbing paint etc. At present it is having an R&D and manufacturing facility in Pune, Maharashtra.

SJVN signs MoU for 1800 MW Kotpali Pumped Storage Project

Executives during the signing of MoU for development of 1800 MW Kotpali Pumped Storage Project (PSP) in Chhattisgarh

Shimla, Himachal Pradesh: SJVN has signed a Memorandum of Understanding (MoU) with Government of Chhattisgarh and Chhattisgarh State Power Generation Company Limited (CSPGCL) for development of 1800 MW Kotpali Pumped Storage Project (PSP) in Chhattisgarh.

The Kotpali PSP is an off-stream closed-loop type pumped storage project located in Balrampur District, Chhattisgarh. With an installed capacity of 1800 MW, the project is expected to generate approximately 3967 million units of electricity annually. Once operational, it will contribute significantly to India's energy transition goals.

The project entails an investment of ₹9,500 crore and is anticipated to generate direct and indirect employment opportunities for around 5,000 people during construction and development phases. It will also drive economic growth, attract investments and create direct and indirect job opportunities in the region.

Welspun inks pact with Saudi Aramco to set up new facility

Mumbai, India: Welspun Corp Ltd has entered into a pact with Saudi Aramco to build a Longitudinal Submerged Arc Welded (LSAW) line pipe manufacturing facility in Saudi Arabia. The facility will be located in Dammam 3rd Industrial City, and will have an annual production capacity of 350,000 MT. It is expected to begin operations by mid-2026. The new facility will be equipped with comprehensive capabilities to support future line pipe requirements for Saudi Aramco's ongoing and upcoming projects, including the transmission of oil, gas, hydrogen, and Carbon Capture Utilisation and Storage (CCUS) developments.

Sudarshan Chemical completes acquisition of Heubach Group

Mumbai, India: Sudarshan Chemical Industries Limited announced that through its wholly owned subsidiary Sudarshan Europe B.V., it has completed its acquisition of Germany-based Heubach Group in a combination of an asset and share deal.

This strategic acquisition creates a global pigment leader, bringing together SCIL's operations and expertise with Heubach's technological capabilities. It will enhance SCIL's product portfolio, giving it access to a diversified asset footprint across 19 international sites. The combined company will have a broad pigment portfolio of high-quality products and a strong presence in major markets including Europe and the Americas.

The new Sudarshan is ideally positioned to deliver high-quality solutions that fit its global customers' needs. Rajesh Rathi will lead the combined company as Managing Director and Chief Executive Officer alongside a high-performing leadership team with techno-managerial competencies.

Heubach has a 200-year-old history and became the second largest pigment player in the world after its integration with Clariant in 2022. It had over a billion euros in revenue in FY21 and FY22, with a global footprint especially in Europe, Americas, and the APAC region. Heubach faced financial challenges over the past two years due to rising costs, inventory issues, and

high interest rates. SCIL's acquisition of Heubach will address these challenges with a clear turnaround plan.

Commenting on the closure of the acquisition, Rathi said, "Today marks an exciting new chapter as we unite with Heubach to become an inspirational leader in the colorants industry. The combined company builds on the rich legacies of both Sudarshan and Heubach. Our goal is now to create the world's most valuable pigment company with great financial strength and profitability. Together, we will drive continuous innovation and deliver breakthrough solutions that benefit each of our stakeholders."

Coromandel International signs agreement to acquire controlling stake in NACL Industries

New Delhi, India: Coromandel International Limited, one of India's leading agri-solutions provider, announced the signing of definitive agreements to acquire majority stake in NACL Industries Limited (NACL). NACL is an India based Crop Protection player having strong branded formulation business in domestic markets, exports Technicals in key global geographies and has presence in contract manufacturing operations with global multinational agrochemical companies.

Coromandel is set to acquire 53 per cent shareholding in NACL industries, for consideration of ₹ 820 Crores at ₹76.7 price per share from the current promoter KLR Products Limited. Coromandel also proposes to make an open offer to the public to acquire upto 26 per cent of the equity share capital of the company as per the SEBI Takeover Regulations. The proposed transaction is subject to regulatory approvals and is likely to be consummated over next few months.

The proposed acquisition will position Coromandel as one of the leading players in the Indian Crop Protection industry with a wide range of technicals and pan India presence in domestic formulation business. This will also help in expanding Coromandel's scale, accelerating its entry into contract manufacturing business, fast-tracking new product commercialization and expanding its product portfolio.

NACL Industries operates Technical and Formulation plants in Andhra Pradesh, besides having centralized R&D facility near Hyderabad. NACL's subsidiary has also recently invested in Technical grade facility at Dahej, capable of manufacturing Active Ingredients. It has established formidable partnerships with key global players, offering contract manufacturing services for over two decades. The company has strong brand presence in domestic formulations segment with pan India footprint.

Reflecting on the transaction, Coromandel's Executive Chairman Arun Alagappan stated, "This is a defining moment for Coromandel International's Crop Protection business. Coromandel's long-term strategy has always been centered on driving sustainable growth and market leadership. The decision to acquire NACL Industries is a natural extension of company's growth vision. By combining our extensive distribution network and deep industry expertise with NACL's manufacturing capabilities, diversified product portfolio and large formulations presence, we are setting the stage for a significant increase in operational scale. The acquisition not only expands our scale but also enables us to tap into critical customer segments and secure strategic CDMO relationships."

Anupam Rasayan signs LOI with leading Korean MNC

Surat, India: Anupam Rasayan India Ltd, a leading custom synthesis and specialty chemicals company, has signed a 10-year letter of intent valued at USD 106 million (approximately ₹922 crores) with a Korean multinational recognized for its leadership in specialty chemicals for a high-performance niche chemical expected to be supplied from FY26.

This partnership reinforces Anupam's expertise in delivering advanced chemical solutions and strengthens its presence in high-growth global markets.

Gopal Agrawal, CEO of Anupam Rasayan, said: "Securing this long-term LOI with a global industry leader is a testament to our strong R&D capabilities and commitment to innovation. The specialty chemical covered under this agreement has niche applications in the aviation and electronics sectors. With our robust backward integration capabilities, we ensure a stable and efficient supply chain, offering reliability and consistency to our global customers. Expanding into South Korea adds another significant geography to Anupam Rasayan's global presence, positioning the company for long-term growth in one of the world's most advanced manufacturing hubs."

Anupam Rasayan India Ltd is one of the leading companies engaged in the custom synthesis (CSM) and manufacturing of specialty chemicals in India.

Silox Group inaugurates new Research & Innovation Centre in Gujarat

Vadodara, India: Silox Group has inaugurated its new Research & Innovation Centre (RIC) in the presence of Her Royal Highness Princess Astrid of Belgium.

The new facility will complement its existing research and development activities that, to date, will mainly focus on the core inorganic chemicals activities of the group, to include the innovation areas in which Silox plans to invest going forward.

The RIC will focus on fundamental research, enhancing the circularity and sustainability of its current product portfolio, and new developments for recycling valuable materials with a focus on critical metals. The RIC is expected to be fully operational by the 2nd quarter of 2025.

The RIC will also act as an incubation centre to develop new products, support new application developments for new market needs and complement research needs of the global group entities. The initial investment represents roughly Euro 2 million and will be enhanced in future to meet the emerging needs of Silox activities worldwide.

Evonik Coating Additives launches first mass balanced products for coatings and inks

Essen, Germany: Evonik Coating Additives introduces its first two mass balanced products, TEGO® Wet 270 eCO and TEGO® Foamex 812 eCO, providing coating and ink formulators with the same high-performing defoamer and wetting agent properties they expect, but with a reduced carbon footprint.

The raw materials used to produce these additives – both organic and inorganic – have the greatest impact on the final product's carbon footprint. By investing in ISCC certified raw materials, Evonik Coating Additives has significantly reduced that footprint. The newly implemented mass balance approach allows for the allocation of bio-attributed or recycled-attributed feedstock to specific products, providing a traceable and credible way to reduce fossil carbon use in coatings. "By using ISCC certified raw materials, we are contributing to the replacement of virgin fossil resources by renewable feedstocks. This allows us to support our customers in the reduction of their Scope 3 upstream emissions" says Tim-Frederic Sloot, Head of Sustainability at Evonik Coating Additives, who led the development of the first mass balanced products.

BASF and Sika launch new epoxy hardener

Mumbai, India: BASF and Sika have jointly developed a new amine building block for curing epoxy resins, which is now commercially available under BASF's Baxxodur EC 151 brand. This new development is particularly interesting for flooring applications, for example, in production plants, storage and assembly halls, as well as parking decks.

Baxxodur EC 151 gives epoxy resin flooring solutions a low viscosity and optimum flow properties. As a result, the coatings are easy to apply and spread evenly. Compared to conventional hardeners, significantly less thinner is required, and up to 90 percent less volatile organic compounds (VOCs) are released. Baxxodur EC 151 thus enables the production of ultra-low VOC formulations. It also allows for greater use of mineral fillers, which not only lowers costs but also contributes to sustainability.

Epoxy resin coatings formulated with Baxxodur EC 151 cure quickly and thoroughly over a wide temperature range. This extends their applicability during colder months of the year, especially at temperatures between 5 and 10 degrees Celsius, where conventional hardeners tend to "freeze". Compared with conventional hardeners, the curing time is reduced by up to two thirds, meaning that the coating can be walked on shortly after application.

The cured epoxy resin products are characterized by an aesthetic, glossy surface. Clouding, which is caused by haze formation (so-called "blushing") and which occurs with conventional hardeners, particularly in edge areas, is avoided. The products have excellent color stability and are resistant to mechanical and chemical influences. This makes them particularly durable and significantly reduces maintenance costs.

As part of the research cooperation, Sika has developed the new amine building block as a high-performance hardener for more efficient and sustainable epoxy

products and successfully applied it in Sikafloor® floor coatings. BASF has developed a suitable manufacturing process and scaled it up from the laboratory to production scale.

Covestro increases capacity for polycarbonate specialty films in Thailand

Germany: Covestro has further increased its global capacity for polycarbonate (PC) specialty films at the Map Ta Phut Industrial Park in Thailand. The investment is in the higher double-digit million Euro range, the project has been completed on schedule. A total of around 40 new jobs will be created.

"The new production facilities are equipped with state-of-the technology to enable an efficient production and thereby reduce our CO_2 emissions," says Thorsten Dreier, Chief Technology Officer of Covestro. "With the expanded capacity, we can meet our customers' growing demand for innovative specialty films, especially in medical technology, in the region Asia-Pacific and strengthen our Solutions & Specialties segment."

Covestro has been operating a production facility for Specialty Films in Thailand since 2007. The range comprises polycarbonate films from the Makrofol® range and Bayfol® products made from polycarbonate blends. These high-performance specialty films are used in many applications across multiple industries, such as healthcare, mobility and Identification Documents.

"The new production facilities are important to us because it enables faster time to market and at the same time expands our market access in Asia-Pacific," says Aukje Doornbos, Global Head of the Specialty Films business entity. "With market-focused innovations and a stronger customer orientation we want to drive growth for Covestro."

Cabinet approves setting up of new Brownfield Fertilizer Plant in Assam

New Delhi, India: The Union Cabinet, chaired by the Prime Minister Shri Narendra Modi, has approved the proposal for setting up of a new Brownfield Ammonia-Urea Complex of 12.7 Lakh Metric Tonnes (LMT) annual capacity of Urea production. The plant will be set up within the existing premises of Brahmaputra Valley Fertilizer Corporation Limited (BVFCL), Namrup Assam, with an estimated total project cost of ₹10,601.40 crore with Debt Equity ratio of 70:30 through a Joint Venture (JV), under the New Investment Policy, 2012 read with its amendments on 7th October, 2014. The tentative overall time schedule for commissioning of Namrup-IV Project is 48 months.

Additionally, the Cabinet also approved the National Fertilizers Limited (NFL)'s equity participation of 18 per cent in relaxation to the limits prescribed in Department of Public Enterprises (DPE) guidelines; and constitution of an Inter-Ministerial Committee (IMC) to oversee the process of setting up of Namrup-IV Fertilizer Plant. In the proposed JV, equity pattern will be Government of Assam (40 per cent); Brahmaputra Valley Fertilizer Corporation Limited (BVFCL) (11 per cent); Hindustan Urvarak & Rasayan Limited (HURL) (13 per cent); National Fertilizers Limited (NFL) (18 per cent); Oil India Limited (OIL) (18 per cent). BVFCL's share of equity shall be in lieu of tangible assets.

The project will increase the domestic Urea production capacity in the country especially in the North-Eastern region. It will meet the growing demand of Urea fertilizers of North East, Bihar, West Bengal, Eastern Uttar Pradesh, and Jharkhand. The establishment of Namrup-IV unit will be more energy efficient. It will also open avenues for additional direct and indirect employment opportunity to the people of the area. It shall help achieve the vision of self-reliance in Urea in the country.

CSIR-IIIM & HAPICO Industries sign MoU for biopesticide development

Dr Zabeer Ahmed, Director CSIR-IIIM and Shabeer Ahmed, MD, HAPICO Industries, after signing the MoU at Jammu.

New Delhi, India: The CSIR - Indian Institute of Integrative Medicine (CSIR-IIIM), Jammu, signed a Memorandum of Understanding (MoU) with HAPICO Industries Private Limited on 20 March 2025 to jointly develop novel biopesticides.

The MoU was formally signed by Dr Zabeer Ahmed, Director, CSIR-IIIM, and Mr. Shabeer Ahmed, Managing Director, HAPICO Industries, in the presence of Dr Asha Chaubey, Senior Principal Scientist & Head, FMB Division; Dr Saurabh Saran, Principal Scientist, FMB; and Dr Love Sharma, Scientist, RMBD&IST.

This strategic partnership aims to address the detrimental impact of chemical pesticides on human health and the environment. Given the rich biodiversity of medicinal and aromatic plants, the collaboration seeks to harness their potential for developing innovative and sustainable biopesticide solutions.

Speaking on the occasion, Dr Zabeer Ahmed reaffirmed the commitment of CSIR-IIIM to the translational and sustainable approach in biopesticide development and providing industrial interface to the technologies emanating from the collaboration, ensuring direct benefits for farmers across the country. CSIR-IIIM, with its advanced fermentation and microbial technology infrastructure, has been actively engaged in research pursuits and development of agricultural solutions, including plant growth-promoting products, Active Pharmaceutical Ingredients (APIs), enzymes and biocontrol formulations.

Shabeer Ahmed, Managing Director, HAPICO Industries, highlighted the collaboration as a strategic initiative to expand the company's product portfolio and contribute to sectoral growth. "By leveraging CSIR-IIIM's scientific expertise, HAPICO aims to develop innovative, sustainable solutions that align with the evolving market demands," he stated.

Elaborating on the technical aspects, Dr Asha Chaubey, Head, FMB Division, emphasized that the focus of the collaboration would be on formulating a biopesticide derived from a potent indigenous microbial strain identified by CSIR-IIIM.

Mitsui Chemicals sets up coating technical center in India

Coating machine

Gurugram, Haryana: Mitsui Chemicals, Inc. has announced that its subsidiary Mitsui Chemicals India Pvt. Ltd. has established the Coating Technical Center (CTC) in Gurugram, in Haryana. The new center has been created with the aim of improving technical support capabilities in the company's coatings and engineering materials business.

Against the backdrop of mounting concern about environmental problems and the tightening of government regulations, India is seeing growing demand for sustainable packaging. Of particular note are moves to reduce the use of disposable plastic and switch to alternative materials.

The facility is equipped with coating machines capable of handling all kinds of coating methods – including gravure, reverse gravure and air knife – along with analyzers. This will allow customers' issues to be quickly resolved in India rather than having to send products to Japan for testing and evaluation, as had been the case previously. In addition, the CTC will help support customers in developing products by undertaking R&D focused on the latest coating technologies, as well as by providing technical guidance to customers on getting the most out of Mitsui Chemicals' products.

Future of Water: Decentralised Management for a Water Secure World

Innovation in water technology is not just a solution but a necessity for economic stability. Johkasou, a Japanese innovation, is a compact and efficient on-site wastewater treatment system. This article explains in detail the technology and how decentralized wastewater treatment systems like Johkasou offer a transformative approach, enabling businesses to reduce their environmental footprint and secure water resources sustainably.

Water is the lifeblood of industries, agriculture, and human settlements. Yet, India is at a critical juncture, grappling with freshwater stress that severely impacts its environment, economy, and businesses. As water resources diminish, the urgency to adopt sustainable water management practices has reached the boardrooms of stakeholders. Innovation in water technology is not just a solution but a necessity for economic stability.

India's Freshwater Stress & Impact on Businesses

The environmental consequences are dire, with polluted rivers, shrinking aquifers, and degraded ecosystems. For the businesses, the impact is equally profound. Industries such as agriculture, manufacturing, and power generation rely heavily on water. Scarcity leads to increased operational costs, supply chain disruptions, and reputational risks.

Why Water Management Should Be a Boardroom Priority

Water scarcity is a pressing reality, and businesses must treat water as a critical resource for sustainability, compliance, and risk mitigation. Regulatory bodies like the CPCB mandate wastewater treatment, while global frameworks such as TCFD emphasize water risk in governance. From 2000 to 2023, India launched landmark initiatives that improved urban water and sanitation systems, but challenges remain.

Sustainability, driven by customers, employees, and stakeholders, demands attention to water's critical role in food supply, energy saving, and achieving SDG goals like the Green Mission and Net Zero Mission. Embracing decentralized water management can empower industries to manage resources locally and reduce reliance on external systems, paving the way for a secure water future.

Decentralized Wastewater Treatment Using Johkasou

Johkasou, a Japanese innovation, is a compact and efficient on-site wastewater treatment system. Widely used in Japan, it has proven effective in managing domestic and industrial wastewater. Its adaptability makes it an excellent solution for urban housing complexes, small industries, and even rural areas in India.

Typical Installation Consideration

Site Assessment: A feasibility study is done to estimate the volume of domestic wastewater generated.

Design Customization: It is done based on the site conditions, the usage pattern, and the potential reuse of treated wastewater.

Deployment: The system is installed underground or in compact spaces, ensuring minimal disruption. It can also be integrated with other plumbing and tertiary treatment systems.

Applications of Treated Wastewater

A decentralised approach can play a crucial role in meeting the objectives of:

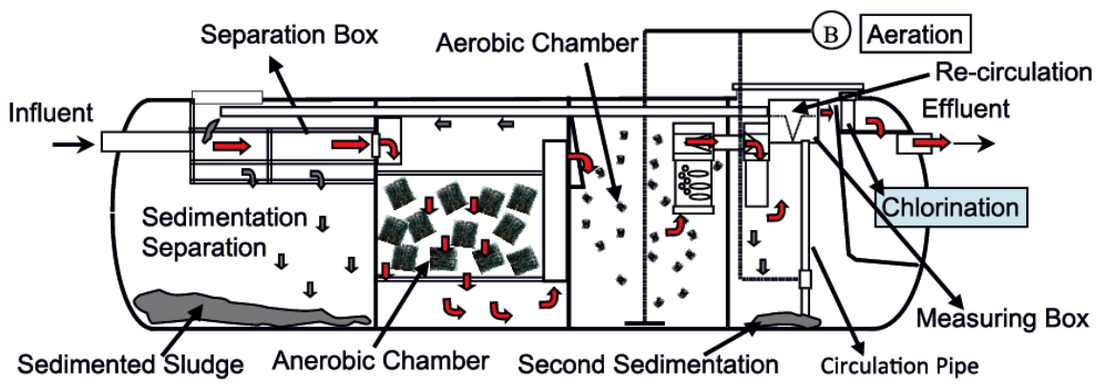
Industrial Use: Cooling systems, cleaning, and other nonpotable processes.

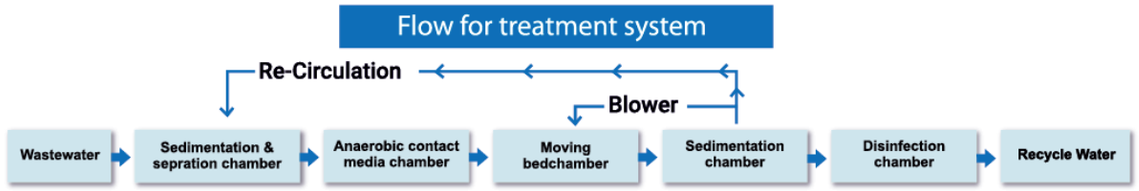
Civic Usage: Flushing toilets, cleaning roads, and firefighting.

Benefits of Decentralized Water Management

Localized Water Management: By implementing decentralised water management systems, each local industry can manage its water resources.

Process of Treatment of Johkasou





The Johkasou system employs advanced biological and mechanical processes to treat wastewater. Here's a breakdown

01 Separation Box
Separate solids in wastewater by gravity and prevent the agitation of the excess sludge in the Sedimentation & Separation Chamber by influent.

02 Separation & Sedimentation Chamber
Separate solid debris or impurities from water in influent and circulated water and store these sediments in the chamber. Accumulated sludge should be de-sludged from the tank periodically at least once in 6 – 12 months.

03 Anaerobic Chamber
It is filled with filter materials, which separate solids and keep anaerobic microorganisms from decomposing organic matter.

04 Moving Bed Chamber
It is filled with mesh cylindrical media, which retain aerobic microorganisms to decompose and remove organic matter from wastewater.

05 Sedimentation Chamber
In order to obtain clear treated water, separate the excess sludge (suspended solids, SS) by gravity. The settled sludge is constantly returned to the sedimentation & separation chamber by the airlift pump.

06 Disinfection Chamber
Disinfect the treated water to discharge to the river or other water bodies.

Inlet Outlet

Comprehensive 360° Approach: Industries can tap into alternative sources like rainwater harvesting and groundwater recharge, reducing the strain on centralized water sources.

People Participation and Ownership: Decentralisation encourages people's participation and ownership in water management. When industries are involved in decision-making processes and actively engaged in maintaining water infrastructure, there is a higher likelihood of sustainable practices and effective long - term management.

Benefit to Industries

Energy Saving: Reduces energy consumption through efficient wastewater treatment.

Environmental Compliance: Ensures eco-friendly practices and aligns with sustainability goals.

Regulatory Compliance: Adheres to all waste water treatment regulations.

Water Conservation: Reclaims and saves fresh water while improving sanitation conditions.

Sustainability Focus: Serves the environment by saving water and energy, helping industries become more sustainable.

Conclusion

Water scarcity demands urgent and innovative solutions. Decentralized wastewater treatment systems like Johkasou offer a transformative approach, enabling businesses to reduce their environmental footprint and secure water resources sustainably. By integrating water management into strategic priorities, industries can mitigate risks, enhance resilience, and contribute to a circular economy. As India navigates its water crisis, adopting such solutions is not just a choice—it is an imperative. The time to act is now, turning challenges into opportunities for a sustainable future. ■

Author

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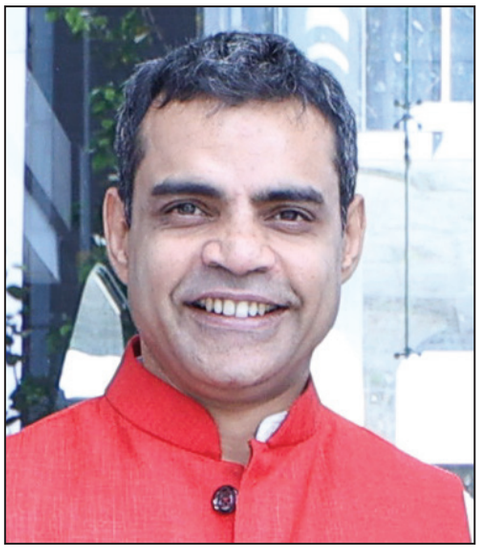
GUEST COLUMN

The Future of Carbon Capture: Digitalization, Machine Learning, and Cost Reduction Strategies



Ashwin Raikar
Managing Director
Nauvata Energy Transition (NET) Enterprise Pvt Ltd

The cost and efficiency of Carbon Capture, Utilisation and Storage (CCUS) systems are significantly impacted by technological advancements. The World Economic Forum has projected a 15 per cent decrease in global carbon emissions due to the digitalization of CCUS systems. This report emphasizes that the digital technology sector holds immense potential to accelerate efforts in keeping global temperature rise well below 2°C, positioning it as a powerful driver of climate action.

The urgency of tackling climate change has led to a focus on technologies that can effectively capture and store carbon dioxide (CO_2) in safe geological storage. Recent advancements driven by digitalization and machine learning offer an opportunity to reduce the cost of delivering Carbon Capture and Storage (CCS) projects.

Digitalization and Machine Learning: Transforming CCUS Efficiency

Carbon capture systems are designed to capture CO_2 emissions from industrial processes and direct air, and then utilize or store the captured carbon. The primary methods are Industrial Flue Gas Capture and Direct Air Capture (DAC), both crucial in the broader decarbonization effort. The lifecycle of decarbonization projects varies significantly depending on the industry and specific processes, making a tailored approach essential.

While the focus on capturing CO_2 remains the same, the cost and efficiency of Carbon Capture, Utilisation and Storage (CCUS) systems are significantly impacted by technological advancements. The World Economic Forum has projected a 15 per cent decrease

in global carbon emissions due to the digitalization of CCUS systems, underscoring the growing importance of these innovations. Connectivity will play a pivotal role in scaling many high-impact climate solutions. The recently launched Exponential Climate Action Roadmap outlines strategies for implementing the Carbon Law across key sectors of the global economy. This report emphasizes that the digital technology sector holds immense potential to accelerate efforts in keeping global temperature rise well below 2°C, positioning it as a powerful driver of climate action.

Improved Economics and Efficiency

Digital technologies such as IoT, Cloud Computing, and Artificial Intelligence (AI) are transforming CCUS systems, helping to reduce both capital and operational expenditures (OPEX). The operational side, in particular, benefits from predictive algorithms and AI-driven models, improving the efficiency of monitoring measurement and verification which is key to managing risks for CCS projects in the operating phase.

Machine Learning in Carbon Capture

Machine learning (ML) is key to improving the efficiency of CCUS systems, particularly in assessing solvents for CO_2 capture. By examining the physio-chemical properties of different solvents, ML models can identify the most suitable options for various industrial applications. This helps ensure the long-term effectiveness of carbon capture systems. ML is also instrumental in optimizing simulations and models of CO_2 capture processes, simplifying complex datasets, and analyzing multi-variate factors like the two-phase transport of CO_2. This helps scale up large CCUS operations and fine-tune processes that were previously too complex for manual analysis. Moreover, machine learning can assist in determining storage locations for captured CO_2 and identifying the most effective catalysts for CO_2 utilization.

However, while these applications are promising, several challenges remain. ML training models for CCUS data are still underdeveloped, and the lack of open-source data for AI models hampers the training process. Furthermore, there is a need for real-time scaled testing to understand how these models will perform in large, dynamic operations. With global environmental regulations becoming stricter, CCUS systems will also need to be scaled up to handle increased loads in the future.

Advancements in process simulations are playing a crucial role in minimizing risks across the CCS value chain. For example, improved modelling techniques allow more accurate identification of potential failure points in CO_2 transportation and compression. Additionally, Computational Fluid Dynamics (CFD) enhances the ability to predict CO_2 leakage scenarios, leading to stronger and more reliable system designs.

Cost Reduction Strategies in CCUS

Cost remains a significant barrier to the widespread adoption of CCUS technologies. Fortunately, several strategies are being explored to make these systems more cost-effective.

Cost Reduction in Carbon Capture: Since capture alone accounts for around 70 per cent of total CCUS costs, improving its efficiency is crucial. Several innovations can contribute to this:

- **Advanced Sorbents and Solvents:** Emerging materials such as Metal-Organic Frameworks (MOFs) and solid adsorbents offer significant potential for lowering energy consumption in the carbon capture process.
- **Process Integration:** Utilizing waste heat from industrial plants to regenerate solvents can lower energy costs and improve efficiency.
- **Membrane Technology:** Emerging membranes that reduce energy consumption offer operational cost savings.
- **Direct Air Capture (DAC) Innovations:** Modular and scalable DAC systems are helping reduce costs per ton of CO_2 captured.
- **Automation and AI:** Optimizing capture processes through machine learning can reduce downtime and enhance overall efficiency.

Economies of Scale and Modularization: Larger CCUS projects benefit from economies of scale. By sharing infrastructure such as pipelines, storage, and monitoring systems, per-unit costs are significantly lowered. Additionally, modular and standardized designs for carbon capture plants help streamline construction, reducing capital expenditures. Projects

like Norway's Northern Lights initiative, which uses shared CO_2 transport and storage hubs, are leading the way in reducing infrastructure duplication.

Cost Reduction in Carbon Utilization (CCU): Expanding the market for CO_2-based fuels, chemicals, and materials can make carbon utilization more profitable. Additionally, advancements in carbon mineralization for cement and construction materials can reduce energy requirements. Electrochemical CO_2 conversion is also progressing, with new electrolysis techniques reducing costs for producing synthetic fuels and chemicals.

Cost Optimization in Carbon Storage (CCS): Optimizing site selection for storage, especially using depleted oil and gas reservoirs, can lower geological risks and reduce costs. Improvements in injection and monitoring technologies, such as fibre optic sensing and AI-based leak detection, help reduce long-term operational costs. Furthermore, Enhanced Oil Recovery (EOR), where captured CO_2 is sold for use in oil recovery, can offset costs in early-stage CCS projects.

Policy and Financial Mechanisms: Shaping the Future of CCUS

Governments worldwide are introducing financial mechanisms to support the growth of CCUS technologies. Carbon pricing and credits are vital to making CCUS more economically viable, as they increase the financial incentives for reducing emissions. Governments in countries like the US and the UK have introduced tax incentives and subsidies (e.g., US 45Q tax credit, UK CCS funding) to bolster project economics.

Public-private partnerships (PPPs) are also becoming more common, allowing joint funding models that reduce investor's financial risk.

Streamlining Deployment: Faster Development and Reduced Time

To scale CCUS deployment, there is a focus on reducing development timelines. Streamlined permitting and regulatory processes can prevent lengthy approval periods, while pre-approved storage sites reduce the time needed for feasibility studies. Additionally, technologies like digital twins — which simulate CCUS plant performance before actual deployment — help minimize errors and optimize performance from the outset.

Conclusion

While CCUS systems remain expensive, the combination of digitalization, machine learning, and innovative cost-reduction strategies holds great promise for making carbon capture and storage more viable. As technological advancements continue and the global community pushes for more ambitious climate goals, CCUS systems will play an increasingly critical role in reducing emissions and meeting global sustainability targets. With ongoing research and collaboration, the future of CCUS looks bright, offering hope in the battle against climate change. ■

Surface Coating Technologies: Enhancing Corrosion Resistance with FRP Lining and Glass Flake Coating

Amongst surface coating technologies, Fiber-Reinforced Plastic (FRP) lining and Glass Flake coating are the most effective protective coatings. These provide superior resistance to aggressive environments. This article throws light on these two most effective ways of surface coating which are prevalent in the industry.

Surface coatings play a crucial role in mitigating material degradation caused by corrosion, chemical exposure, and mechanical wear. Industries such as chemical processing, oil & gas, marine, and wastewater treatment extensively employ advanced coating technologies to prolong equipment life and maintain operational efficiency. Among the most effective protective coatings are Fiber-Reinforced Plastic (FRP) lining and Glass Flake coating, both of which provide superior resistance to aggressive environments.

Scientific Principles of Surface Coatings

Surface coatings primarily function as protective barriers between a substrate (typically steel, concrete, or other metals) and environmental aggressors. The primary threats include Corrosive Chemicals (Acids, alkalis, solvents, and gases), Aqueous Environments (Saltwater, wastewater, and moisture ingress) and Thermal and Mechanical Stress (High temperatures, pressure, impact forces, and abrasion/wear). The efficacy of any surface coating is determined by several key scientific principles. Let us look at some of the key ones:

Electrochemical Protection: Coatings prevent the formation of electrochemical cells — which are typically responsible for the corrosion process — by acting as insulators between the substrate and electrolytes (e.g., water, acids, salts).

- **Permeation Resistance:** Coatings need to prevent the diffusion of corrosive agents (e.g. water, oxygen, acids) into the substrate. The molecular structure of the coating determines its ability to resist this permeation.

- **Adhesion Mechanisms:** Coating effectiveness is influenced by the adhesion strength to the substrate. The main forces at play are mechanical interlocking, chemical bonding, and physical adsorption.

Effective ways of surface coating

Based on the above key principles, we will look at two of the most effective ways of surface coating which are prevalent in the industry.

FRP lining

FRP lining is a composite material composed of a polymer matrix reinforced with high-strength fibers, primarily glass or carbon fibers. The mechanical and chemical properties of FRP linings are highly dependent on the type of resin and fiber reinforcement used:

- **Polymer Matrix:** FRP linings are composed of thermosetting resins such as polyester, vinyl ester, or epoxy, which are selected based on the type of chemical exposure and mechanical demands.
- **Fiber Reinforcement:** Glass fibers (e.g. E-glass, C-glass, S-glass) or carbon fibers are embedded within the resin matrix. The fibers provide high tensile strength, impact resistance, and fatigue endurance.
- **Filler Additives:** Silica, alumina, and other fillers improve the thermal resistance of the lining, reduce permeability, and increase overall strength.

The primary objective of FRP linings is to provide a structural barrier against aggressive environments. The challenges to choosing the right FRP lining have to consider factors like delamination, permeation to various corrosive agents, fatigue failure due to mechanical stress and thermal expansion of various composites and metals.

Glass Flake Coatings

Glass Flake coatings is a formulation which consists of ultra-thin glass flakes embedded in a thermosetting resin matrix (e.g., epoxy, polyester, or vinyl ester). The key design features of Glass Flake coatings are:

- Glass Flakes are typically 5-10 µm thick and 100-400 µm in size, with a high aspect ratio (length to thickness). This creates a lamellar structure with stronger adhesion to substrates, which improves diffusion resistance and mechanical strength.
- **Resin Matrix:** The resin encapsulates the glass flakes, binding them into a continuous film. The choice of resin additives like UV inhibitors, Silica etc determines the thermal and chemical resistance of the coating.

The key design goal for glass flake coatings is to create a dense, impermeable barrier that prevents chemical attack. The critical design challenges for these coatings focus on preventing issues like flake loss/chipping, cohesion loss and permeation under high pressures.

Industry Applications & Case Studies

Now that we have established the material compositions and the key design and failure mechanisms for these two types of corrosion-resistant coatings and linings, let us review a few industrial applications for them and how each of them is applied depending on the design requirements. We have further added some case study examples of our clients for each of these industries.

Chemical Processing Plants

- **FRP Lining:** Used in storage tanks, chemical reactors, and pipelines exposed to strong acids.
- **Glass Flake Coating:** Applied on containment areas and industrial flooring to prevent corrosion from spills.
- **Suyash Case Study:** An HCL acid storage tank in a refinery was lined with FRP for internal protection, while its exterior was coated with glass flake epoxy to withstand atmospheric exposure.

Oil & Gas Industry

- **FRP Lining:** Used for subsea pipelines, Gate and globe valves, separators, and storage tanks in offshore facilities.
- **Glass Flake Coating:** Protects drilling platforms, refinery structures, and pipeline exteriors and various types of valves.
- **Suyash Case Study:** Various types of gate, globe and check valves are lined with glass flake coatings for protection against seawater. We have also supplied pipes which are internally and externally coated with glass flake for corrosion protection.

Internally and externally coated pipes with Glass Flake Epoxy.

Glass flake epoxy coated valves.

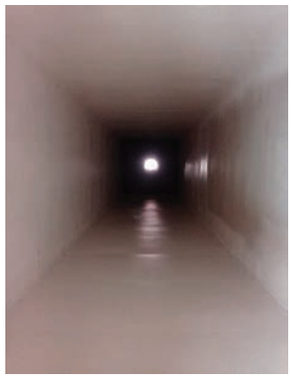
Wastewater Treatment Plants

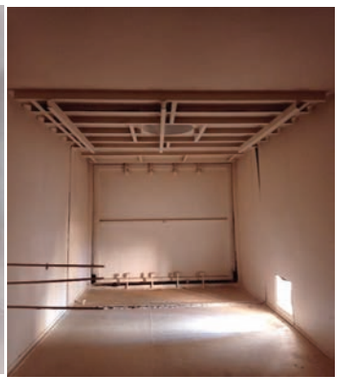
- **FRP Lining:** Used in sewage digesters and clarifiers.
- **Glass Flake Coating:** Applied on concrete basins and pipelines.
- **Suyash Case Study:** We have lined many RCC aeration basins and concrete tanks with FRP for protection from effluent water and seawater in some cases.

Power Plants & Energy Sector

- **FRP Lining:** Used in FGD systems and cooling towers.
- **Glass Flake Coating:** Protects chimneys and heat exchangers.
- **Suyash Case Study:** For FGD ducts and scrubbers, we have applied Glass Flake coating which can withstand temperatures of upto 200 Degrees Celcius of flue gases for our coal-fired power plant client. We have done FRP lining for condenser water boxes for sea water protection. RCC Aeration basins are lined with FRP lining for protection from effluent water.

FRP lining to Aeration basin.





FGD Ducts with Glass Flake Coating for temp upto 200Deg C.

Pharmaceutical Industry

- **FRP Lining:** Used in chemical processing tanks, solvent storage, and cleanroom flooring.
- **Glass Flake Coating:** Applied to bioreactors, fume hoods, and ventilation ducts to prevent chemical attack.
- **Suyash Case Study:** FDA approved Glass Flake coating was applied to a filter for our client in the US pharma industry.

Steel Industry

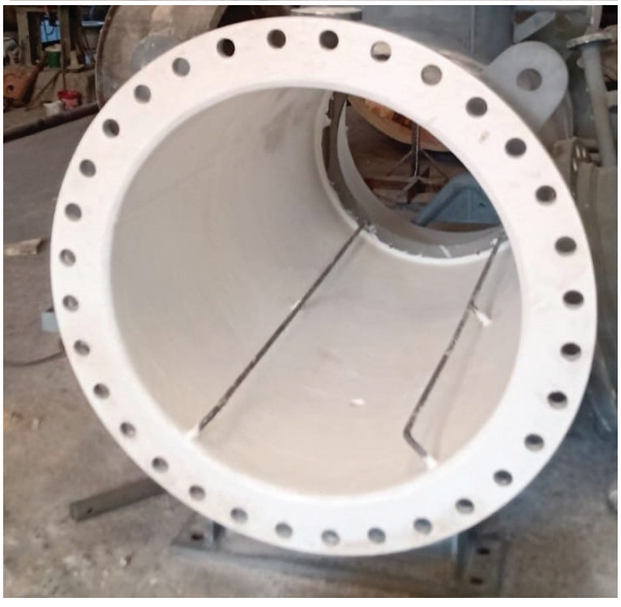
- **FRP Lining:** Used in acid pickling tanks, cooling water circuits, and gas scrubbers.
- **Glass Flake Coating:** Protects steel rolling mill structures, chimneys, and exhaust ducts.
- **Suyash Case Study:** MS tanks are lined with FRP for pickling purposes to increase the lifespan of the acid bath tanks.

Anodizing Industry

- **FRP Lining**: Applied in anodising tanks, chemical etching baths, and effluent treatment plants.
- **Glass Flake Coating:** Used on structural steel supports and fume extraction ducts.
- **Suyash Case Study:** We have supplied numerous MS tanks lined with FRP to the anodizing industry including for etching and powder coating

Conclusion

A lot of research is advancing rapidly in high-performance coatings — such as nanocoatings, self-healing coatings, and advanced polymer-based solutions —their commercial adoption is often hindered by cost considerations. Industries, especially in price-



FDA approved Glass Flake Coating for Tanks.

MS tanks lined with FRP for the anodizing and powder coating industry.

sensitive markets, are reluctant to switch to premium coatings unless the long-term benefits (like reduced maintenance and extended asset life) significantly outweigh the upfront costs.

The choice between FRP linings and Glass Flake coatings depends on operational conditions, mechanical stress, exposure to aggressive chemicals, and budget considerations. While FRP is preferred for structural integrity and long-term durability, Glass Flake coatings offer ease of application for surface protection.

Looking ahead, advancements in nanotechnology and hybrid coatings are set to enhance coating performance, sustainability, and lifespan of the coating. By leveraging these cutting-edge technologies, industries can extend asset lifespans, lower maintenance costs, and improve safety standards in harsh operational environments. Investing in the right protective coatings is crucial for long-term asset reliability, operational efficiency, and sustainable industrial practices. ■

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Conductive Polymers as Corrosion Resistant Additive for Paint

Conductive polymers based coatings have been found to be promising replacements for Cr(VI)-containing coatings, due to their reversible redox properties and conductivity. The advantage of using conductive polymers is that the electrical property of these materials can be reversibly controlled because of their reversible redox property, easy to interface with electronic device, flexibility, long life and high stability.

Corrosion is a universal phenomenon. India loses more than ₹ 2 trillion per year, whereas worldwide loss due to corrosion is estimated to be over USD2.5 trillion which is around 3.4 per cent of the world's GDP. Hazardous heavy metals such as the hexavalent chromium Cr(VI) containing materials are considered to be the most effective corrosion resistant additive but these are highly toxic, carcinogenic and causes irreversible health damage and are already banned globally. Zinc and/or zinc compounds are at present considered to be the alternative for Chromates. Though these materials are environmental compliant, these have limitations and are marine pollutant.

The quest for alternative for Cr+6 remains the favourite topic amongst researchers and conductive polymers based coatings have been found to be promising replacements for Cr(VI)-containing coatings, due to their reversible redox properties and conductivity.

The conductive polymers were discovered by Hideki Shirakawa, Alan MacDiarmid, and Alan Heeger in the mid-1970s, who were later awarded the 2000 Nobel Prize in Chemistry for their discovery and development of conductive polymers. Scientific community was excited to see the ability to dope these polymers over the full range from insulator to metal, which created new fields of research and a number opportunities started to open up. It was thought in the initial years that it would not be long before such materials could be put on practical use. It was not long, however, before these new materials proved to be unstable, insoluble and infusible. Various approaches were adopted to overcome these drawbacks and to use for different applications.

Conductive polymers such as PEDOT: PSS, polyaniline (PAni), polypyrrole (PPy), polythiophene (PTh), etc have been studied extensively in the recent decades for various applications such as light emitting diodes, EMI shielding, electrochromic devices, electrostatic charge dissipation, sensors and actuators, energy conversion systems, membrane filtration, catalysts and corrosion protection systems etc. Advantage of using conductive polymers is that the electrical property of these materials can be reversibly controlled because of their reversible redox property, easy to interface with electronic device, flexibility, long life, high stability, and environmental friendly.

After the initial reports by Mengoli [1] et al and DeBerry [2], interest in using conductive polymers in corrosion control have been growing and intensive efforts have been made to develop such coating systems. One of the chemistry Nobel laureates of 2000, Alan G. MacDiarmid famously quoted that "Corrosion, being an electrochemical phenomenon, can be tackled through the use of electrochemistry and conductive polymers". The corrosion protection by conductive polymers has been explored widely across globe and numerous scientific articles are being published every year in scientific journals. Among different conductive polymers, polyaniline (PAni), with its four different oxidation states viz., Leucoemeraldine (LB), Emeraldine Base (EB), Emeraldine Salt (ES) and Pernigraniline (PE), is found to be widely accepted material for anticorrosion application among researchers.

Dr. Bernhard Wessling, the renowned authority in the field of conductive polymers, had shown the world how to process conductive polymers (by dispersion) and

about the corrosion resistant property of conductive polymers. He made significant contributions to the field of conductive polymers, particularly in overcoming the insolubility of conductive PAni, a major limitation in its practical applications. His key breakthrough was the development of a process to disperse PAni nanoparticles in a stable form that allowed PAni to be used in various applications such as flexible electronics, antistatic coatings, corrosion protection, electromagnetic shielding etc. His dispersion technology enabled practical use of PAni in corrosion protection for metals, which proved highly effective. He successfully took it to the market under the brand name CORRPASSIVE. Wessling's innovations transformed PAni from an academic curiosity into a commercially viable material.

The PAni (with potential that differs only slightly from silver) ennobles the surface of conventional metals such as iron, steel, copper, aluminium or zinc while shifting their surface potential. As soon as a direct conductive contact is established between the PAni and the metal to be protected, a dual protective mechanism starts to take effect. It furthermore passivates the conventional metals by forming a metal oxide layer of up to 1 micron thickness in between the metal surface and the primer coating.

Conductive PAni also has the ability to protect the defect sites (scratches, or pinhole). At defect sites of the coating, galvanic coupling takes place between exposed iron and the PAni (ES) causing reduction of the PAni-ES to PAni-LB. The release of the counter ion (A-) from PAni may form an insoluble iron complex passivating the metal surface at the defect in a 'smart' way, providing self-repairing property of conductive PAni. [5]

In one of the study, author prepared PAni-ES based coating and applied on C-steel coupons and investigated their anticorrosion property using different electrochemical techniques dipped in 3 per cent NaCl solution.[6] In the Open circuit potential

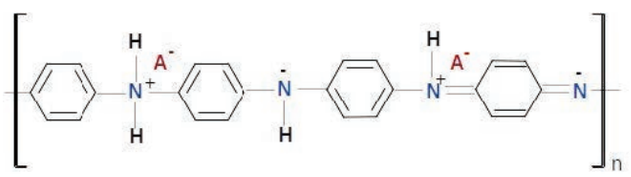

Fig 1: Schematic representation of conductive Polyaniline (A : Dopant, counterion)

Fig 2: Honshu-Shikoku Bridge, Japan coated with CORRPASSIVE, conductive polymer based coating system

(OCP) study, the OCP of PAni based coating was above 0.3 V immediately after exposure but dropped about 0.35 V in the first hour (see Figure 4). After that, it gradually increased and stabilized at around 0.2 V.

The coating provides large ennoblement (OCP of C-steel: -0.6V) when compared to uncoated Csteel indicating passive state of metal and is well protected. On the other hand OCP of coating without Pani-ES, fluctuation was observed and was never stable indicating the onset of pitting in pinholes of the coating and blocking of the pinholes by corrosion products. After 15 days of exposure red rust inside the coating was observed confirming limited barrier effect of the blank coating layer, which degrades with time. This proves that the conductive polymer present in the coating is the key to the ennoblement and stabilizing the corrosion protection of the coating. The OCP results are in agreement with the Electrochemical Impedance Spectroscopy (EIS) investigation also, revealing oxidation power and redox property of the PAni in coating.

The drop and rise in the OCP and the change in the charge transfer resistance involve:

Phase I: Oxidation of Fe (Fe → Fe^{2+}), reduction of PAni (ES → LB);

Phase II: Formation of oxide (Fe^{2+}, Fe^{3+}), re-oxidation of PAni (LB → EB → ES) and reduction of dissolved oxygen ($O_2 + 4e^- + 2H_2O \rightarrow 4OH^-$) and

Phase III: Stabilized conductive PAni (inset Figure 4).

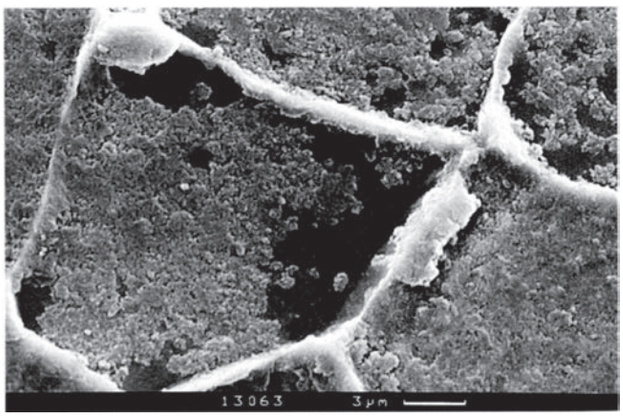

Fig 3: SEM picture of a steel surface with oxide layer within the grain boundaries when coated with PAni based coating. [3,4]

These observations are in agreement with the reports by Wessling and others. The potentiodynamic polarization study also, demonstrated high corrosion protection property of PAni based coating. Various studies show that PAni based coating systems has the ability to out-perform even the best conventional anticorrosion coating systems. Advantages of PAni based anticorrosion technology are:

- Safe and environmentally friendly alternative to hazardous anti-corrosion pigments.
- Considerable reduction in coating thickness compared to conventional systems, without compromising performance and quality standards.
- PAni loading of 1.0 - 1.5 per cent only in the coating is enough for achieving effective corrosion protection.
- Scratch and pinhole tolerant.

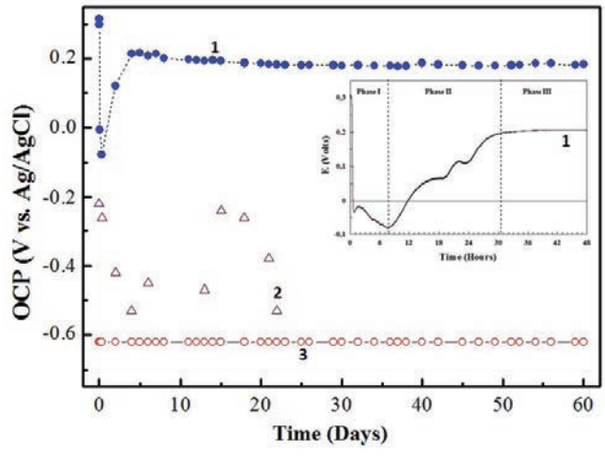

Fig 4: OCP vs time graph for C-Steel coated with PAni based coating (1), coated with blank coating (2) and bare C-Steel (3). Inset continuous OCP of PAni based coating for 48 hours.

PAni based technology and their scientific engineering of anti-corrosion coating systems, have the potential to revolutionize corrosion protection.

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Role of PEM Electrolyser & Optimisation in Hydrogen Generation

PEM electrolysis is a viable alternative for generation of hydrogen in conjunction with renewable energy sources. It particularly matches and complements the photovoltaics. PEM electrolysers are simpler than conventional alkaline electrolysers, and can be operated in variable power input mode.

PEM electrolyser is a device that produces hydrogen via water electrolysis by means of a Proton Exchange Membrane. Here, the rate at which Hydrogen is produced determines the PEM Electrolyser's Efficiency in converting input electric energy through an external circuit into hydrogen under the chosen operating environment. In other words, this device produces hydrogen gas by splitting water molecules using electricity, in which a solid polymer membrane selectively allows protons to pass through, aiding the separation of hydrogen and oxygen gases, making it a key technology for clean hydrogen generation, particularly when paired with renewable energy sources due to its high efficiency and rapid response to fluctuating power input.

Optimisation of a PEM Electrolyser primarily aims at adjusting operating parameters like current density, temperature, and pressure to maximize hydrogen production while minimizing energy consumption, often achieved through advanced materials, electrode design, and control systems to improve overall efficiency and cost-effectiveness. In a Polymer Electrolyte Membrane (PEM) electrolyser, the electrolyte is a solid specialty plastic material. Water reacts at the anode to form oxygen and positively charged hydrogen ions (protons). The electrons flow through an external circuit and the hydrogen ions selectively traverse across the PEM to the cathode.

The PEM electrolyser utilizes the solid polymer electrolyte to conduct protons from the anode to the cathode while insulating the electrodes electrically. The enthalpy required for the decomposition of water is 285.9 kJ/mol at S.T.P. A portion of the required energy for a sustained electrolysis reaction is supplied by thermal energy and the remainder is supplied through electrical energy. PEM electrolysers use cells with a solid polymer electrolyte. The cells typically operate at temperatures between 50°C and 80°C and at pressures between 20 and 40 bar. In both the anode and cathode, the catalyst layer is the location of the half-cell reaction in a PEM fuel cell. The catalyst layer is either applied to the membrane or to the gas diffusion layer.

The working current density of PEM water electrolysis technology with polymer as electrolyte can be as high as 1-3A/cm2, the electrolysis efficiency is high, the volume is smaller under the same power, and the purity of the hydrogen produced can reach 99.999 per cent. Proton exchange membrane (PEM) electrolysis is a process that produces hydrogen from water with an efficiency of 60-90 per cent. PEM electrolysis is considered highly efficient and is often used to produce hydrogen from renewable energy sources.

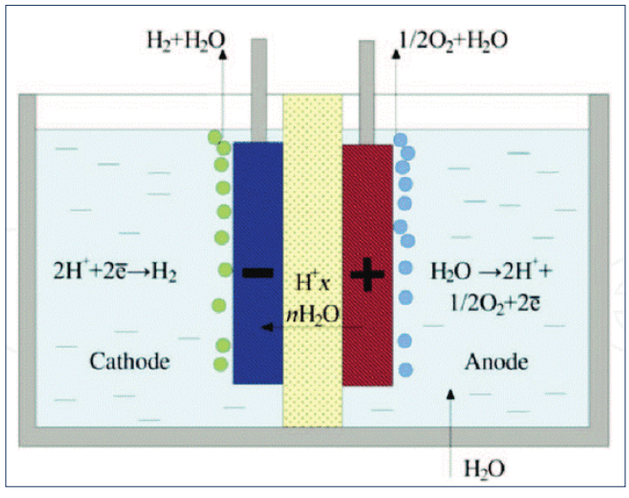


Fig 1: PEM Electrolysis

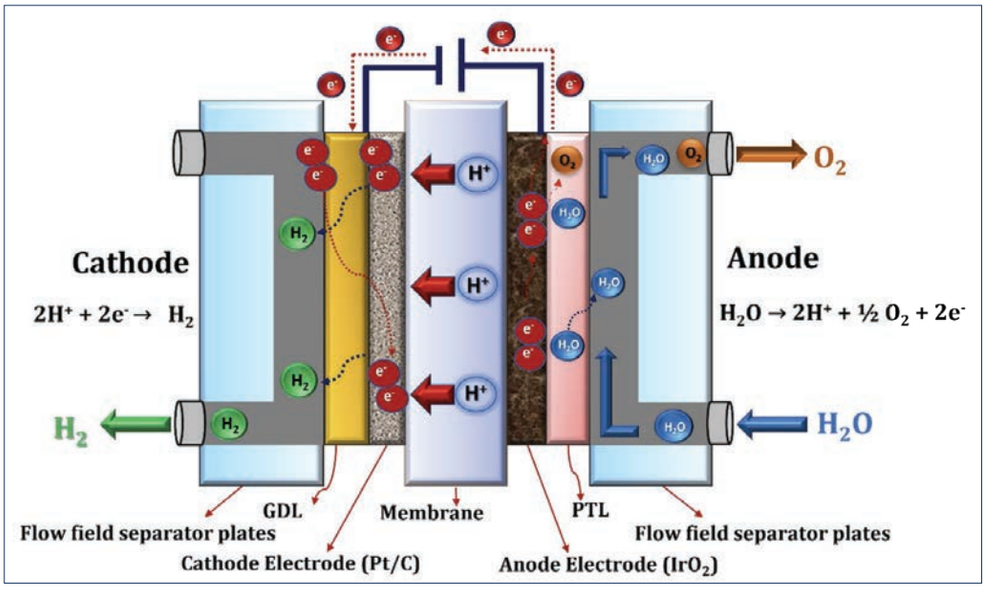


Fig 2: PEM Water Electrolysis Technology

Platinum (Pt) is the most popular catalyst for the hydrogen evolution reaction (HER) in proton exchange membrane (PEM) water electrolysers. However, Pt is expensive and rare, so researchers are looking for alternatives. Some potential alternatives include Transition Metal Phosphides (TMPs), molecular catalysts, and carbon-supported electrocatalyst.

PEM (Proton Exchange Membrane) Electrolyser comprises a proton exchange membrane (the solid electrolyte), electrodes (typically with a catalytic material like platinum), gas diffusion layers (to distribute reactant gases), and bipolar plates (for current collection).

A single polymer electrolyte membrane (PEM) fuel cell supplies little energy – which is why many of them are usually installed in a stack. With around 400 cells, you can achieve a total electrical output of up to 120 kW. PEM water electrolysis provides electrolytic hydrogen for large-scale energy storage and mobility based on renewable energy sources. Currently, only a small share of the global hydrogen demand is served by PEM electrolysis due to the relatively high costs associated with this technology. Overall H2 costs are influenced by operating costs, which are governed by electricity prices and the efficiency of the electrolyser.

The advantages of PEM technology, it's often noted that PEM electrolysis has a fast response ramp-up and ramp-down capability, as well as a wide dynamic operating range of 0-100 per cent – making it ideal for generating hydrogen using excess renewable energy. Water electrolysis is a mature technology, and it is being used for hydrogen production capacities ranging from few cm³/min to thousands m³/h. It is relatively efficient (>70 per cent), but because it needs high quality energy (electricity) hydrogen produced by water-electrolysis is expensive (>USD20/GJ).

Most of the electrolysers used today in capacities up to several thousand m³/h are based on alkaline (KOH) electrolyte. Another option is to use a proton exchange membrane as electrolyte. This perfluorosulfonic acid polymer (also known as Nafion™) has been used in chlor-alkaline electrolysis and also in fuel cells. PEM

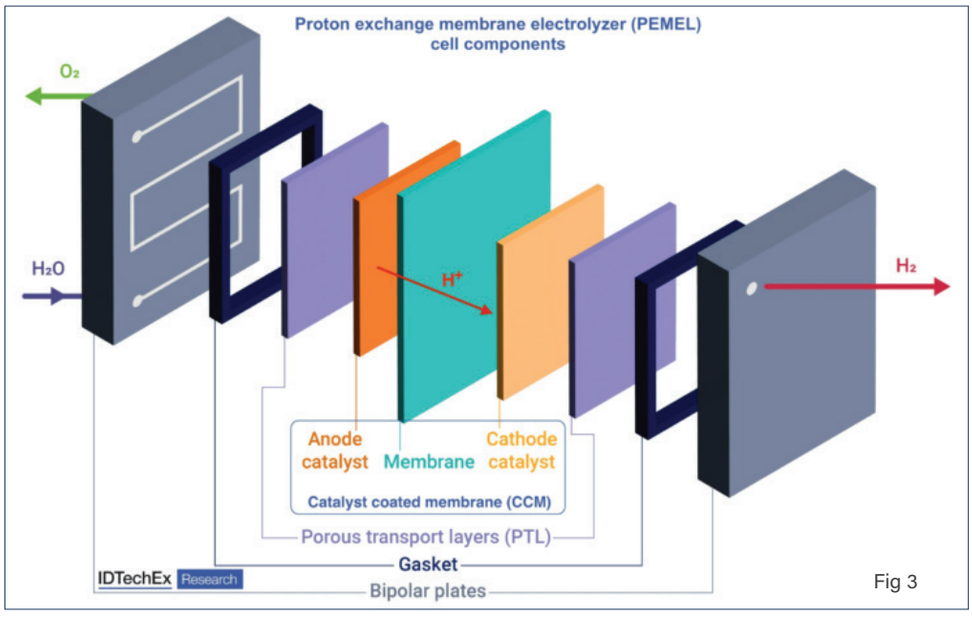


Fig 3

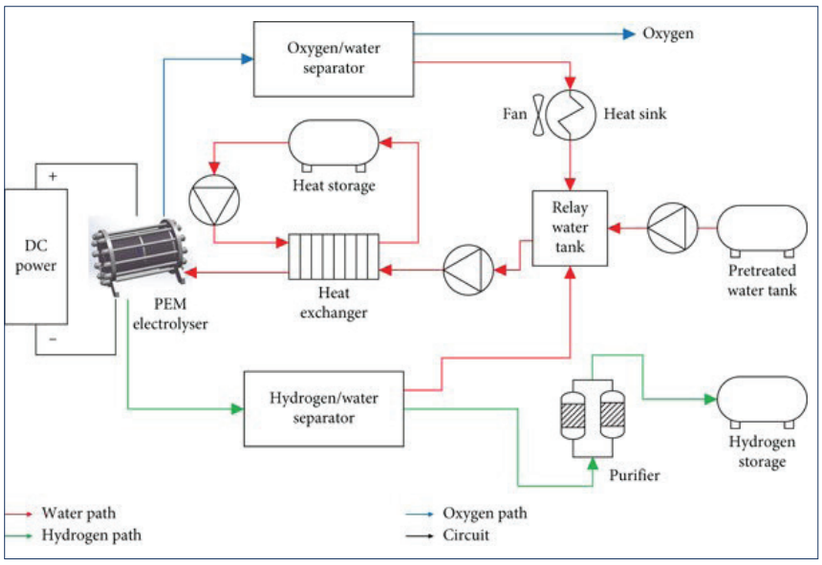


Fig 4: Schematic Diagram of PEM Electrolyser System

electrolysis is a process just reverse of a PEM fuel cell process. Water is split into oxygen, protons and electrons on one electrode (anode) by applying a DC voltage.

PEM electrolysis is a viable alternative for generation of hydrogen in conjunction with renewable energy sources. It particularly matches and complements the photovoltaics. It may be coupled either directly, if the polarization i–V curves are well matched, or a DC/DC regulator may be used with or without maximum power point tracking. PEM electrolysers are simpler than conventional alkaline electrolysers, and can be operated in variable power input mode. PEM electrolysers can generate hydrogen and its impact has been considerable. Efficiency improvements of 20 per cent have been demonstrated for membrane and catalyst configurations that have been tested to over 1000 hours. Cost reductions of over 15 per cent of the total stack cost have also been proven to be feasible.

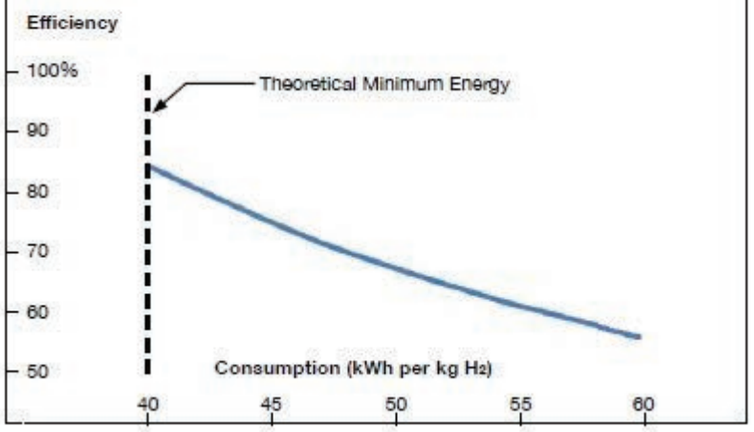
When determining the electrical efficiency of PEM electrolysis, the HHV can be used. This is because the catalyst layer interacts with water as steam. As the process operates at 80°C for PEM electrolysers, the waste heat can be redirected through the system to create the steam, resulting in a higher overall electrical efficiency. The energy efficiency of hydrogen generation through PEM (Proton Exchange Membrane) electrolysis is typically around 50-60 per cent, meaning that for every kWh of electricity input, roughly 0.5-0.6 kWh of energy is converted into usable hydrogen, with the cost per kWh of hydrogen produced through PEM electrolysis ranging from USD 0.05 to 0.07.

Due to the strong natural bonding between hydrogen and oxygen in a water molecule, electrolysis is an energy intensive process. The theoretical minimum energy (electrical) needed to split water electrochemically is 285.8 kJ/mole of water. This translates to just under 40 kWh per kg of H_2, or a "conversion efficiency" of 83 per cent (as shown in the Plot below).

In the real world, the typical commercial electrolyser requires an energy input of around 55 kWh per kg H_2, for a conversion efficiency of about 60 per cent. In a nutshell, PEM Electrolysers are valued because of their higher energy efficiency, wider operating temperature, and ease of maintenance as opposed to the rest of the hydrogen electrolysers. PEM electrolysis has an electrical efficiency of about 80 per cent in working application, in terms of hydrogen produced per unit of electricity used to drive the reaction.

The efficiency of PEM electrolysis is expected to reach 82-86 per cent circa 2030, with improved durability as

Electrolyzer conversion efficiency vs. energy consumption. Curve converts common measure of electrolyzer energy consumption (kWh per kg hydrogen) to conversion efficiency. Theoretical minimum energy requirement of about 40 kWh/kg H2 relates to an efficiency of almost 85%. (Basis: hydrogen LHV = 113,719 Btu/kg.) Fig 5



progress in this area is relentlessly underway, including replacement of Platinum [Pt] with [W] as a catalyst with a view to attainment of cost-reduction. Current stack cost ranges from 384–1071 €/kW (PEM). Stack costs may reduce to 63–234 €/kW (PEM) by 2030. Cost reductions are driven by higher current density (PEM) and lower catalyst loading (PEM).

Polymer-electrolyte or proton-exchange membrane units have a higher capital cost ranging from USD1,400 to 1,700 per kW due to costly catalysts, however reflecting higher efficiency closer to 52 kWh input per kg of Hydrogen produced. Electrolyser stack lifetime also significantly affects the cost of hydrogen production. The current expected lifetime is of 7–10 years, which is equivalent to 60,000–80,000 hours of operation for Proton Exchanging Membrane (PEM) Electrolyser.

Based on current market trends in India, a PEM Electrolyser with an efficiency close to 52 kWh/kg of hydrogen produced would cost between ₹2.5 - 3.5 crore per MW capacity, depending on the specific technology, manufacturer, and scale of the project; this translates into ₹250 - 350 per kg of hydrogen production capacity. ■

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Preventing Chemical Leaks: The Vital Role of Advanced Sealing Solutions

Responsible for transforming raw materials into valuable products, the chemical industry is widely regarded as one of the most important economic sectors. The aggressive and often hazardous nature of the chemicals involved in these processes demands robust and reliable engineering solutions. One of the most critical components in ensuring the safety, efficiency, and environmental compliance of chemical processing plants is the sealing solutions.

The chemical industry is a complex amalgamation of processes and operations that use chemistry to manufacture various products. The scope of the raw materials used in these processes is vast, and they produce a variety of primary, secondary, and tertiary products, a distinction that indicates the distance of the product from the end user, primary being the most distant. The essential need for manufactured chemical products is, therefore, often unapparent, as each one is passed from one process to the next before emerging in the market.

In general, the chemical industry is divided into the following areas:

- Basic chemicals
- Fine chemicals
- Specialty chemicals
- Inorganic chemicals
- Organic chemicals

One of the most critical components in ensuring the safety, efficiency, and environmental compliance of chemical processing plants is the sealing solutions.

The production processes for each of these areas require unique assets and applications that can withstand the aggressive nature of the raw material as it moves from one state to the next, see Figure 1. For this reason, specially developed sealing solutions are required.

Importance of Seals

Seals play a pivotal role in chemical processing. By preventing fluid, gas, and other material leaks, they ensure that nothing harmful infiltrates production or negatively impacts the surrounding environment.

Beyond safety, seals are vital in maintaining process efficiency. They help regulate critical parameters such as pressure, temperature, and flow rates, directly influencing the consistency and quality of the production process. Seals ensure optimal operating conditions, enhance production efficiency, and reduce operational costs. Furthermore, by acting as a protective barrier, sealing solutions significantly extend the lifespan of equipment, minimizing wear and tear and reducing the need for frequent maintenance or replacement, ultimately contributing to long-term savings and increased operational reliability.

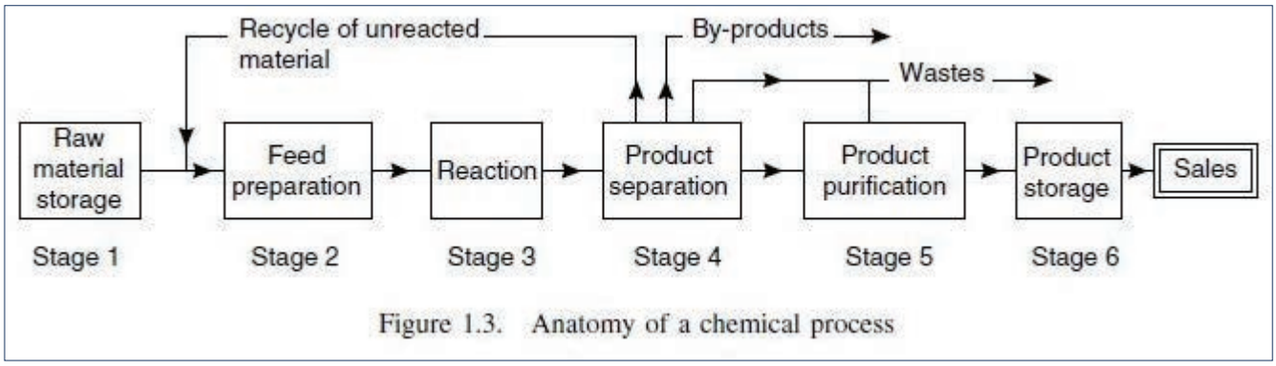


Fig 1: Depiction of a chemical process.[1]

Seal Type and Material Selection

A seal's chemical compatibility with system fluids is, therefore, essential for achieving reliable and durable performance. As the way polymers and other raw materials used in seals react with fluid chemicals varies greatly, the selection process can be highly challenging, particularly when relying solely on chemical compatibility charts.

For example, when specific chemicals interact with some materials, the chemical can 'attack' the polymer bonds, degrading the polymer's properties. In some instances, chemicals can leach ingredients from the polymer, weakening it or stripping away essential mechanical properties. Other chemicals may permeate the polymer, leading to swelling. This swelling can be beneficial or detrimental, depending on the application. In some cases, the media may not impact the polymer at all. Instead, it may negatively impact one of the other raw materials utilized in the sealing material, leading to mechanical degradation and potential failure.

The wide variety of processes and chemical media used in the chemical industry means there is no 'one size fits all' choice regarding sealing. Most chemical plants utilize a wide variety of sealing solutions. These include:

- **Elastomeric:** Made from a wide array of different polymers, such as NBR (Nitrile Butadiene Rubber), EPDM (Ethylene Propylene Diene Monomer), Silicone, Neoprene, FKM, and more; these seals can be used in a variety of applications in the form of gaskets, o-rings, and specialty molded seals.

- **Compressed Fiber:** Made from a combination of an elastomeric binder and synthetic, organic, and/or inorganic fibers, along with other ingredients, these materials are often used in a wide variety of generalized services.

- **Flexible Graphite**: Chemically expanded and then manufactured into rolls or sheets, graphite seals offer excellent chemical resistance while also handling higher temperatures than seals containing rubber. Many graphite sealing materials also feature layers of metallic reinforcement to make them stronger and allow them to resist higher operating pressures.

- **PTFE (Polytetrafluoroethylene):** Perhaps the most commonly used material in chemical processing sealing solutions, PTFE offers exceptional chemical resistance to even the most aggressive media.

- **Metal:** More common in applications with extremely high temperatures and pressures, metal-based sealing solutions still have their place in chemical processing plants. Made entirely of metal or a combination of a metal carrier element with a softer sealing element (like graphite or PTFE), these seals are utilized to some degree in nearly every industrial manufacturing plant worldwide.

Pros and Cons

With so many options for sealing solutions, choosing which is best suited for a particular application can be challenging. Due to the aggressive nature of many raw materials used in chemical processing facilities, the margin for error is low, and safety is paramount. The ideal solution should offer safe and reliable performance over the life of the process until the next scheduled maintenance event. Working closely with a knowledgeable sealing product manufacturer or supplier can be an asset to any chemical plant.

In general, it is important to remember that every sealing solution has its own set of pros and cons. For example,

elastomeric seals can create a seal at lower loads than most other seals. They also tend to be relatively inexpensive. That is great, right? Well, not so fast. They also crush at much lower loads than other seals, degrade more rapidly over time (especially at elevated temperatures), and exhibit a high level of relaxation, meaning they do not retain load well. They also vary greatly in their compatibility with various media based on the polymer.

PTFE-based seals, on the other hand, can withstand the most aggressive chemicals on the planet. They are generally considered soft, can conform to flange imperfections well, and have an indefinite shelf life. These are all great qualities and characteristics. The principal drawbacks of PTFE seals are the higher cost and the fact that PTFE, in its virgin form, is highly susceptible to creep relaxation.

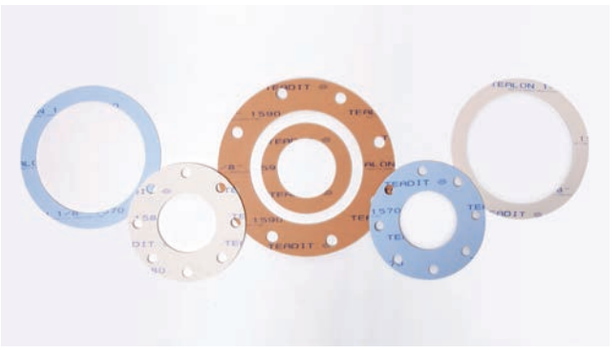
Choosing the right sealing solution for an application requires carefully considering the many variables at play. There are times when a rubber seal is the right choice. Other times, it may be graphite, compressed fiber, or PTFE.

A Look at HF Production – A Case Study

Perhaps one of the most dangerous and aggressive processes in chemical processing can be hydrogen fluoride production. If incompatible materials react, they can cause corrosion, mechanical weakening, and other undesirable interactions. Therefore, it is essential to devote significant time to not only the seal material but also the seal itself. For example, deciding which gasket type to use for sealing in HF production requires careful consideration.

While HF process units are carefully monitored and controlled, unexpected problems can occur. Water introduced and remaining in the system during cleaning or maintenance activities or intrusions from leaks in other parts of the manufacturing process can lead to HF acid formation, which in turn leads to corrosion and, eventually, dangerous leaks. Areas within the process that provide the potential for pooling are at the most significant risk for acid corrosion. Therefore, a seal that does not fill gaps can lead to flange and sealing surface corrosion.

To address the challenges of properly and adequately sealing HF applications, manufacturers have designed unique sealing technologies. These seals marry



PTFE-based gaskets are often a reliable choice for sealing in chemical processing.

different sealing materials and technologies together to take advantage of their various strengths and create a tandem seal that utilizes semi-metallic technologies with different fillers and facings. There are design variations between the type of metal construction (spiral wound, solid metal with serrations, corrugated metal, etc.) used for the primary seal in this type of application. Regardless of the selected construction style, it is highly recommended that a high-temperature, oxidation-inhibited grade of flexible graphite is specified as the primary sealing material due to its tight sealing performance.

Specialized gaskets for HF service often incorporate an expanded PTFE (ePTFE) secondary sealing element. PTFE is highly valued in harsh environments due to its near-universal chemical resistance. ePTFE is exceptionally compressible, allowing it to conform easily to flange surfaces that may be worn or corroded to completely fill and eliminate any gaps. There are several design variations, including thickness, core types, and adherence methods, that are used for

Engineered solutions, like this example of an Echelon gasket for use in HF service, take advantage of the strengths of different materials and sealing technologies.

secondary sealing. When choosing expanded PTFE for secondary sealing, specifying a low-creep material with uniform density is crucial.

Solutions to Sealing Challenges

Understanding which sealing solution will provide the optimal seal can prevent costly downtime, reduce maintenance needs, and extend the life of equipment, making it an essential investment for any chemical processing facility. Addressing these challenges requires a combination of material science, engineering expertise, and regular maintenance practices:

- **Material Selection:** Choosing a suitable material is crucial. Seals made from PTFE or other specialized elastomers are often used for chemical compatibility due to their resistance to a wide range of chemicals. Materials like graphite or metal seals may be required for high-temperature applications.
- **Advanced Design:** Modern seals are designed to accommodate the specific conditions of chemical processing environments. This includes using composite materials, special coatings, and advanced geometries that enhance sealing performance and durability.
- **Regular Maintenance and Monitoring:** Implementing a proactive maintenance program can help identify wear and tear before it leads to failure. This might include regular inspections, performance monitoring, and replacing seals as part of routine maintenance schedules.
- **Custom Solutions:** In some cases, like the previous example of HF production, standard seals may not be sufficient. Custom-designed seals can be tailored to the specific requirements of a chemical process, ensuring optimal performance and longevity.
- **Training and Education:** Ensuring plant personnel are trained in adequately installing, maintaining, and replacing seals can prevent many common issues. Knowledgeable operators can spot potential problems early and take corrective action before a seal fails.

In the complex and demanding chemical processing environment, sealing solutions are more than just a minor component — they are vital to the operation's safety, efficiency, and success. By understanding the challenges and employing suitable materials, designs, and maintenance practices, chemical processing plants can ensure their seals perform effectively, safeguarding their operations and the environment.

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1. https://chemicalprojects.wordpress.com/2013/12/15/the-anatomy-of-a-chemical-manufacturing-process/

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Saurus939 Vacuum Pump: Unique in Reliability, Performance & Consumption

Saurus939 vacuum pump is particularly suitable for the most demanding applications, ensuring constant vacuum level and flow rate over time. Powerful, efficient, but absolutely safe - Saurus939 guarantees optimum safety through the whole process and complete purity of the final product. In other words, ensures an uncontaminated vacuum.

Saurus939 has all the Italvacuum experience, a vacuum pump that is particularly suitable for the main chemical and pharmaceutical processes. A simply designed machine, that combines traditional robustness and reliability with the most evolved technology. Saurus939 has always been the core business of Italvacuum, one of the leading manufacturers of vacuum pumps as well as a worldwide reference point in the design and manufacture of vacuum dryers.

Resistance, strength, and consumption of oil are virtually eliminated thanks to the innovative LubriZero® system, a solution that guarantees perfect operation and optimum results with total respect for the environment. Designed to work with both the most common and the most aggressive solvents, Saurus939 guarantees:

- Absolute safety for both operators and the process
- Easy round-the-clock operation
- Unrivalled performance
- Nominal flowrate up to 3,800 m^3/h
- Vacuum level up to 0.03 mbar

Minimum operating costs, thanks to:

- Low energy consumption motors
- Innovative LubriZero system, with negligible oil consumption
- Easy and economical maintenance

Saurus939 vacuum pump is particularly suitable for the most demanding applications, ensuring constant vacuum level and flow rate over time. Powerful, efficient, but absolutely safe - Saurus939 guarantees optimum safety through the whole process and complete purity of the final product. In other words, ensures an uncontaminated vacuum.

Use in Fine Chemicals Industry

Fine chemicals, which are used as raw materials in the pharmaceutical, biopharmaceutical and agrochemical sectors, differ from basic chemical products because of their high purity. Producing fine chemicals involves many processes of synthesis and purification employing vacuum technology. These processes include reaction, drying, distillation, and crystallization.

Reaction Processes

Chemical reactions are widely used in synthesizing compounds, where the vacuum is required to avoid high temperatures and to remove oxygen and secondary products. Reactions normally take place at temperatures around 10/20 mbara. Vacuum reactors generally have a volume between 1 m^3 and 10 m^3. For these applications, it is often sufficient to use a vacuum pump with a nominal output between 80 and 380 m^3/h.

Here, the double-stage Saurus939 is the ideal solution, thanks to its resistance to corrosive solvents and reliability in the most demanding work environments. Examples of areas where the Italvacuum vacuum pump has been used include the synthesis of:

- Compounds for the agrochemical sector, where the ATEX Zone 0 version of the Saurus939 is used.
- Performance additives for the lubrication market, where the Saurus939 piston pump is the only technology that can be used because of the aggressive solvents and significant amount of powdered materials involved.

Drying Processes

Vacuum drying takes place immediately after centrifugation or filtration. It is a process that removes the moisture from a wet solid by introducing heat. This operation is performed under vacuum to dry heat-sensitive substances at temperatures that are lower than would otherwise be possible. In the fine chemical industry, vacuum drying is a batch operation and can be carried out using a variety of technologies, depending on the product involved.

Applications for the Italvacuum vacuum pump include drying:

- Raw materials for the pharmaceutical industry, where the double-stage roots compressor version of the Saurus939 piston pump is used
- Raw materials for the biopharmaceutical industry, where the basic double-stage version of the Saurus939 vacuum pump is used.

Distillation Processes

Vacuum distillation is a process in which the pressure above a liquid mixture is reduced to less than the latter's vapor pressure, thus causing the more volatile liquid to evaporate. This process is used when the liquids to be distilled have low volatility (Teb > 150°C) or can undergo chemical decomposition at temperatures near their atmospheric boiling point. Vacuum distillation is also used to remove impurities from temperature-sensitive materials such as flavorings.

The pressure at which distillation is carried out may vary according to the compounds to be separated, ranging from values near absolute vacuum up to 60 mbara. Vacuum distillation columns generally have a volume between 5 m^3 and 20 m^3. For these applications, it is advisable to combine the Saurus939 vacuum pump with a Roots compressor in order to increase nominal output and reduce limit pressure.

Applications of the Italvacuum vacuum pump include the distillation of plant-based fragrances and flavorings for the cosmetics and food industries.

Crystallization Processes

This is a process in which a solid compound is precipitated from a solution. Crystallization is employed in cases calling for extremely low operating pressures, obtained under very low absolute pressures, and for applications that involve relatively small amounts of high value-added material. It is thus usually a batch operation.

Crystallization cycles last from 2 to 8 hours. The pressure at which crystallization is carried out can vary from near absolute vacuum up to 30 mbara. Vacuum crystallizers generally have a volume between 1 m^3 and 4 m^3. For these applications, it is often essential to employ the Saurus939 vacuum pump in combination

with a Roots compressor. Thanks to an uncontaminated vacuum and continuous recovery of extracted solvents, the Italvacuum vacuum pump maintains total finished product purity.

Use in Pharmaceutical Industry

Vacuum pumps are among the most widely used types of equipment in the pharmaceutical industry. They are employed at all scales, from pilot to industrial production, and by all sectors, from manufacturers of intermediates to producers of Active Pharmaceutical Ingredients (APIs). A typical process calling for vacuum technology is drying, which is a crucial step in the pharmaceutical production sequence.

Drying takes place immediately after centrifugation or filtration. It is a process that removes the moisture from a wet solid by introducing heat. This operation is performed under vacuum in order to dry heat-sensitive or hygroscopic substances at temperatures that are lower than would otherwise be possible. In the pharmaceutical industry, drying is a batch operation and can be carried out using a variety of technologies, depending on the product involved.

Crystalline products produced by synthesis (reactors) are chiefly processed using dynamic dryers (i.e., rotary and horizontal paddle dryers). These products must have a very specific particle size and very low humidity. Amorphous or plant and animal based products, on the other hand, are normally processed in static dryers. Particle size is not usually a determining factor for these products, since they are subsequently ground, and the moisture content is never as strictly controlled.

Dynamic Drying

In a dynamic system, the drying process's effectiveness depends not only on the system itself but also on the vacuum unit. This is the typical case found in the production of Active Pharmaceutical Ingredients (APIs) using rotary dryers and horizontal paddle dryers. Here, the vacuum pump must cope at the same time with aggressive organic solvents such as acetone, toluene and so forth, and the potential interaction with solid powder particles (especially if they are not adequately removed by the filter systems). The Italvacuum vacuum pump can deal with both these issues.

Where very low final moisture content is required, dynamic dryers are often combined with pumps coupled with root compressors. For processing purposes, these compressors must be activated at the final stage of drying in order to extract the last traces of solvent retained in pharmaceutical powders. Under these circumstances, the condenser which is always mounted upstream of the Saurus939 vacuum unit is bypassed and the positive-displacement compressor is activated.

With the compressor's help, it is possible to reach very high vacuums – at least an order of magnitude below the levels that could be reached with the vacuum pump alone – together with extremely high output (here again, the output increases by around one order of magnitude).

In drying APIs, other vacuum technologies are less effective than the Saurus939 pump. Rotary vane pumps and liquid-ring pumps have a number of shortcomings when used with aggressive solvents, including a short life cycle and limited application in severe operating conditions. Dry pumps, on the other hand, have difficulty dealing with processes involving a great deal of interaction with solid particles, as they are particularly susceptible to damage by minimum quantities of dust.

Static Drying

By contrast with dynamic dryers, static dryers, which are universal systems capable of drying any product, rarely need root compressors. In addition, this technology only sporadically requires a filter between the dryer and the vacuum unit.

An example of an application consists of drying plant extracts, a typical process used in today's booming herbal industry. This sector combines the most modern extraction technologies with the vacuum drying techniques that the pharmaceutical industry has used from its beginnings. Natural and plant-based products are subjected to solvent extraction. The batch resulting from this process is then dried in order to retain all its heat-sensitive properties without change.

The vacuum pump and the condenser unit are activated during this process. Both remain active for the entire duration of the process. The double-stage version of the Saurus939 vacuum pump is used with or without a roots compressor.

With a strong presence in the Indian market spanning 25 years, Italvacuum has successfully installed hundreds of pumps across India. The company's commitment to the Indian market is further strengthened through its strategic partnership with Vacuum Drying Technology India, a collaboration that has flourished for over 20 years. This partnership ensures comprehensive local service support for all customers in the region.

The company is participating in the upcoming Ankleshwar Industrial Expo 2025. Visitors can find Italvacuum at booth A115, where the company will be exhibiting alongside its partners from Vacuum Drying Technology India. The expo, scheduled for April 17-19, 2025, will be held near Yogi Estate, GIDC Ankleshwar, Gujarat, India. ■

For more info, please visit: www.italvacuum.com

Compact Ejectors: Combining Cutting-edge Technology with Resource Efficiency

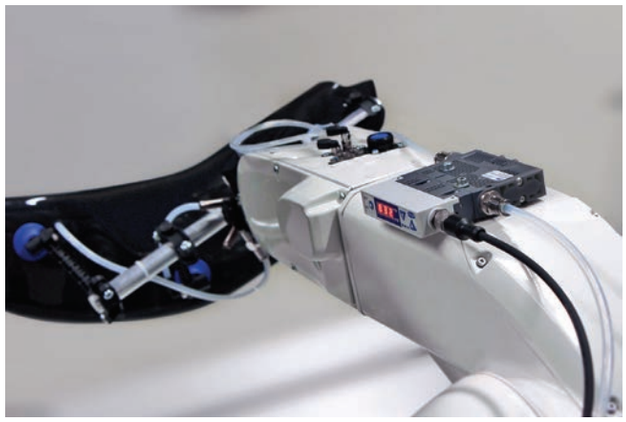
Compressed air, though indispensable in vacuum systems, is often one of the most energy-intensive resources in automated operations. Recognizing this, Schmalz has embedded air-saving technology into its ejector designs. This innovation optimizes air usage, significantly reducing compressed air consumption by up to 80% compared to conventional systems.

In an era where sustainability is a global priority, industries are tasked with balancing operational efficiency and environmental responsibility. This challenge is particularly evident in manufacturing, where resource-intensive processes, such as the use of compressed air in automation, contribute significantly to energy consumption. Optimizing these processes is essential to reduce environmental impact and achieve long-term cost savings. Schmalz has addressed this need by developing a series of compact ejectors SCPSc and SCPSi that combine cutting-edge technology with resource efficiency.

Generation and monitoring of the vacuum in automated systems

Sustainability as a Design Principle

Compressed air, though indispensable in vacuum systems, is often one of the most energy-intensive resources in automated operations. Recognizing this, Schmalz has embedded air-saving technology into its ejector designs. This innovation optimizes air usage, significantly reducing compressed air consumption by up to 80% compared to conventional systems. Beyond energy savings, this reduction translates into lower greenhouse gas emissions, supporting the global push toward sustainable manufacturing. Moreover, the SCPSc and SCPSi models incorporate durable materials and robust designs that extend their operational life. This minimizes the frequency of replacements and reduces material waste, further contributing to sustainability goals.

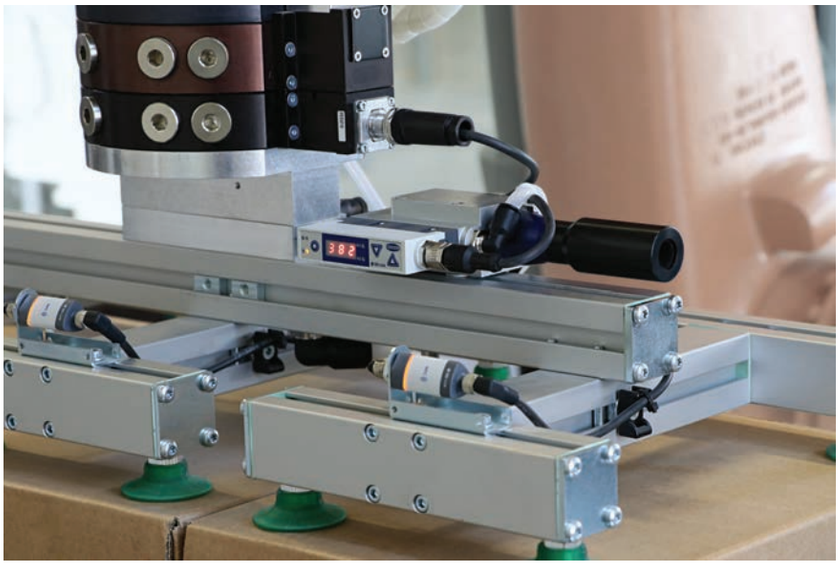


Compact ejectors: Use in robot handling and on linear axes

Advancing Automation with Intelligent Design

The compact ejectors are meticulously designed to meet the demands of modern automation. Their compact and lightweight construction allows for seamless integration into automated systems, particularly in applications with limited space or high dynamics. The SCPS series offers fundamental reliability, while the SCPSc and SCPSi models bring advanced features tailored to specific industrial requirements.

The SCPSc model includes a user-friendly 7-segment display that provides clear, real-time information about system status and vacuum parameters. This ensures



Compact ejector for handling of airtight and slightly porous workpieces

ease of operation and simplifies configuration, even in complex setups. The SCPSi variant takes this a step further by offering digital connectivity via IO-Link. This enables real-time monitoring of vacuum levels, energy consumption, and cycle times, allowing for integration with Industry 4.0 systems.

Applications across Industries

Compact ejectors play a critical role in a variety of industrial applications. They are particularly suited for handling airtight and slightly porous workpieces, ensuring high precision and efficiency. Industries such as automotive, packaging, electronics, and logistics rely on these ejectors for diverse applications, including robot handling, pick-and-place operations, and linear axis systems.

For example, in the automotive industry, ejectors assist in lifting and positioning car body panels with optimized air consumption. Similarly, in packaging operations, they excel in handling lightweight and porous materials, such as cardboard, ensuring smooth and reliable processes. These versatile devices are indispensable wherever precision handling and energy efficiency are required.

Enhancing Sustainability through Air Saving

The air-saving function integrated into SCPSc and SCPSi is a defining feature that sets these ejectors apart. By actively monitoring vacuum levels, the system ensures that compressed air is used only when necessary, preventing waste and reducing operational costs. This function is particularly impactful in high-cycle operations where air consumption can quickly escalate without proper control.

The SCPSi model's advanced monitoring capabilities amplify these benefits. Its IO-Link interface not only facilitates seamless communication with automation systems but also enables users to track energy metrics in real time. This empowers businesses to make data-driven decisions, optimizing their processes for both efficiency and sustainability.

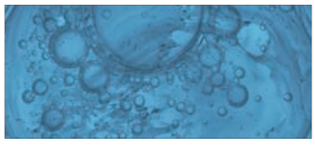
Intersection of Technology & Responsibility

Schmalz compact ejectors demonstrate how advanced engineering can contribute to sustainability goals. By minimizing air consumption and integrating with modern digital systems, these ejectors not only improve operational efficiency but also align with environmental objectives. Manufacturers who choose these models benefit from a solution that enhances both their operational performance and their sustainability efforts. ■

B&R Industrial Automation launches AI smart camera

B&R Industrial Automation has launched a smart camera that perfectly synchronizes AI image processing with real-time data, keeping vision in the control loop for maximum precision. A specialized AI processor provides fast and accurate deep learning functions including anomaly detection and Optical Character Recognition (OCR). An intelligent combination of rule-based and AI-driven tools ensures precise defect detection and enables machine builders to tackle complex vision challenges faster. Integrated asset management functionality and a deep learning tool for training and evaluation keep productivity high and costs low. ■

Perstorp launches Neptem™ range of emulsifiers



Perstorp, a leading global innovator in specialty chemicals and a wholly owned subsidiary of PETRONAS Chemicals Group Berhad (PCG), has launched the Neptem™ range for alkyds, a portfolio of emulsifier solutions enabling the next generation of high-performance, low-VOC waterborne alkyds. In response to the coatings industry's shift towards solutions with a lower environmental impact, Perstorp has developed this portfolio to enable the reduction of the carbon footprint and VOCs of alkyd formulations by enabling a seamless transition to waterborne alkyds.

The Key features of Neptem for alkyds include high-performance emulsification, ensuring waterborne alkyds match or exceed the quality of traditional solvent-based systems; transition to low-VOC coatings, thus reducing greenhouse gas emissions compared to solvent-borne systems and extended application range.

Neptem emulsifiers expand the potential of waterborne alkyd resins, accommodating a broader range of alkyds with different oil lengths, making it possible to formulate beyond the traditional applications. ■

Cosmo Specialty Chemicals launches heat seal coating solution

Cosmo Specialty Chemicals has announced the launch of an innovative COSEAL-601 heat seal coating solution. The company's heat seal coating technology has demonstrated remarkable market performance. Recent performance data shows COSEAL-601 achieving superior sealing strength, particularly in the crucial 120-160°C temperature range. The product has demonstrated exceptional versatility across both 2-ply and 3-ply aluminium foil laminated structures. The COSEAL-601 coating offers several key advantages with its ready-to-use formulation for immediate application, superior adhesion to aluminium foil laminate structures, optimal sealing performance at 120-140°C, low coefficient of friction with a block-free formulation, enhanced compatibility with high-speed manufacturing and superior resistance to water and oil. The product has been specifically engineered for both 2-ply structures (45-60 GSM Paper/6.35-9µ Foil/HSL coating) and 3-ply structures (45-60 GSM Paper/10-12µ PET/6.35-9µ Foil/HSL coating), offering versatility across different packaging requirements. ■

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Biotech is one of the fastest-growing industries in the world right now, especially in India. The Indian bioeconomy registered a remarkable 28% growth in 2022. The past three years have been enormously successful, especially considering the challenges posed by the COVID-19 pandemic. The Indian bioeconomy is forecasted to reach USD 300 billion by 2030, a significant increase from its current valuation of USD 140 billion, which constitutes 4% of the total GDP of our country's growth. The BioPharma industry contributes approximately 43% to the economy and extends beyond pills; it encompasses aspects of healthcare, wellbeing, and cognitive enhancement. To capitalize on green growth and the bio economy, we are establishing Bio enablers in the form of Bio manufacturing hubs through Public-Private Partnerships.

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R.N.I. No. 11403/1966 Date of Publication: 29th of every month. Postal Registration No: MCS/095/2023-25
Posted at Patrika Channel Sorting Office, Mumbai 400001, on 30th of every month. Total Pages No.: 54

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Scope for Specialty Chemicals World Expo 2026

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

Scope for Biopharma World Expo 2026

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

FACT & FIGURES 2024

- **750** EXHIBITORS FROM 15+ COUNTRIES
- **25871** VISITORS FROM 53 COUNTRIES
- **8** TECHNICAL CONFERENCES
- **250+** GLOBAL SPEAKERS
- **1500+** BUSINESS DELEGATES
- **2500+** ENGINEERING PHARMA & SCIENCE STUDENTS AT STUDENT OUTREACH PROGRAM FROM 28 STATES & UNION TERRITORIES

SCALE@CHEMTECH World Expo 2024
60+ GLOBAL CLIMATE TECH STARTUPS FROM 20 COUNTRIES
40 TECHNICAL PRESENTATIONS

BRICS WORKING GROUP BRAIN STORMING SESSION

Organised by:

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