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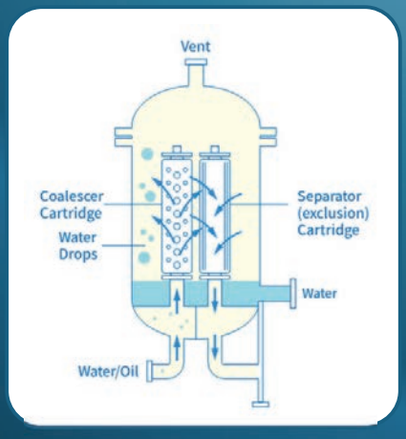

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E-mail: sales@jasubhai.com

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BASF and Pune Knowledge Cluster celebrate four years of WEnyan

Mumbai: BASF Chemicals India Private Limited (BCIPL), in collaboration with the Pune Knowledge Cluster (PKC) of Principal Scientific Advisor's (PSA) office, successfully celebrated the completion of four impactful years of the WEnyan (Women in Education and Knowledge) program.

The event, held at the BASF Innovation Campus, marked a key milestone in the journey of WEnyan — a research scholarship program for women from disadvantaged communities in Maharashtra. It was graced by Dr. Ashish Lele, Director of CSIR–National Chemical Laboratory, Pune (CSIR-NCL), as Guest of Honour, and Dr. Shailaja Donempudi, Distinguished Scientist and Head of the Business Development Group at Council of Scientific and Industrial Research (CSIR). Over the past four years, WEnyan has supported women in STEM through financial aid, mentorship, and community engagement, with a strong focus on inclusion. During the event, 43 scholars from two graduating cohorts were felicitated in recognition of their academic and research achievements. The event also saw the release of the WEnyan Compendium 2025–26.

Building on the success of WEnyan, BCIPL further strengthened its commitment to advancing diversity in science with the launch of WESER – Women Empowered for Science and Engineering Research, a postdoctoral fellowship initiative introduced earlier this year. The program is designed to support talented women researchers, particularly those from Economically Weaker Sections (EWS), by providing financial assistance, structured mentorship, and access to high-quality research opportunities.

A key highlight of WESER is the opportunity for fellows to work closely with leading faculty at premier institutions such as Indian Institute of Technology, Bombay (IIT Bombay), Indian Institute of Science Education and Research, Pune (IISER Pune), and CSIR-National Chemical Laboratory, Pune (CSIR-NCL) gaining exposure to cutting-edge research environments and industry-relevant innovation.

Alexander Gerding, Managing Director, BASF India Limited & Head – BASF Group Companies in India, said, "We are proud to see how the WEnyan program has grown into a meaningful platform that empowers women in science and engineering. The achievements of the students over the past four years reflect the strength of collaboration between industry and academia. Initiatives like WEnyan and our newly launched WESER program reaffirm BASF's commitment to fostering diversity, innovation, and inclusive growth in India's scientific ecosystem."

Dr. Avinash Kumbhar, CEO, Pune Knowledge Cluster (PKC) of The Principal Scientific Advisor's Office, added, "The WEnyan Scholarship Program, sponsored by BASF and implemented by the Pune Knowledge Cluster, has evolved into a transformative platform that nurtures talent, fosters mentorship, and empowers women scholars to emerge as confident leaders and innovators. In doing so, it exemplifies the Pune Knowledge Cluster's vision of building a future-ready, skilled workforce capable of driving innovation and societal progress."

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Epigral Limited's Q1FY27 PAT jumps 25% YOY to ₹99 Cr

Ahmedabad: Epigral Limited, one of India's leading integrated chemical manufacturers, has announced its financial results for the quarter ended June 30, 2026. The company posted a growth of 25 per cent in PAT for Q1FY27 at ₹99 Cr, as compared to ₹79 Cr in Q1FY26. The company's quarterly revenue rose by 15 per cent to ₹709 Cr as against ₹615 Cr recorded in Q1FY26.

Epigral's board approved its entry into the epoxy resin and formulations business with a planned production capacity of 1,25,000 TPA and setting up Multi-Purpose Plant (MPP). The company will undertake the project with an estimated capex investment of approximately ₹600 crore. The company expects to commission both the commercial plant in H2FY28.

The strategic expansion marks Epigral's forward integration into the advanced materials and specialty chemicals segment, supported by strong and growing demand from key user industries including construction, renewable energy, automotive, electronics, infrastructure, marine, aerospace, industrial flooring, and semiconductor applications.

Epoxy resin is a critical material used in high-performance and quality-driven applications such as windmill blades, fiber reinforced polymers, tile adhesives, industrial coatings, chemical storage systems, electrical insulation, marine structures, and automotive components.

The move is strategically significant for Epigral as key raw materials required for manufacturing epoxy resin, including Epichlorohydrin (ECH) and Caustic Soda, are already produced within the company's integrated manufacturing complex at Dahej. More than 50 per cent of the raw material value for the proposed project will be sourced internally, further strengthening Epigral's backward integration advantages and operational efficiencies.

Epigral is also setting up a Multi-Purpose Plant (MPP) to manufacture downstream products of the Epichlorohydrin and Chlorotoluenes value chains. The facility is aimed at addressing the growing domestic demand for pharmaceutical and agrochemical intermediates and water treatment chemicals in India.

In line with its phased development approach, Epigral is also establishing a pilot plant facility for Epoxy Resin & Formulations and MPP, expected to be operational by Q2FY27. The pilot facility will help validate product quality, optimise manufacturing processes, and facilitate customer approvals ahead of commercial-scale operations.

Commenting on the results and development, Maulik Patel, Chairman and Managing Director, Epigral Limited, said, "Epigral delivered steady growth in Q1FY27 despite severe macroeconomic volatility driven by geopolitical tensions in West Asia. The quarter was marked by fluctuations in raw material and finished goods prices, alongside elevated freight costs and shipment delays. Leveraging its diversified product mix, Epigral successfully navigated these headwinds to achieve 15 per cent revenue growth and an EBITDA margin of 25 per cent.

While geopolitical challenges persist, operating conditions have stabilized. Backed by India's strong economic growth trajectory, management maintains a positive outlook. To drive future diversified growth, the Board approved strategic investments in a new Epoxy Resin & Formulations plant and a Multi-Purpose Plant (MPP). Both expansions will enhance efficiency within Epigral's integrated manufacturing complex by utilizing internal raw materials. Specifically, the Epoxy Resin plant will consume ECH and Caustic Soda, while the MPP will be downstream of Epichlorohydrin and Chlorotoluenes Value Chain. The Epoxy Resin plant will cater to domestic and global demand across the renewable energy, infrastructure, electronics, automotive, and industrial sectors. Concurrently, the MPP will meet rising domestic demand for pharmaceutical and agrochemical intermediates and water treatment chemicals."

Capacity expansion and green steel to drive long-term growth in India's iron and steel industry

Mumbai: In a decade, India has moved from the fourth-largest producer to the second-largest producer and consumer of crude steel in the world, a shift driven by sustained capacity additions, government-led infrastructure investment, and deepening domestic demand. These gains, and the headwinds that accompany them, are the subject of the latest Rubix Industry Insights report by Rubix Data Sciences.

The report charts how India's steel industry arrived at this point. In 2024, the country ranked second globally in crude steel production and finished steel consumption, and was the world's largest producer of sponge iron. Meanwhile, India's global share of crude steel production doubled from 5 per cent in 2014 to 8 per cent in 2024, while its share of finished steel consumption rose from 5 per cent to 8 per cent over the same period.

India has outlined an ambitious roadmap for the sector, aiming to increase crude steel capacity from around 200 million tonnes per annum (MTPA) at present to 300 MTPA by 2030-31, with capacity targeted to reach 400 MTPA by 2035-36 and 500 MTPA by 2047.

The report attributes this growth outlook to strong structural drivers. As nearly half of India's population is expected to live in urban areas by 2047, demand for housing, transportation networks, industrial infrastructure and smart cities is expected to increase significantly, driving sustained steel consumption. To achieve the 400 MTPA production target, the industry is estimated to require investments of nearly ₹17 trillion.

At the same time, India's dependence on imported coking coal, currently around 90 per cent of the requirement, remains a structural vulnerability that the sector has yet to meaningfully address. The report also highlights India's accelerating transition towards green steel production through initiatives such as the Green Steel Mission, increased adoption of renewable energy, greater use of scrap-based steelmaking and the development of green hydrogen-based technologies. These initiatives are becoming increasingly important as global markets introduce carbon-related trade measures such as the European Union's Carbon Border Adjustment Mechanism (CBAM).

This growth is also being supported by a coherent policy architecture. The Production Linked Incentive (PLI) scheme for specialty steel, the Domestically Manufactured Iron and Steel Products (DMI&SP) Policy, and the National Steel Policies of 2017 and 2025 together provide a framework spanning demand creation, import substitution, and long-term capacity planning. On the sustainability front, India became the first country in the world to introduce a formal Green Steel Taxonomy in 2024, classifying steel by carbon emission intensity and establishing a star-rating system to incentivise decarbonisation across the sector.

According to Tushar Bhaskar, President, Rubix Data Sciences, the numbers tell a compelling story, but they also reveal the scale of what remains to be done, "India's steel industry has made genuine strides over the past decade in production and consumption, and now in shaping its green steel agenda. At the same time, the structural challenges are real. India currently emits around 2.65 tonnes of CO_2 per tonne of finished steel produced, roughly 32 per cent above the global average, and imports nearly 90 per cent of its coking coal requirements. Closing these gaps is not a matter of policy intent alone; it requires consistent execution and significant capital over a long horizon. The decarbonisation agenda is a commercial necessity as well as a competitive opportunity."

He added that the growth story and the risk story are inseparable. "The demand fundamentals are strong, and the policy direction is largely right. But the ₹17 trillion investment pipeline also represents a significant concentration of counterparty and supply chain risk. Coking coal import dependence, input cost volatility, and the pace of green transition will determine whether the capacity additions translate into a durable competitive advantage or simply add to the pressure on margins." ■

Atul Gupta assumes charge as CMD of EIL

Atul Gupta has assumed charge as Chairman & Managing Director (CMD) of Engineers India Ltd (EIL). A Mechanical Engineer from GBPUAT, Pantnagar, Shri Gupta is a seasoned leader with over three decades of distinguished experience in conceptualising and executing complex projects across domestic and international markets. He has led cross-functional teams in delivering multi-billion-dollar projects on time, cost-effectively and to the highest quality standards. Prior to assuming the role of Chairman & Managing Director, he headed the Company's Commercial Directorate from August 2022, where he led key functions such as Business Development and Supply Chain Management with a strong focus on growth, operational excellence, transparency, efficiency and value creation.

PCBL Chemical Limited appoints Vaneet Kumar as Chief – Batteries

PCBL Chemical Limited has announced that it has appointed Vaneet Kumar as Chief – Batteries | Executive Director, to lead its advanced battery materials portfolio. Bringing over two decades of distinguished leadership experience, Kumar will drive PCBL's next phase of technological growth. He has valuable industry experience in energy storage, automotive sector and leading cutting-edge innovation in battery technology. This experience includes his tenure with SVOLT Energy Technology, ACME Cleantech Solution Pvt. Ltd, Great Wall Motors Pvt. Ltd, etc. His last assignment was as SVP & CTO - Battery with Adani New Industries Ltd. He has completed his B.Tech in Instrumentation Engineering from Punjab Technical University and M.Tech in Instrumentation from IIT Bombay.

ABB's Machine Automation division appoints Pratip Samanta as Regional MD for Southern and Eastern Asia

B&R, ABB's Machine Automation division, announced the appointment of Pratip Samanta as new Regional Managing Director (RMD) for Southern and Eastern Asia, effective July 1, 2026. Pratip Samanta succeeds Jhankar Dutta.

Pratip brings over 21 years of leadership experience in Industrial Automation, IT Services, Digital Consulting, and Strategic Account Management. Most recently, he served as Global Client Partner at Tata Consultancy Services (TCS) in Munich, where he drove strategic growth and large-scale digital transformation initiatives for global energy technology clients. He previously worked at ABB from 2008 to 2017 in several leadership roles across sales, consulting, and operational transformation, and brings additional expertise from his tenure at Siemens in Automation & Drives, where he helped industrial customers enhance operational efficiency and technological adoption. Pratip holds a Bachelor of Engineering from Vidyasagar University with focus on Electrical Engineering and attended TCS Emerging Leaders Program supported by Ohio State University and TATA Management Training Center. He succeeds Jhankar Dutta, who has decided to leave the company to pursue new career opportunities. ■

thyssenkrupp nucera and BHEL enter collaboration to advance green hydrogen electrolysis in India

thyssenkrupp nucera and BHEL sign their strategic collaboration agreement at BHEL's headquarters in New Delhi, India. Copyright: BHEL

Mumbai / Dortmund: thyssenkrupp nucera and Bharat Heavy Electricals Limited (BHEL) have signed a strategic collaboration agreement for alkaline water electrolyzer manufacturing for green hydrogen projects in India. The partnership marks another decisive step in thyssenkrupp nucera's strategy to strengthen its position in one of the world's most important future green hydrogen markets. The agreement was signed at BHEL's Corporate Office, New Delhi, India.

Under the agreement, thyssenkrupp nucera and BHEL will work together on the phased localization of alkaline electrolyzer module fabrication in India. The collaboration focuses on establishing local manufacturing capabilities, joint participating in tendering processes, and supporting green hydrogen project implementation in the Indian market.

"India is one of the most important growth markets for thyssenkrupp nucera," said Kiran Joseph, CEO of thyssenkrupp nucera India. "Scaling green hydrogen in India requires solutions that are reliable, scalable, and aligned with the country's industrial ambitions. This collaboration with BHEL underlines our commitment to support the build up of a robust green hydrogen market in India over the long term."

LANXESS to start local production of fire-resistant hydraulic fluids in India

Mumbai: LANXESS, a leading global specialty chemicals company, will start local production of Fire-Resistant Hydraulic Fluids (FRHF) at its Jhagadia site in India.

With the start of production in Jhagadia, LANXESS strengthens access to its globally recognized Reolube® phosphate ester-based fire-resistant hydraulic fluids, bringing proven products closer to customers in India and across the IMEA region.

Neelanjan Banerjee, Senior Vice President and Global Head of the Business Unit Lubricant Additives, LANXESS, said, "Local production of Reolube® fire-resistant hydraulic fluids in India is an important step in strengthening our customer proximity and supply reliability in a fast-growing region. It reflects our confidence in India's potential and our commitment to delivering globally proven, high-performance solutions closer to where our customers need them."

Establishing local production in Jhagadia marks an important step in further embedding LANXESS'

technology and capabilities in the region. This is complemented by the recent opening of a dedicated Application Development Center in Thane, providing local technical support and customer proximity. Together, these investments form the foundation of a structured local network, to serve customers more directly and position LANXESS as a leading local supplier in this segment.

Fluor enters into long-term agreement with Aramco

Fluor has maintained a presence in the Kingdom of Saudi Arabia since the 1940s providing support for the nation's growth and development from its office in Al Khobar (pictured).

Irving, Texas: Fluor Corporation has announced that it has been selected by Saudi-based Aramco as a Program Management Consultancy (PMC) contractor under a Long-Term Agreement (LTA) to support its global capital projects portfolio. The LTA will allow efficient deployment of Fluor's global expertise, local workforce and digital project delivery capabilities.

The LTA covers future opportunities for pre-FEED, FEED, engineering, project management, procurement oversight, construction management and program execution services across a range of upstream, downstream, petrochemical and infrastructure developments.

"We are honored to be selected by Aramco for this strategic long-term agreement – supporting the company's objectives to enhance energy security, operational efficiency and sustainable growth," said Pierre Bechelany, Fluor's Business Group President of Energy Solutions.

With more than 80 years legacy in the Kingdom of Saudi Arabia, Fluor has supported Aramco across some of its most significant facilities and infrastructure programs.

L&T wins order from Kuwait Oil Company for hydrocarbon onshore business

Mumbai: L&T Energy Hydrocarbon Onshore business has secured a major Engineering, Procurement and Construction (EPC) order from Kuwait Oil Company (KOC) for its key Jurassic Light Oil (JLO) export facilities and the upgrade of existing export network.

The scope encompasses EPC of six new crude oil storage tanks, each with an operating capacity of 618,000 barrels, and associated facilities, on a Lump Sum Turnkey basis.

The project also involves the installation of new pipelines and comprehensive upgrades to Kuwait's existing crude loading and export network to seamlessly accommodate increased production and enhance the country's crude handling capabilities.

Commenting on the order win, Mr. E. S. Sathyanarayanan, Senior Vice President & Head of L&T Energy Hydrocarbon Onshore and Member of the Divisional Board – L&T, said: "We are pleased to be entrusted with this major strategic project by Kuwait Oil Company. The development of the Jurassic Light Oil export infrastructure is an important investment in Kuwait's energy sector and we are committed to supporting the country's energy ambitions through reliable and world-class project execution."

L&T Energy Hydrocarbon Onshore is a significant EPC Business of L&T, delivering comprehensive Lump Sum Turnkey solutions across the upstream, midstream and downstream hydrocarbon sectors. With a strong execution track record across global markets, it has delivered refinery expansions, petrochemical complexes, gas processing plants, LNG terminals, fertiliser plants and cross-country pipelines projects.

GreenH Electrolysis develops hydrogen production and refuelling station for India's first hydrogen powered train

Shri Ashwini Vaishnaw, Union Minister of Railways, GoI, at GreenH's hydrogen Production and Refuelling Station at Jind.

New Delhi / Haryana: GreenH Electrolysis, a joint venture between H2B2 Electrolysis Technologies, a leading Green Hydrogen technology company and Castlegreen Energy Private limited – a company headquartered in North India, have developed the Hydrogen Production and Refueling Station for India's first indigenous hydrogen-powered Train, which was inaugurated by the Honourable Prime Minister of India, Shri Narendra Modi at Jind, on July 17, 2026.

Indian Railways had awarded the contract to retrofit Diesel Electric Multiple Unit rake, on the Sonipat-Jind section, from diesel to a hydrogen-powered train, to Medha Servo Drives Limited. In turn, Medha contracted GreenH to provide the Engineering, Procurement, and Construction (EPC) of the hydrogen production and refuelling station. The hydrogen production and refuelling station is a fully integrated turnkey solution encompassing process engineering, electrical systems, instrumentation and controls, and advanced safety systems to support seamless train operations.

The facility features India's largest railway hydrogen storage and refuelling infrastructure, integrating 3,000 kg of hydrogen storage, hydrogen compressors, and hydrogen dispensers with pre-cooler integration, enabling safe, efficient and rapid refuelling of hydrogen-powered trains. Beyond supporting this project, it showcases how indigenous innovation can accelerate India's green hydrogen ambitions while contributing meaningfully to the vision of *Viksit Bharat.*

Mr. Dhiman Roy, CEO and Director, GreenH Electrolysis Pvt. Ltd. said, "The inauguration of India's first hydrogen-powered train is a defining moment in the country's clean energy journey, and we are honoured to have contributed to this national milestone. At GreenH, we are proud to have designed and delivered the hydrogen production and refuelling infrastructure that powers this pioneering project. Our 1 MW electrolyser, manufactured at our facility in Jhajjar, Haryana, using advanced technology from our parent company H2B2 Electrolysis Technologies, has the capacity to produce 420 kg of green hydrogen per day, enabling reliable, round-the-clock operations. We remain committed to partnering with the Government and industry to develop the infrastructure that will drive the decarbonisation of transport and other hard-to-abate sectors." ■

Circularity in Petrochemicals: Transforming Waste Challenges into Resource Opportunities

Author
Vishal Sharma
ED & CEO
Godrej Industries Ltd (Chemicals)

For decades, the petrochemical industry has focused on improving yields. Better catalysts, more efficient processes, and higher conversions have all helped manufacturers produce more from the same amount of raw material. That pursuit of efficiency continues today. What is changing is where manufacturers are looking for the next opportunity. Increasingly, the conversation extends beyond the production process itself. It includes everything that leaves the process as well. Materials that were once treated as waste are being re-evaluated for the value they still contain. Solvents, process residues, by-products, wastewater, and even waste heat are no longer viewed only through the lens of disposal. They are becoming part of a broader discussion around resource productivity, emphasizes ***Vishal Sharma, ED & CEO, Godrej Industries Limited (Chemicals).***

The business case for circularity is gaining momentum globally. Municipal and industrial water reuse alone could grow eight-fold by 2040[1], creating an important new source of industrial water while reducing pressure on freshwater resources. This shift is gradually changing how circularity is understood in the petrochemical industry.

Circularity Begins Much Earlier than Recycling

Circularity is often associated with recycling, but for manufacturers it begins much earlier. The first question is not how waste should be managed. It is why it was created in the first place.

Every manufacturing process generates material that falls outside its intended output. Some of it is unavoidable. Some of it results from process limitations, incomplete conversions, or inefficient resource use. The more these losses can be reduced within the process, the greater the opportunity to recover value before materials leave the plant.

That is why circularity is becoming closely linked with process optimization. Improving reaction efficiency, recovering solvents, reusing process water, and finding productive applications for by-products all contribute to extending the useful life of resources already entering the manufacturing system. Viewed this way, circularity is less about managing waste and more about making better use of materials that have already been purchased.

Technology is Expanding What can be Recovered

Recovering value from industrial streams has always been technically possible. What has changed is the range of technologies now available to do it more efficiently. Advanced separation systems, solvent recovery technologies, digital process monitoring, improved catalysts, and better process controls are allowing manufacturers to recover materials that may previously have been difficult or uneconomical to reclaim.

Technology is also improving visibility. The European chemical industry continues to place circularity at the center of manufacturing strategy[2] by prioritizing resource reuse, alternative feedstocks, and the recovery of high-quality materials from industrial waste streams. Manufacturers are developing a clearer understanding of where materials are being lost, how resources move through production, and which process streams offer the greatest recovery potential. These insights help guide investment decisions far more effectively than broad assumptions about waste reduction. The objective is not to recover everything. It is to recover those resources that create meaningful operational and commercial value.

Circularity is often discussed as an environmental objective. Increasingly, it is also becoming a business strategy. Recovering valuable materials reduces dependence on virgin resources. Better resource utilisation lowers operating costs. Reusing process streams can improve resilience against fluctuations in raw material availability while helping manufacturers respond to growing customer expectations around responsible production.

Scaling Circularity is a Shared Challenge

While individual technologies continue to improve, scaling circular manufacturing is rarely straightforward. Recovery systems need to fit existing production processes. Recovered materials must consistently meet quality requirements. Supply chains often need to adapt to accommodate recycled or recovered feedstocks. In many cases, the economics depend on collaboration well beyond the manufacturing site itself. This is where circularity becomes a value chain discussion rather than an individual company initiative.

Technology providers, manufacturers, customers, recyclers, engineering firms, and policymakers each influence how effectively materials remain in productive use. Progress depends less on isolated investments and more on improving coordination across these different participants. For many companies, therefore, the challenge is not proving that circular solutions work. It is creating the conditions that allow them to work consistently at commercial scale.

Environmental & Business Performance are Becoming Closely Linked

Circularity is often discussed as an environmental objective. Increasingly, it is also becoming a business strategy. Recovering valuable materials reduces dependence on virgin resources. Better resource utilisation lowers operating costs. Reusing process streams can improve resilience against fluctuations in raw material availability while helping manufacturers respond to growing customer expectations around responsible production.

Global buyers are paying closer attention to how products are manufactured, not only what they contain. The conversation around circularity is no longer limited to environmental performance[3]. Increasingly, it is being viewed as a practical way to strengthen supply chains, reduce dependence on virgin raw materials, and improve long-term competitiveness. Resource efficiency, traceability, and environmental performance are becoming part of supplier conversations across many industrial sectors.

For petrochemical manufacturers, this changes the role of circularity. It is no longer confined to waste management or sustainability reporting. It increasingly influences operational efficiency, commercial competitiveness, and long-term customer relationships. That is, perhaps, the most significant shift taking place.

The companies that create the greatest value over the coming years are unlikely to be those that simply generate less waste. They will be the ones that recognise opportunity in material streams that have traditionally been overlooked and redesign their manufacturing systems to keep those resources in productive use for longer. ■

References

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INTERVIEW

“India Continues to be One of our Most Important Growth Markets”

John Valukas

President - Lubrizol Engineered Materials Business, Lubrizol

Binay Agrawal

Business Head CPVC, Lubrizol IMEAl

Mittal Shah

Business Head Medical Devices & EP, Lubrizol IMEA

Globally, customer requirements are evolving and witnessing a dramatic change in terms of supply chains, localisation and resilience amid changing geopolitical and economic conditions. In a freewheeling exclusive joint interview with Chemical Engineering World, ***John Valukas, President - Lubrizol Engineered Materials Business, Lubrizol; Binay Agrawal, Business Head CPVC, Lubrizol IMEA and Mittal Shah, Business Head Medical Devices & EP, Lubrizol IMEA****, share at length the evolving trends across specialty materials, healthcare manufacturing, infrastructure and India’s growing role in global supply chains.*

What according to you are the evolving trends in the Chlorinated Polyvinyl Chloride (CPVC) and medical tubing market?

John Valukas: The CPVC market is evolving rapidly. Growth is increasingly coming from Tier-2 and Tier-3 cities, driven by urbanization, rising incomes, and organized housing. Beyond plumbing, CPVC is also gaining adoption in data centres, fire protection systems, and industrial applications thanks to its durability, corrosion resistance, and fire resistance properties.

At the same time, stronger alignment with BIS, UL, and NSF standards is raising quality benchmarks and boosting confidence in high-performance systems. The future of CPVC will be driven not just by construction growth, but by the demand for safer, more reliable, and higher-performance infrastructure.

India continues to be one of our most important growth markets, and our focus going forward is quite clear - we want to build locally, scale with the market, and support its long-term development. Ultimately, our goal is to grow with India, while also contributing to its role as a reliable manufacturing and innovation hub for global markets.

On the medical side, the shift is toward high-performance, biocompatible materials, including TPU, and precision components, especially as minimally invasive procedures and more advanced devices continue to grow.

Overall, what ties both markets together is the move toward localized manufacturing that meets global standards. That is leading to stronger, more integrated value chains, where materials are not just inputs, but key enablers of reliability, compliance, and end performance.

How would you describe the growth of Lubrizol in the Indian market with respect to CPVC and medical tubing industry?

John Valukas: Lubrizol's growth in India is unique as it has grown alongside the CPVC industry itself. We introduced CPVC to the Indian market more than 25 years ago, and since that time we have not only pioneered the adoption of FlowGuard® Plus CPVC but enhanced the ecosystem — from manufacturers and channel partners to plumbers, builders, and homeowners.

Today, our commitment is stronger than ever. Through a Make in India, local-for-local strategy, a fully integrated manufacturing footprint, including our CPVC resin facility at Vilayat and expanded compounding capabilities at Dahej, we are combining global technology with local manufacturing excellence.

These investments strengthen India's infrastructure and water management needs, enhance supply chain resilience, and reinforce our role as a trusted partner in the nation's growth.

In medical tubing, we are extending the same philosophy by building localized, high-value manufacturing ecosystems. Our medical tubing facility in Chennai, brings world-class, ISO 13485-certified production closer to customers and supports the development of advanced medical devices within India. These capabilities will also enable Indian OEMs design and manufacture products for global markets.

Overall, our focus is on building in India, for India, and for global markets, enabling innovation, strengthening local ecosystems, and positioning India as a strategic hub for both infrastructure and advanced healthcare manufacturing.

What according to you are the challenges for growth in the CPVC industry?

Binay Agrawal: While the long-term outlook for CPVC in India remains highly positive, the industry faces three important challenges. First is commoditization, driven by price-focused buying. As adoption increases, differentiation is becoming harder for end-users, with decisions increasingly driven by price per meter rather than performance. This puts pressure on industry to discourage continued investment in innovation, quality, and technical support.

Second is inverted duty structure and circumvention by anti-dumping duty by imports of CPVC from certain countries. The rapid growth of the category has attracted unorganized players and inconsistent quality standards. While there is import duty of 5-8 per cent on PVC imports from select countries, import duty on CPVC from those same countries is 0 per cent. This is driving more manufacturing of CPVC resin outside India. There are also allegations of CPVC material being rerouted through countries like Malaysia and Japan to circumvent the anti-dumping duty. This, along with poor quality of imported material, pose a serious risk as failures in duplicate material can erode confidence in the entire CPVC category.

Third is limited awareness beyond plumbing. While CPVC is well established in domestic plumbing, its potential in industrial, fire sprinkler and other infrastructure applications remain underpenetrated.

Addressing these challenges requires a collective effort with stronger education, wider awareness of standards and applications, and deeper ecosystem engagement.

At Lubrizol, we see our role not just as a material supplier, but as a partner in industry development. With our localized manufacturing footprint and long-standing presence in India, we are well positioned to expand awareness, improve quality benchmarks, and support the next phase of growth for the CPVC industry.

How has Lubrizol leveraged the increasing role of innovation in CPVC and medical tubing markets?

John Vaukas: Innovation has always been central to how we approach both of these segments, but more importantly, it is how we translate materials science into real-world performance and customer value.

Through continuous advancements in CPVC technology, market education, and industry standard-setting, we have expanded CPVC applications from plumbing to fire protection and industrial systems. Lubrizol also helped raise industry benchmarks by promoting rigorous product testing, third-party certifications, system validation, application-specific performance standards and quality assurance protocols.

In medical tubing, innovation is even more closely tied to enabling next-generation healthcare solutions. Leveraging our expertise in advanced polymers and precision component manufacturing, we are developing solutions that meet increasingly stringent requirements of performance and patient safety.

What has also evolved is the way we innovate. Today it is far more collaborative and application-driven. We work closely with OEMs and partners to support design-to-market acceleration, helping bring complex, minimally invasive devices to market faster and more reliably.

Overall, for us, innovation is not just about material development; it is about co-creating solutions with customers, anticipating future application needs, and enabling long-term performance across critical industries.

How would you describe the growth of the medical device manufacturing capabilities of India?

Mittal Shah: India's medical device manufacturing sector is at a very interesting inflection point. What we are seeing now is a clear shift from being largely import-dependent to becoming a more self-reliant and globally competitive manufacturing hub.

This growth is being driven by a combination of factors.

Innovation across specialty chemicals and healthcare manufacturing is definitely accelerating and becoming far more purpose-driven. In advanced engineered chemicals, the shift is toward materials that are designed for specific applications, rather than one-size-fits-all solutions. There is also a much sharper focus now on sustainability, regulatory alignment, and local relevance, especially in markets like India where scale and standards are both evolving.

Government-led initiatives such as PLI schemes and the broader Make-In-India agenda have created a strong foundation, while rising domestic healthcare demand is accelerating the need for locally produced, high-quality devices.

At the same time, there is a growing emphasis on meeting global quality and regulatory standards, which is enabling Indian manufacturers to strengthen their export competitiveness. This is particularly evident in segments like consumables, medical tubing, and mid-complexity devices, where India is already building strong capabilities.

What is especially encouraging is the gradual shift toward more complex, value-added segments. As the ecosystem matures — with better infrastructure, skilled talent, and stronger partnerships, we are seeing increased traction in areas such as minimally invasive devices and precision components.

Overall, the trajectory is clear - India is evolving from a volume-driven market to a capability- and innovation-driven manufacturing base, with the potential to play a much larger role in the global medical device value chain.

Lubrizol had entered into a partnership with Polyhose in 2024. Could you throw more light on how this partnership has evolved?

Mittal Shah: Our partnership with Polyhose has evolved into a strong, complementary collaboration focused on building a robust medical tubing ecosystem in India. At its core, it brings together Lubrizol's global expertise in medical devices design and manufacturing

with Polyhose's strength in polymer processing. Over time, this has developed into a more integrated and capability-driven partnership, enabling us to better address the evolving needs of the MedTech industry.

A key milestone in this journey has been the inauguration of our medical tubing facility in Chennai, which reflects our shared commitment to localizing high-value manufacturing. This allows us to deliver precision component solutions, while improving speed, reliability, and responsiveness for customers.

More importantly, the partnership is helping build a future-ready MedTech ecosystem in India, aligned with global quality standards and driven by local capability. By combining innovation, manufacturing scale, and close collaboration, we are strengthening India's role in the global medical device supply chain.

Are there any new acquisitions in the pipeline?

John Valukas: Lubrizol continues to evaluate strategic opportunities aligned with its growth priorities.

How would you describe the growth of innovation in the specialty chemicals and healthcare manufacturing industry?

John Valukas: Innovation across specialty chemicals and healthcare manufacturing is definitely accelerating and becoming far more purpose-driven. In advanced engineered chemicals, the shift is toward materials that are designed for specific applications, rather than one-size-fits-all solutions. There is also a much sharper focus now on sustainability, regulatory alignment, and local relevance, especially in markets like India where scale and standards are both evolving.

For healthcare, innovation is increasingly about improved patient safety and care. High-tech components are playing a much bigger role in enabling minimally invasive procedures and more advanced devices, which ultimately improve patient care.

What is also changing is how innovation happens; it is no longer siloed. It is far more collaborative, with closer engagement between material companies, manufacturers, and OEMs to bring solutions to market faster.

How would you describe the overall growth and adaptation of digital innovation in the industry today?

Binay Agrawal: Digital innovation is becoming essential across the industry to stay competitive. We are seeing digital tools help companies move faster in product development, improve manufacturing consistency, and make better, data-driven decisions. Technologies like automation and advanced analytics are also helping reduce downtime and improve quality.

There is also a big shift in how companies manage their supply chains, with better visibility and traceability, which is critical in today's environment.

Overall, companies that build digital capabilities into their core operations will be better positioned to respond quickly, scale efficiently, and deliver consistent value to customers.

What are the future plans of Lubrizol with respect to the India market in CPVC and medical tubing segment?

John Valukas: India continues to be one of our most important growth markets, and our focus going forward is quite clear - we want to build locally, scale with the market, and support its long-term development.

In CPVC, this means continuing to strengthen our integrated manufacturing footprint and ecosystem partnerships, while driving wider adoption across both traditional and emerging applications.

In medical tubing, we see a strong opportunity to expand high-value manufacturing and innovation capabilities in India, particularly as the country positions itself as a global hub for MedTech. We will continue to bring latest TPU polymers and manufacturing technologies from our global manufacturing ecosystems, to our Indian OEM customers.

More broadly, our approach is to combine global expertise with strong local execution, working closely with customers, investing in capabilities on the ground, and supporting the overall ecosystem.

Ultimately, our goal is to grow with India, while also contributing to its role as a reliable manufacturing and innovation hub for global markets. ■

GUEST COLUMN

The Cold Chain Blind Spot in Refining & Petrochemicals

AKASH AGARWAL

CEO , Crystal Group
(Crystal Logistic Cool Chain Pvt Ltd)

Why India's fastest-growing industrial sector can no longer afford to ignore temperature-controlled logistics, explains ***Akash Agarwal, CEO, Crystal Group (Crystal Logistic Cool Chain Pvt Ltd).***

India is on the cusp of a petrochemical revolution. With a planned capital expenditure of ₹3,28,227 crore (roughly US$ 37 billion), the country is positioning itself to supply nearly one-third of global capacity additions by 2030. Refineries are expanding. Specialty chemical parks are coming up. Polymer plants are scaling. And yet, amid all this industrial ambition, there is one invisible infrastructure gap that continues to quietly bleed efficiency, compromise product integrity, and cost the industry hundreds of crores every year: the cold chain.

Super freezer placed at a chemical plant

Most conversations about cold chain in India revolve around food, pharmaceuticals, or vaccines. But walk into any large refining complex or petrochemical facility and you will find temperature-sensitive materials sitting in conditions they were never meant to withstand catalysts exposed to humidity, specialty chemicals losing efficacy in open storage, biological additives degrading in transit, and process samples losing integrity before they reach the lab. The cold chain blind spot in this industry is real, and it is expensive.

What Exactly Needs Temperature Control in a Refinery?

The average person thinks of a refinery as a hot place - all flare stacks, steam, and high-temperature reactors. And they are not wrong. But every large refining or petrochemical complex also handles a surprising range of materials that require controlled thermal environments:

- **Catalysts and Catalyst Carriers:** Many hydroprocessing and Fluid Catalytic Cracking (FCC) catalysts are moisture-sensitive and must be stored below specific humidity and temperature thresholds. Improper storage leads to activity loss before the catalyst even enters the reactor.

- **Specialty Additives and Chemicals:** Corrosion inhibitors, antifoulants, demulsifiers, and pour-point depressants are often temperature-sensitive blends. Exposure to heat cycles during transit or storage degrades their molecular structure.

- **Laboratory and Quality Control Samples:** Process samples drawn for compliance testing must arrive at analytical labs without thermal degradation. A compromised sample means a compromised result and potentially, a regulatory headache.

The point is simple: the boundary between 'industrial' and 'cold chain' is more porous than the industry acknowledges.

"India is building world-class petrochemical capacity. It is time to build a world-class cold chain to match."

The Hidden Cost of Ignoring Temperature

Let us put numbers to the problem. India's catalyst market alone is estimated at over ₹4,000 crore annually, and a significant portion of that spend is lost to avoidable degradation not because the catalysts are defective, but because the cold chain that should protect them does not exist.

Consider a typical scenario: a refinery imports a high-performance hydrocracking catalyst from a European supplier. The material is shipped correctly in temperature-controlled containers across the ocean. It clears customs at JNPT. And then it sits in a non-refrigerated CFS shed, in a bonded warehouse without climate control, in a truck without insulation until it finally reaches the plant, sometimes weeks later, having been exposed to Mumbai's humid coastal air and summer temperatures that regularly breach 38°C.

By the time it reaches the reactor, the catalyst has already begun to lose activity. The plant will never know exactly how much. They will simply find that run lengths are shorter than expected, selectivity is lower than the datasheet promised, and the next purchase order goes in sooner than planned.

This is not a hypothetical. It is the current operating reality for dozens of refineries, petrochemical complexes, and specialty chemical manufacturers across India.

India's Cold Chain Infrastructure: Where It Stands

India has made remarkable strides in cold chain development over the past decade, largely driven by the food processing and pharmaceutical sectors. As of 2024, India has approximately 8,000+ cold storage facilities with a combined capacity of over 35 million metric tonnes. Reefer truck fleets have expanded significantly. Temperature-controlled warehousing is growing at over 15 per cent annually.

But this growth has been sector-specific. The overwhelming majority of India's cold chain capacity is designed for produce of potatoes, apples, onions or for pharmaceuticals. The industrial cold chain, particularly for the refining and chemical sectors, remains dramatically underdeveloped.

The reasons are structural. Food and pharma companies buy cold chain services in large, predictable volumes. Refineries and chemical plants use temperature-controlled logistics episodically for a catalyst change, for a specialty chemical consignment, for an import shipment.

Modular Cold Chain: The Practical Solution

The good news is that the industrial cold chain problem does not require massive greenfield investment to solve. Modular, containerised cold chain infrastructure has matured significantly and is now a practical, cost-effective answer for refineries and petrochemical plants.

Reefer containers — ISO-standard refrigerated containers of 20ft and 40ft — can be deployed at plant sites in days, not months. They require no civil work, can be connected to standard power supply, and offer precise temperature control from -25°C to +25°C. For a refinery handling temperature-sensitive catalyst shipment, two or three well-positioned reefer containers can protect millions of rupees worth of materials at a fraction of the cost of a permanent cold room.

Blast freezers offer rapid temperature pulldown for materials that need to be quickly brought to and held at low temperatures useful for bio-based feedstocks and certain specialty chemicals that arrive warm and need to be stabilised before storage.

Modular Infrastructure

Modular cold rooms can be constructed within existing plant infrastructure with a relatively small footprint.

"Temperature control is not just a pharmaceutical problem. In refining and petrochemicals, the integrity of your catalyst is the integrity of your process."

Walk into any large refining complex or petrochemical facility and you will find temperature-sensitive materials sitting in conditions they were never meant to withstand catalysts exposed to humidity, specialty chemicals losing efficacy in open storage, biological additives degrading in transit, and process samples losing integrity before they reach the lab. The cold chain blind spot in this industry is real, and it is expensive.

Built with PUF (Polyurethane Foam) insulated panels and precision refrigeration systems, they can be sized exactly to requirement and expanded as needs grow.

The key advantage of modular infrastructure is flexibility. A refinery planning a major catalyst changeout can bring in temporary reefer capacity for the duration of the project and remove it afterward. A specialty chemical plant that handles seasonal imports can scale cold storage up and down with demand. This asset-light approach fits well with the capital discipline that most Indian industrial operators apply to non-core infrastructure.

The Opportunity Ahead

India's petrochemical sector is entering a decade of accelerated investment. New integrated refinery-cum-petrochemical complexes are being planned at Ratnagiri and elsewhere. The specialty chemicals sector - now a US$ 40 billion industry - is growing at 12-14 per cent annually, with exports rising sharply. Bio-refinery projects are moving from pilot to commercial scale. All of this points to a rapidly growing requirement for industrial cold chain capability.

For logistics and infrastructure providers, this represents a significant white space. The companies that move early to understand the thermal management requirements of the refining and chemical sectors and build the specialised capabilities to serve them will have a structural advantage as the sector grows.

For plant operators, the ask is simpler: include temperature requirements in your material specifications, your logistics vendor evaluations, and your plant-side storage planning. The cost of getting this right is a rounding error compared to the cost of getting it wrong.

Conclusion

The refining and petrochemicals sector has, for too long, treated cold chain as someone else's problem. It is not. Every catalyst, every specialty additive, every bio-derived feedstock, and every process sample that moves through the Indian industrial system has a thermal story and right now, most of those stories do not have a happy ending.

The infrastructure exists. The technology is proven. The economics work. What is missing is awareness and intent. As India doubles down on its petrochemical ambitions, the cold chain conversation needs to move from the food aisle into the refinery gate. The sooner the industry recognises the blind spot, the sooner it can eliminate it. ■

About the Author

Akash Agarwal, CEO of Crystal Group (Crystal Logistic Cool Chain Pvt Ltd), *a Mumbai-based company with over six decades of experience in cold chain infrastructure, modular structures, and temperature-controlled logistics solutions. Crystal Group operates across multiple product lines including reefer containers, blast freezers, cold rooms, modular cold stores, and portable cabin structures, serving clients across pharmaceuticals, food processing, chemicals, Dairy and industrial sectors across India.*

For more details: www.crystalgroup.in / +91 91361 21497 / marketing@crystalgroup.in

"The question is not whether your process chemicals need a cold chain. The question is how much you are already losing because you do not have one."

CLOSING THE LOOP:

How Adhesive & Coating Technologies Are Building Circular Packaging Ecosystems

S. SUNIL KUMAR

Regional Director Packaging - IMEA
Henkel Adhesive Technologies

Packaging has always been a product of its era. In the post-war decades, the goal was preservation and convenience. In the era of globalization, it was shelf life, cost efficiency, and supply chain speed. Today, as the consequences of a linear 'make-use-discard' model become impossible to ignore, the packaging industry is grappling with a more demanding brief: do everything you did before, but design for a world where nothing is wasted. At the heart of this transformation are unlikely heroes: adhesives and coatings. ***S. Sunil Kumar, Regional Director Packaging – IMEA, Henkel Adhesive Technologies,*** further explains how adhesive and coating technologies are building circular packaging ecosystems.

Long overlooked as mere supporting materials, adhesives and coatings are now taking centre stage as the technologies enabling circular packaging to work in practice. Whether it is making flexible laminates recyclable, enabling paper-based formats to replace plastics, or reducing the material load of every pack that rolls off a converter's line, chemistry is quietly reshaping the packaging landscape.

In India, where packaging is emerging as a high-growth sector, the stakes could not be higher. Flexible packaging occupies a significant place in the country's packaging landscape, with pouches, sachets, stand-up bags and multi-layer laminates among the most prevalent formats. And it is precisely these formats, lightweight, barrier-rich, multi-material, that have historically been the most difficult to recycle.

The Regulatory Inflection Point

India's packaging industry is navigating a period of increasing regulatory scrutiny. The Plastic Waste Management Rules, 2016, have been amended multiple times, with 2025 updates strengthening traceability requirements and subsequent draft amendments proposing phased recycled-content and reuse obligations for plastic packaging. For rigid plastic packaging, the proposed recycled-content requirement starts at 30 per cent in 2025–26 and rises to 60 per cent by 2028–29, while flexible plastic packaging is subject to an initial 10 per cent requirement, increasing in later phases.

A 2026 amendment takes India's circular packaging agenda a step further by introducing mandatory reuse obligations for rigid plastic packaging. In doing so, it broadens the regulatory focus beyond recycling alone toward a more circular model that also incorporates reuse.

For the converter and brand-owner community, these mandates translate directly into material innovation imperatives. The industry is rapidly moving toward mono-material packaging structures and all-polypropylene (PP) or all-polyethylene (PE) solutions that are compatible with existing mechanical recycling streams. This transition requires not just film and resin innovation, but a fundamental rethink of how those structures are laminated, sealed, and coated, which is precisely where adhesive science enters the equation.

Heat seal coating applications

Recyclability by Design: The Adhesive's New Role

The biggest challenge in recycling flexible packaging lies in the multi-material laminate. A typical retort pouch or snack pack combines PET for strength, aluminium for barrier protection, and PE for heat sealing. These layers are held together by laminating adhesives. Each material has value on its own. But once combined, the structure becomes very difficult to recycle because mixed materials cannot be sorted and processed cleanly.

This challenge has pushed adhesive chemistry in two directions. The first is compatibility. Adhesives now have to work with mono-material laminates without contaminating the recovered polymer or affecting how it can be processed. Some certified laminating adhesives are already compatible with PE and PP recycling streams, with that performance validated by independent testing. In effect, the adhesive becomes part of the recycled material rather than a barrier to it.

The second direction is debonding, the deliberate engineering of adhesives that can release their bond under specific conditions at end-of-life, allowing mixed-material laminates to be separated into purer, higher-value streams. This technology is already enabling the commercial recycling of previously unrecyclable formats such as aluminium-plastic laminates, including flexible packaging for coffee, pharmaceuticals, and personal care products by allowing the adhesive layer to 'let go' during the recycling process, so that both the metal and polymer components can be recovered.

Together, these two capabilities, compatibility and controlled debonding, represent a systemic shift. Recyclability is no longer a property of the film substrate alone; it is a designed outcome of the entire laminate structure, with adhesive chemistry as a central variable.

Paper's Renaissance and the Coating Imperative

Perhaps no trend illustrates the changing role of adhesives and coatings more vividly than the resurgence of paper-based packaging. Driven by consumer demand for visible sustainability signals and regulatory pressure to reduce virgin plastics, brands across FMCG, food service, e-commerce, and personal care are exploring paper as an alternative substrate. India's e-commerce sector, supercharged by rapid delivery models that now demand impact-resistant, tamper-evident packs, is a particularly active frontier.

But paper, in its unmodified state, is a poor packaging material. It is moisture-sensitive, lacks barrier properties, and cannot be heat-sealed. The traditional solution was to laminate paper with plastic films. But this only replaced one problem with another, creating mixed-material structures that are just as hard to recycle as many all-plastic laminates.

Water-based, solvent-free barrier and heat-seal coatings can now be applied directly to paper. This gives paper many of the functional benefits of a polymer laminate while keeping the pack mono-material and compatible with paper recycling processes such as repulping and deinking.

These coatings can protect against moisture, grease and oxygen, while also making paper heat-sealable. That makes paper-based packaging viable for food contact applications, sachets, mailers and flexible food service formats. The EPIX platform shows this shift in action. With fully plastic-free mailers recyclable through standard paper recycling streams, it demonstrates how coating technology is opening up packaging formats that were not possible just a few years ago.

For India's converters and brand owners, many of whom are simultaneously managing EPR compliance, raw material inflation, and the need to maintain shelf appeal, these solutions offer a genuinely enabling pathway. Paper-based formats can reduce the plastic content of a packaging portfolio materially, while coatings ensure that the structural and barrier performance that brands require is not compromised.

Material Efficiency: Doing More with Less

Circular packaging is not only about what happens at end-of-life. It is equally about how much material enters the system in the first place. Adhesive and coating technologies play a significant and underappreciated role here too.

Precision application technology, the ability to apply hot melt adhesives at exact weights, in exact patterns, with minimal overspray has materially reduced adhesive consumption per pack without compromising bond performance. For high-speed packaging lines running millions of packs per year, this translates to a measurable reduction in chemical input. Similarly, solvent-free

Opening mailer with EPIX 9909

laminating adhesives eliminate the need to flash off and recover solvent during the lamination process, reducing energy consumption and VOC emissions at the converter.

In end-of-line packaging, case sealing, tray forming, label application, adhesive innovation is enabling the lightweighting of corrugated and carton board formats. Thinner boards with higher performance can be run at faster line speeds using next-generation hot melts that offer broader processing windows and lower application temperatures, reducing both material and energy intensity. The packaging that reaches the Indian consumer today, whether a pharma blister, an FMCG pouch, or a quick-commerce delivery box, increasingly carries a smaller material and carbon footprint than its predecessor, in part because of chemistry-led efficiency gains.

The Collaboration Imperative

It is worth being clear about what adhesive and coating technologies can and cannot do in isolation. No single material input can solve the systemic complexity of packaging circularity. Recyclability requires not just a well-designed laminate, but a waste collection infrastructure that reaches that laminate, a sorting system that correctly identifies it, and a recycling facility capable of processing it at scale. In India, as recycling infrastructure continues to develop and the informal sector plays an important role in material recovery, there is a growing opportunity to turn technical recyclability into stronger recycling outcomes.

This is why the most consequential developments in this space are collaborative. The transition to circular packaging is being driven by extended ecosystems, adhesive and coating experts working alongside film producers, brand owners, converters, recyclers, and infrastructure developers, sharing technical knowledge, co-developing materials, and validating systems end-to-end. Independent certification of recyclability claims, validated against recognized testing protocols, is becoming a baseline expectation rather than a differentiator.

India's packaging community is increasingly engaged in this collaborative model. Forums convened by industry bodies, policy engagement on EPR design, and pilot recycling initiatives for flexible packaging are all gaining momentum. The country's scale, and the sheer volume of packaging material it processes means that solutions developed and proven here have the potential for global relevance.

Conclusion

The packaging industry's transition to circularity is not a single technology shift. It is a structural transformation of how materials are selected, designed, used, and recovered. Adhesive and coating technologies occupy a pivotal position in that transformation, not as peripheral inputs, but as design enablers that determine whether a packaging structure can realize its circular potential.

For India, the alignment of regulatory momentum, market scale, and technology availability creates a genuine opportunity to leapfrog legacy packaging formats and build a more circular packaging ecosystem from a position of strength. The chemistry to enable that transition exists. The question now is how rapidly and systematically it can be deployed, across converter lines, brand portfolios, and the full arc of the packaging value chain.

In that effort, adhesives and coatings, though invisible and functional, are essential and may prove to be among the most important materials of our time. ■

GUEST COLUMN

REVAMP INSTEAD OF NEW CONSTRUCTION:

How Modernization Becomes a Strategic Growth Driver

DR. ULF BÄUMER

Senior Director of Service and
Senior Director of Digitalization
thyssenkrupp nucera

Now more than ever, the chlor-alkali industry needs a change in perspective. For too long, growth and state-of-the-art technology deployment has been equated primarily with new construction. But under today's conditions, that logic falls short: investment costs are rising, energy efficiency is becoming a competitive factor, sustainability requirements are tightening, and capital must be deployed more selectively than ever before. Companies that focus only on new plants may overlook the biggest lever for growth: their existing assets, emphasizes ***Dr. Ulf Bäumer, Senior Director of Service and Senior Director of Digitalization, thyssenkrupp nucera.***

The central question for the industry is no longer simply where new capacity can be built. It is this: How can existing industrial assets be used more intelligently? Chlor-alkali plants are capital-intensive, complex production systems that have evolved over decades. Many have been continuously expanded, adapted, and aligned with changing market conditions. That is precisely where a strategic value often underestimated lies. Companies that systematically analyze and further develop existing plants can often achieve growth faster, more resource-efficiently, and more economically than through a complete new-build project.

The first mistake would be to underestimate revamp as mere repair work

This is exactly where the revamp approach comes in. It is neither cosmetic retrofit nor a simple replacement of individual components. Revamp means the customized modernization, optimization, and further development of all sections of the existing chlor-alkali plants throughout their entire lifecycle. As an engineering and service approach, it makes it possible to systematically analyze plants, make bottlenecks visible, and unlock performance reserves in a targeted way.

Modernization thus moves from a perceived obligation to an active lever for growth and transformation. Revamp helps adapt existing plants to new production targets, higher efficiency requirements, and stricter sustainability standards – without automatically accepting the risks, lead times, and investment volumes of a greenfield project. In markets characterized by high demand volatility and rising cost pressure, this flexibility is not a side issue. It can be a determining factor in competitiveness.

That is why every revamp journey starts not with technology, but with uncomfortable yet necessary questions: Where is the plant losing performance? Which routines are masking structural weaknesses? Which bottlenecks are accepted in day-to-day operations even though they destroy value? The answer lies in a fact-based analysis of:

- Efficiency losses and capacity limits
- Operating and maintenance data
- Actual bottlenecks such as recurring disruptions and workarounds

The systematic evaluation of this information, which is often already available within the company, creates transparency about the real causes of performance and efficiency losses. Through audits, spot checks, and studies, it is translated into a clear basis for decision-making:

- Where do losses occur?
- Which components are limiting performance?
- Which measures make economic sense?
- Where are differences in comparison to state-of-the-art processes and technologies?

This transparency is particularly important because the causes of performance limits are often not where they are initially assumed to be. In plants that have been operating for many years, process adjustments, changing raw material qualities, new operating modes, or additional auxiliary systems can affect the overall system over time.

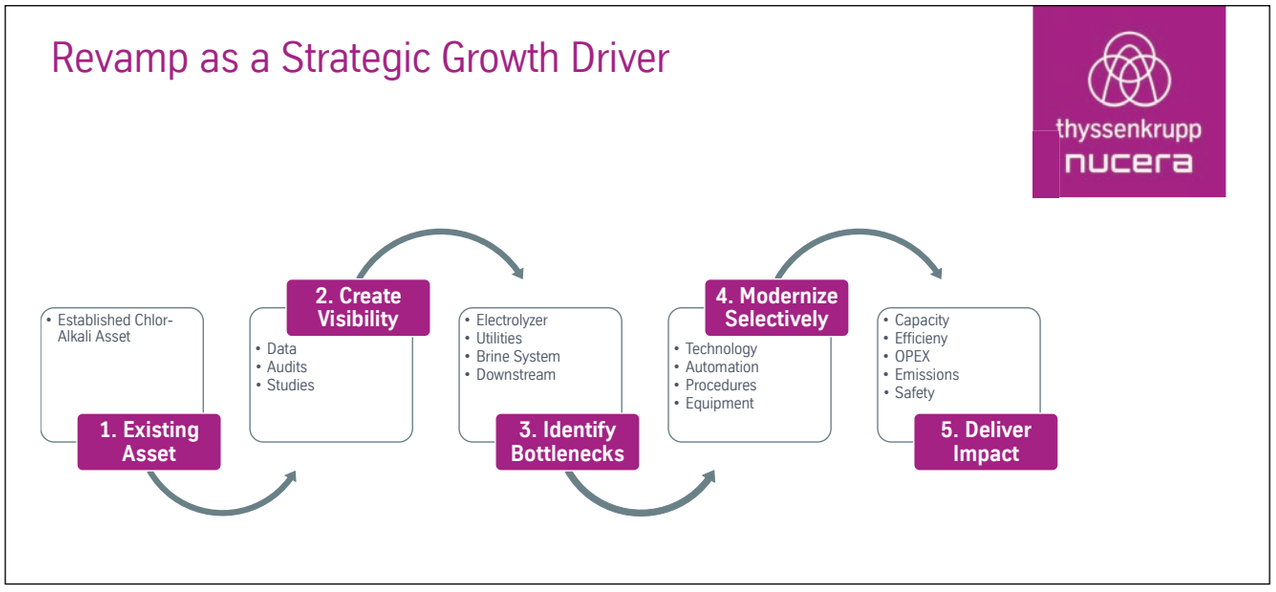
Individual disruptions are often addressed pragmatically in day-to-day operations without fully understanding their underlying structural connections. That is precisely the risk: what appears operationally routine can destroy strategic value. A professional revamp approach consolidates these experiences, complements them with engineering expertise, and turns them into a reliable basis for decision-making. This phase determines whether modernization remains a patchwork – or becomes a well-founded investment decision.

If you do not know your bottlenecks, you may invest in the wrong place

A central element of successful revamp projects is debottlenecking – the systematic identification and elimination of bottlenecks. Many chlor-alkali plants contain significant hidden performance reserves. Unlocking this potential does not require an isolated intervention, but a holistic view of the plant, including:

- Electrolyzer
- Power supply systems
- Brine circuit
- Downstream processes
- Interfaces within the balance of plant

In practice, capacity limits are often not determined by a single main unit. Rather, they result from the interaction



of many subsystems. If, for example, electrolyzer output is increased, brine quality, power supply, gas treatment, cooling, safety systems, and downstream processes must also be aligned accordingly. Replacing individual components in isolation may therefore have little effect if other system limits are not considered. Debottlenecking provides the necessary overall view.

The key point is this: debottlenecking is not only a technical exercise. It is a strategic instrument that helps plant operators make the economic impact of potential modernization measures visible. A debottlenecking study often becomes the gateway to investment decisions because it does not merely identify technical options; it evaluates their impact on capacity, energy consumption, emissions, and operating costs. It helps prevent capital from being tied up where it has the least effect.

Based on this analysis, the result is not a standard solution but a customized revamp concept, often accompanied by a roadmap for the phased execution of debottlenecking actions designed to minimize the impact on plant availability. The aim is to achieve maximum impact with minimal intervention and the shortest possible downtime. Typical measures include:

- Replacement or retrofitting of components
- Integration of new electrolysis technology
- Automation and efficiency upgrades
- Capacity increases through debottlenecking
- Reduction of energy consumption, emissions, and OPEX
- Improvements in safety and plant availability

An effective revamp concept therefore does not follow the principle of "more technology equals more value." On the contrary, the more precise the analysis, the more targeted the intervention can be. The goal is not maximum change, but maximum value creation. For operators, this means shorter downtimes, more predictable project execution, and an investment profile that can be gradually aligned with the plant's actual needs.

Specific solutions such as Sulphate Removal Units (SRU) for reducing emissions and losses, Chlorate Decomposition Units (CDU) for optimizing the brine circuit, or the Electrolyzer Maintenance Switch (EMS) for safer maintenance processes show how targeted modernization measures can support both sustainability and efficiency goals.

Such solutions demonstrate that revamp is not only about higher capacity. Stability, safety, availability, and the reduction of operating costs are just as relevant. In an industry where energy consumption is a major cost factor and sustainability requirements continue to rise, even targeted efficiency improvements can have a significant impact on long-term competitiveness. Modernization thus becomes an instrument that connects operational excellence with sustainability goals.

That is the decisive difference: existing plants are not treated as legacy liabilities, but as strategic assets. Companies that replace them before understanding their full potential may waste time, capital, and industrial substance.

Execution Decides: Collaboration beats Component Thinking

One of the most important lessons from revamp projects is this: success is rarely driven by technology alone. Operators can increase capacity, reduce energy consumption, stabilize or lower emissions, improve plant availability, and extend the lifetime of their assets. But whether modernization actually delivers this value contribution depends to a large extent on the collaboration between operator, service, engineering, and project management. Early alignment, clearly defined interfaces, and shared target pictures are often more important than the selection of individual components.

This is all the more true because revamp projects are often planned and executed while production continues. Shutdown windows are limited, interfaces are complex, and requirements for safety and availability are high. Success is therefore not decided only on the construction site, but already in the early concept phase. The more clearly operators and technology partners define expectations, responsibilities, data basis, and project goals, the better technical risks and operational impacts can be managed.

Practice shows that successful revamps occur where operators and the right technology partners work together over many years and develop a shared understanding of the plant. Revamp is therefore not a classic supplier project. It is a collaborative development process – and also a test of how seriously operators take lifecycle management.

Effective revamp activities therefore require an experienced partner who understands not only the technology itself, but also the process, the operational interdependencies, and the interfaces across the entire plant. In this sense, the role of a technology partner increasingly goes beyond supplying equipment: it is about acting as a system integrator who brings together process know-how, engineering expertise, and practical execution experience to turn modernization into measurable value.

The Future Belongs to Lifecycle Thinking – Not to New-build Reflex

The greatest opportunity of revamp lies in its role within a holistic lifecycle concept. Modernization should not be understood as a one-off project, but as a continuous improvement process. Only the interplay of operational reliability, targeted revamps, technology upgrades, and digital performance solutions creates the foundation for long-term competitiveness. Companies that only start discussing modernization once performance losses become visible are acting too late.

This lifecycle mindset fundamentally changes the perspective on plant management. Instead of discussing modernization only when performance losses become apparent, forward-looking development moves into focus. Digital transparency, regular performance assessments, and structured service concepts can help identify the need for action early and enable better investment planning.

The chlor-alkali industry faces the task of achieving more with existing plants: more efficiency, more sustainability, more value creation. Revamp does not offer a standardized toolkit for this. It offers a strategic path for developing plants step by step. That is precisely its strength: it combines technical precision with investment discipline.

For operators, this also means staggering investment decisions more carefully and aligning them with actual performance data. Not every modernization project needs to be implemented immediately as a large-scale initiative. Often, the greatest benefits come from a sequence of carefully coordinated steps: first, create transparency; then, prioritize bottlenecks; next, carry out targeted modernization; and finally, continuously monitor the results. This approach increases flexibility and improves the ability to respond to market changes.

As a result, revamping becomes a strategic alternative to the knee-jerk decision to build new facilities. The point is not to replace greenfield projects across the board. In many cases, new facilities will still be necessary. But in the future, the crucial question must be asked earlier: What role can existing assets play in the growth strategy? Those who consistently ask this question not only tap into technical reserves but also gain new degrees of freedom for capital allocation, sustainability, and operational resilience.

The future, therefore, does not automatically belong to new plants. It belongs to operators who recognize the value of their existing plants, consistently tap into that value – and view modernization not as a cost factor, but as a strategic growth driver. ■

GUEST COLUMN

Mental Wellbeing: A Growing Need for Industrial Workers

DR. NEENA SAWANT

Professor & Head, Department of Psychiatry,
Topiwala National Medical College &
BYL Nair Charitable Hospital, Mumbai

Chemical plants and industrial workplaces are often described as the backbone of modern society. From pharmaceuticals and fertilizers to fuels, polymers, paints, and food processing, chemical engineers and industrial workers help keep the world functioning smoothly. Yet behind the efficiency charts, production targets, safety audits, and process controls, there is another important issue that deserves equal attention — mental wellbeing, emphasizes ***Dr. Neena Sawant, Professor & Head, Department of Psychiatry, Topiwala National Medical College & BYL Nair Charitable Hospital, Mumbai.***

For many years, industries focused mainly on physical safety. Helmets, gloves, gas detectors, safety drills, and hazard protocols became essential parts of industrial life. However, emotional health and psychological wellbeing were often ignored. Today, industries across the world are realizing that mental wellbeing is not a "soft issue." It directly affects safety, productivity, teamwork, decision-making, and quality of life. Workers represent half the world's population and are the major contributors to economic and social development. Health systems in Indian industries are regulated by the Indian Factories Act but very few industries look into mental wellbeing. Focus has been on occupational hazards like accidents, asthma, lung problems, cancers, hearing loss etc.

Industrial workers, supervisors, operators, and engineers work in demanding environments. Long shifts, exposure to hazards, pressure to avoid errors, machine breakdowns, emergencies, and balancing family responsibilities can create significant stress. When stress becomes continuous and unmanaged, it may lead to anxiety, burnout, depression, substance use, sleep disturbances, relationship difficulties, and even accidents at work.

Mental wellbeing is therefore not only a personal concern but also an industrial necessity.

Why Industrial Workers Are Vulnerable to Stress

Industrial environments have several unique stressors that may affect mental health.

1. Shift Duties and Sleep Disturbance: Many chemical plants operate 24/7. Employees often rotate between day shifts and night shifts. Irregular sleep patterns disturb the body's biological clock.

A worker who sleeps poorly for several days may experience:

- Reduced concentration
- Irritability
- Fatigue
- Slower reaction time
- Memory difficulties

In high-risk industries, poor concentration can increase the chances of human error.

2. High Responsibility and Fear of Mistakes: Chemical engineers and operators often manage systems where small mistakes can have major consequences. Pressure to maintain temperature, pressure, flow rates, and safety parameters can become mentally exhausting.

Workers may constantly fear:

- Equipment failure
- Production loss
- Safety incidents
- Regulatory issues
- Criticism from management

Over time, this fear creates chronic stress.

3. Hazardous Work Environment: Exposure to noise, heat, chemicals, confined spaces, and emergency situations can create continuous psychological tension. Even if safety measures are excellent, the mind may remain in a constant 'alert mode.'

4. Work-Life Imbalance: Many industrial workers travel long distances, work overtime, or remain unavailable during festivals and family events due to plant operations.

This may lead to:

- Family conflicts
- Emotional exhaustion
- Reduced social interaction
- Feelings of isolation

5. Job Insecurity and Performance Pressure

Automation, contract jobs, and increasing competition sometimes create insecurity among workers. Fear of losing employment or not meeting targets can significantly affect mental wellbeing.

6. Workplace Relationships: Workplace harassment, bullying, humiliation by seniors etc increase stress.

Understanding Mental Wellbeing

Mental wellbeing does not simply mean the absence of mental illness. It refers to the ability to:

- Handle stress effectively
- Maintain healthy relationships

- Work productively
- Think clearly
- Adapt to challenges
- Enjoy life and feel emotionally balanced

Just as physical health changes over time, mental health also fluctuates. Every worker may experience periods of stress, sadness, frustration, or anxiety. Seeking help should be viewed as a sign of responsibility, not weakness.

Common Signs of Poor Mental Wellbeing in Industrial Workers

Mental stress often develops gradually. Workers and supervisors should learn to identify early warning signs.

Emotional Signs

- Irritability
- Frequent anger
- Anxiety
- Feeling overwhelmed
- Loss of motivation
- Hopelessness

Physical Signs

- Headaches
- Fatigue
- Poor sleep
- Body aches
- Increased use of alcohol or tobacco

Workplace Signs

- Frequent absenteeism
- Reduced productivity
- More errors at work
- Difficulty concentrating
- Poor communication
- Unsafe behavior

Social Signs

- Withdrawal from colleagues
- Increased conflicts
- Reduced participation in team activities

Recognizing these signs early can prevent larger problems later.

Case Example 1: The Experienced Operator: Mr. S was a 48-year-old plant operator working in a fertilizer unit for over 20 years. He was known as a sincere and hardworking employee. After a major maintenance shutdown, the workload in his unit increased significantly. He began doing extra shifts and sleeping only 4–5 hours daily.

Initially, he ignored his tiredness. Slowly, he became irritable and started arguing with coworkers. He lost interest in family activities and began consuming alcohol more frequently to 'relax.'

One day, during a routine operation, he missed an important valve-checking step. Fortunately, the error was identified early, and no accident occurred.

After counseling by the occupational health team, it became clear that he was suffering from severe stress and burnout. He was advised proper sleep hygiene, stress management strategies, temporary workload adjustment, and psychological support. Within a few months, his functioning improved significantly.

Stress and Safety: An Important Connection

In industries, mental wellbeing and safety are closely linked.

A stressed worker may:

- Miss warning signals
- Forget procedures
- Take unsafe shortcuts
- React slowly during emergencies

Studies across industries have shown that fatigue and emotional distress increase workplace errors and near-miss incidents.

Chemical industries already invest heavily in process safety management. Including mental wellbeing within safety culture is therefore a logical and necessary step.

Burnout in Engineers and Supervisors

Burnout is increasingly common among engineers and managerial staff. It occurs due to prolonged workplace

stress and is characterized by:

- Emotional exhaustion
- Cynicism or detachment
- Reduced sense of achievement

Engineers often face additional pressures such as:

- Meeting deadlines
- Managing teams
- Handling audits
- Solving emergencies
- Balancing technical and administrative roles

A burnt-out engineer may appear physically present but mentally exhausted.

Case Example 2: The Young Chemical Engineer: Ms. R, a 27-year-old process engineer, had recently joined a petrochemical company. She was enthusiastic and ambitious. However, within a year, she began handling multiple responsibilities including production monitoring, reporting, vendor coordination, and safety documentation.

She frequently stayed late at work and checked emails even at home. Gradually, she developed anxiety before going to work and started feeling that she was "never doing enough."

Despite good performance, she constantly feared failure. She developed sleep problems and panic-like symptoms before presentations.

With guidance from senior mentors and counseling support, she learned time management, relaxation techniques, and work-life boundaries. Her confidence and emotional wellbeing improved over time.

Breaking the Stigma Around Mental Health

One of the biggest challenges is stigma.

Many workers believe:

- "Stress is normal; just tolerate it."
- "Talking about emotions is weakness."
- "Only severely ill people need mental health help."

Because of these beliefs, employees often suffer silently.

Industries must create an environment where seeking help is accepted and encouraged. Mental health discussions should become as normal as safety discussions.

What Industries Can Do

1. Promote Open Communication: Supervisors should encourage workers to speak about stress without fear of punishment or ridicule.

Simple practices include:

- Team discussions
- Feedback sessions
- Mental health awareness talks

2. Ensure Reasonable Workload

Continuous overtime and inadequate staffing increase burnout risk. Balanced schedules improve both morale and productivity.

3. Improve Shift Management: Rotating shifts scientifically and ensuring adequate rest periods can reduce fatigue.

4. Provide Mental Health Support

Industries can:

- Arrange counseling services
- Conduct stress management workshops
- Train managers to identify distress
- Provide employee assistance programs

5. Encourage Peer Support: Workers often open up more easily to colleagues than supervisors. Supportive team culture can make a major difference.

6. Recognize Good Work: Appreciation improves morale and emotional resilience. Even small recognition can boost motivation.

Simple Stress Management Strategies for Workers

Mental wellbeing does not require complicated techniques. Small daily habits can help greatly.

1**. Sleep Properly**: Aim for regular and sufficient sleep, especially after night shifts.

2. Maintain Physical Activity: Walking, stretching, yoga, or exercise reduce stress hormones and improve mood.

3. Eat Balanced Meals: Skipping meals and excessive caffeine may worsen anxiety and fatigue.

4. Stay Connected: Talking to family, friends, or coworkers reduces emotional burden.

5. Take Short Breaks: Brief pauses during work help improve focus and reduce mental fatigue.

6. Avoid Excessive Alcohol or Tobacco: These may provide temporary relief but worsen stress and sleep problems over time.

7. Practice Relaxation Techniques: Deep breathing, mindfulness, and meditation can calm the mind.

8 .Use of Apps for mental wellness: Saksham Mental Wellness App is available on both android and ios platforms free of cost.

Facebook - https://www.facebook.com/SakshamIndiaApp

Instagram - https://www.instagram.com/sakshamindiaapp

YouTube - https://www.youtube.com/channel/UCtl_wkLUN2Z9VamYMG-_mCA

Role of Leadership in Mental Wellbeing

Leadership plays a major role in workplace mental health. A psychologically safe workplace allows employees to report mistakes, discuss concerns, and ask for help without fear.

Supportive leaders:

- Listen respectfully
- Encourage teamwork
- Avoid humiliating workers publicly
- Recognize stress signs
- Promote healthy work culture

On the other hand, toxic leadership can worsen anxiety, fear, and burnout.

The Future of Industrial Mental Health

Globally, industries are increasingly recognizing mental wellbeing as part of occupational health.

Forward-thinking organizations are now introducing:

- Wellness programs
- Employee counseling
- Stress audits
- Flexible policies
- Mental health awareness training

In the future, industries that prioritize employee wellbeing are likely to have:

- Better productivity
- Lower absenteeism
- Improved safety culture
- Higher employee satisfaction
- Better retention of skilled workers

Conclusion

Chemical industries are built on systems, processes, precision, and safety. But behind every process is a human being. Machines can be maintained regularly; human minds also need care and support. Mental health is an ongoing journey of care, resilience, and support.

Mental wellbeing is not a luxury. It is essential for safe operations, effective teamwork, innovation, and quality of life. Industrial workers and engineers face unique pressures that deserve understanding and attention.

A healthy workplace is not only one where accidents are prevented, but also one where workers feel respected, supported, emotionally balanced, and psychologically safe.

When industries invest in mental wellbeing, they are not only caring for employees — they are strengthening the entire organization. Mental health components need to be integrated in existing industrial health systems. Because ultimately, the most valuable asset in any industry is not machinery or infrastructure, but people. ■

EXPANDING ELECTRIC VEHICLE LOGISTICS BEYOND METROS:

A Vision for Sustainable Deliveries

PUSHPANK KAUSHIK

CEO & Head of Business Development
Jassper Shipping

Sustainability in India is no longer a distant ambition but an immediate priority. As the logistics sector evolves in response to rapid urbanisation and the surge in e-commerce, the shift towards cleaner and more efficient operations has become inevitable. According to a report by NITI Aayog, Electric Vehicle (EV) adoption in India has grown from just 50,000 units in 2016 to over 2 million in 2024, signalling rapid momentum. The report also highlights that India aims to achieve 30 per cent EV penetration by 2030, indicating the need for a much stronger push in infrastructure, financing, and ecosystem development, writes ***Pushpank Kaushik, CEO & Head of Business Development, Jassper Shipping.***

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Electric Vehicle (EV) adoption is steadily gaining momentum as a driver of sustainable growth. While metro cities are advancing with stronger infrastructure and organised fleet systems, non-metro regions continue to face structural limitations, particularly in infrastructure, which restricts large-scale adoption.

EV Adoption in Urban India

India's EV sector is witnessing rapid transformation, particularly within the logistics space, with metro cities leading the shift. Backed by supportive policies, stronger infrastructure, and easier access to capital, urban centres have emerged as early adopters of EV-led logistics. The surge in e-commerce and the growing need for efficient last-mile delivery have further accelerated this transition, making EVs an integral part of urban supply chain operations.

As Tier-2 and Tier-3 cities experience steady economic and digital growth, logistics demand is expanding across these regions. This shift underscores the need to extend EV infrastructure, financing access, and service ecosystems into emerging markets to enable wider and more balanced adoption.

Bridging the Gap: Challenges and Solutions for Non-Metro EV Adoption

While the opportunity in non-metro regions is significant, the transition to EV-led logistics remains uneven due to structural and operational barriers. Addressing these challenges requires a solution-driven and ecosystem-focused approach.

1. **Infrastructure Gaps and Charging Accessibility:** One of the most critical barriers in smaller cities is the limited availability of charging infrastructure, making EV operations less reliable and scalable. Charging networks must expand beyond urban clusters, with strategic deployment across Tier-2 and Tier-3 cities as well as key transportation corridors. Strengthening public–private partnerships can accelerate infrastructure development and improve accessibility.

2. **High Upfront Costs and Limited Financing Options**: The initial cost of EVs continues to be a deterrent for small fleet owners, particularly in regions where access to affordable financing remains limited. Innovative financial models such as leasing, subscription-based ownership, and pay-per-use systems can make EV adoption more viable. Enhanced access to credit, insurance, and targeted incentives will further reduce entry barriers.

3. **Underdeveloped Service Ecosystem and Skill Gaps:** A lack of service centres, trained technicians, and reliable maintenance support creates operational uncertainty for EV users outside metros. Building a decentralised support ecosystem, comprising local service networks, skilled workforce development, and reliable repair infrastructure, is essential for long-term sustainability and scalability.

4. **Fragmented Ecosystem and Limited Stakeholder Coordination:** The absence of a fully integrated ecosystem across regions slows down EV adoption and limits operational efficiency. A collaborative approach involving governments, logistics operators, and manufacturers is critical. Strong alignment across policy, technology, and operations will ensure a more cohesive and scalable EV logistics framework.

India's EV sector is witnessing rapid transformation, particularly within the logistics space, with metro cities leading the shift. Backed by supportive policies, stronger infrastructure, and easier access to capital, urban centres have emerged as early adopters of EV-led logistics. The surge in e-commerce and the growing need for efficient last-mile delivery have further accelerated this transition, making EVs an integral part of urban supply chain operations.

Expanding EV Potential Beyond Urban India

Advancements in EV technology, particularly in battery range, durability, and adaptability, are making electric mobility more practical across diverse geographies.

Advancements in EV technology, particularly in battery range, durability, and adaptability, are making electric mobility more practical across diverse geographies. As Tier-2 and Tier-3 cities continue to expand, they are emerging as key markets for the next phase of EV logistics growth.

As Tier-2 and Tier-3 cities continue to expand, they are emerging as key markets for the next phase of EV logistics growth. Policy support is also playing an important role in accelerating this transition. Government initiatives aimed at improving affordability and strengthening domestic manufacturing are helping reduce barriers to adoption and making EVs more accessible to a wider base of operators.

At the same time, the rapid growth of e-commerce and logistics networks in non-metro regions is driving demand for more efficient and sustainable delivery solutions, further reinforcing the case for EV integration beyond urban centres.

Enabling Inclusive Growth in EV Logistics

Expanding EV logistics beyond metro cities is critical to unlocking its full potential across India. As demand rises in emerging markets, a more inclusive approach is needed, one that extends infrastructure, access, and ecosystem support beyond urban centres. Integrating EVs into these growing logistics networks can significantly reduce emissions while improving efficiency and lowering long-term costs.

This transition goes beyond technology adoption. It requires building systems that are accessible, resilient, and well-coordinated across regions. The future of India's logistics sector will depend on how effectively EV adoption scales nationwide, driven by innovation, infrastructure development, and strong stakeholder collaboration. ■

GUEST COLUMN

Crafting the Future of Fragrance with High-Value Chemistry

MAHESH BABANI

Chairman and Managing Director

Privi Speciality Chemicals Limited

A transition is occurring in the global aroma chemical industry. Earlier, dominated by commodity aromas produced in large volumes, the current trend sees aroma molecules with innovation, complexity, performance, and sustainability setting the standards for competitive advantage. Such a shift has transformed the global aroma chemicals market into an exciting opportunity space for integrated chemical companies that can capitalize on both scalability and innovative product development, emphasizes ***Mahesh Babani, Chairman and Managing Director, Privi Speciality Chemicals Limited.***

The global aroma chemicals market was worth[1] over USD 6 billion in 2024 and has a forecasted growth rate of around 5.7 per cent up until 2033. In parallel, the overall flavours and fragrances market will be worth over USD 57 billion in 2033[2] owing to more demand for premium personal care, fine fragrances, and home care products.

Value is being created in aroma chemical molecules that provide excellent sensory performance, increased stability, improved diffusion properties, greater durability, and flexibility in formulation. As fragrance companies develop new scent structures and complex formulas, high value chemistry will be absolutely crucial for the development of new fragrances.

The future of fragrances lies in both the changing demands of consumers as well as the sophisticated science involved in formulating unique, sustainable, and superior scent products. With the shift of global requirements towards speciality aroma chemicals, companies possessing an advantage in backward integration, terpenes, process development, and research-oriented manufacturing processes will have more leverage in their competitiveness.

Evolution from Volume Chemistry to Value Chemistry

Conventionally, the aroma chemicals industry was based on economies of scale and the efficient generation of generic molecules used in soaps, detergents, and mainstream personal care products. Although these product segments remain important, consumer needs have evolved considerably in terms of the global landscape.

Modern consumers link perfumes to their identities, well-being, and a luxurious lifestyle. This trend has prompted fragrance producers to introduce new types of compounds used in unique formulations of perfumes. According to a report[3], molecules produced via biotechnology, nature-identical ingredients, and high-performing fragrance molecules are shaping the future of perfumery and personal care formulations.

Consequently, global firms in the sector have been focusing more on molecules that differentiate than those that homogenise the fragrances. There is an increasing need for terpenes, terpenoids, speciality musks, and aroma intermediates that improve fragrance performance.

In comparison with commodity chemicals, speciality aroma chemicals need more intensive research, extensive development processes, sophisticated purification techniques, and elaborate process engineering. Moreover, technical challenges are made even greater by stringent regulatory obligations under international regimes like IFRA and REACH.

This means that the competitive edge in the industry is increasingly tilting towards players having superior chemistry skills, robust manufacturing platforms, and the capability to provide ultra-pure chemicals across the globe.

Why Backward Integration Matters in Aroma Chemistry?

A key aspect in the emerging scenario in the domain of fragrance chemicals is the increasing importance attached to backward integration. With uncertainties in the availability of feedstock, cost considerations and geopolitical tensions in the global supply chain, an integrated system for manufacturing becomes increasingly significant.

The availability of feedstock plays an integral role in determining the quality and purity of the product in the domain of aroma chemicals. More importantly, through backward integration, chemical companies can go past the mere manufacture of molecules to become involved in downstream chemistry platforms.

An integrated method is beneficial to sustainability goals. Using terpene feedstock that is renewable in nature and achieving higher atom efficiency through innovative methods can help reduce waste production while addressing the needs of the global market towards greener chemistry.

Increased focus on sustainably sourced aromatic compounds is driving the industry forward. Market research[4] shows an increase in global demand[5] for aroma compounds derived from natural sources, biotechnology, and eco-responsible sources, particularly in high-end personal care products and perfumes.

Strategic Differentiation Through R&D and Process Innovation

Producing highly valuable aroma compounds relies on catalyst-driven processes, intricate synthesis processes, tight impurity control, and novel separation processes. Even minor advancements in selectivity, yield maximisation, and processing efficiency can have a significant impact. With fragrances growing ever more complex, the customer base is increasingly becoming demanding of their own unique solutions. The value of application-oriented R&D and product innovation has been greatly enhanced.

As such, leading chemical companies have started spending substantially on research facilities, process development at pilot scale, analysis, and applications laboratories for developing the future chemistry of fragrances. The emphasis is not only on large volume manufacture of common chemicals. On the contrary, there is a rising importance being laid upon the development of unique molecules and performance enhancers.

Process innovation is another crucial aspect that helps boost competitiveness by using energy-efficient processes, advanced catalysis, continuous processing, and better recovery systems. This integration of chemical know-how and process engineering has enabled Indian speciality chemical manufacturers to gradually ascend the value chain ladder and become key partners for global fragrance companies.

India: A Growing Player in the International Aroma Chemicals Industry

India is emerging as a manufacturing base and innovation leader in the international aroma chemicals sector. Not only does India have competitive pricing and large-scale production capacities, but Indian producers are now investing in speciality chemistry, manufacturing, and compliance with global regulations.

India[6] is projected to record one of the highest growth rates in the global aroma chemicals market in the coming years. The growth is attributed to several factors, such as high chemical engineering competencies, developing speciality chemicals production, improved environmental controls, and rising investments in R&D-based manufacturing.

Furthermore, Indian producers can provide comprehensive services throughout the entire process of producing aroma chemicals, which includes feedstock sourcing, terpene production, customized aroma molecule development, and contract synthesis for global customers.

India is gradually moving away from the production of commodity chemicals and intermediates towards manufacturing of speciality ingredients for the global market, which have high growth potential.

Building the Chemistry of Future Fragrances

The future of fragrances lies in both the changing demands of consumers as well as the sophisticated science involved in formulating unique, sustainable, and superior scent products. With the shift of global requirements towards speciality aroma chemicals, companies possessing an advantage in backward integration, terpenes, process development, and research-oriented manufacturing processes will have more leverage in their competitiveness.

With enhanced capacities in custom formulation, integrated manufacturing operations, and speciality aroma chemicals, Indian chemical manufacturers are now establishing themselves as key players in the international fragrance value chain industry.

The transformation underway in the aroma chemicals sector is not simply a shift in product mix. It is a shift in mindset from scale-driven manufacturing to knowledge-driven value creation. The companies that will lead the industry forward are those that recognise that the future of fragrance will be built on innovation, speciality chemistry, sustainability, and deep customer collaboration. ■

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Waste Valorisation: Cracking, Not Burning

A cold-plasma reactor cracked ten consecutive batches of unsorted city waste at 300–400°C — plastics, tyres, flowers, fish, prawn and chicken — into a hydrocarbon-and-oxygenate liquid and a recovered carbon, with no flame, no ash and nothing for the landfill. The chemistry of cracking by ion radical rather than flame, what the streams are made of and where they go, and why both the environmental and the cost cases come out different, emphasizes ***Tushar Barol, Business Development-Technical, Entity 1 Value emission Pvt. Ltd.***

For a century, the municipal-waste question has come down to a temperature and a flame. Incinerators oxidise For a century, the municipal-waste question has come down to a temperature and a flame. Incinerators oxidise refuse at 850–1,100°C; refuse-derived-fuel (RDF) lines shred and dry the burnable fraction so a kiln can burn it later. Both are combustion routes — directly or one step removed — and both end the same way for the chemistry of the waste: it is converted irreversibly into carbon dioxide, water and ash. A May 2026 demonstration at Sri Venkateswara University (SVU), Tirupati, tested a different proposition: that the same waste can be taken apart chemically, its carbon and hydrogen kept rather than burned. The reactor was the Ramcharan Cold Plasma Pyrolysis Reactor (RCPPR), from Chennai's Entity 1 Value Emissions; ten back-to-back batches were run across the waste streams below.

Cracking by Ion Radical, not by Flame

A cold plasma is an ionised gaseous radicals in a state of deliberate equilibrium between thermally conducting and insulating state. An external electric field accelerates free ionic gas radicals into energies of several electron-volts — an effective electron temperature of hundreds of degree Celsius — while the ions and neutral molecules around them stay captured close to ambient thereby deliberately creating the required temperature gradient. The energy lives in the ionic radicals, not in the bulk gas. When those energetic ionic radicals collide with feedstock molecules they transfer necessary thermal energy to the extent that the heat breaks them by dissociating bonds and stripping electrons to generate a population of radicals, ions and excited species that conventional routes can only reach with far more heat.

That radical chemistry is what does the cracking. The long-chain molecules in the feed — the polyolefins

Summary

- Ten back-to-back batches of mixed, unsorted, wet-and-dry city waste — temple flowers to end-of-life tyres, marine to poultry wastes — were cracked at 300–400°C in a sealed, oxygen-starved reactor: no combustion, no smoke, zero residue.
- Each run resolved into two recovered streams — a liquid fuel and a recovered solid carbon — with established homes as fuels, refinery feedstock and biochar, not burned to ash.
- By deleting the flue-gas cleaning, ash handling and pre-sorting plant that combustion routes carry, the process changes both the environmental and the cost equations — structurally, not incrementally.

Waste stream in	Recovered products	Where it goes — applications
Mixed plastics & packaging	Pyrolysis oil + light process gas	Oil as an industrial fuel-oil substitute or, upgraded, a refinery and petrochemical feedstock; the gas recovered as process heat
End-of-life tyres	Pyrolysis oil + recovered solid carbon + gas	Recovered solid carbon as a solid fuel for boilers and kilns; oil as a fuel or, upgraded, a feedstock
Food, kitchen, fish & poultry waste	Oxygenated liquid + biochar	Biochar as a soil amendment, an adsorbent and a filtration carbon; the liquid recovered for energy
Temple flowers, coconut, sugarcane	Bio-oil + biochar	Valorises devotional and agri-residue — biochar to agriculture and water treatment, carbon kept out of landfill
Unsorted municipal waste	Blended liquid + carbon + gas	Decentralised municipal valorisation at the waste source: no pre-sorting, nothing to landfill

Table 1: What the demonstrated feedstocks become, and where the recovered streams go. Across all ten runs the residue to disposal was nil.

and styrene-butadiene of plastics and tyre rubber, the cellulose, hemicellulose, lignin, proteins and lipids of biological waste — have their C–C, C–H and C–O bonds cleaved into shorter fragments, which recombine and stabilise as smaller, recoverable molecules. Thermal pyrolysis reaches the same place by brute heat, holding the whole charge at 450–800°C; the plasma supplies the activation electronically, so the reactor sits at a measured 200–350°C while the chemistry behaves as though it were much hotter. Critically, the chamber is oxygen-starved, so the pathway is scission and reforming, not oxidation — nothing is burned to CO_2 and water, and the carbon and hydrogen stay in the product. A small reagent dose assists the chemistry. No flame, no combustion air, no stack.

The feedstocks were chosen to be deliberately punishing — pooja flowers, fish and prawn waste, chicken waste, mixed plastics, tyres and coconut shell, wet and dry, loaded without sorting — the very streams that defeat a sorting-dependent RDF line. Every one resolved into the same pair of recoverable streams, with nil residue.

From Waste to Product: What it's Made of, and Where it Goes

In chemical terms, the two collected streams are what cracking these feedstocks should give, and each has an established home. The condensed liquid is a hydrocarbon mixture from the plastic and tyre fraction, an oxygenated condensate from the wet biological fraction. As recovered it is an industrial fuel-oil substitute for kilns, boilers and gensets; fractionated and upgraded, the hydrocarbon cut becomes a feedstock for the refinery and petrochemical chain — chemical recycling that returns plastics towards building blocks rather than burning them once. The solid is a recovered carbon. From the tyre and polymer feed it is a dense, high-carbon char recovered as a solid fuel — an energy-rich substitute for coal in boilers and kilns. From the biomass it is a biochar, with a ready market as a soil amendment, an adsorbent for water and air treatment, and a route to durable carbon storage. The non-condensable balance is a light, combustible process gas — the fraction RCPPR characteristically yields — burned back into the process as heat to offset the reactor's own energy draw.

The point for a chemicals business is that none of these is terminal. What an incinerator would have turned into heat and ash, the reactor keeps as molecules with a destination — fuels, carbons and feedstocks. That is the premise of valorisation: the output leaves as the raw material for the next product.

And it does so at rate and at grade. Because the cold-plasma cracking is driven electronically and uniformly, the process holds product grade steady run to run — turning a high, continuous throughput of mixed waste into fuels and biochar of consistent quality. It is that combination of feedstock breadth, throughput and product consistency, in a single non-combustion step, that no other waste-conversion route has so far delivered.

Zero Residue, No Stack: The Environmental Case

The environmental case follows directly from the chemistry. Because nothing is oxidised, there is no flame, no smoke and none of the flue gas that obliges an incinerator to run a full air-pollution-control (APC)

	Incineration	RDF (produce-and-burn)	Cold-plasma pyrolysis (this route)
Environmental outcome	Destroys the material; emits; lands the ash	Defers the burning — and its emissions — to another stack	Converts waste to products on site; nothing combusted
Stack & dioxins	Continuous flue gas; dioxin-forming zone; full APC train	Chlorine from PVC carries forward to the point of burning	No flame, no flue gas; the dioxin-forming window is removed
Residue to landfill	15–30% as ash, often hazardous	20–40% rejects, plus ash where burned	Nil — the solid is recovered as carbon
Primary output	Heat or power, plus ash to dispose of	A fuel still to be combusted somewhere else	A liquid + recovered carbon — chemical feedstock
Cost profile (qualitative)	Carries APC, ash-disposal and landfill costs	Carries a pre-processing plant plus a downstream burn	Sheds APC, ash and pre-processing; return is product-led

Table 2: Benchmarked against the two routes most often proposed for mixed urban waste. The contrast is mechanistic, not incremental.

train; the off-gas is largely water vapour plus that recoverable process gas, not soot and fly ash. Dioxins and furans, which assemble by de novo synthesis in the chlorine-bearing 200–400°C zone downstream of a burner, need oxygen to form; in an oxygen-starved reactor that pathway cannot proceed — prevention by design, not abatement. And the residue line is starkest of all: incineration turns 15–30 per cent of its input into bottom and fly ash, often hazardous; RDF rejects 20–40 per cent before anything is burned; this route sent nothing to landfill across all ten runs, diverting wet organics that would otherwise rot to methane and leachate.

Why the Cost Logic is Different

The cost logic is different for the same reason. This is not a cheaper incinerator — it removes cost categories the combustion routes cannot escape. No flue gas means no gas-cleaning train; no ash means no hazardous-ash disposal; taking mixed wet waste as it arrives means none of the drying-shredding-sorting-de-chlorination plant that RDF depends on. And because the outputs are saleable products rather than heat-plus-ash, the return is product-led, not gate-fee-led. Full costing is being finalised separately; the point here is structural — the route deletes line items its rivals are stuck with.

The demonstration was reported by *The Hindu* on 2 June 2026 and witnessed on site by Tirupati's Municipal Corporation Revenue Officer with SVU's Vice-Chancellor, Rector and Registrar. What a demonstration cannot yet settle, it should name: the electrical energy per tonne — net of the recovered process gas — is what will ultimately decide how low-carbon the route is at full municipal scale. But what it established is hard to argue with. Across ten consecutive runs on the worst feedstock a city can present, the reactor cracked waste into a recoverable liquid and a recovered carbon at 200–350°C, with no combustion and nothing buried. For an industry that builds value molecule by molecule, that is the interesting part — the waste does not leave as emissions and ash, but as the feedstock for the next product. ■

Disclosure: *The author is associated with the commercialisation of the RCPPR technology (Entity 1 Value Emissions Pvt. Ltd., Chennai). Findings are drawn from the ten-run demonstration at Sri Venkateswara University, Tirupati (May 2026); comparative ranges for incineration and RDF reflect established waste-engineering practice.*

Author

Tushar Barol
Business Development-Technical
Entity 1 Value Emission Pvt. Ltd.

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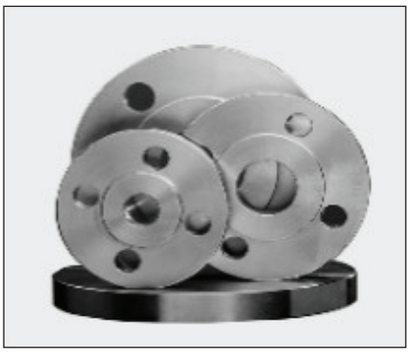
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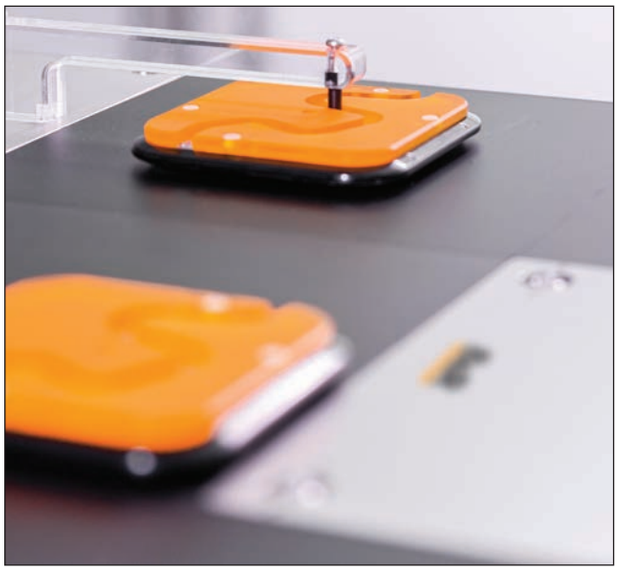
B&R Introduces New Solutions for More Autonomous Packaging Production

Packaging requirements are increasing rapidly: more product variants, tighter timelines and shorter product lifecycles are placing growing demands for packaging operations. At Interpack 2026, ABB's Machine Automation division introduced new automation solutions based on B&R technology designed to enable manufacturers adapt existing packaging lines more quickly, efficiently and sustainably.

With ACOPOS 6D Hybrid, B&R further expands the flexibility of its planar transport system and complements it with ACOPOS 6D LaunchPad, a software tool for simulation-based engineering and con-figuration. The hybrid concept combines magnetically levitated ACOPOS 6D shuttles for high-value process steps with conventional transport systems such as conveyors, robots or other manipulators for less critical tasks, all coordinated within a single control architecture.

Using ACOPOS 6D LaunchPad, machine layouts, shuttle flows and process sequences can be designed, simulated and optimized virtually before hardware is installed, allowing manufacturers to validate performance, reduce commissioning time and scale systems step by step as requirements evolve. Once the hardware becomes available, the transition from simulation to reality is seamless: thanks to the 'Configure and Run' approach, the virtual setup can simply be transferred to real hard-ware. The result is a reduction in engineering effort, fewer late-stage changes, and a faster time-to-market, turning virtual engineering into a decisive competitive advantage.



Integrated Color Vision Ready-to-use for Packaging

The new B&R Color Camera improves key printing performance indicators by enabling vision based process corrections at production speeds of up to 500 m/min. Integrated directly into the machine control loop, the solution supports first time right printing, reduces material waste at the source and increases overall equipment effectiveness, contributing to more sustainable and cost efficient printing processes.

Designed for modern packaging and printing applications, such as labeling, with frequent design changes and challenging materials, e.g., glossy, transparent and multi-colored substrates, the Color Camera enables autonomous process optimization. Intelligent adaptive algorithms, including auto-exposure, continuously adjust to changing conditions without manual intervention, helping to prevent scrap.

Unlike standalone vision systems, the B&R Color Camera integrates vision, motion and control on single deterministic platform, enabling real-time, in-cycle corrections with microsecond-level synchronization. A unified hardware and software platform supports both monochrome and color applications, simplifying machine design, accelerating commissioning and allowing scalable vision functionality within a single engineering environment.

"Our innovations here at Interpack highlight that we aim to enable the packaging industry to respond to the most pressing challenges: fast turnovers, constantly new variants, and an overall maximized productivity– so packaging can get personal," said Lazaros Patsakas, Global Industry Segment Man-ager CPG at B&R. "These challenges can only be solved with intelligent, future ready automation." ■

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Taj Building, 3rd Floor, 210, Dr. D N Road, Fort, Mumbai – 400 001, INDIA.
Tel: +91-22-4037 3636, **Email:** sales@jasubhai.com

Ahmedabad / Vadodara - +91-93262 90114 | Bangalore - +91-93262 90114 / 98926 44177 |
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sales@jasubhai.com

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