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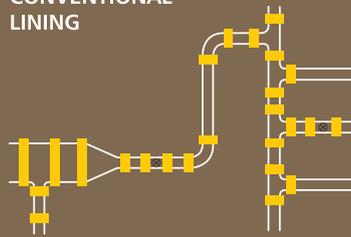
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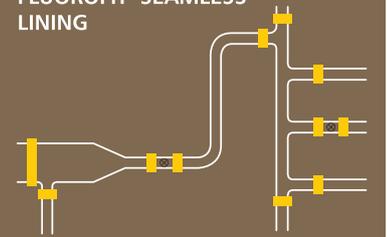
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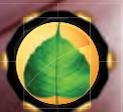
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EPC 4.0: Accelerate digital transformation in the new normal

How can Capital Projects be better managed with EPC 4.0?



Amish Sabharwal

Engineering Business Unit Lead, AVEVA

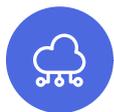
EPC 4.0 is here and more powerful than ever

In the new normal, Engineering Procurement and Construction (EPC) companies are facing key challenges including reduced Capital Expenditure (CAPEX), increased indirect costs and managing remote 'digital' teams. In fact, according to a [study by McKinsey & Company](#), "companies across sectors and the globe have announced CAPEX cuts ranging from **10 to 80%**".

This means EPC 4.0 or the digital transformation of project execution and asset lifecycle is a critical strategic priority to maximize productivity and efficiency gains. Companies looking to adopt EPC 4.0 can consider the following actions:



Expand the usage of the **Digital Twin technology** beyond the project phase and integrate the design phase with the entire value chain.



Adopt **unified cloud platforms** that provide a common data-centric environment to improve remote work productivity and collaboration.



Take advantage of **emerging digital technologies** to drive operational agility, meet changing customer needs and stay competitive.

EPC 4.0 is not entirely a new concept for the industry. We have seen companies reduce the Total Installed Cost (TIC) of their projects by **10%**, with **7%** savings in engineering and procurement, and **3%** savings in construction.

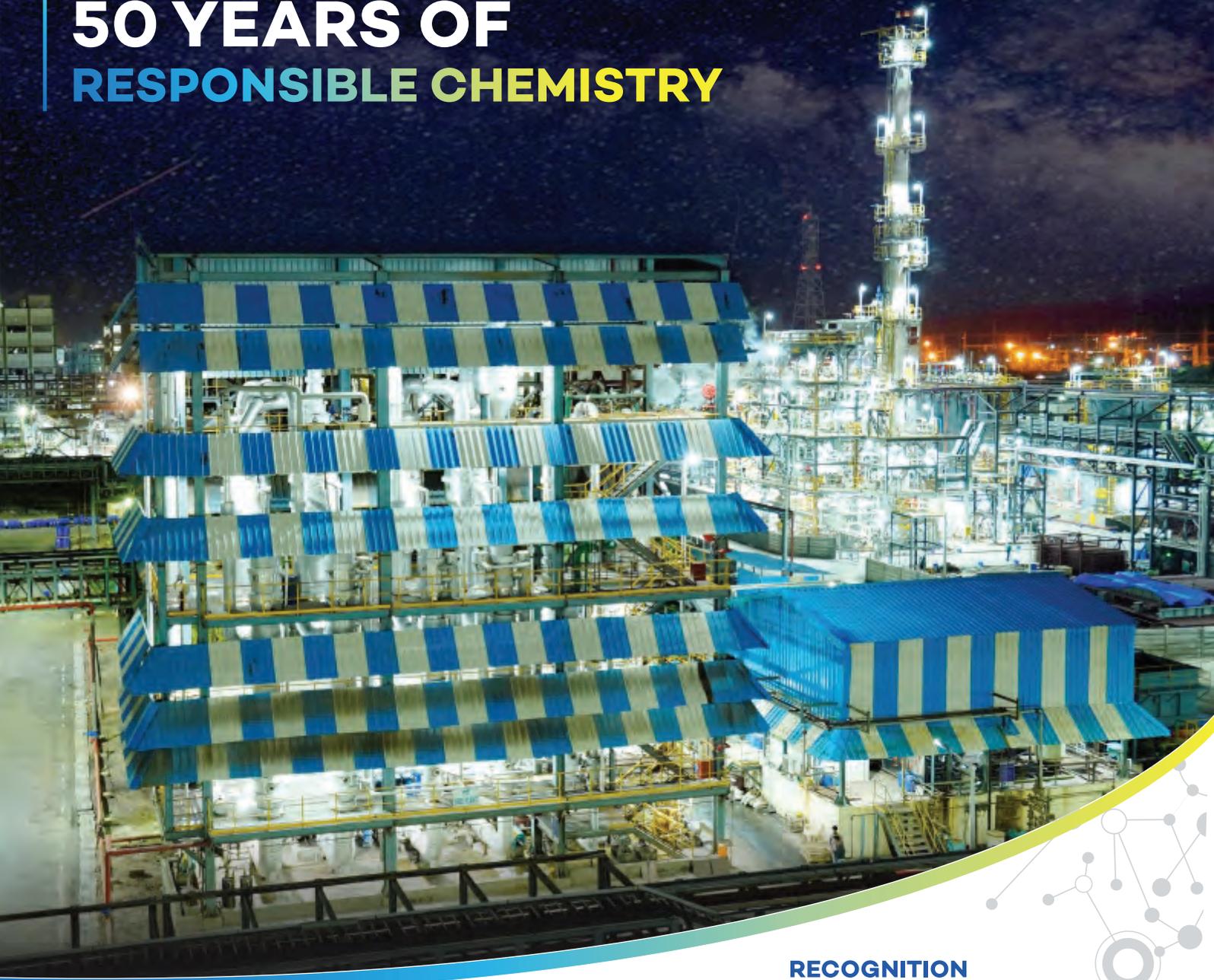
Even prior to the pandemic, the industry has long struggled with driving productivity and reducing project costs. Another [study from McKinsey](#) found that **98%** of mega-projects incur cost overruns or delays.

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About AVEVA

AVEVA is a global leader in engineering and industrial software driving digital transformation across the entire asset and operational life cycle of capital intensive industries. The company's engineering, planning and operations, asset performance, and monitoring and control solutions deliver proven results to over 16,000 customers across the globe. Its customers are supported by the largest industrial software ecosystem, including 4,200 partners and 5,700 certified developers. AVEVA is headquartered in Cambridge, UK, with over 4,400 employees at 80 locations in over 40 countries. For more details contact Ms. Srilakshmi Lakshmanan, AVEVA India Marketing at srilakshmi.lakshmanan@aveva.com or visit: www.aveva.com

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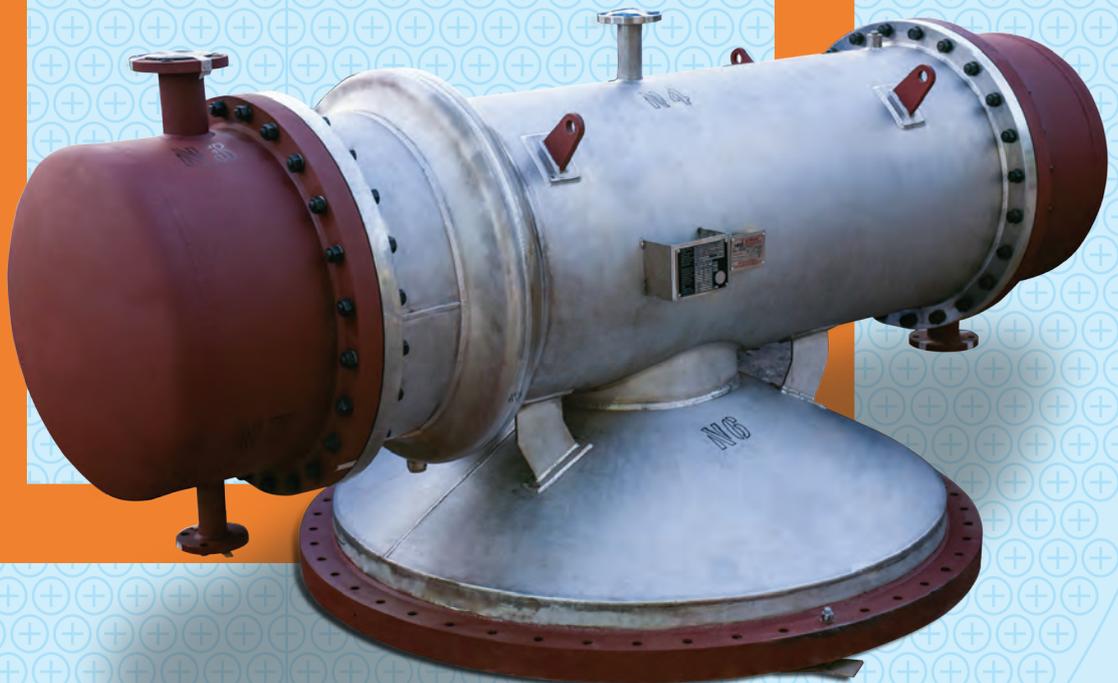
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CTO/EVP - R&D, AVEVA

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Deepak Fertilisers H1 FY21 PAT jumps 4.5 times; Fertilisers Segment Profitability improves further



Sailesh C Mehta, CMD, DFPCL

Mumbai, India: Deepak Fertilisers And Petrochemicals Corporation Limited, one of India's leading producers of Industrial Chemicals and Fertilisers, announces its results for the quarter and half year ended September 30, 2020. Commenting on the performance, Sailesh C. Mehta, Chairman & Managing Director, Deepak Fertilisers And Petrochemicals Corporation Limited, said, "Despite the continued operational challenges faced due to the COVID-19 pandemic, we witnessed improvement in overall economic activity on a pan India level as lockdown restrictions were eased and normalcy returned partially. Heavy rainfall during Q2 has ensured optimal water levels across major reservoirs in core areas where we operate. We expect a good rabi season which might get slightly delayed as we witnessed above average rainfall during the tail end of the monsoon season. I say this with immense satisfaction, that our Company continues to progress well both on financial and operational fronts. We have been continuously striving towards enhancing profitability by focusing on high margin businesses along with the cost optimization initiatives. We

are pleased to announce a strong financial performance during the first half of FY2020-21. We continued to connect virtually with farmers and our team did a phenomenal job of reaching key stakeholders through digital means and we achieved robust sales volumes of our differentiated grade Smartek offerings in Q2. Our CNB business reported fourth consecutive profitable quarter in a row.

IPA demand tapered down after it rose to unprecedented levels in Q1 in expected line. We continue to focus on specialised grades and service offerings to the pharma industry which will help even out the margin impact in the IPA segment. Our health and hygiene products under the brand CORORID are gaining popularity and we are working on plans to systematically push the brand across segments.

Demand for Nitric Acid improved to pre-Covid levels and so did the realisations. We expect strong traction the next two quarters for CNA segment fuelled by encouraging demand for chemical intermediates used across pharma, agrochemicals and polymers. TAN segment faced challenges primarily on demand front due to monsoon and Covid impact, however, the contribution margins remained in line with the expectations. Demand for coal and limestone mining is expected to improve in Q3 as the economic activity picks up and we expect revival for TAN segment in the second half of the financial year.

We remain profitably aligned to the Indian growth story by supporting critical sectors of the economy such as agriculture, pharmaceuticals, mining, infrastructure, health and hygiene, among others. Capex outlay, that were undertaken few years back, have now started bearing fruits and expected to grow in the coming quarters. Recent reforms announced by the Central Government under the Atmanirbhar Bharat initiative augurs well

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for the economic growth trajectory of India and should positively support growth across our business verticals”

Fertiliser Segment delivered another quarter of strong performance backed by improved volumes, good demand of our differentiated products led by favourable monsoon and our continuous efforts. Manufactured fertilisers revenue increased by 29% y-o-y to Rs. 540 Cr in Q2FY21. Trading revenue grew by 65% y-o-y to Rs. 152 Cr for Q2FY21

Manufactured chemical business reported revenue of Rs. 541 Crores in Q2FY21 as compared to Rs. 524 Crores in Q2FY20. Chemical Trading sales increased by about 59% y-o-y to Rs. 167 Crores in Q2FY21, due to increase in prices. Segment margins improved from 13.4% in Q2 FY20 to 15.4% in Q2 FY21. IPA revenues increased by 42% y-o-y to Rs. 149 Crores in Q2FY21. Improved margins were primarily driven due to higher realisations compared to Q2 FY20. However, IPA sales volumes were adversely impacted by about 25% y-o-y due to production constraints arising out of pandemic. Softening in IPA prices have been witnessed compared to Q1 FY21. With gradual normalization of downstream industries, sales volume of Nitric Acid during the quarter improved by about 21% over Q1FY21. However, it was lower by about 8% compared to Q2 FY20. Capacity utilization at Dahej plant improved to 80% level during the quarter as compared to 68% during the same period last year.

The impact of COVID and the resultant lockdown were witnessed across TAN Business, both domestic (HDAN, LDAN and AN Melt) and exports. Seasonally low demand in Q2 due to monsoon along with slowdown in demand due to COVID impacted TAN Business. Demand from coal and limestone mining is likely to recover in Q3 as the economy continues to open up. Major raw

materials prices declined compared to Q2 FY2020

NTPC develops Geo-polymer aggregate from fly ash

New Delhi, India: NTPC Ltd, India's largest power producer and a PSU under Ministry of Power, has successfully developed Geo-polymer coarse aggregate from fly ash. The development will help in replacing natural aggregates reducing the impact on environment.

NTPC's research project on production of Geo-polymer coarse aggregate from fly ash has met the statutory parameters of Indian Standards and was confirmed by National Council for Cement and Building Materials (NCCBM). NTPC has successfully developed Geo-polymer coarse aggregates as a replacement to natural aggregates. The technical parameters as per Indian standards for its suitability to use in concrete works were tested by NCCBM, Hyderabad and the results are in acceptable range. The development is NTPC's R&D achievement in expanding the horizon in ash utilisation.

India's demand for these aggregate touches close to 2000 million metric tons mark every year. The aggregate developed by NTPC from fly ash will help in meeting the demand to a great extent and also will reduce the impact on environment caused by Natural aggregates which require quarrying of natural stone. In India, every year, approximately 258 MMT of ash is produced by the coal fired thermal power plants. Out of this around 78% of the ash is utilised and the balance remains unutilised which remain in ash dykes. NTPC is exploring alternate ways to utilise the remaining ash which includes the current research project to generate aggregates using more than 90% ash.

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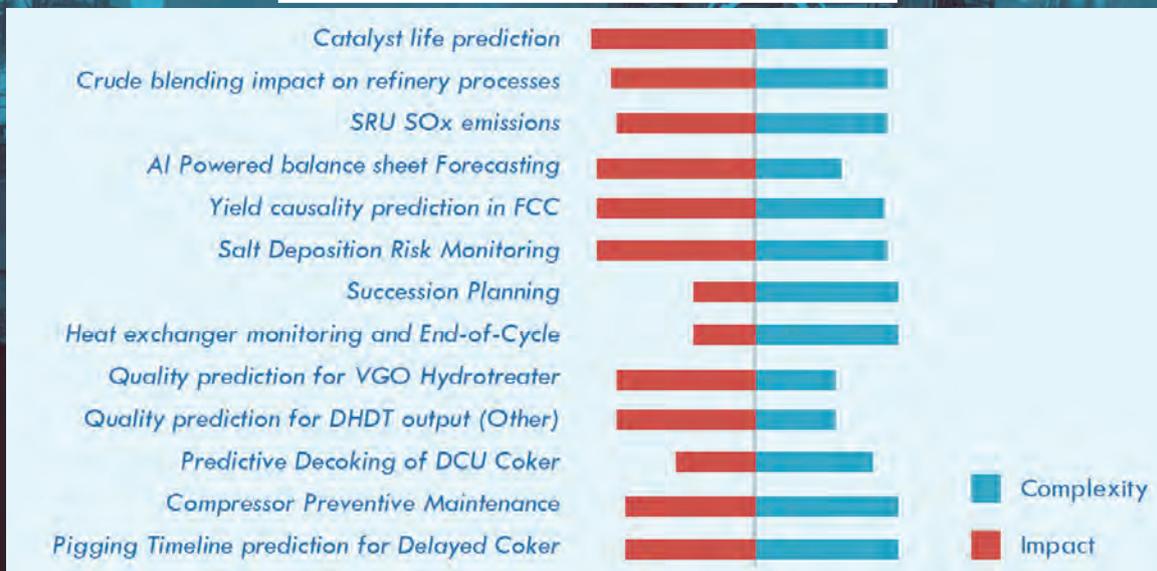
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The Geo-polymer aggregates finds its extensive usage in construction industry turning the ash eco-friendly. These aggregates are extremely environment friendly and does not require any cement for application in concrete where the fly ash based Geopolymer mortar acts as the binding agent. The Geo-polymer aggregates will help in reducing carbon emission and has great potential for reduction of water consumption.

Well Control Operation in Progress



Snubbing unit

Noida, U.P: The snubbing unit which has been brought from Calgary, Canada reached Baghjan well site yesterday evening. With all equipment and accessories related to Snubbing Operation in place at site, arrangement for placing snubbing unit is in progress. It is expected that after completion of all necessary pre operation activities, the well killing operation by the snubbing unit will commence within next couple of days. Meanwhile, the flow of gas from the well to nearby Early Production Setup (EPS) at Baghjan is being maintained with all operating parameters within desired level and safety measures in place. While, the final assessment report of the impacted families which has been carried out by the office of Deputy Commissioner, Tinsukia and directive of Honourable NGT are yet to be received, OIL

on the basis of the interim recommendations of the Hon'ble NGT and discussions with DC, Tinsukia has till date released an amount of Rs 36.90 crores as compensation to the impacted people. This includes an interim relief of Rs 10.93 crores to 3000 families who had stayed in relief camps. Moreover, an amount of Rs 25 lakhs were paid to each of the 12 families whose houses have suffered the most due to the fire on 9th June, 2020 and Rs 10 lakhs to 57 families whose houses were also damaged during the fire. 561 families whose houses or whose standing crops and horticulture have been partially damaged received Rs 2.5 lakhs each. It may be noted that as on date, OIL has deposited all the compensation and relief amounts as mandated by the government/statutory authorities Moreover as discussed with DC, Tinsukia, OIL has agreed to release an amount of Rs 50,000.00 to 1289 families every month to take care of their livelihood expenses till the well is brought under control. A total of 46,786 Metric Tonnes of Crude Oil and 124.15 Million Metric St. Cubic Meter of Natural Gas have been lost respectively till date as a result of protests/blockades/bandhs in and around Baghjan area since 27th May, 2020 due to the Blowout.

Praj unveils technology to produce biogas from biomass

Pune, India: Praj Industries' demonstration plant that deploys innovative technology for the production of Compressed Biogas (CBG) was inaugurated by Union Minister, Prakash Javadekar. Located in the Praj Matrix R&D campus, the plant deploys Praj's technology which utilises a proprietary microbial consortium made from feedstock such as agri residues and press mud. Also known as Renewable Natural Gas or RNG, CBG forms part of Praj's Bio-Mobility™ portfolio which uses captive bio based feedstock to produce

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India imports more than 80% fossil fuel, which is likely to increase to 90% in the near future. Transportation is the single largest user of fossil oil, and third largest GHG emitter. Further, with India committed to reduce its GHG emissions by 30-35% by 2030, it has become imperative to commercialise alternative indigenous energy sources derived from advanced biofuels technologies. Moreover, biofuels like CBG produced from agricultural crop waste is also an alternative to the burning of agri residue after harvesting. Since last 20 years, Praj has executed more than 50 biogas plants; most of them operating on industrial waste streams. Its latest technology which has multi-feed flexibility is automated and offers several other benefits through its signature L-EPC (Licence – Engineering procurement and construction) and O&M model. Additional advantages include round the year biogas production, best in class yields, more efficient degradation

and gas upgradation, and low utility footprint. The plant will also co-produce high quality organic manure certified by Natural Organic Certification Agro (NOCA).

Speaking on the occasion, Dr. Pramod Chaudhari, Executive Chairman, Praj Industries, said, "The CBG demo plant is another step closer to reducing carbon emissions and pollution. Besides reducing the import of natural gas and crude oil, our technology will boost entrepreneurship, economy and employment in rural India. This project is aligned with our endeavours towards energy self-reliance and supports the national commitment in achieving climate change targets".

AVEVA Recognized by Frost & Sullivan with the 2020 Best Practices Award

Mumbai, India: AVEVA, a global leader in engineering and industrial software, today announced it had been recognized with this year's Frost Radar™ Best Practices Award for growth, innovation, and leadership excellence in the asset performance management (APM) market. The Frost Radar is a dynamic tracking tool that offers the frequent rating and positioning of companies that are leading the industry in growth and innovation. The Growth Innovation Leadership (GIL) Best Practices Award is bestowed on companies that consolidate or grow their leadership position by continuously innovating and creating new products and solutions that serve the evolving needs of the customer base.

AVEVA was recognized with the GIL award for its strong digital and innovative initiatives and features included in its APM 4.0 framework, including AVEVA Insight, a cloud offering that



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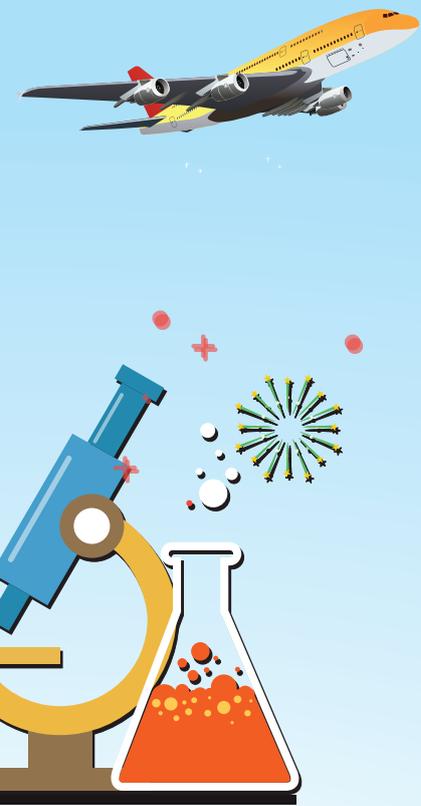
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provides end users with actionable insights from anywhere, anytime, and any device. AVEVA's APM 4.0 framework (connecting engineering, operations, and performance) enables customers to predict unplanned failures and balances four key value drivers, such as asset performance, safety and compliance, cost control, and resource management, to drive the greatest monetary and business value for customers.

AVEVA's artificial intelligence (AI) and machine learning (ML) capabilities (e.g., predictive and prescriptive maintenance) are cited as well, which have helped many customers increase equipment reliability and operational performance. Ram Ramasamy, Global Client Leader at Frost & Sullivan: "The APM market is evolving from a linear value chain to a circular digital-thread-centric value chain. AVEVA's APM 4.0 framework, which connects engineering, operations, and performance, aligns with this transformation. AVEVA's APM 4.0 balances four key value drivers, namely asset performance, safety and compliance, cost control, and resource management, in a business context to drive the greatest monetary and business value for customers."

"This award is testament to AVEVA's strong position in the APM market, particularly given the in-depth and robust nature of this report," said Kim Custeau, APM Business Lead at AVEVA. "Frost & Sullivan's recognition of our APM offering and value delivered to customers this year is a great accomplishment for AVEVA. In a challenging global environment, AVEVA is committed to helping organizations accelerate their digital transformation journey, by helping them manage risk and reduce OPEX."

Bentley Systems Commits USD 100 Million of Venture Funding to Accelerate Infrastructure Digital Twins



Greg Bentley, CEO , Bentley Systems

EXTON, Pa. : Bentley Systems, Incorporated (Nasdaq: BSY), the infrastructure engineering software company, announced the establishment of Bentley iTwin Ventures to invest in promising technology companies addressing the emerging opportunity for infrastructure digital twin solutions for roadways, railways, waterways, bridges, utilities, industrial facilities, and other infrastructure assets.

Bentley iTwin Ventures is a USD 100 million corporate venture capital fund which fosters innovation by co-investing in startups and emerging companies that are strategically relevant to Bentley Systems' objective of advancing infrastructure through going digital. The fund will target investments in transformational digital twin solutions supporting the design, simulation,

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construction, and/or operations of physical infrastructure. Bentley iTwin Ventures will invest in early and mid-stage companies that demonstrate ability to develop applications and solutions that leverage and extend infrastructure digital twin opportunities, particularly in the public works and utilities, and industrial and resources, infrastructure sectors. The fund will invest in opportunities which can leverage Bentley's iTwin Platform and open-source toolkits, supporting subject matter expertise, commercial teaming, and/or global reach and relationships within the infrastructure engineering community.

"Taking advantage of the momentum from Bentley Systems' initial public offering, we are excited to expand our Acceleration Initiatives by formally launching the Bentley iTwin Ventures fund to support the growth of entrepreneurial companies dedicated to infrastructure digital twin solutions," said Greg Bentley, CEO of Bentley Systems. "Our iTwin Platform provides a scalable open-source foundation for technical and commercial innovation that will empower a vibrant ecosystem to creatively combine and connect what digital twins now make possible for infrastructure constituents. Proprietary analytics, data services, benchmarking, and infrastructure-as-a-service commercial models, for instance, are not in Bentley Systems' direct scope, but we are glad to have a stake in bootstrapping these future successes. Here's to the fullest going-digital ecosystem for infrastructure digital twins!"

The Cohesive Companies Announces the Acquisition of PCSG

EXTON, Pa: The Cohesive Companies, a digital integrator investment of the Acceleration Fund of Bentley Systems, Incorporated (Nasdaq: BSY), the infrastructure



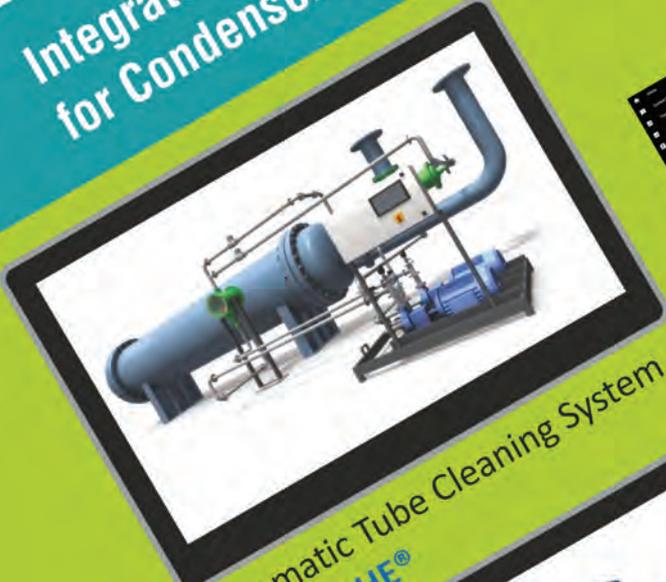
Dr. Mark Bew MBE, Chairman of PCSG

engineering software company, announced its acquisition of Professional Construction Strategies Group Ltd, (PCSG). Founded in 2000 by Katherine Bew, chaired by Dr. Mark Bew MBE, and headquartered in Croydon, UK, PCSG has developed world-leading methodologies, talent, and experience in advisory services to built-environment owners for transformative benefits in going digital, advancing BIM and GIS through infrastructure digital twins. Now within The Cohesive Companies, the organization can dramatically grow its advisory scope (already at over 50 professionals), both in global scale and to reach all infrastructure sectors. Greg Bentley, Bentley Systems' CEO, said, "Mark Bew's visionary thinking about the potential of BIM advancement through digital twins has spearheaded the UK's world leadership in digital ambitions for infrastructure, and has also inspired us at Bentley Systems. We recognize that owner-operators need advisory services to guide their transformations to digital workflows – and that all of us in their ecosystem benefit from expert consultancy services propagating best practices in digital twin adoption. "Accordingly, we're determined to catalyze the market development of digital integrators through our Cohesive portfolio developments. As so many sector-leading



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infrastructure owners have strongly endorsed the PCSG team and their results, the opportunity for Cohesive to join forces with Mark and Katherine Bew to globalize their work is fortuitous.”

Dr. Mark Bew MBE, Chairman of PCSG, said, “Katherine and I are delighted to be joining The Cohesive Companies. Deepening what we can offer to existing clients, while at the same time broadening our scope through this comprehensively global organization, is a very exciting opportunity for us, our clients and our partners. “Our vision is one of infinitely smarter futures where a digitally engineered built environment supports the delivery of infinitely better social, environmental and financial outcomes. I particularly want to thank our world-class PCSG team and our farsighted clients for enabling and embracing this tremendous opportunity to accelerate the realization of this vision.”

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Nextchem & IndianOil sign India's 1st circular economy MoU



Pierroberto Folgiero, Maire Tecnimont Group & NextChem CEO

Mumbai, India : Maire Tecnimont S.p.A. announces that NextChem, the Group's

subsidiary dedicated to green chemistry and technologies for the energy transition, and Indian Oil Corporation Ltd. (IndianOil), have signed a Memorandum of Understanding for the development of industrial projects using NextChem technologies to foster the industrialization of the circular economy in India. The projects will be focused on plastics recycling, producing biofuels from renewable feedstock and circular fuels and chemicals from non-recyclable waste.

IndianOil is India's national integrated oil company with business interests across the entire energy value chain in Oil, Natural Gas as well as non-conventional sources. Under the agreement, Indian Oil and NextChem will jointly explore integrated opportunities for the valorization of the waste by utilizing Nextchem's technologies for plastic waste Upcycling and Waste-to-Chemicals solutions. NextChem, relying on the historical and solid presence of the Maire Tecnimont Group in India (with over 2,000 engineers and approx. 3,000 E&I professionals in Mumbai), will guarantee the technological solutions and the best know-how for project development and execution.

IndianOil is working to develop a sustainable business model of closed loop ecosystem of waste-plastics under its “Plastic Neutrality Initiative” and is looking for partners who can contribute to addressing the end-life management of plastic waste in the country. IndianOil furthermore intends to introduce recycles as a new line of product portfolio in addition to the existing virgin polymers business. NextChem is developing several technological solutions related to generating value from waste, providing its contribution by scouting, pivoting, industrializing and finally commercializing a portfolio of sustainable technologies.

Pierroberto Folgiero, Maire Tecnimont



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Group and NextChem Chief Executive Officer, commented: "We are really proud to be partner of choice in the first industrial initiative in India's circular economy sector with such an historical and prestigious player as Indian Oil Corporation. The Country needs to rapidly develop a sustainable system to recycle waste to enhance their value via chemical conversion, by introducing available technologies. We can support this transition with Nextchem's expertise in developing and industrializing green chemistry and circular economy solutions combined with the Group's outstanding track record in managing complex technological projects"

Circularise and Porsche collaborate with Borealis, Covestro and Domo Chemicals to enable the traceability of plastics in the automotive sector

Circularise, the blockchain supply chain transparency provider, as part of the Startup Autobahn innovation program, recently launched a project with Porsche and its pioneering material suppliers –Borealis, Covestro and Domo Chemicals – to enable the traceability of plastics on blockchain and to ensure that the use of sustainable materials in Porsche cars can be proven. By digitizing materials Circularise was able to create a digital thread through the whole supply chain, enabling material traceability, tracking the CO2 footprint and other sustainability metrics like water savings. Getting information from supply chains has always been a challenge. Not only because of the inherent complexity of the supply have chains and the multitude of suppliers, but also due to concerns around

trusted, privacy and confidentiality. That is why blockchain is offering such a fitting solution to transparency challenges in supply chains. "We believe transparency should not come at the cost of reduced privacy and confidentiality. That is why we developed our patent pending technology for creating verified statements on public blockchains without revealing any underlying sensitive data. While this raw data is very valuable in a B2B setting, consumers demand a more distilled and interactive version. We are proud to present exactly that in collaboration with Porsche and some of their pioneering suppliers," says Mesbah Sabur.

Porsche has a large number of suppliers providing parts to its cars but it doesn't stop the company looking for more information about the materials that go into its cars. According to Antoon Versteeg, Project Lead Innovation Research at Porsche, "We need to know more details on the parts and materials being used in our products, that means information on production processes deep down the supply chain, statements of recycled content and more. With the help of Circularise, as well as with the help of their partners we were able to trace for a number of specific cases plastics from raw material production to the final car." A number of suppliers who can deliver sustainably produced materials for the automotive industry were involved in this project to realise the final outcome. Each batch of material was digitized on the blockchain receiving a digital copy called digital twin. The digital twin carries all relevant information regarding the batch, such as its environmental footprint and origin. This digital

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for safety and environment

thread created transparency between project partners leading to an improved supply chain collaboration.

This also offers great advantages to the material manufacturers. According to Thomas Nuyts, Director of Global Product Management at Domo Chemicals, "as leader in the production of sustainable polyamides, we at Domo can only gain by making the supply chain more transparent. By tracking our materials, we will make a huge step ahead in supporting the automotive industry in its sustainability challenges. Besides providing recycled solutions from current sources we also aim to enlarge this loop and find new raw materials for our products to meet the mobility needs of today and tomorrow."

However, the companies cannot simply create a digital twin. First, the batch of materials needs to be audited by an independent third party to verify that the material and related claims are true. "Verification is essential. Even with a supply chain involving blockchains we want independent auditors for our system. And this is how we gain the trust and confidence of all our value chain members. Several years from now, after these systems are in place on a wider scale, things will have been standardized. For now, it's still early days. Auditors and certifications are essential to ensure that no one can engage in greenwashing. But we really need to pick up the pace as we keep moving towards more circularity," says Christopher McArdle, Borealis Vice President Polyolefin Strategy and New Business Development.

Once the materials are digitized, the parties

along the supply chain can now update the digital twin mimicking the physical supply chain and reflecting the manufacturing processes along the lifecycle of the product. Due to Circularise's "Smart Questioning" technology this process can happen while preserving everyone's privacy regarding their identity and business relations and protecting confidential information.

Burkhard Zimmermann, Head of Resin, Digital Transformation & Sustainability at Covestro's Polycarbonates segment: "For us, it is really important to share information and be more transparent while maintaining confidentiality. For instance, the material composition is of competitive advantage so we would never share that openly. Here, Circularise helps us to maintain this confidentiality and only disclose the information needed from raw material producer to recycler. And with that, we can close the loop." Not only this approach helps car manufacturers to make better decisions for the next generations of vehicles and support end-of-life recycling approaches, it also helps final consumers to learn more about their vehicle and its origins, enabling them to make more sustainable choices. Ultimately reducing the environmental impact across the whole value chain. ■

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Deepak Nitrite reports sharp rebound in Q2FY21



Maulik Mehta, CEO & Executive Director, Deepak Nitrite Ltd.

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Vadodara, India: Deepak Nitrite Limited (DNL), one of India's leading chemical intermediates company received Forbes Asia Best Under Billion Top 200 Award. To celebrate the success of these 200 Best Under A Billion companies, Forbes Asia Best Under A Billion Virtual Forum and Awards Ceremony was held on November 23 from Singapore. The annual Forbes Asia Best Under A Billion list spotlights top performing publicly listed companies in the Asia-Pacific region with sales under \$1billion. From 18,000 small and mid-sized companies, 200 companies were selected based on a composite score that incorporated their overall track record in measures such as debt, sales and

earnings growth over both the most recent fiscal one- and three-year periods, and the strongest one- and five-year average returns on equity. The criteria also ensured a geographic diversity of companies from across the region. By using metrics both quantitative and qualitative, the final list of 200 companies were shortlisted.

Maulik Mehta, CEO & Executive Director, Deepak Nitrite Ltd. while receiving this prestigious recognition said: "I am delighted to receive Forbes prestigious recognition and ranking at a time- when company has entered 50th year of operation. I dedicate this award to our employees, customers and partners who have partnered with us to create this legacy. As a company we look forward to strengthening this legacy and are committed to build a sustainable future." Christopher "Kip" Forbes, vice chairman of the Forbes Publishing company was present at the virtual event. He congratulated the winners from Asia. ■



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Odisha Government approves industrial projects worth Rs 464.72 crore



Asit Tripathy, Chief Secretary & Chief Development Commissioner, Odisha Government

The State Level Single Window Clearance Authority (SLSWCA), led by Asit Tripathy, Chief Secretary has approved 4 industrial projects in the metal & metal downstream and food processing sectors in principle. Projects include:

- Medium Density Fibreboard (MDF) manufacturing facility with an annual capacity of 72,000 cubic meters initiated by M/s Galax Industries Private Limited against an investment of INR 93 crores to be set up in Malipada, District – Khorda.
- 120 KLPD grain-based distillery unit for manufacturing of Extra-Neutral Alcohol (ENA)/Ethanol and 4 MW cogeneration power plant in Khorda and Nayagarh against an investment of INR 151.72 crore.
- M/s. Envirocare Infrsolution Private Limited's new unit at Lathikata in

Sundergarh by setting up a Pellet plant of 1.6 MTPA capacity for investment of Rs 120 crore

- 4 MTPA Slurry Pipeline project from its proposed Beneficiation Plant at Koira to Pellet plant at Lathikata, Dist- Sundergarh initiated by M/s. Envirocare Infrsolution Private Limited to be set up against an investment of INR 100 crores

Since February 2020, the state has attracted over Rs. 1,19,214.72 crores worth of new investments with potential employment opportunities for over 54,131 persons since February 2020.

Rs. 2 lakh crore to be invested for setting up 5000 Compressed Bio-Gas in India

To boost availability of affordable and clean transport fuels, a MoU was signed today between MoPNG and leading oil & gas marketing companies & technology providers to establish Compressed Bio-Gas (CBG) plants across India under the Sustainable Alternative Towards Affordable Transportation (SATAT) initiative, in the presence of Union Minister of Petroleum & Natural Gas & Steel, Dharmendra Pradhan. MoUs were signed with energy companies viz. JBM Group, Adani Gas, Torrent Gas and Petronet LNG for setting up of Compressed Bio-Gas (CBG) plants, and with technology providers in CBG sectors IndianOil, Praj Industries, CEID Consultants & Bharat Biogas Energy for facilitating availability of technology for

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Dharmendra Pradhan, Union Minister, MoPNG & Steel, Government of India

the projects. Government of India, under the SATAT initiatives envisages setting up of 5000 CBG plants by 2023-24 with production target of 15 MMT, facilitating the creation of new employment opportunities and enhancing farmers' income towards further invigorating the rural economy.

Minister said, "I am glad to note that Indian industry players have shown immense interest in SATAT. Letter of intent for 600 CBG plants have already been given and with today's signing of MoUs for 900 plants, a total of 1500 CBG plants are at various stages of execution. Rs 30,000 Cr of investment is envisaged in these 900 plants. A total of 5000 CBG plants with approximate investment of Rs. 2 lakh crores are envisaged. Biofuels have the potential to reduce our fuel import bill by Rs. 1 lakh crore."

SATAT (Sustainable Alternative Towards Affordable Transportation) initiative for boosting production and availability of CBG as an alternative and affordable clean fuel for transportation sector was

launched by Government of India in October 2018. The scheme envisages setting up of 5000 CBG plants by FY 2023-24. Signing of the MoUs will give a big fillip to the clean energy initiative of the Government. MOU Signing ceremony marks MoPNG's commitment towards SATAT and the increased participation of the private sector would help the nation in achieving indigenous and sustainable production of clean fuel. SATAT initiative is also an important step towards fulfilment of India's COP-21 commitments for carbon emission reduction. Union Minister, in his address, affirmed that completion of 5000 CBG plants will facilitate in lowering greenhouse gas emissions, remunerating farmers for agricultural residues and reducing natural gas imports, in line with the Aatmanirbhar Bharat and Swachh Bharat missions.

Petroleum Minister lays foundation stone for the first 50 LNG fueling stations, says 1000 LNG stations will be set up in next three years

Dharmendra Pradhan, Minister of Petroleum & Natural Gas and Steel laid the foundation stone for the first 50 LNG fueling stations, across the golden quadrilateral and major National Highways. This is part of a slew of initiatives of the Ministry of Petroleum and Natural Gas in realizing Hon'ble Prime Minister, Narendra Modi's vision of transforming India into a Gas based



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economy. Government has identified LNG as a transport fuel as a priority area considering the potential of manifold benefits in terms of reducing vehicular pollution, saving in terms of import bill of the country and wide ranging benefits that may accrue to fleet operators, vehicle manufacturers and other entities in the gas sector.

Government will set up LNG stations at the distance of 200-300 km on golden quadrilateral, and within 3 years, we will have 1000 LNG stations on all major roads, industrial hubs and mining areas. He expressed confidence that 10% of the trucks will adopt LNG as fuel.

44 The Secretary, Ministry of Petroleum and Natural Gas Tarun Kapoor said that the Government is making a long-term plan to promote LNG. The first trial of the fuel was started in 2015, and it is now ready to take off on the commercial scale. He expressed confidence that LNG's use will increase and adopted for long haul trucks and buses. These fifty LNG stations will be set up and commissioned in partnership by country's Oil & Gas majors such as IOCL, BPCL, HPCL, GAIL, PLL, Gujarat Gas and their Joint Venture Companies and subsidiaries. Out of these 50 LNG stations, IOCL will set up 20 LNG Station, while BPCL and HPCL will set up 11 each LNG station. These 50 LNG stations are being put up at the nation's Golden quadrilateral and major National highways where LNG is to be made available for heavy vehicles and buses.

Danfoss supports 'Atmanirbhar Bharat'

Danfoss India has finalised plans to invest Rs. 100 crore to expand its manufacturing base at Oragadam in Tamil Nadu. Over the next 2-3 years, this move will enable the company to increase local manufacturing from 35-40% to 90 % by partnering with local MSME supply chains. The company is investing in power electronics products & solutions to meet anticipated demand from domestic as well as international markets. In the last 6 years, the group has invested over Rs. 1000 crore and has increased the focus on localization based on Indian R&D and manufacturing.

SRF approves CAPEX for capacity edition

The Board of Directors of SRF has approved the capital expenditure plan to set up a second BOPP film line and metallizer at Indore in Madhya Pradesh, either directly or through a wholly-owned subsidiary. Current capacity of plant is 45,000 TPA and proposed capacity addition is 60,000 TPA. Proposed capacity will be added in 20 months at a cost of Rs 424 crore which will be financed through a mix of debt and internal accruals. ■

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Euro Chlor launches its Mid-Century Strategy

Towards a safe, competitive and green European chlor-alkali industry



Euro Chlor has just released its “Mid-Century Strategy for a Sustainable Chlor-Alkali Industry (MCS)” that defines what the sector aims to look like by 2050, as well as the direction planned to ensure that this safe, competitive and green European chlor-alkali industry will be here for the benefit of Europe in 2050.

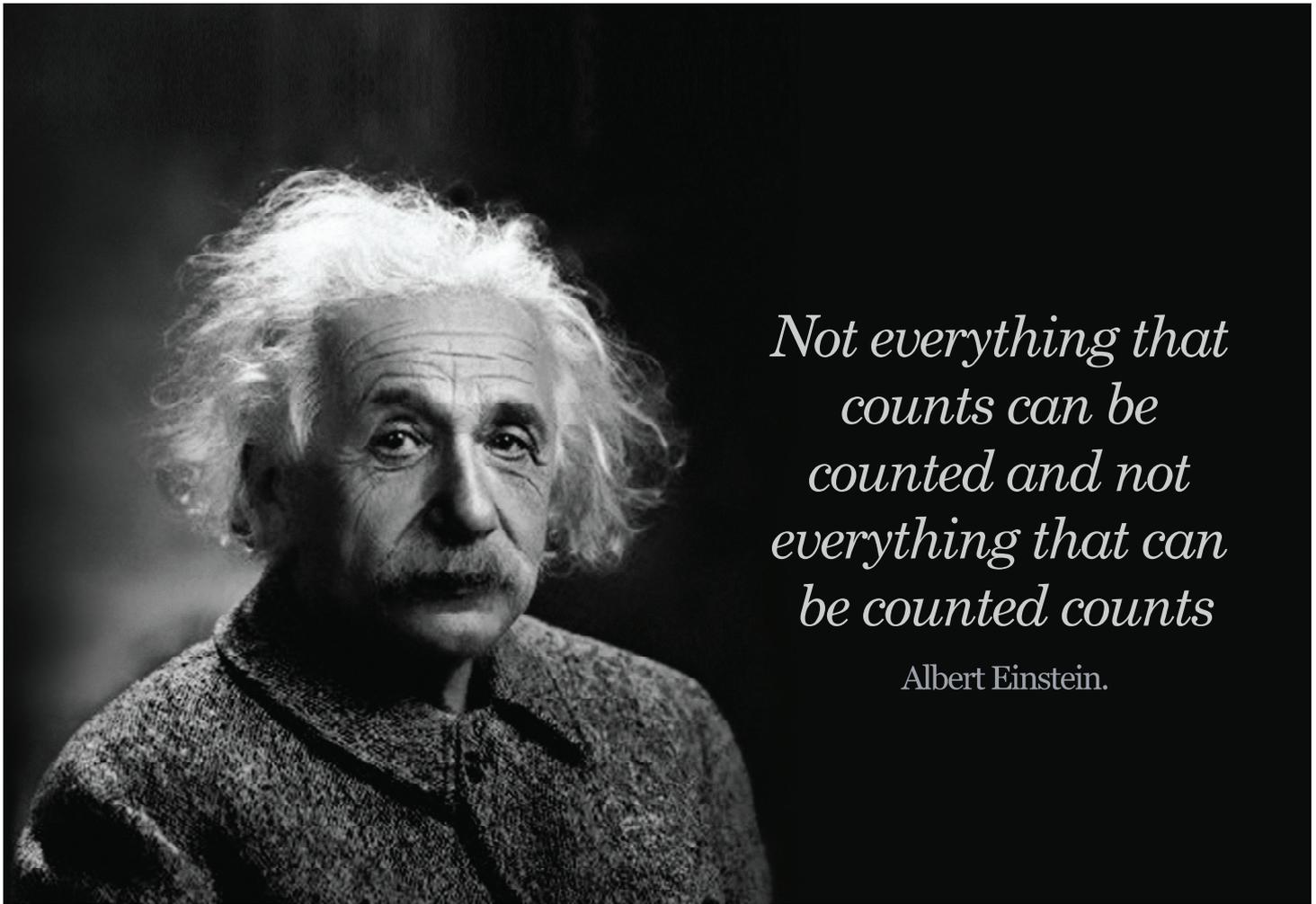
The work started in the run up to Euro Chlor’s third 10-year Sustainability Programme (2021-2030), builds on the Cefic Mid-Century Vision (MCV) and addresses some future needs of European society in the context of the EU Green Deal. Consultant Roland Berger performed a detailed analysis of industry trends, the development of possible future scenarios and organised interviews with relevant stakeholders. The outcome was Euro Chlor’s inspiring new vision “Towards a safe, competitive and green European chlor-alkali industry” and mission “to be a safe and competitive supplier of chlor-alkali products and an integral part of Europe’s climate neutral and circular economy transition”.

Euro Chlor’s 38 producing members operate 60 manufacturing locations in 19 European countries, representing 97% of all European production capacity.

Euro Chlor represents the interests of chlor-alkali producers in Europe; encourages best practices in safety, health and environmental protection and promotes the economic and social benefits of chlor-alkali and the many industries that rely on them.

Based in Brussels, Belgium, Euro Chlor is a sector group of Cefic (European Chemical Industry Council), which represents chemical companies across Europe.

In addition to a new vision and mission, the MCS defines key priority elements that Euro Chlor members will work on in the coming decades. The association aims to keep safety as its main priority,



Not everything that counts can be counted and not everything that can be counted counts

Albert Einstein.

Math of real world seldom adds up due to intangible variables that cannot be easily captured. For final tally, we know we don't just have to win contracts, we must earn customer confidence too. Our main focus is customer delight achieved due to & through positive interactions, quality alertness, proactive involvement and personalized service for varying situations & requirements.

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continuing to measure Lost Time Injuries (LTI) incidents and process incidents with a continuous aim for zero, as well as stepping up its focus on safe transportation of their products. At the same time, Euro Chlor plans to contribute to Europe's climate neutral ambitions by further focusing on its drive for energy efficiency and more closely investigating its carbon footprint. This includes determining the chlor-alkali industry's role in a more electrified and greener future and striving for 100% hydrogen utilisation. These elements will also help keep the European chlor-alkali industry competitive. In addition, the association intends to better close the loop in its own production processes and work together with downstream users to increase circularity in the downstream chlorine value chain.

Originally planned at Euro Chlor's Technology Conference last May, the launch of the MCS was postponed to the Association's Annual General Meeting on 11 September 2020 due to COVID-19. The Technology Conference www.eurochlor2021.org will now be held on 4-6 May 2021 and give an update on the MCS progress. More information can be found at www.eurochlor.org/mcs, which, along with #eurochlorMCS, will be updated with progress. ■

For more information

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Staffing has been outsourced for a while in India. It has however been primarily disorganized. It was mainly for unskilled workers and helpers. Factory owners would ask local influential people to hire and deploy people to factories. It was primarily used to avoid labour issues.

Technical or Engineering staffing is approximately two to three decades old and is the need of an hour. Professionals are hired for specific projects, and bring their knowledge and experience with them for to execute their projects better. This industry is now worth more than Rs. 5000 Crores and continually expanding. There are a few companies who are specialized

in this service, till date. This sector is predominantly controlled by pop and mom shop companies.

Technical staffing has come as a win – win for both employers and employees. Certain professionals are looking for flexibility in work, and would like to spend quality time with their families during vacations. Projects are however generally in remote locations with poor infrastructure, education, and health care. Such professional thus let their families stay home, and work on these specific sites. Once the project is over, they may vacation with family, and thereafter search for other assignments. Such methods are popular with Refinery, Pipelines, and the Power

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Industry and creates profitable situations for employer, Employee and Technical Staffing company.

Staffing companies are differentiated into two, Payroll staffing and Recruiting Staffing. Payroll staffing does not locate engineers and primarily payrolls people who are identified by company. The challenge is to source candidates meeting client requirements. Recruiting staffing companies alternatively, comprise domain knowledge to identify, and recruit suitable talent for specific projects. If permitted decision making, it is preferable to utilise technical staffing companies that contain domain knowledge for recruiting purposes.

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When one is hiring through tech staffing companies, ensure that professionals are hired for their respective projects as their owner's representative, and are not subject to differential treatment. Enable them to become part of the team. Technical Staffing Companies comprise multiple projects and help professionals to get another assignments.

In the early 1980's, Staffing was primarily used by the private sector. Over last 15 – 20 years however, both Private and Public sector company are benefiting. Both PSU and Private industries have begun using third party staffing company. It has benefitted them significantly in today's times. Several companies or their owners, and managers have multiple apprehensions

Technical Staffing is widely used for

- Project Management
- Engineering Design
- Construction Supervision
- Inspection Services
- Safety / HSE monitoring
- Pre-Commissioning & Commissioning activities

about professionals hired through technical staffing companies: They are as follows -

- The primary cause for apprehension is degree of commitment exhibited by professionals. Multiple companies feel that professional hired through third party rolls are not committed to work, and may leave without giving a notice period. They say however, that it has been rare for people to leave without proper notice or reasons. The industry is small, and people would not like to jeopardize their career.
- Fair pay is important. If Staffing Companies do not give fair pay, professionals may not stay and leave after short durations.
- The necessity of compliance. It is very important that hiring services complete due diligence of their respective staffing companies before appointing them.



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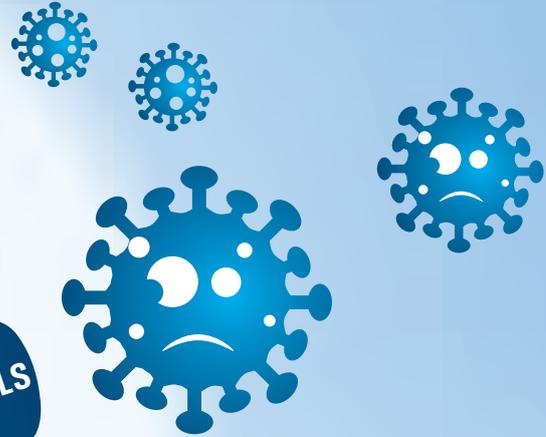
The reputation, ethics, and financial strength of the company are critical to appointment of professionals, and the execution of services.

It is important that hiring services understand that they are dealing with humans, and not products. The price should be fair so that both Staffing companies, and Professional beginning work are excited, and keen to complete your project.

Advantages of Staffing Companies that address such apprehensions are as follows

- The importance of flexibility in hiring
 - If one has the right partner with appropriate sourcing skills, consequent projects will take place without errors. Specialists can be recruited dependent on project requirements.
- Project - specific hiring: No two projects in different industries are similar. Skills required for specific projects, to O&M are different. With Tech Staffing companies, one is able hire appropriate talent for their respective profiles.
- Industry specific hiring: If one is looking for power plant expertise for refineries, or prefer expertise for infrastructure projects within renewable power project backgrounds, project timelines become stricter and each delay increases cost.
- Compliance Management: It is important that the law of land is followed and there are no unethical activities are carried out.
- Fund / Finance Management: Staffing companies may also help funding salaries. They may help those not getting paid with salaries for up to two months.
- Focus on care activities.
- Outsourcing of recruitment activity like Sourcing and Mobilization.
- Outsourcing of HR and Admin activity of Professionals hired
- Cost advantage: All the cost and work related to HR, and payroll gets outsourced and helps control project cost.
- Professionals bringing in project knowledge, and expertise are important in overcoming staffing apprehensions. Professionals may have worked on similar projects in India or internationally. The knowledge on safety, and execution may be important requisite projects.

In conclusion it is important to understand one's technical staffing partner in entirety, their knowledge, reputation and measures of compliance prior to partnering with them. Kindly do your due diligence and take advantage of technical staffing. ■



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Evolution of Piping as an Engineering Discipline

Author delves into evolution of piping as an engineering discipline since 1979/1980 through 1989/90 and beyond to the millennium. As also, how it is being corroborated with the Plant Operator/Owner by a Process Plant Piping Engineer. Even piping material and its choice by weighing pros & cons has significantly evolved/ developed through continuous improvements based on feedback taken by piping manufacturing giants/ steel mills around the globe. By doing so, ultimately in the long run, operating a Process Plant becomes cost-effective.

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Pipes are erected and routed both Inside Battery Limits (ISBL) and Outside Battery Limits (OSBL) of a given Process Unit. The scheme is decided by the plant/equipment layout/piping General Arrangement Drawings (GAD) which are then to be converted to isometrics for use by the fabrication yard at site utilising Specified Quality of Piping Materials. All the Shop-joints are subjected to Radiography & DP tests, referred to as Non- Destructive Tests (NDT).

80's through the 90's to the millennium

A Pre-Fabrication Shop was set up at Kandla Free Trade Zone (KFTZ) in 1982 facilitating Export of Piping Spools to Middle-East based on Approved for

Construction (AFC) drawings, piping layouts and piping isometrics of a given project. Planned percentage of Piping-spools' tonnage can be achieved owing to deployment of 6G Qualified Pipe Welders on daily basis.

In 1985, when Plants for Man-Made Fibres were being constructed, in which Process Plant Building had pipes running ISBL to the tune of multiple times 100,000 inch-metre of erection, isometrics in bulk quantity were to be produced based on equipment and piping layouts.

The process of rolling out the Piping Isometrics would be error – free, which was the clear indicator of high productivity. This involved training the designers at the design centre for 2D depiction of isometrics. To achieve highest orders of productivity, develop error-free isometrics



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LPR – Corrosion Probes	Water lines, Cooling water ,
Microcor – Advanced ER Corrosion probe	Multi-Phase flow media, Oil, Water, Gas ...all
Microcor – Sand Erosion Probe	Up-stream Oil wells, Rigs
Bio-Probe	On crude, Oil and & water lines
Injection Quill system	For injecting Corrosion Inhibitor, Chemicals into the pipeline

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Name of product / System	Name of Test	Test Standard
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HIC System	Hydrogen Induced Cracking (HIC) Testing in sour environment	NACE TM0284
HPHT Autoclave And Re-circulating Flow Loop System	Corrosion Resistance, High Pressure Vessels, Dynamic Autoclaves	NACE TM0177 NACE TM0198 NACE TM0284
	Sour Service Corrosion Testing	NACE MR0175 ISO 15156
Slow Strain Rate Test (SSRT) Or Constant Extension Rate test	Slow Strain Rate Test (SSRT) Or Constant Extension Rate test	All of the above
DCPD System	Crack extension / crack growth measurement	

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as well as to cope up with the schedule of the erection contractor, we developed the novel idea of using flexible copper wire as the demo tool. The wire could be shaped, bent and rolled to resemble a piping run or isometric

Then, in 1990, we migrated to Plant Design System (PDS) 3D - modelling for implementing it on a Pilot Project of Non-tearing Paper. In 3D environment we would extract Pipe Isos which further would depict various kinds of pipe-support, its type being decided by the outcome of Piping Stress Analysis. In the Millennium Year, one could achieve a higher productivity in the generation of Layouts and Isometrics using Plant Design Management System (PDMS), 3D Modelling.

Handling the Stress

In effect, for completeness of Piping System, what is required is the method of holding pipes on to supports that can absorb stresses developed owing to thermal loads when routing the piping loops on to concrete sleepers or on to the pipe-racks (could be concrete columns & beams or simply steel structure). Stress Analysis of various test-packs or loops based on AFC P&IDs ought to be carried out using a universal programming tool.

Process Piping arrangement and its induced stress as a result of high pressure & temperature of the fluid depending on

kinematic viscosity and flow rate, need to be anchored or moving / sliding on to a variety of supports that are either custom-built or like in case of spring-hanger supports are required to be calibrated to match the functional design of the piping system in question.

In the designing of piping system, care has to be exercised in choosing the extent of radius in various bends that come into play lest stress concentration occurs, resulting in fatigue failure of materials or offset of pipe lengths while the plant is in running condition, including unseating of pipe from its support, e.g. hanger-type support.

Heat & Mass Balance is done through Steady State Modelling and results are tabulated in PFD (Process Flow Diagram) based on which Material of Construction (M.O.C.) of Equipment & Piping is decided. Bearing the above in mind, one is required to select the M.O.C. of piping material, at the same time addressing the material handling and ease of erection issue.

To cite one example of H.P. Steam process piping material, what comes immediately to mind is Deutsche Babcock Werke (DBW) developed Piping Material thus X20Cr Mo V121 alloy that has thin Pipe-thickness even for large diameter Pipes.

Layout & Designing

In Piping Engineering or Equipment Layout Designing, P&ID the deliverable of



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Process Engineering department becomes the governing document for planning of TEST PACKS for Hydro-testing purposes. Upon successfully testing of individual test-packages, System-wise sizable number of lines are brought together for Hydro-Testing purpose. Likewise, other process and utility systems are successfully hydro-tested. Ultimately, all the systems that qualify for hydro-test are joined with match-points to ensure that the said Plant is ready for trial-runs. Finalisation of plant layout is based on operating and control philosophy covering its start-up and running as well as during its shut-down times. After all, layout of Plant is based on Safety studies & governing guidelines.

Design of Process Plant Layout ought to address crucial aspects of Protection, e.g. leaks, liquid overflow, excess temperature, etc. Any revision in Piping System has to be verified by carrying out stress analysis and not otherwise. The design pressure of each component in the Piping System will be equal to the most severe pressure expected during service. Surge effects, e.g. water-hammer is analysed and pipe-supports are designed to withstand such loads.

Slug flow or force is yet another aspect that comes into play during the flow of gas & liquid simultaneously in a piping system, when the slug is having higher velocity than the Mean Velocity of a 2-phase flow. The resultant impact force is calculated

as a Dynamic Amplification Factor (DAF), which occurs due to change in fluid direction.

Subsequent to building of a Process Plant's Equipment Layout at the hands of the Plant Owner &/or its 3rd Party Approver, the GADs are rolled out and piping isometrics generated and plant design completed. Application or implementation of concurrent engineering is then executed by way of incorporation of other engineering disciplines' interference checks for routing of process pipes.

A 'FLY-BY' 3D Model is saved and handed over to the client for the purpose of maintaining the record and future use for modification of plant, when the need arises. In case, the client wants to capture the physical dimensions of each and every component that has gone into his Process Plant, the same is made possible through 'Laser Grammetry', by means of which the Point Cloud Data gets converted to images and pictures are formed through a compatible camera, viz., Leica Brand Camera handled by trained operators positioned within the main process plant building. ■



Author

Nandkumar Kakde

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Polypropylene – Emerging Scenario: Dream Surge in Five Years



Jayant D Divey

Polyolefins Technology Consultant

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Polypropylene or PP is the second most important thermoplastic after Polyethylene. Its per capita consumption is a kind of parameter used for measuring economic advancement of a country. PP capacity is poised to double up from current 4.8 MMTPA to 9.4 MMTPA in a matter of five years by 2025. This trend will penetrate in to industrial and hence economic activities across India by creating opportunities for new investments, revenue generation and employment. This article is intended to briefly capture the emerging PP scenario in next 5 years.

Polypropylene or PP is the second most important thermoplastic globally by volume, only exceeded by polyethylene or PE. PP has become integral part of our daily life through its versatile applications. PP is produced in three different types namely Homopolymer PP (PP-H), Random Copolymer PP (PP-RC)

and Impact Copolymer PP (PP-IC). Impact Copolymer PP is also called Hetero-Phasic PP. The consumption of thermoplastics in general and PE and PP in particular has become a kind of economic parameter for the progress of a country.

Propylene is the main raw material for producing PP. Propylene is sourced from



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Table 1: Emerging Polypropylene (PP) Capacities in India in KMPTA
(Kilo Metric Tonnes per Annum)

Company	Location	State		Technology Licensor
HPCL Rajasthan Refinery Limited (HRRL)	Barmer	Rajasthan	980	Lummus Novolen
Hindustan Mittal Energy Limited (HMEL)	Bhatinda	Punjab	500	LyondellBasell
Indian Oil Corporation Limited (IOCL)	Panipat	Haryana	450	LyondellBasell
IOCL	Paradip	Odisha	680	
IOCL	Vadodara	Gujarat	420	Lummus Novolen
IOCL	Barouni	Bihar	200	
Chennai Petroleum Corporation Limited (CPCL)	Manali, Chennai	Tamil Nadu	475	Lummus Novolen
Nayara Energy	Wadinar	Gujarat	450	W R Grace
Bharat Petroleum Corporation Ltd (BPCL)	Rasayani	Maharashtra	450	W R Grace
Total Capacity			4605	

upstream plants which are of following types:

- Naphtha Cracker – the most conventional source or Gas Cracker or Dual Feed Cracker
- Petro Fluid Catalytic Cracker or Petro FCC or Petro Residue FCC
- Deep Catalytic Cracker (DCC)
- Propane De Hydrogenation (PDH)

Propylene produced in FCC units is typically called Refinery Propylene. The

proportion of Propylene used for producing PP has been consistently increasing in favour of Refinery Propylene since early 1990's. The Propylene produced irrespective of source as raw material for manufacturing PP resin is called Polymer Grade Propylene since it has to meet stringent specifications required for propylene polymerization reaction using Ziegler-Natta (ZN) family of catalysts. Typically polymer grade Propylene is 99.50 % V/V purity as minimum.



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Indian Scenario - Current & Emerging

In India Reliance Industries Limited was the first refinery & petrochemicals complex to pioneer the production of polymer grade Refinery Propylene in late 1990's. All other PP units were based on Cracker Propylene until MRPL (Mangalore Refinery & Petrochemicals Limited) and HMEL (Hindustan Mittal Energy Limited) started producing PP using Refinery Propylene in 2010's

As of 2020, operating PP capacity in India is approx. 4.8 Million Metric Tonnes Per Annum (MMTPA) as compared to about 80 MMTPA globally which means about 6% of global.

Many Refiners in India have already initiated plans to foray in to petrochemicals to improve upon Gross Refining Margin (GRM). They are integrating refinery with PP either by installing Petro FCC or Cracker or combination of both. Of Course PP is not the only petrochemical product that is part of refinery integration but may also include Polyethylene or Mono Ethylene Glycol or Para Xylene or Purified Terephthalic Acid in different combinations.

The emerging PP capacities in India as per the information available in public domain is as follows:

Thus total of 4.60 MMTPA PP capacities are progressively expected to be commissioned starting from 2022 to 2024. Therefore let

us assume that by 2025, PP capacity in India will increase from current 4.8 MMTPA to $4.80 + 4.60 = 9.40$ MMTPA against expected global capacity of about 130 MMTPA that is about 7.2 % which is some improvement over 2020.

Year PP Capacity (MMTPA)		
2020	4.80	100%
2025	9.40	195%

This can be summarized in following manner:

Increase in 5 years by stupendous 95%! This surge roughly means that the PP capacity will practically double in a matter of just 5 years! Thus PP consumption in India which was thus far constrained by supply, will suddenly find abundant capacity to engine the growth of PP consumption from approximately 4 kg per capita to 8 kg per capita in 5 years.

As can be noted from the Table 1 above, these capacities will also be spread across the nation and will promote industrialization and benefit states like Rajasthan, Bihar and Odisha which did not have such plants. Thus states like Rajasthan, Bihar and Odisha are likely to share a significant growth in their areas which will boost the state economy in terms of investment, revenue and employment.

Similarly, another noteworthy aspect is that all the three major global PP technology licensors namely LyondellBasell (Bulk Slurry Phase Polymerization), Lummus

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Email : sales.thane@polyvalve.com

Table 2: Polypropylene (PP) - Typical Applications

Type	Typical Applications
PP - Homopolymer	
Injection Moulding	Industrial Products, Furniture, Housewares, Rigid Packaging, Thin Wall Containers, Closures, Syringes
Extrusion	Pipes, Sheets, Thermoforming, Tubings, Blow Moulded Bottles Strappings
Tubular Quench Films (TQ Films)	Textile Overwraps, Garment Bags, Snack Food Packaging
Bi-axially Oriented PP Films (BOPP Films)	Lamination, Food Packaging, Adhesive Tapes, Synthetic Paper
Oriented Tapes	Woven Fabrics & Woven Sacks for Packaging, Sacks & FIBC for Outdoor Applications
Fibre Spinning	Staple Fibres, Carpets, Multifilament Yarn, Non-Woven Fabrics
PP - Random Copolymers	
Injection Moulding	Rigid Containers, Housewares, Syringes,
Blow Moulding	IV Fluid Bottles, High Clarity Bottles
Extrusion	Heat Seal Coating
PP - Impact Copolymers	
Injection Moulding	Furniture, Industrial Products, Automotive Parts, Luggage, Washing Machines Tubs, Batteries, Rigid Packaging, Appliances
Extrusion	Hollow Corrugated Sheets, Thermoforming

Applications of PP: The typical applications of PP resin are mentioned in the Table 2 below.

These PP applications have become inevitable part of our daily life style. While the products from all these licensors are well established in India to a large extent; the respective resin producers will have good competition among themselves to hard sell their products in emerging markets along with established existing players. The consistency in product quality and some uniqueness or differentiation or innovativeness in product range will be the key challenge for the new producers.

The healthy competition will compel the producers

to not only meet the highest product quality standards demanded by the market but also scout for speciality applications which they can serve.

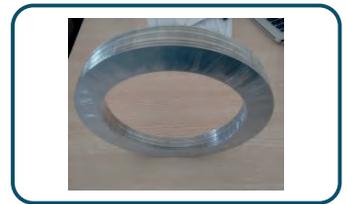
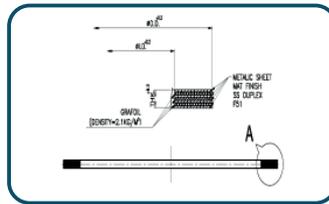
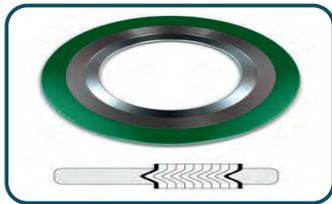
Novolen (Vertical Stirred Bed Gas Phase Polymerization) and W R Grace (Fluidized Bed Gas Phase Polymerization), will have their significant presence in India through these new plants.

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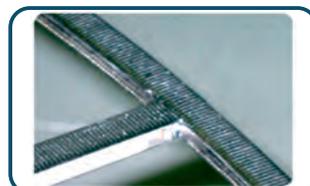
SOFT GASKETS

(Non Asbestos, PTFE Gaskets, Graphite, Rubber)



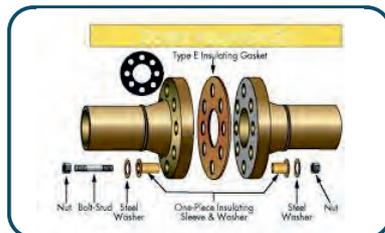
METALLIC GASKETS

(Serrated, Ring Joint, Kamprofile Gaskets)



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Raw Materials for Manufacturing PP

Typically any such polymer plant requires three types of input raw materials.

- The major raw materials by volume are of course supplied within the complex for example propylene, ethylene, hydrogen etc.
- The second category of input chemicals are of proprietary nature for example main polymerization catalysts which is supplied by the Licensors.
- Third category of input raw materials are chemicals which are called co-catalysts for example aluminium alkyls, electron donors to control product quality and polymer additives. These are high value speciality chemicals which are imported as well as purchased locally.

Polymer additives form approximately 1% of the main resin that is 4.6 MMTPA of PP will need 46,000 TPA of polymer additives. This offers a great opportunity to manufacture these chemicals locally to a large extent thus providing challenging opportunity to existing producers as well as new entrants. Indigenous production of such chemicals will also take the clarion call of "Atmanirbhar" further.

PP Downstream Industry

Higher production capacity is also expected to translate in to large number of new plastic processors or plastic converters who are first hand customers of PP resin producers.

Small to medium scale plastic processors form the bulk of the plastic industry in India. No doubt the existing processors will aim to enhance the capacity but nevertheless a large number of new plastic processing units are expected to come up or rather surge across India which will be a boost to the Indian economy. One can imagine that such plastic converters will be in excess of 10000 units across India.

Plastic Waste

With capacity doubling up, the problems arising out of plastic waste are also expected to rise. However, the problem is not because of plastic by itself but because of inadequate plastic recycle and disposal mechanism. Manufacture of Polypropylene is practically pollution free industry which is a great advantage. It is possible to think of installing incinerators on cooperative basis wherever possible for efficient disposal of plastic waste as is practised in the West. This can be alternate to plastic waste which cannot be recycled.

Conclusions

Polypropylene production is expected to double from current 4.8 MMTPA to 9.4 MMTPA in a matter of five years by 2025. This capacity surge will boost the consumption pattern of PP across the country by significantly penetrating the rural India. It will thus facilitate to boost the economy by investment, revenue generation and employment in addition to improvement in quality of everyday life. ■

Separator and Mass Transfer Internals for Oil & Gas Industry



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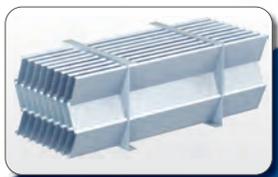
Multi-Cyclones



Structured Packing



Vane Inlet Device



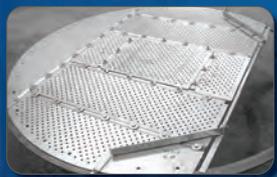
Vane Pack



Wiremesh Mist Eliminator



Chevron Type Mist Eliminator



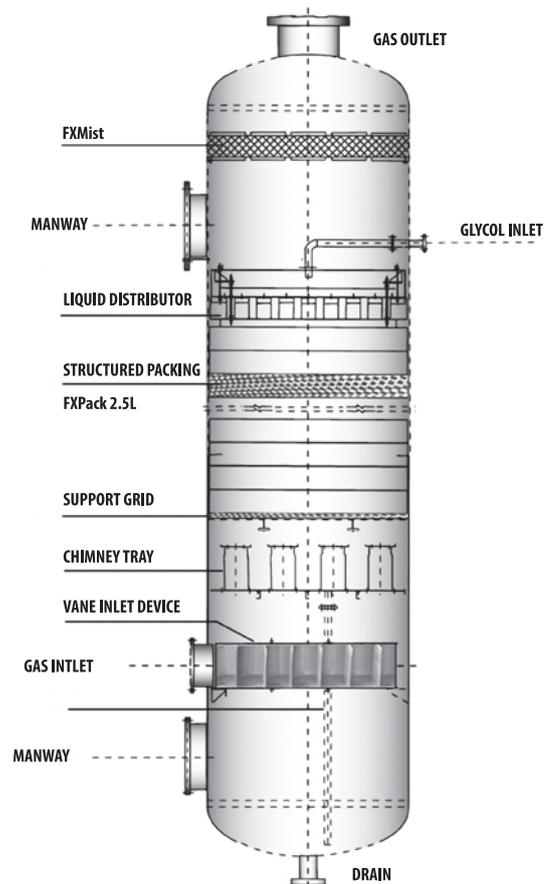
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ROD Baffle Heat Exchanger



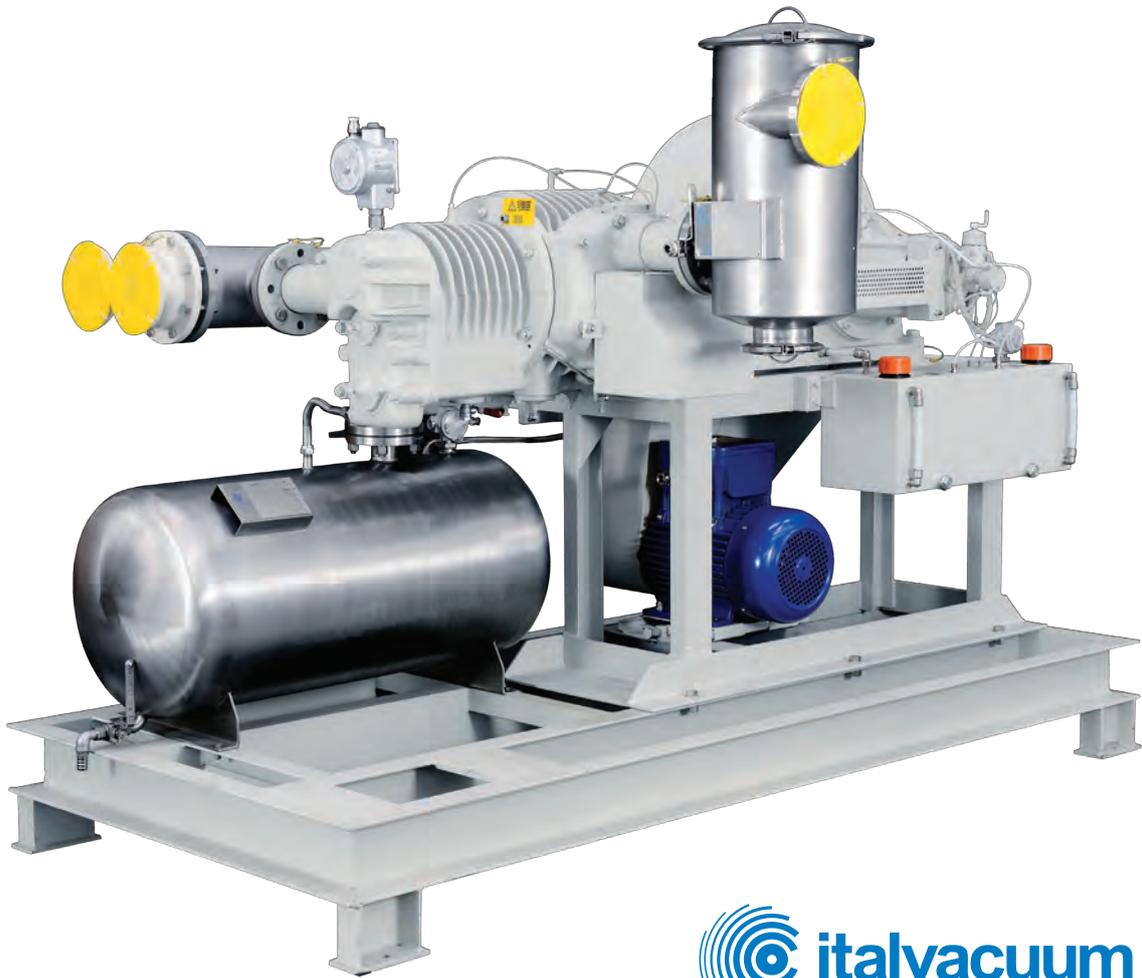
Fig. 1: ROD Baffle Heat Exchanger

ROD Baffle Heat Exchangers are Shell and Tube type Heat Exchangers utilizing rod baffles to support the tubes and secure them against vibrations. ROD Baffle Heat Exchanger design provides superior pressure drop performance on Shell side and operates without tube vibration failures. The term “baffle” refers to an annular ring in which the ends of a support rods are connected, hence the term “Rod Baffle”

Equipment Details	
Project	Mono Ethylene Glycol
Size	Dia 2.35 m X 16.6m Long
Tube Qty	8233 Nos
Tube Size	15.875 mm OD X 1.65 mm Thk X 13500 mm Lg
MOC	SS 304
Weight	140 MT

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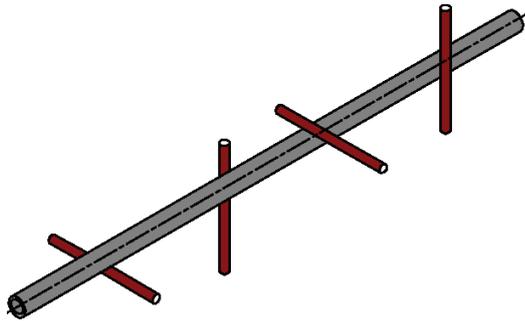


Fig. 2: Four Point Tube Containment

application will be a Rod Baffle Heat Exchanger. Rod Baffle Exchanger can reduce Pressure drop by 50% than a traditional Plate Baffle Exchanger.

The four-point tube containment (as shown in Figure-2) and minimum contact between rods and tubes virtually eliminate tube vibration failures. With the more stringent pressure loss criteria, higher heat-transfer rates could be achieved with the ROD baffle design.



Fig. 3: Tube & Rod Assembly

Tube & Rod Assembly

A ROD Baffle tube bundle is surrounded by Shell and the Tubes in the tube bundle are supported by rod baffle assemblies. One set of baffle contains 4 baffle rings out of which 2 rings will be with horizontal rod configuration and 2 rings will be with vertical rod configuration placed alternatively. Total set of baffles required will be based on Tube Length. Number of rods in baffle ring is based on tube count and pitch. Precise care has to be taken for welding of rods to baffle ring & the overall bundle assembly as mismatch in dimension will not allow tube insertion.

Since this type of Exchanger are used in Gas – Gas applications, Tube bundle at Inlet/Outlet is prone to vibrations and to avoid such vibrations, Vapor belts at inlet and outlet of Shell side Nozzles are provided as shown in Figure-1.

Rod baffle Exchangers can be used in Fixed Tube-sheet Configuration and U-Tube configuration. Precision Equipments has a specialized experience in Design and Fabrication of Rod Baffle Heat exchangers with Fixed Tube-Sheet as well as U-Tube configurations. ■

For more information

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Sriperumbudur - 602 105, Chennai, India.
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Expediting Commercialization, Enhancing implementation of In-house Technologies



IndianOil R&D has spearheaded investments for development and commercialization of Petrochemical catalysts, processes and products. Best of brains with global experience in the best universities have been enrolled for value creation. State of the art infrastructure has been created along with the conducive environment as enablers for the scientists to think and create.

*In an exclusive interaction with **Chemical Engineering World**, **Dr. SSV Ramakumar, Director (R&D) IndianOil** says, "With upcoming scale-up facilities and pilot plants at new R&D Centre, research in Petrochemicals will gain further impetus."*

Dr. SSV Ramakumar
Director (R&D) IndianOil

Walk us through the expansion plan of next generation technology center announced by IndianOil for an investment of Rs. 2282 crores. Tell us in detail about the intended new areas of research in the facility.

R&D-II Campus is being set up at Sector 67 Faridabad which will be known as Indian Oil Technology Development & Deployment Centre (IOTDDC). A major constituent of the new facility will be four Centres of Excellence in the areas of Alternative & Renewable Energy (i-CARE), Nanotechnology (CEN), Corrosion Research (CRC) & Synthetic Biology (CSB). Under this Centre, various research activities in the above and associated fields will be undertaken. Demonstration projects related to Alternative & Renewable energy such as gasification, hydrogen production, storage & transportation, different types of Fuel cell, solar energy, 2nd generation bio fuels etc. will also be undertaken. This centre is designed to be a Energy Neutral Campus where all the process loads will be catered by electricity generated through PV solar with design of 9 MW solar power; re-assuring our commitment to PARIS climate change agreement toward reduction of CO2 emission. An elaborate rationalization exercise had been carried out with a view to achieve integration of all research facilities in Campus-I and Campus-II.

What are the key focus areas for the research that would be of highest

relevance for the petrochemicals industry? How is the organization aligning the resources, technologies & infrastructure to gear up for the future?

The key focus areas for research in downstream petrochemicals are namely Ziegler-Natta Catalysts, Specialty Products, Niche Grades, Additives and Petrochemical Processes & Catalysis. IndianOil R&D has been able to create extensive IP in the space of highly crowded ZN Catalysts. The catalysts suitable for producing polypropylene and polyethylene, evaluated at length including 3rd parties, are under commercialization.

We have designed the catalyst and process for producing Ultra High Molecular Weight poly-alpha-olefins for application as Drag Reducing Agent for pipeline transportation of hydrocarbons. These are highly specialized linear polymers with >20 million molecular weight. Unique patented catalyst systems have been developed for the oligomerization of olefins to specialty chemicals / products. R&D has been able to comprehend the complete portfolio of olefin catalysis right from oligomerization to ultra high molecular weight products.

R&D has contributed significantly in the development of niche PP and PE grades, expanding the existing grade slate with targeted import substitution. Recent developments include Polyisoprene with

specialized applications. Graduating beyond olefins, research on acrylate based chemistry has been translated to design Pour Point Depressants (PPD).

Being part of an environmentally conscious organization, R&D is focusing on development of Bioplastics, Biodegradable & Compostable Polymers. Mechanical recycling is one of the focus area where-in upcycling of waste is being targeted. Launch of waste plastic based commercial solution for Bitumen packing is one such highlight. The waste plastics which have reached end of life will be processed through indigenous pyrolysis technology. Focus on chemical recycling has resulted in unique catalyst and process solution for providing styrene from the polystyrene waste. These products will help in reduction of carbon footprint of IndianOil.

IndianOil R&D has spearheaded investments for development and commercialization of Petrochemical catalysts, processes and products. Best of brains with global experience in the best universities have been enrolled for value creation. State of the art infrastructure has been created along with the conducive environment as enablers for the scientists to think and create. With upcoming scale-up facilities and pilot plants at new R&D Centre, research in Petrochemicals will gain further impetus.

Which were the biggest challenge areas that could be handled well after implementation of company's own patented technologies?

For expediting the commercialization as well enhancing the implementation of IndianOil's technologies, a dedicated group has been set up. The group has developed the required capabilities for preparation of Basic Design & Engineering Package (BDEP) and providing the services as necessary for single point licensing of technologies in line with industry practice. Already, it has prepared several BDEPs on in-house developed technologies for setting up commercial scale units. This has been a significant milestone in recent times, which has enabled implementation of in-house developed technologies at faster pace with improved customer's satisfaction.

Most of our technologies address specific challenges being faced in the industry. Some of such cases are:

- **Upgradation of bottom of the barrel to lighter products** is the need of the hour to sustain the refinery operation owing to reduction in fuel oil demand FO due to its replenishment by natural gas. On the other hand, production of petrochemicals in refineries is important not only for improving the margin but also to address the future uncertainty wrt demand of liquid

transportation fuels. Our flagship INDMAX Technology addresses both these issues synergistically. This essentially makes INDMAX a highly attractive technological option in both current and emerging scenarios.

- **Delayed Coking technology** is in extensive use in many refineries for upgradation of heavy residue. However, production of low value fuel grade coke in considerable yield makes this technology option uneconomical. Addressing this aspect, revamp of existing coker unit at Barauni Refinery has been implemented in 2017, wherein significant benefits in terms of reduction of coke as well as energy consumption have been realized. Based on this, other projects are lined up aiming at deriving similar benefits.
- **The in-house developed indeDiesel® technology** played an important role in achieving the target of production of BS-VI quality diesel from April, 2020 onward. indeDiesel® technology was implemented in three refineries of IndianOil located at Vadodara, Bongaigaon and Haldia. Further, in order to reduce the dependency on imported catalyst for running DHDT/DHDS units, IndianOil has come out with state-of-the-art catalyst know-how. Recently, the performance of the in-house developed catalyst has been

successfully demonstrated in DHDT unit at Digboi Refinery for BS-VI diesel production. Based on this, we are now planning its use in a larger unit of 2.7 MMTPA capacity. It is important to note that the upcoming Catalyst Manufacturing facility of IndianOil will reduce dependency of imported catalyst significantly, a significant step towards 'Atmanirbhar Bharat'

- **Meeting BS-VI specification** for Gasoline has become complex owing to specific limits on several parameters such as Octane, RVP, aromatic content, etc. As a result, it requires streams from several units in definite proportion to achieve the specifications of the final product pool. Any problem in any of the associated units will have impact on gasoline production. Keeping this scenario in mind, IndianOil has come out with another relevant technology named as Octamax®, which produces gasoline component of very high RON, but with low RVP and aromatic content from C4 stream of catalytic / thermal cracker units. Already, the technology has been commercialized at Mathura Refinery and additional units are at different stages of implementation.

Which of these technologies are already in use in other company facilities and are likely to be implemented in Paradip Project?

The details of technologies which are commercialized & being implemented in various IndianOil refineries are given below:

- Technologies such as INDMAX, indeDiesel®, indeHex® have multiple commercial reference and many additional units are under various stages of implementation.
- INDADept, Zeosom® and Delayed Coker have one commercial unit each in operation
- Technologies such as indSelectG, indDSN®, indDSK® and indJet each has one commercial unit in various stages of implementation.
- Ind-CokerAT and AmyleMax® technology have been successfully demonstrated in commercial scale.

Technologies which are likely to be implemented in Paradip Refinery are:

- indDSK® unit employing in-house developed catalyst is being set up at Paradip Refinery for production of ultra-clean Pipeline Compatible Kerosene (PCK). The unit is scheduled to be commissioned in 2021-22.
- Feasibility of setting up facility at Paradip Refinery based on in-house developed technology for production of Needle coke has been completed. Needle coke is a premium quality coke used for manufacturing graphite

electrode for steel industry. Following Stage-I approval of the project, preparation of BDEP by R&D Centre is in progress.

- Another promising technology named as 'indLPet' is under active consideration for further expansion of the refinery. Like INDMAX, this technology produces petrochemical feedstocks bringing much needed flexibility in refinery operation in days to come.

Are these technologies available commercially as well & if these have been bought by other refiners already?

All the technologies as indicated in the previous reply are available commercially for licensing. IndianOil can act as single point licensor on its own or through its selected partner. The technologies which have been adopted by other refineries (non-IndianOil) include:

- INDMAX by overseas refinery, NIS, Serbia and CPCL
- indeHex®, a technology for production of food grade hexane, is installed at Bhatinda Refinery of HMEL
- Octamax by CPCL for its upcoming CBR project.

Tell us about some of the latest innovations that are available commercially (please share 4-5 line about each of these technologies which

can be developed as a separate article to highlight these technologies to the industry as a part of the profile)

- **LPG Hydrotreating Technology**

In order to meet the upcoming specifications of LPG, a customized hydrotreating technology has been developed employing proprietary catalyst and tailor-made process conditions. Unlike competing technologies, this converts mercaptans present in the feed to hydrogen sulphide and achieves very low sulfur in the product. For commercialization of the technology, setting up of 152 kTA unit has been planned for which BDEP has been prepared in-house. Feasibility of second unit in another refinery is in progress.

- **Gasoline Production Technologies**

a) **Octamax®**: Octamax is a commercially proven technology for production of high-octane gasoline blending stock from C4 streams. The technology has been demonstrated by setting up a grass root unit at Mathura Refinery. Since the blending RON of the Octamax product is very high, even higher than conventional alkylate, it provides great flexibility to the refiners, especially in BS-VI scenario.

b) **AmyleMax®**: It is a catalytic etherification technology developed by IndianOil R&D for producing high octane mixed ethers streams from C5-90°C Cut of FCC gasoline /Naphtha Cracker streams. As RON of AmyleMax product is high, it provides flexibility to refiners for increasing gasoline volume and / or production of premium gasoline of higher octane. Already the technology has been demonstrated in commercial scale at Gujarat Refinery.

c) **indSelectG** : FCC & Coker gasoline streams are major components of gasoline pool in a refinery. Since these streams contain higher sulfur, there is a need for reducing the sulfur by minimizing the impact on the RON loss. indSelectG technology achieves these objectives using proprietary catalyst and optimized process scheme. The technology is under implementation stage for deep desulfurization of light cut of gasoline for INDMAX unit at Guwahati Refinery.

- **indJet® Technology**

Envisaging significant growth in ATF demand, indJet® technology has been developed for production of ATF of emerging specifications. It is a low

severity hydrotreating technology for selective removal of mercaptan sulfur while minimizing the removal of other sulfur compounds. indJet® unit is currently under implementation at Barauni Refinery and the grass root scheduled to be commissioned in 2021-22.

▪ **indeDiesel® Technology**

Introduction of ultra-low-sulfur diesel (ULSD) necessitated quantum improvement in performance of Diesel Hydrotreating technology. indeDiesel® is a commercially proven technology for meeting BS-VI Diesel specifications. The technology offers the flexibility to upgrade middle range straight run distillates, coker gas oil and light cycle oil from Catalytic Cracking units to ultra-low sulphur, high cetane diesel meeting ULSD specification. Five number of projects have already been successfully implemented employing indeDiesel® technology and sixth grass root unit is planned to be commissioned in 2023.

▪ **indLPet Technology**

indLPet technology is a hydrocracking based technology employing proprietary catalyst for conversion of low value cracked diesel range streams like Light Cycle Oil (LCO) and Coker Gas Oil (CGO) to high value petrochemical feedstocks. The technology is being commercialized

through revamp of existing DHDS unit of one of the refineries. Further, as indicated above, it is under active consideration for a grass root unit for further expansion of IndianOil's latest refinery at Paradip.

▪ **Bottom Up-gradation technologies**

a) Delayed Coking

The ability of this technology to convert heaviest residue stream provides much needed flexibility to the refiners. The technology was used to revamp a 600 kTA Delayed coking unit at Barauni Refinery significantly reducing the coke yield along with energy saving. Another unit is now being revamped employing this technology aiming at achieving similar benefits.

b) indCokerAT

Delayed Coking technology has gained importance for bottom of the barrel upgradation, however, high yield of low-grade coke impacts the unit margin. To address this, IndianOil R&D has developed Ind-CokerAT technology for residue upgradation with lower coke make and corresponding improvement in distillate yield in comparison to a conventional Delayed Coker technology. Apart from improving the unit

margin, ease of integration in existing Delayed Coker unit makes adoption of the technology attractive. It has already been demonstrated in commercial scale unit in batch mode of operation in existing facility of a refinery and efforts are underway for setting up commercial unit.

▪ **Naphtha Up-gradation technologies**

a) INDALIN: INDALIN has capability to convert low value olefinic naphtha streams to LPG / light olefins and BTX enabling refineries to improve profitability. The technology has wide range of operability to maximize either light olefins or BTX depending on refiner's objective. In the scenario of declining gasoline demand, this technology can offer flexibility for sustaining refinery profitability through production of value-added petrochemical feedstocks.

b) INDLIN-Plus: This is a variant of INDALIN technology wherein through improvising the process scheme and conditions following benefits are achieved.

- a. Production of high yield of saturated LPG meeting specification of auto grade fuel
- b. Expanding feed flexibility to include naphtha range

feedstocks up to FPB of 400°C from any source including natural gas condensate.

The process also produces high octane gasoline containing higher quantity of aromatics such as toluene, xylene with simultaneous reduction in olefins and sulfur in liquid product. The technology can be directly integrated with aromatics complex for production of petrochemicals.

How can digitalization be a game changer to accelerate research and reduce the time to bring innovations to the market?

Digitalisation will cut down the product/process technology developmental cycle by providing remote & instantaneous access to the test data as well as the pilot/ demo plant data. In this era of fast emerging technologies where R&D plays a leading role in establishing the products / processes, the advent of new digital transformation techniques and analytical tools, will hasten the decision making through data driven process. Using simulation & modelling techniques, the iterations for arriving at the final product design can be significantly reduced. Further, cloud computing will be facilitating the seamless integration, centralized dashboarding of research work thereby providing a platform for managing research at micro level. In addition, IndianOil R&D views digitalisation as a way of serving customers with remote proactive diagnostics of critical facilities

Commercialization status of IndianOil Technologies

Technology	Description	Commercial Reference	Status
Zeosom [®]	Light naphtha octane boosting	1 unit at Bongaigaon Refinery	Operational
indDSN [®]	Process for desulfurization of naphtha	1 unit at Bongaigaon Refinery	Under implementation
indSelect ^G	Hydrodesulfurization with minimum octane loss	1 unit at Guwahati Refinery	Under implementation
AmyleMax [®]	Enhancement of Octane through etherification	Demonstrated at Commercial Scale	Demonstrated at Commercial Scale
INDAdept ^G	Sulfur removal from gasoline	1 unit at Guwahati Refinery	Operational
Octamax [®]	Conversion of C4 to high octane gasoline blending stock	1 unit at MR 1 unit in CBR, CPCL 1 unit at JR	Operational Under implementation Under implementation
indJet	Hydrotreating process for ATF	1 unit at Barauni	Under implementation
indDSK [®]	Process for desulfurization of kerosene	1 unit at Paradip	Under implementation
indeDiesel [®]	Ultra low sulfur DHDS/DHDT process	2 units at Bongaigon 2 units at Gujarat Refinery 1 unit at Haldia Refinery 1 unit at Barauni Refinery	Operational Operational Operational Under implementation
INDMAX	Residue up gradation by cracking to light olefins	1 unit each at PDR, GR 1 unit each BGR, JR, BR, PR 1 unit at NIS, Serbia	Operational Under implementation Under implementation
Delayed Coker	Residue upgradation	1 unit at Barauni Refinery	Operational
Ind-Coker ^{AT}	Residue upgradation with lower coke make & superior distillate yields	Demonstrated at Commercial Scale	Demonstrated at Commercial Scale
indeHex [®]	Production of polymer and food grade hexane	1 unit at Gujarat Refinery 1 unit at Bhatinda Refinery of HMEL	Operational Operational

when implemented at customer facilities on pan India basis.

How is IndianOil R&D leveraging digitalization across all the functions?

IndianOil R&D is engaged in Research which encompasses Refining Technology, Alternate Energy, Lube Technologies, Automotive Research, Petrochemical, Nano Technologies, and Pipeline Research etc. We at R&D are vying to leverage digitalisation for monitoring performance efficiency of its own products & process technologies on a continuous basis. Digitalisation in the development life cycle has enabled R&D to come up with products / process technologies in shortest time. We track the development life cycle on real time basis using recipe customization tool, sample management application, automated test equipment, parametric analysis of test results, gathering field trial data using Industrial Internet of Things (IIoT) and process/ product optimisation.

This remote monitoring of performance of R&D developed products/ process technologies enables us to provide the vital technical support to our sister divisions / customers as well as paves way for the continuous betterment of our products/ processes. Such remote monitoring solution have been implemented through IIoT enablement of demonstration / commercial plants that have come up based on R&D's indigenous

technologies. The recently commissioned HCNG plants at Rajghat, Biomethanation plants at Namakkal, Faridabad etc., are a few examples of such initiatives. Similar IIoT based scheme is on the anvil for interlinking and monitoring the long-term test facilities of R&D such as Engine Test beds, Refinery Pilot plants, Tribological test rigs etc. which operate round the clock. This initiative is aimed at remote monitoring of tests, data capture, retrieval, and data analytics on cloud platform.

Implementation of Artificial Intelligence & Machine Learning concepts in the Inhouse development of Instrumented Pipeline Inspection gauges and the automation of its data analysis is another example of IndianOil R&D leveraging Digital tools. R&D is also working on improving its operational efficiency through networking of laboratories and facilities within the campus as well as with that of other Quality control laboratories of sister divisions. The concept of data capture through E-Lab Notebook (ELN) is under implementation. ■

Research & Development Centre, IndianOil



Video link: <https://youtu.be/sfPC8QpQW6A>



IGBC Platinum rated R&D Campus

IndianOil is India's flagship Maharatna national oil company with business interests straddling the entire hydrocarbon value chain - from refining, pipeline transportation &

marketing, to exploration & production of crude oil & gas, petrochemicals, gas marketing, alternative energy sources and globalisation of downstream operations. It also has global aspirations, fulfilled to an extent by the



indeDiesel plant at Bongaigaon Refinery

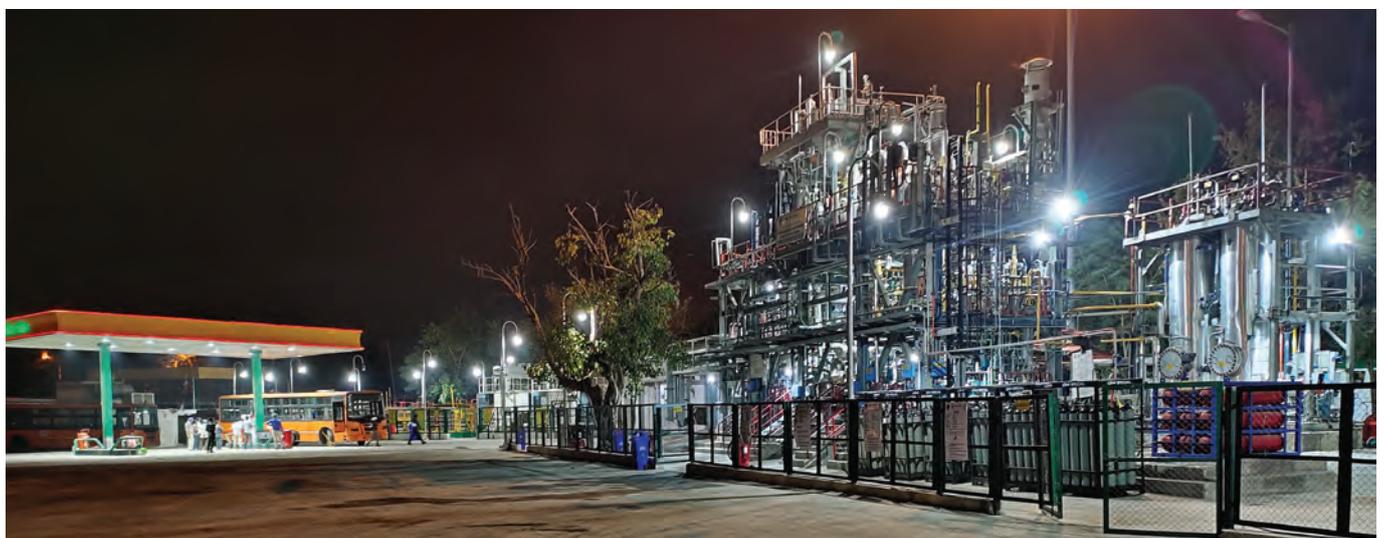
formation of subsidiaries in Sri Lanka, Mauritius, the UAE, Sweden, USA and The Netherlands. It is pursuing diverse business interests with the setting up of over 15 joint ventures with reputed business partners from India and abroad to explore global opportunities.

IndianOil's world class R&D Centre, one of Asia's finest in downstream petroleum R&D, is focused on

developing innovative, environment friendly and customer centric products and process technologies in the field of energy and allied areas. With core competence in lube, refinery process, catalyst and pipeline technology areas; it also now focusing on a whole gamut of sunrise areas & alternate energy domains like petrochemicals, Plastic neutrality, bio-fuels, Hydrogen, Fuel cells, and CCUS technologies.

The state-of-the-art R&D facilities are located on a sprawling 65 acre campus in Faridabad, Haryana on the outskirts of the National Capital. An impressive array of most advanced equipment is available to the researchers and scientists round-the-clock. Presently,

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HCNG plant at Rajghat , New Delhi



INDMAX at Paradip Refinery

cutting-edge research in nanotechnology, petrochemicals & polymers, coal gasification/liquefaction, and gas-to-liquid technologies. With four decades of pioneering work in lubricants formulation, refinery processes and pipeline transportation, the Centre

crossed the 1,000-patents milestone in 2019-20.

To further expand its footprint, IndianOil is planning to set up a net-zero power & water neutral research centre confirming to global level, consisting of high end research in alternative & renewable Energy (I-CARE), Corrosion research, nanotechnology and synthetic biology. The Centre is also nurturing an eco-system conducive for innovations in the domestic hydrocarbons sector through a Startup Fund. ■

the campus has also been awarded the most prestigious platinum rating by Indian Green Building Council (IGBC).

This prestigious award is indeed a great reflection of the commendable and continual effort towards achieving excellence.

The vibrant research undertaken in tribology is showcased by IndianOil's SERVO productline comprising more than 4,000 lubricant & grease formulations and 850 active grades to suit virtually every application. In addition, the Centre has also developed several refinery process technologies and catalysts specially suited to Indian conditions. The Centre's forte also includes alternative energy programmes in bio-energy, solar energy, Hydrogen energy, H-CNG blends, synthetic fuels and shale oil. It is also focussing on

For more information

Active patents: <https://iocl.com/AboutUs/Patent%20Database-For%20IOCL%20Web%20Site%20as%20on%2031.05.2020.pdf>

Website: https://iocl.com/AboutUs/Research_Development.aspx

Efficient Operation of Wet Scrubbing System in Pollution Containment

Working of wet scrubbers working depends on the type of gas contaminant i.e. solid, liquid & odour, collection mechanisms and scrubbing liquid used. For gaseous contaminants, mass transfer is the mechanism that absorbs the gas into a liquid through creation of liquid films or droplets. Large surface area packing media, trays, fluidized beds and hydraulic or shear atomization techniques are mostly used to create the films and droplets necessary for mass transfer to occur. A chemical reagent scrubbing liquid is incorporated in many cases to enhance removal of contaminants by producing a stable salt by-product. The predominant mechanism used for particulate collection is impaction between the particle contained in the gas stream and liquid droplets. The liquid droplet encapsulates the particle into a larger size so both can be removed from the cleaned gas stream either centrifugally or by means of mist eliminator. The smaller the size of the particle the smaller the size of the droplet needed to collect the particle. Normally, a droplet no larger than 10 times the size of the particle must be used. The smaller the droplet the more energy it takes to create it either hydraulically or through gas shear effects. For hot gases scrubbing system has perfected a method to condense water vapour onto the particle to achieve a larger size agglomerated mass to increase removal efficiency at reduced energy cost. Hydrophobic particles are also hard to scrub wherein it is perfected chemical additions to the scrubbing liquid to overcome the problem. There are various control devices for controlling particulate contaminants however article covers only on the wet scrubbing system in detail.



Efficient Operation of Wet Scrubbing System in Pollution Containment Control Process and Devices for Gaseous Pollutants

Control Process

- **Adsorption:** Passing a stream of effluent gas through a porous solid material (the adsorbent) contained in an adsorption pad. Types of adsorbents: Activated carbon, alumina, silica gel etc.
- **Absorption:** Involves bringing pollutant gas in contact with a liquid absorbent (solvent) so that one or more constituents of the pollutant gas are removed, treated or modified.
- **Types of absorbents:** Aqueous solutions of alkalis (Na^+ and NH_3) and alkaline earth (Ca and Mg)

Control Devices

- **Wet Collectors:** Wet collectors, or scrubbers, remove particulate matter from gas streams by incorporating the particles into liquid droplets directly on contact.
- **Electrostatic Precipitators:** Particulates moving through a region of high electrostatic potential tend to become charged and are then attracted to an oppositely charged

area where they can be collected

- **Fabric Filters:** The particulate laden gas stream passes through a woven fabric that filters out the particulate matter and allows the gas to pass through.

Wet Scrubber

A wet scrubber is an air pollution control device that removes Particulate Matter (PM) and acid gases from waste gas streams of stationary point sources. The pollutants are removed primarily through the impaction, diffusion, interception and/or absorption of the pollutant onto droplets of liquid. The liquid containing the pollutant is then collected for disposal. There are numerous types of wet scrubbers which remove both acid gas and PM. 2

Wet dust laden cum ammonia emissions sources and their related emission species from NP/NPK /urea plants in Fertilizer are:

- **Reactor:** ammonia, fluorides.
- **Ammoniator-granulator:** ammonia, fluorides, particulates.
- **Dryer:** ammonia, fluorides, particulates, combustion gases.
- **Cooler:** ammonia, fluorides, particulates.
- **Product sizing and material transfer:**

particulates.

- **Urea** : Prilling tower

Process Capture Mechanisms

Particulates contact liquid droplets in wet scrubbers through several mechanisms. Impaction is the primary capture mechanism. When waste gas approaches a water droplet, it flows along streamlines around the droplet. Particles with sufficient inertial force maintain their forward trajectory and impact the droplet. Due to their mass, particles with diameters greater than 10 μm are generally collected using impaction. Turbulent flow enhances capture by impaction. Particles dominated by fluid drag forces follow the streamlines of the waste gas. However, particles that pass sufficiently close to a water droplet are captured by interception, due to the surface tension of the water droplet. Particles of roughly 1.0 to 0.1 μm in diameter are subjected to interception. Increasing density of droplets in a spray increases interception. Very small-sized particles are subjected to Brownian motion, irregular motion caused by random collisions with gas molecules. These particles are captured by the water droplet as they diffuse through the waste gas. Collection due to diffusion is most significant for particles less than 0.5 μm in diameter. Capture mechanisms that are used less frequently include condensation and electrostatics scrubbing.

In condensation scrubbing, a gas stream is saturated with water vapour and the particle is captured when the water condenses on the particle. In electrostatic scrubbing, contact is enhanced by placing an electrostatic charge on the particle, droplet, or both.

Control Devices for Particulate Contaminants

These can be divided into five major groups:

- Gravitational settling chambers
- Centrifugal collectors

- Cyclones
- Dynamic precipitators

iii. Wet Collectors

- Spray towers
- Cyclonic Spray Towers
- Dynamic Scrubbers
- Tray towers
- Venturi scrubbers
- Dynawave Wet gas scrubber

iv. Electrostatic precipitators

v. Fabric Filters

The article is focused on the wet collectors systems for particulate contaminants. Various features of different wet collector systems have been elaborated in subsequent paragraphs.

Wet Collectors

Spray Tower

The simplest type of scrubber is the spray tower. In a spray tower, particulate-laden air passes into a chamber where it contacts a liquid spray produced by spray nozzles. Towers can be placed in either vertical or horizontal waste gas flow paths. The liquid spray can be directed counter to, in the same direction or perpendicular to the gas flow. Figure: 1 shows an example of a vertical counter current spray chamber. The gas flow enters at the bottom of the tower and flows upward. Water sprays downward from nozzles mounted on the 2-6 walls of the tower or mounted on an array at the tower center. Water droplets capture particles suspended in the gas flow through impaction, interception and diffusion. Droplets large enough to settle by gravity

collect at the bottom of the chamber. Droplets that remain entrained in the gas stream are collected on a mist eliminator upstream of the nozzles.

Spray towers rely primarily on particle collection by impaction; therefore, they have high collection efficiencies for coarse PM. Typical removal efficiencies for a spray tower can be as great as 90% for particles larger than 5 μm . Removal efficiencies for particles from 3 to 5 μm in diameter range from 60 to 80%. Below 3 μm , removal efficiencies decline to less than 50%. Spray tower applications include control of PM emissions from grinding operations, pigment operations, and dust control in fertilizer plants. Spray towers can also be applied to control PM from asphalt plant aggregate dryers. Spray towers have lower capital costs than other wet scrubbers. Also, spray towers generally have lower power consumption and are not prone to fouling, so operating costs are also lower. Operating costs of spray towers increase for fine PM applications, because such systems require high liquid to gas ratios. Typical gas flow rates for spray towers are 1 to 47 standard m^3/s .

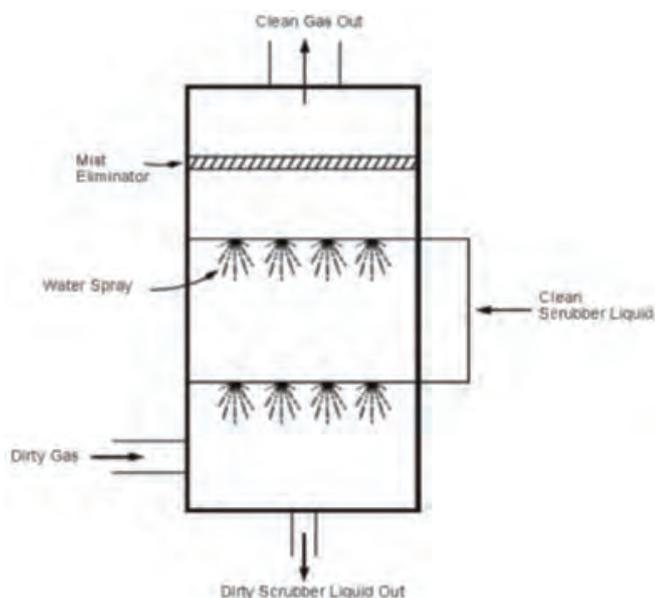


Fig 1. Spray Tower

Cyclonic Spray Tower

Cyclonic spray towers differ from spray tower designs in the manner waste gas stream flows through the chamber which is in a cyclonic motion. The cyclonic

motion is produced by positioning the gas inlet tangential to the wall of the scrubbing chamber or by placing turning vanes within the scrubbing chamber. The gas inlet is tapered so that the gas velocity increases as it enters the tower. The scrubbing liquid is sprayed from nozzles in a central pipe (tangential inlet) or from the top of the tower (turning vanes). Figure: 2 shows a diagram of a cyclonic spray tower with a tangential inlet. Liquid droplets entrained in the gas stream experience a centrifugal force resulting from the rotating motion of the gas stream, causing them to migrate toward to the tower walls. The droplets impact on the tower wall and fall to the bottom of the tower. Droplets that remain entrained in the waste gas can be removed with a mist eliminator. Cyclonic spray towers have greater collection efficiencies than simple spray towers due to the greater relative velocity between the droplets and the waste gas in a cyclonic tower. Collection efficiencies for this type of scrubber are as high as 95% for particles greater than $5\ \mu\text{m}$, and from 60% to 75% for submicron particles. Typical applications are for dust control in fertilizer plants are grinding operations. Gas flow rates range from 1 to $47\ \text{m}^3/\text{s}$ and power input for a cyclonic scrubber is generally 1 to 3.5 horsepower per $30\ \text{m}^3/\text{minute}$. Capital costs, operation and maintenance costs are slightly higher for cyclonic spray towers due to their more complex design.

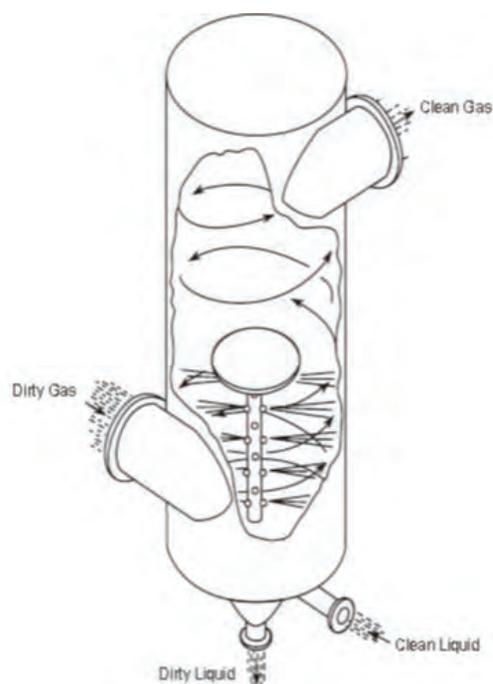


Fig: 2 Cyclonic Spray Scrubber

Dynamic Scrubber

Dynamic scrubbers Figure: 3 are also known as mechanically-aided scrubbers or disintegrator scrubbers. This type of scrubber is similar to spray towers, but with the addition of a power driven rotor that shears the scrubbing liquid into finely dispersed droplets. The rotor can be located inside the tower or outside the tower, connected by a duct. A mist eliminator or cyclonic separator removes the liquid and captured PM. Most dynamic scrubber systems humidify the waste gas upstream of the rotor to reduce evaporation and particle deposition in the rotary area.

Dynamic scrubbers efficiently remove fine PM, but the addition of a rotor to the scrubber system increases the maintenance

costs. Large PM abrades the rotors and the humid gas stream corrodes them. A pre-treatment device, such as a cyclone, often precedes a dynamic scrubber to remove large PM from the waste gas stream. Power consumption is also high for this type of scrubber, between 4 to 10 kilowatts (kW) per 1000 acfm. Dynamic scrubbers generally can treat gas flow rates between 1,000 and 50,000 scfm. Collection efficiencies for dynamic scrubbers are similar to those for cyclonic spray towers. Capital and O&M costs are moderately higher than costs for simple spray towers due to the rotor. 5

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Tray Towers

Tray tower scrubbers consist of a vertical tower with several perforated trays mounted horizontally in the tower Figure:



Fig: 3 Dynamic Scrubber

4. Gas enters the tower at the bottom and travels upward through openings in the trays, while the scrubbing liquid flows from the top and across each tray. The gas mixes with the liquid flowing over the tray, providing more gas-liquid contact than in spray tower designs. The gas velocity prevents liquid from flowing down through the perforations in the tray. The impingement plates are continuously washed clean of collected particles by the flowing liquid. Tray towers are designed to provide access to each tray for cleaning and maintenance. Large PM can clog the perforations, therefore, some designs place impingement baffles upstream of each perforation to remove large PM prior to the waste gas entering the opening [6]. This type of tray tower is referred to as an impingement-plate or impactor scrubber. Tray towers do not effectively remove submicron particles, however, collection efficiencies of 97% are possible for particles larger than 5 μm . Tray towers also effectively remove soluble gases. Therefore, they are useful when both particulate and gaseous pollutants are required to be removed. Typical applications include lime kilns, bagasse and bark boilers, and secondary metals industries. Gas flow rates for tray tower designs are generally between 1,000 to 75,000 scfm. Liquid to gas ratios are low compared to spray towers and ventury scrubbers because the scrubbing liquid



Fig: 4 Tray Tower

is essentially static. Capital and O&M costs of tray and impingement towers are moderately higher than simple spray towers.

Venturi Scrubber

A venturi scrubber has a “converging-diverging” flow channel. In this type of system the cross-sectional area of the channel decreases then increases along the length of the channel. Figure 5 presents a venturi scrubber. The narrowest area is referred to as the “throat”. In the converging section, the decrease in area causes the waste gas velocity and turbulence to increase. The scrubbing

liquid is injected into the scrubber slightly upstream of the throat or directly into the throat section. The scrubbing liquid is atomized by the turbulence in the throat, improving gas-liquid contact. The gas-liquid mixture then decelerates as it moves through the diverging section, causing additional particle-droplet impacts and agglomeration of the droplets. The liquid droplets are then separated from the gas stream in an entrainment section, usually consisting of a cyclonic separator and mist eliminator. Venturi scrubbers are more expensive than spray tower, cyclonic, or tray tower scrubbers; but collection efficiencies for fine PM are higher. High gas velocities and turbulence in the

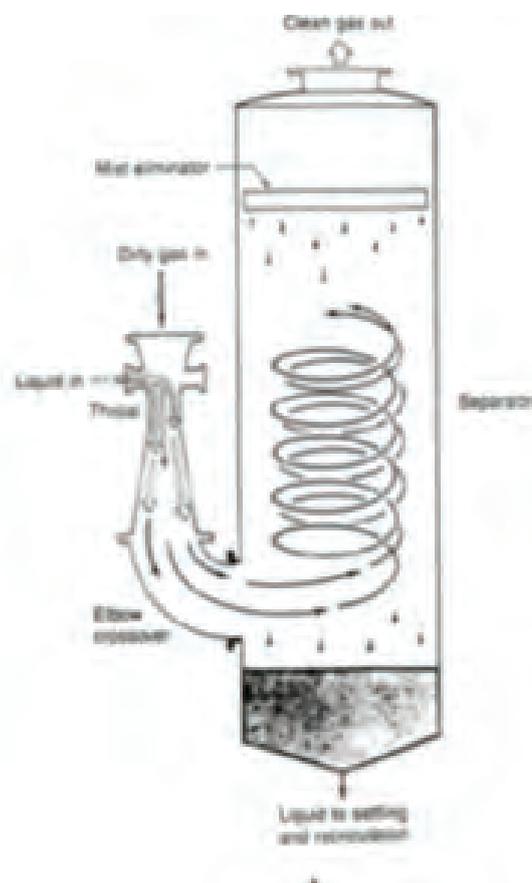


Fig: 5 Venturi Scrubber

ventury throat result in high collection efficiencies, ranging from 70% to 99% for particles larger than 1 μm in diameter and greater than 50% for submicron particles. Increasing the pressure drop in a ventury scrubber increases the efficiency, but the system's energy demand also increases leading to greater operational costs. Capital and O&M costs are moderately higher than costs for simple spray towers.

There are three basic types of ventury scrubbers. The primary difference between the configurations is the energy required for scrubbing the waste gas and moving it through the unit. In a conventional ventury, an external device, typically an induced draft (ID) fan, transfers energy to the liquid-gas stream. The fan can be located either upstream or downstream of the ventury unit. The basic ventury scrubber design is very efficient at removing PM₁₀ from both cost and performance perspective. In a "jet" or "educator" ventury, pressurized scrubbing liquid is injected into the throat. This type of ventury operates at low pressure drops, generally a few inches of water column. A jet ventury has lower collection efficiency for fine PM than a conventional ventury. A "high energy" ventury provides increased collection efficiency for fine and submicron PM. A high energy system utilizes a large ID fan to create a high gas side pressure drop, 75 cm of water

column or greater. This greatly increases the waste gas velocity prior to entering the throat and results in high collection efficiency. However, capital costs and electrical power requirements for high energy systems are much higher than a conventional ventury. Ventury systems can be installed on either horizontal or vertical waste gas flow paths. They can be purchased as packaged, skid mounted units or as field erected units. Materials of construction for system components include carbon steel, stainless steel, duplex alloys, FRP or lined steel. The waste gas properties determine which material is most appropriate for a given application. More than one type of material can be incorporated into a ventury system if necessary.

The basic system components of a ventury scrubber are:

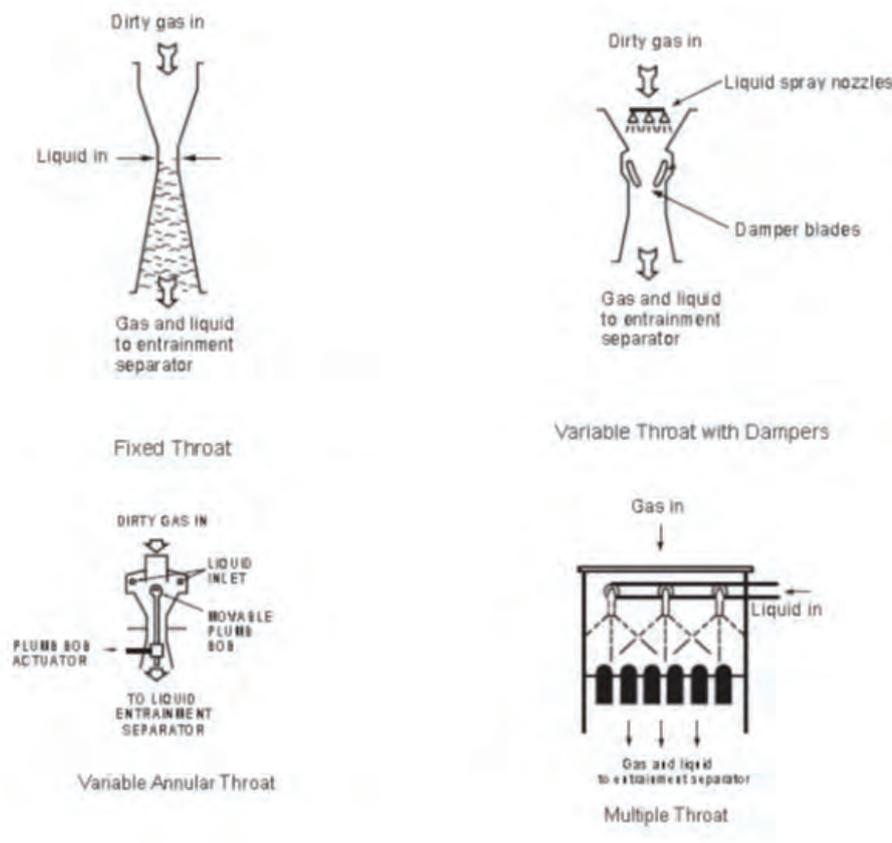
- Liquid storage system and delivery system;
- Liquid injection system;
- Ventury throat section;
- Collection chamber with a mist eliminator;
- Waste liquid collection system and disposal;
- Instrumentation and controls; and
- Auxiliary equipment.

The throat consists of the narrowest portion of the converging-diverging venturi section. This is where the velocity and

turbulence of the waste gas is greatest. In the throat, the waste gas shears the scrubbing liquid into a high density distribution of fine droplets. These droplets collect PM primarily through impaction. The waste gas and scrubbing liquid then pass into the diverging section where the velocity decreases, causing more impaction and liquid agglomeration. There are a number of different throat configurations Figure 6 that are commercially available, including fixed throat, variable throat, and variable annual throat, multiple throats and multiple stages. A fixed throat venturi is the simplest type of venturi. The throat section can be circular or rectangular, depending on the duct shape of the current waste gas system. Rectangular throats are generally limited to a width of approximately 10 inch due to mixing considerations. Circular fixed throats are typically used in high-pressure applications. A variable throat venturi changes the cross-sectional area of the throat through the use of an adjustable damper. There are many different damper designs including conical plugs, discs, and blades. The venturi throat area is increased or decreased by the dampers when the waste gas inlet conditions change. This allows the venturi to maintain the same throat velocity and, therefore, the same collection efficiency even with fluctuations in the waste gas flow conditions. A control system

can be incorporated into the variable throat device to automatically adjust to changes in the gas flow. Automatic throat adjustment is typically used where flow conditions vary widely and frequent adjustments are required. The complexity of a variable throat increases the capital and O&M costs of the venturi. A multiple throat venturi is a set of parallel venturis in one duct section. The throats are created by fixed length rods or flat plates located across the cross-section of the duct. The number of throats and width of the throats vary between designs. Most systems have throats on the order of 1 to 2 inches in width. The throats can be designed as fixed or variable. This type of design not only decreases the throat area but increases the wetted area of the venturi, resulting in higher collection efficiency. Multiple throat venturi systems work efficiently in low pressure applications.

A multiple stage venturi is simply a series of venturi scrubbers. This type of scrubber system can have two basic forms. The first type is a set of venturi throats in series which share a common collection chamber and liquid injection system. The throats are comprised of sets of vanes or baffles within a duct section. The second type of multiple stage venturi places a set of stand-alone venturi scrubber systems in series, each with its own collection chamber and liquid injection system.



liquid balances, the liquid reverses direction, and then falls to the base of the vessel.

5. The gas, on exiting the inlet barrel, turns and moves vertically upward through the tower. The gas encounters a set of chevrons that removes remaining liquid droplets.

6. After the chevron, the gas exits the tower.

System Performance

The parameters affecting the overall performance of a wet scrubber are:

- **Particle size distribution and loading**

The size distribution determines which

Fig: 6 Different throat configurations

DynaWave Wet Gas Scrubber

1. The key is the intimate mixing of the gas and scrubbing liquid in the Inlet Barrel.
2. Gas enters at the top of the vessel and travels down the inlet barrel.
3. Liquid is sprayed upward into the barrel, counter to the gas flow. The gas collides with the liquid to create a turbulent zone, the Froth Zone, where the gas/liquid interface is continuously and rapidly renewed.
4. When the momentum of the gas and

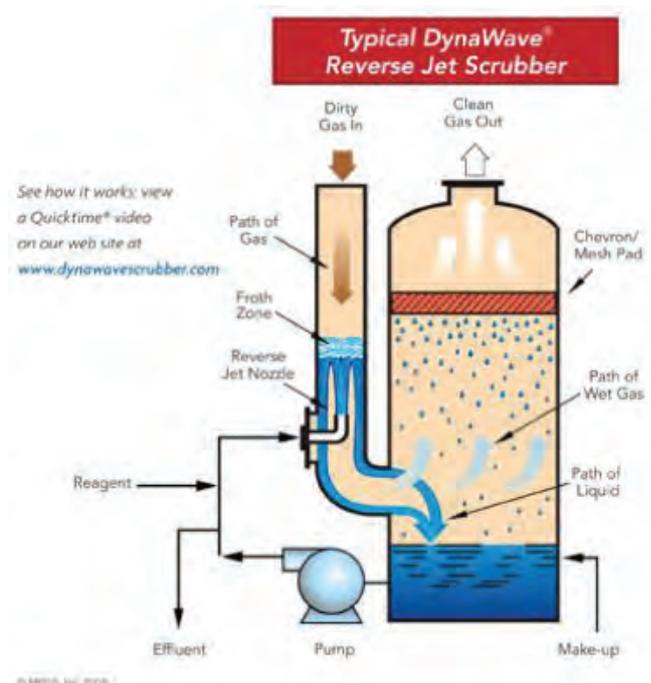


Fig: 7 DynaWave Reverse Jet scrubber

capture mechanism will dominate ie. impaction, interception or diffusion.

Most wet scrubber designs rely almost exclusively on inertial impaction for particulate collection. Particles smaller than $0.1 \mu\text{m}$ are captured primarily through diffusion mechanisms.

- **Waste gas flow rate, temperature and humidity**

The waste gas flow rate is the most important sizing parameter in a wet scrubber. The higher the waste gas flow rate, the larger the venturi system and volume of scrubbing liquid required to treat the waste gas. Wet scrubbers operate at lower gas flow rates than bag houses or ESPs because of the liquid injection.

- **Gas velocity and pressure drop**

Increasing the relative velocity between the gas and the liquid droplets increases the momentum of the particulate, allowing smaller particles to be collected by impaction. 10

- **Liquid-to-gas (L/G) ratio**

Higher L/G ratio increases collection efficiency since the density of droplets across a given cross-section of the venturi is higher.

- **Droplet size**

There is an optimum droplet size for maximizing collection of PM. Smaller droplets has a larger surface area to volume ratio; therefore they capture more particles per volume of liquid injected. However, if the droplet size becomes too small, the momentum of the waste gas can be imparted to the droplets which decrease the relative velocity between the droplet and particles. Lower relative velocity results in lower collection efficiency.

- **Residence time**

Increasing the length of the throat and diverging section, increases the contact time between the liquid and the PM suspended in the waste gas. For high energy systems, it is recommended that the length of the diverging section of the throat to be at least 4 times the width of the throat in order to have sufficient contact time.

Capture Mechanisms

The details of the capture mechanisms are given in **Figure 8** and discussed below:

- **Impaction is the primary capture mechanism.** When waste gas approaches a water droplet, it flows along streamlines around the droplet.

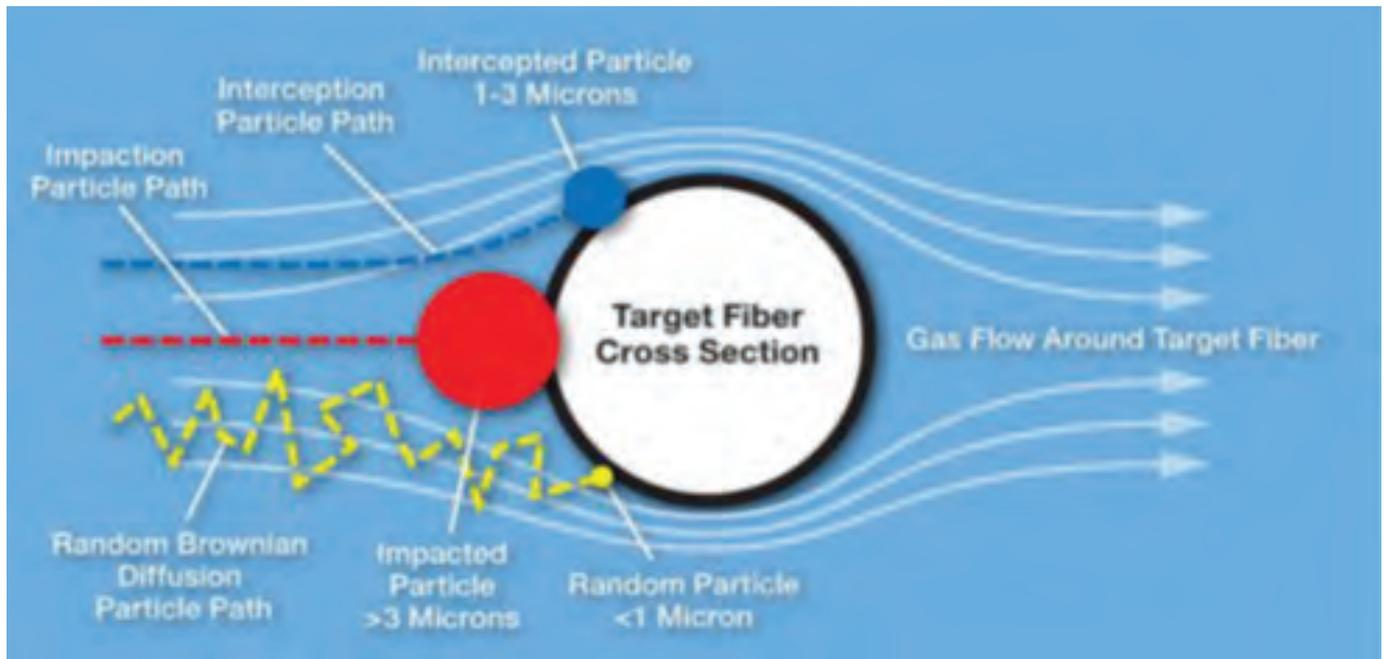


Figure:8 Capture Mechanism

Particles with sufficient inertial force maintain their forward trajectory and impact the droplet. Due to their mass, particles with diameters greater than $10\ \mu\text{m}$ are generally collected using impaction. Turbulent flow enhances capture by impaction.

- Particles dominated by fluid drag forces follow the streamlines of the waste gas. **However, particles that pass sufficiently close to a water droplet are captured by interception, capture due to the surface tension of the water droplet. Particles of roughly 1.0 to $0.1\ \mu\text{m}$ in diameter are subject to interception.** Increasing the density of droplets in a spray increases interception.

- **Very small-sized particles are subject to Brownian motion, irregular motion caused by random collisions with gas molecules.** These particles are captured by the water droplet as they diffuse through the waste gas.

Collection efficiencies

Collection efficiencies for wet scrubbers vary with the particle size distribution of the waste gas stream. In general, collection efficiency decreases as the PM size decreases. Collection efficiencies also vary with scrubber type. Collection efficiencies range from greater than 99% for ventury scrubbers to 40-60% (or lower) for simple spray towers. Improvements in wet scrubber designs have increased collection efficiencies in the sub-micron

range. Wet scrubber systems have some advantages over electrostatic precipitators (ESPs) and bag houses. Wet scrubbers are smaller and more compact than bag houses or ESPs. They have lower capital cost and comparable operation and maintenance (O&M) costs. Wet scrubbers are particularly useful in the removal of PM with the following characteristics:

- Sticky and/or hygroscopic materials (materials that readily absorb water);
- Combustible, corrosive and explosive materials;
- Particles which are difficult to remove in their dry form;
- PM in the presence of soluble gases; and
- PM in waste gas streams with high moisture content.

Wet scrubbers have numerous industrial applications including industrial boilers, incinerators, metals processing, chemical production, and asphalt production, and fertilizer production. The primary disadvantage of wet scrubbers is that increased collection efficiency comes at the cost of increased pressure drop across the control system. Another disadvantage is that they are limited to lower waste gas flow rates and temperatures than ESPs or bag houses. Current wet scrubber designs accommodate air flow rates over 47 actual cubic meters per second (m^3/s)

and temperatures of up to 400°C . Another disadvantage is that they generate waste in the form of a sludge which requires treatment and/or disposal. Lastly, downstream corrosion or plume visibility problems can result unless the added moisture is removed from the gas stream.

Conclusion

The design of wet scrubbers or any air pollution control device depends on the industrial process conditions and the nature of the air pollutants involved. Inlet gas characteristics and dust properties (if particles are present) are of primary importance. Scrubbers can be designed to collect particulate matter and/or gaseous pollutants. The versatility of wet scrubbers allow them to be built in numerous configurations, all designed to provide good contact between the liquid and polluted gas stream.

Wet scrubbers remove dust particles by capturing them in liquid droplets. The droplets are then collected, the liquid dissolving or absorbing the pollutant gases. Any droplets that are in the scrubber inlet gas must be separated from the outlet gas stream by means of another device referred to as a mist eliminator or entrainment separator (these terms are interchangeable). Also, the resultant scrubbing liquid must be treated prior to any ultimate discharge or being reused in the plant.

A wet scrubber's ability to collect small particles is often directly proportional to the power input into the scrubber. Low energy devices such as spray towers are used to collect particles larger than 5 micrometers. To obtain high efficiency removal of 1 micrometer (or less) particles generally requires high-energy devices such as venturi scrubbers or augmented devices such as condensation scrubbers. Additionally, a properly designed and operated entrainment separator or mist eliminator is important to achieve high removal efficiencies. The greater the number of liquid droplets that are not captured by the mist eliminator, the higher the potential emission levels.

Wet scrubbers that remove gaseous pollutants are referred to as absorbers. Good gas-to-liquid contact is essential to obtain high removal efficiencies in absorbers. Various wet-scrubber designs are used to remove gaseous pollutants, with the packed tower and the plate tower being the most common.

If the gas stream contains both particulate matter and gases, wet scrubbers are generally the only single air pollution control device that can remove both pollutants. Wet scrubbers can achieve high removal efficiencies for either particles or gases and, in some instances, can achieve high removal efficiency for both pollutants in the same system. However, in many cases, the best operating conditions for

particles collection are the poorest for gas removal.

In general, obtaining high simultaneous gas and particulate removal efficiencies requires that one of them be easily collected (i.e., that the gases are very soluble in the liquid or that the particles are large and readily captured), or by the use of a scrubbing reagent. ■

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Enabling Smarter Revenue Generation in the Petroleum Refining Industry



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Leading petroleum refineries are continuously pressured to achieve, sustain and reach the next level of performance. Andrew McCloskey, CTO/EVP R&D at AVEVA looks at how digitalized operations and processes can help to accelerate decision making and boost revenues

When we talk about downstream business processes, this commonly refers to the petroleum industry, and is associated with post-production activities. Leading petroleum refineries are continuously pressured to achieve, sustain and then reach the next level of performance.

In the ongoing quest for value creation, businesses are also seeing a new wave of technology-enabled productivity growth. This is acknowledged in McKinsey & Company's research on "Digitising the Value Chain," which states that 80% of operations agree that digitalization is a critical driver of competitiveness.

In monetary terms, “Digital transformation in the Oil and Gas industry could unlock approximately \$1.6 trillion of value for the industry, its customers and wider society. This total estimated value from digitalization can further increase to \$2.5 trillion if existing organizational/operational constraints are relaxed, and the impact of futuristic technologies, such as cognitive computing, is considered – digitalization has the potential to create around \$1 trillion of value for Oil and Gas firms.”¹

Digitalization is gaining momentum. It enables management to receive real-time operational information in an integrated manner and can help businesses break through to the next level of performance in the three key ways:

- **Unlock hidden or captive value:** Performance gains made by early adopters of Refining Operations Management show significant contribution to profitability goals and invested capital.
- **Close the digital operations gap:** Addressing the steps in an end-to-end refinery value chain as an integrated whole is driving the next productivity frontier in petroleum refining. Although it goes by different names (Digital, IoT, Industry 4.0) they all reflect a common theme of digitalization of business processes, with huge potential especially for areas like operations management.

- **Enable a step change in process:** Unlocking hidden value requires dealing with events closer to real time — in particular, the many minor performance deviations or “value leaks” that occur daily.

Unlocking hidden potential

To understand the performance improvement potential in quantitative terms, consider the benefits to a 400,000/bpd refinery from integrated refinery information management processes.

Revenue increase of at least 1% which is worth more than USD 67 Million per year per percent improvement, is achieved through improved availability and yield. Energy efficiency increase of at least 4%, which is worth more than USD 20 Million per year, which is achieved through proactive operations and closer coordination through the ‘internal value chain.’ Further cost reductions of at least 1% is worth more than USD 60 Million per year per percent improvement, which is achieved through logistics improvements within the ‘internal value chain.’

In qualitative terms, the deployment of Refining Operations Management achieves further improvements in the following ways:

1. **Enables planning with accuracy:** Refining Operations Management enables Planning and Scheduling processes to tightly couple with Supply Chain and Operations Management

and allows accurate planning based on accurate demand forecasts and real plant constraints.

2. **Allows the plant to operate optimally, reliably and safely while meeting targets:**

Applications like "Operator Logbook", "Operating Window," "Offsites Management" and others enable digitalized business processes and allow enhanced operator productivity, improved decision making, working within the operating envelope always to improve plant efficiency and asset lifecycle, providing a safer and a more reliable operation.

3. **Measures performance with accuracy:**

Tightly integrated quality management processes benchmarked against stringent quality standards; Well implemented Real-time database, Laboratory Information Management Systems (LIMS), Mass & Energy Balance, Production Accounting; Accurate plant models; Single version of truth achieved through the seamless flow of validated data across all applications via an integrated environment.

4. **Analyses performance with a collaborative analysis tool:** Accurate and robust progress measurement tool to ensure high level of integrity in reporting; Roll-up of individual KPIs to the corporate KPIs; Powerful Visualization and Event Management

tools; Seamless flow of validated data and designed version of truth.

5. **Continuously improves by agile decision making based on reliable data:** Well-designed business processes and workflow management leveraging state-of-the-art technology and industry standards.

Real-time data, real-time insights

As an early adopter of both enterprise and real-time control systems, the petroleum refining industry is well into the digitalization journey. Most operational applications were designed for reporting as opposed to real-time decision making. As a result, the strategy-to-execution linkage is weak, preventing real-time visibility and agility.

The current reality for operational users in refining is that users do not have time to coordinate closely or take advantage of available data; especially data that could provide appropriate insight into upcoming refinery behaviors.

The highly competitive nature of the refining industry has required higher levels of Operational Excellence. But with no relief in sight for margin pressure, there is a general recognition that sustaining the refining business under this "new normal" requires that we change the operational mindset. In other words, businesses need a step change in performance to be able

Real-time Performance Management in Practice

While technology is a critical enabler, successful transformation requires a holistic approach that includes the people- and process-related aspects. These are addressed by the four key pillars:

- 1. Align the Hierarchy of Metrics:** Real-time business measurement system necessary to underpin operations and business measurement incorporates both real-time KPIs and real-time accounting measures to provide a comprehensive view of the value of the operation. Closing the contextual gap means that operators and shift supervisors must be able to understand the real-time financial impact and strategic alignment of decisions and issues. Conversely, upper management needs a direct line of sight into the leading indicators and how they are performing in real-time at the execution level.
- 2. Develop Near-Real-Time Dashboards:** Once the KPI hierarchy has been decomposed through to the operator level (including the financial view), it is embedded in the dashboard to ensure that at every level there is a real-time view of execution in an integrated, strategic context, combining operational and financial KPIs for all stakeholders.
- 3. Empower the Edge:** For corrective action to be taken in a timely manner, those closest to the frontlines or the "edge of execution," must be empowered to act in a way that is consistent with the operational procedures defined. Every person in the operation may perform activities that add or reduce the business value produced by the operation.
- 4. Create a culture of accountability:** In a culture of accountability, people at every level of the organization are not only personally committed to achieving key results set by the organization, but also have to be proactive where they never wait to be asked for a progress report or a follow-up plan.

to survive for the long term and as a result, ensure smart revenue generation.

The key to managing performance in real time is that relevant information reaches the appropriate approval level quickly so

that the decision can be made while the opportunity still exists or before the issue becomes a problem. All too often, the decision cycle takes too long and/or the action fails to impact the KPIs that matter to the business.

What is needed is to compress the time within the decision loop while at the same time enabling informed decisions along the management hierarchy. This approach enables operations to deal with events closer to real time – in particular, the many minor performance deviations that occur daily. These minor deviations or “value leaks”, when undetected and left unchecked, slowly but surely erode profitability over time.

Companies evaluating an integrated, real-time operational system like Refining Operations Management are encouraged to consider the business decision in terms of enabling the right level of operational integration to gain the agility where the business can adapt to changing business conditions and exploit new opportunities. Digital initiatives, if well executed, can unleash enormous opportunities in value

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Context is Decisive : Digital Transformation and AI



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e are at a very interesting juncture of human transformation. The collective human

consciousness is being led into the dimension of Intelligence. We already are and will be creating Intelligence outside our brains. Intelligence that is integrated, narrow as of now but would evolve in decades to General Intelligence. With non-living elements becoming intelligent, the change in human life is unprecedented. The onus to lead it to our collective benefits lies with us.

Manufacturing, like other sectors of the industry is also witnessing and integrating with this change. We at Algo8 have been leading this change for Sectoral Giants in various Process Industries.

Be it Refinery, Power plants, Cements, Paints, Tyres, Chemicals, Fertilizers or Pharmaceuticals, the change is unprecedented.

In our short span of work in India and abroad we have been witnessing and still are witnessing a space of some really impactful Narrow AI adoption which has brought huge benefits for the Industries. I

have listed 5 elements of a Process and Manufacturing Plant which have immense impact to be unlocked using Data and AI. All Plant Leaders would want their plants to be smart plants based on this basis of:

- **Predictive Inbound Supply Chain and Predictive Logistics Control** : There is immense value in Digitalization and AI. Our experience in some areas that we think are immensely important and where we can validate our efficiency are Predictive Procurement, Inventory Management and Supplier/Vendor Management
- **Cognitive Quality, Yield and Efficiency Control** : Offers AI which can transcend traditional advanced process controls to optimize for global optima which are path breaking from the APC. We have had examples where a new paradigm shift has been created using ML on Historical data to predict quality in real time for processes-leading to effective grade changes, and also optimization of energy and predictive pre-emption of process failures around safety, availability. Techniques here rely on

IIoT and Non-Invasive CV Methods

- **AI Based Maintenance:** AI Based Maintenance is again a neo-predictive maintenance paradigm that shifts us from traditional concepts of rule driven thinking to integrative asset and assembly level intelligence. In some cases, we are utilizing Deep Learning to predict failure as much as 40 days before. These methods require very less incidents as data is making them suitable for single line equipment.
- **Computer Vision Methods:** Large Enterprises along with the Small and Medium Ones, all want to learn from the visual history of the plant and are using AI to learn from Thermal, RGB and Multi-Spectral Cameras. We are witnessing a massive transformation in Metals, Plastics and Bottling Industries wherever Visual Defects are to be minimized with unparalleled precision.
- **Conversational AI for Plants:** Presents a unique challenge of integrating search ability and metacognition for Process, Maintenance and Ops data bringing together data from multiple departments for organizing knowledge of all Process Plants so that knowledge is available on a single click.

Clearly, we are seeing something

unprecedented and it is just the start. So, what is the right way to initiate a transformation?

Create the Context for your transformation. Context Is Decisive in Leadership of your organization into Digital Technologies. Context will come from the Future and Not the Data. The Data will give you the power to predict. But what you want to predict is from the Created Future and Vision. We collaborated with IITs to build a course for Leaders to build a perspective and foresight on the usage of this. In the past we have initiated 7 Fortune 500 companies and 20+ Industries into this journey, hand holding them at every juncture, and translating their Vision into Mission and Final Tangible Business Outcomes.

With the vision of the Indian Government to promote India as a Manufacturing hub, it is imperative that we undergo this transformation to unlock immense benefits for the Indian Manufacturing Industry. ■

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Re-defined Need & Solution for Sulphur Removal from Refinery Off-gases

Off-gases released from various industries contain significant amount of sulfur compounds, which pose as critical environmental hazard. The off-gases released from the Hot well of VDU are known as hot well off gases. This gas has utility as fuel gas due to high calorific value. This article gives an overview on method used to reduce sulfur content in off gases so that it is not detrimental to environment and can be utilized as fuel gas.

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In the refining process, the Crude/Atmospheric distillation unit (CDU) separates the lighter hydrocarbons from the heavier oils based on boiling point difference. The CDU is capable of boiling crude oil fractions to temperatures of 400°C. Above this temperature, the oil will thermally crack, or break apart, which inhibits the distillation process. As lighter products are boiled off, the heavier oils, called Bottoms, remain at the bottom of the CDU. To increase the production of high-value petroleum products, these Bottoms are passed through a Vacuum Distillation column (VDU) to further refine them.

As the name vacuum distillation implies, the distillation column is under a vacuum, or is having significantly less pressure than atmospheric pressure. At low pressures,

the boiling point of the CDU bottoms is low enough that lighter products can vaporize without cracking, or degrading, the residual oil.

Vacuum distillation is an indispensable part of the refining process that helps convert heavier oils received from the Atmospheric Distillation Unit (Crude Distillation Unit) into Heavy, Medium, Light Gas Oils with Vacuum Residue which are further processed in different units of Refinery to obtain different Petroleum based products

The vacuum condition in the Vacuum Distillation unit is produced by steam ejectors taking suction from the top of the tower. These ejectors remove inert and other vapour that may exist and pull a vacuum of about 5 mm HG absolute. The uncondensed vapour from the ejectors is vented out through a flare stack. The

condensate from these ejectors are collected in a drum, known as a Hot Well.

The off-gases released from various industries contain significant amount of sulfur compounds, which poses as a critical environmental hazard. The off-gases released from the Hot well of VDU are known as hot well off gases. This gas has utility as fuel gas due to high calorific value.

Principal gas phase impurities are:

Hydrogen sulfide (H₂S), Carbon di-oxide (CO₂), Water vapor (H₂O), Sulfur di-oxide (SO₂), Nitrogen oxides (NO_x), VOC- Volatile Chlorine Compounds (HCl, Cl₂ etc), Volatile fluorine compounds (HF, SiF₄ etc.), Basic Nitrogen Compounds, Carbon Mono-oxide (CO), Carbonyl Sulphide, Carbon di-sulphide (CS₂), Organic sulphur compounds, Hydrogen cyanide, etc

H₂S in refinery recycle and off-gasses is removed from the process by absorption in Amine Absorbers. The rich amine loaded with H₂S is regenerated in the Amine Regeneration Unit by stripping off the acid gas.

In general, gas purification involves the removal of vapour-phase impurities from gas streams. The processes which have been developed to accomplish gas

purification vary from simple once-through wash operations to complex multiple-step recycle systems.

The primary operation of gas purification processes generally falls into one of the following five categories:

- Absorption into a liquid: It is transfer of a component of a gas phase to a liquid phase in which it is soluble.
- Adsorption on a solid: It is the selective concentration of one or more components of a gas at the surface of a microporous solid.
- Permeation through a membrane: In this process, polymeric membranes separate gases by selective permeation of one or more gaseous components from one side of a membrane barrier to the other side.
- Chemical conversion to another compound: It involves the reaction of gaseous with liquids and with solid particles suspended in liquids.
- Condensation: The process consists of cooling the gas stream to a temperature at which the Organic compound has a suitably low vapour pressure and collecting the condensate.

There are many treating processes available. The initial selection of a particular process may be based on feed parameters such as composition,

pressure, temperature, and the nature of the impurities, as well as product specifications. Hot well Off Gas (HWOG) Absorbers is one of such process which are going to discuss in this article.

Hot well Off Gas (HWOG) Absorbers

The HWOG enters through the bottom section of the column, where it is contacted counter currently with the lean amine. In order to increase the mass transfer between the two phases, high efficiency packing is used. This packing provides a high contact surface area and results in substantial absorption of H₂S. The rich amine is sent to the re-generation section, where it is re-generated and recycled back as lean amine.

A process simulation model is developed to simulate Hot well off gases treatment process. Which is tuned with experimental data. Typical feed selected has H₂S in the range of 10-15 wt% and at pressure 0.2-1.0 Kg/cm²g and temperature 40-45 degree Celsius. Methyl Diethanolamine (MDEA) is mostly selected as amine solvent. Column pressure drop is taken in the range of 0.05-0.2 Kg/cm². Up to 40 wt% Methyl Diethanolamine (MDEA) aqueous solution is considered as solvent. Lean amine temperature is maintained 45-50 degree Celcius according to feed gas temperature. H₂S concentration in sweet off gas is aimed to less than 100 ppmw after second section treatment. Simulation results of this case showed that H₂S concentration in gas reduces from 14 wt % to 600-700

ppmw in the first Packed bed section of Absorber Column.

The process is capable of removing H₂S from Hot well off gases to acceptable value. H₂S concentration can be brought down to 1000-1500 ppmw from 10-15 wt%. By increasing lean amine flowrate product specification can be improved further up to 500-600 ppmw.

The advantages of this process are as follows:

- Mainly MDEA based process, as MDEA is most widely used amine in Indian refineries/gas plants
- Operation at very low pressure
- H₂S removal to 100-550 ppmw

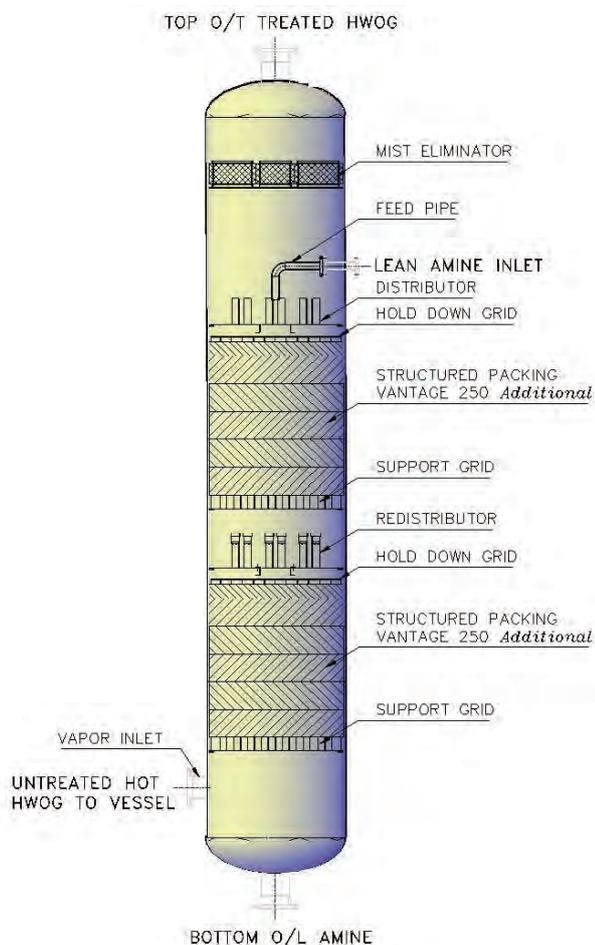
Case Study by Munters

Scope:

Munters was presented with many opportunities to do Process Design, Detailed Engineering and supply of Structured Packing and associated internals (Distributors, Mist eliminator etc.) for the Hot Well off Gas Amine Absorber. The supplies are to the prominent refineries from Fortune 500 list.

Design:

The simulation models were developed based on the different crude oil cases and different inlet concentrations to the Absorbers. Designing was done considering both the Design and Turn up/turn down requirements. The stringent



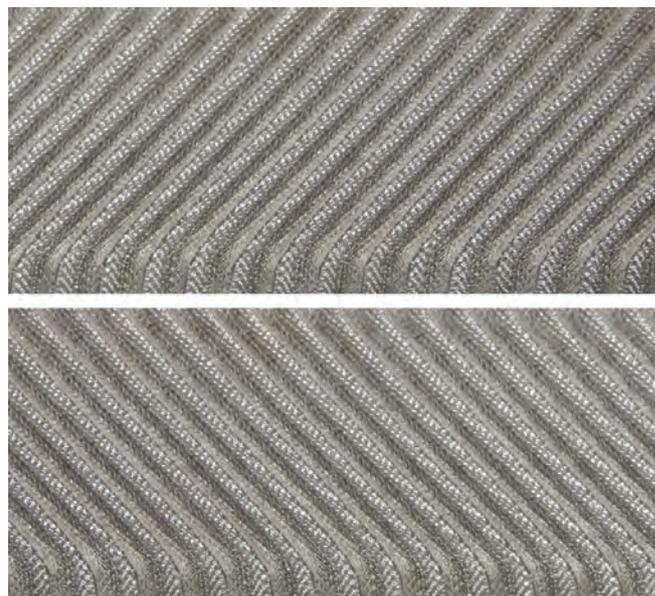
Typical Column sketch for HWOG Absorber

pressure drop requirements across the Amine Absorber was met using Munters High-Capacity Structured Packing series, Vantage® Additional®.

Munters undertook both Process as well as Hydraulics guarantee in their scope alongwith furnishing Heat & Mass balance across the column.

Guarantee Parameter

- Column is designed for Maximum Allowable pressure drop of less than 20 mmWC including Mist Eliminator.
- Carryover of H₂S in sweet gas is less than 500ppm. <0.5 % (by weight)



Munters' Vantage® Additional

Conclusion

Post the Commissioning the Customer desired separation parameters were met and Customer Displayed satisfaction from Munters products as follows to add another feather to thinking hat of Munters team.

“Munters design involving High-Capacity Structured Packing, internals and Mist Eliminator gave satisfactory results. This is definitely a way forward in redefined need of sulfur removal.” ■



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“Technology adoption is the new norm towards recovery”

*Oil & Gas sector across the world have been hit very hard by the COVID-19 pandemic. As oil prices crashed and demand for medical and personal care products soared, parts of the fuel and petrochemical industry found new opportunities, while others, tied to sectors such as construction and automotive, floundered. As the industry moves into the second half of 2020, a combination of renewed lockdowns gives a positive note to Refiners. The COVID situation has presented some short term and long term challenges as well as opportunities. Opportunities like up-skilling workforce and knowledge and embracing disruption as opportunity. “What I feel is COVID has changed the way people work and indeed it has transformed the business we do!”, says **Arun K Singh, Director (Marketing) with Additional Charge of Director (Refineries), BPCL** in an exclusive interaction with **Chemical Engineering World (CEW)***

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Arun K Singh

Director (Marketing) with Additional Charge of Director (Refineries), BPCL

How has this pandemic affected the position of Indian refining sector? Impact on Indian refiners major plans for expansion of refining capacities & petrochemicals integration.

Year 2020 is faced with high volatility for refiners. Prices are extremely dynamic. Margins are very low. Demand for some products (such as LPG, Gasoline) greatly exceeds demand for other products (Gasoil, jet). Refiners are running business scenarios and alternative refinery plans on almost a daily basis. Most workforces were moved to work-from-home scenarios, Indian Refineries are re-examining their digital capabilities, and increasing their focus on digitalization as an essential long-term strategy.

Pandemic has made all refiners shift focus on their investments and revisit their priorities and all players are scrutinizing their expansion and investment plans. Some of the major investments across the world including China and US have delayed their commissioning due to the pandemic's impact.

Petrochemical and refinery integration along with 'Crude to Chemicals' strategy is expected to be the next big game changer in oil business. Refiners have the opportunity to position themselves for long term profitable growth, but this will require strategic investment decisions and moving further downstream. Chemical demand growth tracks GDP growth. Consumption in developing Countries are

growing rapidly with increasing disposable income. This requires further investment to sustain demand growth. For Indian players, focus is shifting from expansion to diversification of product portfolio with increased synergy.

How has the market unrest changed the market & industry dynamics and affected your organization? What are the various tactical strategies that you have adopted during COVID?

The pandemic has posed never seen challenges in the Energy sector like Auto fuels demand crash, Aviation fuel demand collapse due to travel restrictions and lockdowns announced worldwide. All these had a cascading impact on Crude Oil prices and Product Cracks. In spite of all these, the biggest challenge we faced was to maintain Refineries throughput to ensure continuous supply of LPG to homes, propylene to manufacture hand sanitizers and fuel for the necessary services. We have taken many initiatives that include:

- Review of Refinery processing plans, supply demand scenario weekly and take corrective actions due to fluctuating demands.
- Export of surplus products like HSD, naphtha, Lube products and Reformate to avoid Refineries shutting down.
- Adjusting the product patterns/yield based on muted Jet-fuel demand.

- Utilizing the low demand period for taking Turnaround of Units and Catalyst change in Hydro processing Units with remote support from foreign vendors using digital technologies like online streaming etc.
- BPCL liaised very closely with term suppliers and partly succeeded in rescheduling/cancelling / deferment of planned loadings. Also, BPCL approached Govt. of India for leasing a cavern for storage of its crude oil and subsequently sold 3.76 million bbls to ISPRIL for storing at Padur cavern and Cargoes were optimized between Group refineries.
- Import of LPG to meet the growing demand for Cooking Fuel due to Governmental policies.
- Stocking up of Gasoline and Diesel in Marketing Locations.
- Our Refineries developed its own sanitizer, 'Aroma' for its employees just in time, when there was a shortage of sanitizers in the market during ongoing COVID-19.
- Cohesive planning and execution through daily review amongst various Business Units and seamless integration of supply chain processes.
- Engaging teams through digital technologies for technical Skill up-gradation.
- Diversifying crude oil purchases to tap opportunities available for processing new / trial crude oils from new geographies and increase value in BPCL system. Traditionally, crude oil imports were mainly from Arab Gulf & West Africa regions. Specific attempts were made to procure crude oils from diverse geographies, resulting into imports from newer regions such as USA, Latin America, Europe, Russia, Australia, etc.
- BPCL has entered into a strategic partnership with Shell since 2018 to source crude oils from spot market. Thus, this partnership has helped us to make the system more flexible and adaptable to changes globally and realign the processes and systems to mirror best followed international practices, enhance geographic reach and capture best value from the market.
- Exercised the full set of cash management levers, including reducing inventory positions, reviewing payment terms and managing capital expenditures.
- Rebalancing capital spending (CAPEX) and operational expenses (OPEX) is of high priority to match the current business climate.

Tell us about the current refining & petrochemicals manufacturing capacities

& existing product mix offered by your organization. Post pandemic, have there been any changes in plans

Agility and flexibility will be a key in the energy industry, as unpredictable oil and gas prices and patterns of demand will be in front of us. BPCL Refining Capacity matches with the current market share of Petroleum Products. There are no immediate plans for expansion of Refining Capacities. To remain competitive in the dynamic market and preparing ourselves better for the future, BPCL has planned investment in projects that are novel and will be a significant addition to the entire process value chain. Major investments have been planned to venture into petrochemicals, expansion of refining capacities, meeting higher standards, and improving logistics infrastructure. Projects like Kerosene Hydrotreater Unit, Petro Resid FCC, and Lube Oil Base Stocks unit revamp have been planned and are at various stages of development in MR. In KR, Motor Spirit Block Project is underway for maximizing naphtha to MS conversion.

BPCL is in the commissioning phase of niche Petrochemical production at our Kochi Refineries which will add value and de-risk from Refining. We are also executing Polyols project at Kochi to utilize the pre-investments made for Petrochemical expansion. BPCL Product mix mainly focused on meeting the domestic demand of petroleum products and import substitution of Petchem

products. In view of recovery in domestic demand to pre-Covid level we continue to maintain the product mix to meet the domestic demand of Auto Fuels and value added products like Lubricants.

Currently refiners are operating at 60-70% capacities which is quite unusual in the Indian context. In your view, how much time it may take for the market to recover completely & start operating at normal (pre- Covid) capacities?

The demand for petroleum products in October-20 has picked up with reopening efforts related to COVID-19 continue to evolve (lifting up of lockdowns) and starting up of agricultural and festival season. This has propelled product sales to growth pattern HSD and Gasoline are now on growth path. With the increased demand for Retail and Industrial products, our Refineries have ramped up the run rates to 100% of design capacities which is close to pre-Covid level. EIA estimates that global consumption of petroleum and liquid fuels averaged 95.3 million b/d in September and 93.9 million b/d in August. EIA forecasts that global consumption of petroleum and liquid fuels will average 92.8 million b/d for all of 2020, down by 8.6 million b/d from 2019.

What are the biggest challenges for the refiners to comply with the strict environmental regulations & what steps have you have taken in this direction?

Being in close proximity of inhabitation, maintaining the quality of Environment as per standards is the responsibility of Refineries, which our refineries are complying with, all the time. Digitalisation has already created a massive impact on the refineries globally and this trend is going to be more powerful in the future. Several applications and technologies were developed internally in our company thereby creating an environment of entrepreneurship. Existing refinery area falls in the recently updated CRZ area which is making it very difficult for any modernization, up-gradation within the existing boundary walls. We are following up with NCZMA for updation in CRZ map. As per EIA notification 2006, 33% open space should be under green belt area, but as refineries are OLD, open plot space inside refinery not available. Therefore, tree plantation is being done in & around surrounding area. Changing operating strategies and capitalizing on new catalyst technologies to maximize yields of high value products is critical to successfully navigate the current challenging environment.

Tell us about the ongoing projects & future plans of your organization.

The need of the hour for us is to stay relevant, enhance our capacity building ability, be able to significantly improve our efficiencies, and stay in sync in this developing environment. Response to

rapid change will foretell your success in the coming years.

Our ongoing projects at Kochi Refinery include Propylene Derivative Petrochemicals Project (PDPP), Motor Spirit Block Project (MSBP) and Polyols Petrochemical Project. PDPP is under commissioning, which will mark BPCL's entry into niche petrochemicals like acrylic acid, acrylates and Oxo-alcohols. Polyols Project will be second phase of niche petrochemical production with Polyether Polyols as main product. This project will add value to BPCL and nation as a whole by substituting products which are completely imported at present. MSBP is also under commissioning, which is aiming ambitious net zero naphtha project. This should also support the projected growth in clean fuels and realising better margins by upgrading naphtha.

At Mumbai Refinery we are executing Polypropylene and Polyethylene Projects Project which includes Petro Resid Fluid Catalyst Cracker and Ethylene Cracker units also. These projects embark the foray into Polyolefin market and aim to capitalise the location specific advantage of Mumbai Refinery. These projects are in initial stages of study and engineering

Over the horizon of next 4-5 years, which are the key trends that will drive the refining & petrochemicals industry? What does the industry need to do collectively

Prominent trends over the next 4-5 years

- Technology adoption is the new norm towards recovery.
- Increased focus on efficiency and cost reduction to ensure profitability for fuels.
- LNG integration will continue to dominate the changing landscape of Refineries.
- In addition to growing petrochemical demand, new production technology with advanced molecular management is enabling massive economies of scale that lower the cost of petrochemical production, changing the landscape of tomorrow's export market.
- In an increasingly competitive environment, asset utilization has become a critical area of focus.
- Shifting and maintaining investment priority towards chemicals to ensure profitability for another 10-15 years in Asian region.
- Adjust crude- and product-trading strategies to account for changing market dynamics.
- The year 2020 brought Digital disruptions in India. With margins under pressure, the need for the hour is to adopt digital tools and capabilities in order to achieve operational excellence, increased safety, improve efficiencies, achieve faster optimisations to stay ahead in the business.
- As digitalization accelerates in refining and petrochemical facilities, need to stay ahead of ever-growing cyber vulnerabilities in the operational technology (OT).

& as the individual organizations to get back on the path of recovery?

Looking at the growth and low per capita consumption of petrochemicals in India in recent years and the rate at which it is getting promulgated amongst the masses, it is expected that petrochemical business will offer a strong hedge against future uncertainties around fuels.

BPCL looks to strike a balance in meeting our fuel demands while diversifying into petrochemicals to become a dominant

player. While Kochi is focusing on Niche Petrochemicals from olefins, Mumbai will be on Poly-olefins products. This strategy is in line with the supply demand scenario of various products in these segments as well as the margins at various locations. Poly-olefins market will be volume based and niche petrochemicals are mostly dependant on technology, customisation and perfection. ■

Bharat Petroleum Corporation Limited



Bharat Petroleum Corporation Limited (BPCL) came into existence in January, 1976 when Burmah-Shell was taken over by the Government of India. A Fortune Global 500 Company, BPCL is one of the premier integrated energy companies in India, engaged in refining of crude oil and marketing of petroleum products, with a significant presence in the upstream and downstream sectors of the oil and gas industry. BPCL has attained the coveted Maharatna status, joining the elite club of companies enjoying enhanced financial autonomy and other decision making authorities.

BPCL's Refineries at Mumbai and Kochi, subsidiary Numaligarh Refinery Ltd. at Assam and joint venture Bina Refinery at Madhya Pradesh have a combined refining capacity of over 40 MMTPA. While BPCL's upstream subsidiary, Bharat PetroResources Ltd. has acquired participating interests in 27 oil & gas blocks in India and abroad, BPCL's gas subsidiary, Bharat Gas Resources Ltd. has been granted authorization to expand its City Gas Distribution network to 17 Geographical Areas.

BPCL markets its products through a robust marketing and distribution network comprising 16,250 Retail Outlets, 6,110 LPG distributorships, 733 Lubes distributorships, 123 POL storage locations, 52 LPG Bottling Plants, 58

Aviation Service Stations, 3 Lube blending plants and 4 cross-country pipelines.

During the year 2019-20, BPCL's gross revenue from operations stood at Rs.3,27,581 crores, net profit at Rs. 2,683 crores, market sales were 43.10 MMT and market share amongst public sector oil companies was 24.5%. The products have a wide range of applications in industrial, transport, power and agriculture sectors. BPCL has formed 24 joint venture companies covering refining, city gas distribution, renewable energy, pipelines, gas, into-plane servicing, airports, payment banks etc. to cater to the diverse requirements of its customers.

BPCL's next 5 year strategic roadmap, which will entail investments of over Rs 1 Lakh crores, focuses on creating infrastructure, customer centricity through service models and enhanced fuel offerings, enhancing the petrochemicals portfolio, establishing a global footprint in downstream retailing, developing renewable energy sources, inclusive growth, reducing the carbon footprint etc. As a good corporate citizen, BPCL's thrust is primarily in the areas of education, water conservation, skill development, health, community development, capacity building and employee volunteering. With 'Energising Lives' as its core purpose, BPCL's vision is to be the most admired global energy company leveraging talent and technology. ■

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GACL - Writing Success with Salt



Aerial view of GACL Caustic Soda Complex, Vadodara, Gujarat



ujarat Alkalies and Chemicals Limited (GACL) was established in the year 1973 in Vadodara, Gujarat to manufacture Caustic Soda and allied products. Promoted by the Government of Gujarat, by harping on cutting edge technology, groundbreaking research and development and through strategic diversification, GACL

has emerged as one of the largest manufacturers of caustic soda with around 12% share in domestic Chlor-Alkali sector. From an initial capacity of 37,425 TPA caustic soda, the organization has enhanced its capacity to 4,12,500 TPA and the facilities are spread over 2 complexes at Vadodara and Dahej. From its two facilities, GACL now offers 36 products.



Hydrogen Peroxide Plant, Dahej Complex

With a strong dealer network, in-house research and Development facilities, proximity to major raw material sources and markets GACL is scaling new peaks of glory. By balancing the interest of mother nature, society, employees, customers, stakeholders and shareholders, the organisation is making its growth more meaningful.

The Organisation has co-promoted Gujarat industries power company Ltd., Enviro Channel Ltd., Gujarat Chemical Port Terminal Company Ltd., Gujarat Guardian Ltd., GACL-NALCO Alkalies & Chemicals Pvt. Ltd. etc. along with other corporations

to ensure the industrial growth in Gujarat.

With more than 5,000 customers including some of the finest global corporations, GACL has established itself strongly in the markets of North America, Europe, Africa, Asia Pacific, MENA (the Middle East and North Africa) and other regions. The organization is playing a significant role in enriching Gujarat and empowering the progressive strides of the nation.

In its more than 45 years of journey, GACL has become a competitive and global corporation. It offers products having agricultural and industrial applications thus becoming an integral part of



Panoramic view of GACL Dahej Complex, Dist. Bharuch, Gujarat

people's daily life. The synergistic product development techniques and processes with the global best corporations have further helped GACL consolidate its place as a leading chemical corporation. GACL is constantly diversifying its offering and adding new products and expanding its existing capacities:

- 800 TPD Caustic Soda Project integrated with a 130 MW coal-based power plant in JV with NALCO
- 1,05,000 TPA Chloromethanes Project
- 33,870 TPA Phosphoric Acid Project
- 10,000 TPA Hydrazine Hydrate Project
- 39,600 TPA Chlorotoluenes Project

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Chloromethane Plant, Vadodara Complex

- Expansion of existing Dahej Caustic Soda Plant from 785 TPD to 1310 TPD

- 65 MW Coal based Power Plant

To fuel its growth further, GACL is working on establishing new projects and expanding its capacity.



The Organisation has planned to expand its operation in the next 3-4 years by establishing.

Beyond its dynamic product basket, GACL has distinguished itself with the Green Initiative. It was the pioneer in the caustic soda industry to replace the Mercury Cell Technology with the environment-friendly membrane cell technology way back in 1989. GACL is also the first state promoted enterprise to adopt renewable wind energy to fuel its progress. The Organisation has a current total installed Wind Power capacity of 171.45 MW and 35 MW Solar Power Project for its captive use. With this, the aggregate renewable energy capacity reached to 206.45 MW, which caters more than 25% of energy requirements.

Keeping an eye on the future, the organization is also considering the manufacturing of various Chlorine-based products so that the production of Caustic Soda can be optimized while consolidating and maintaining

its prime position in Chlor-Alkali and other integrated downstream products. Going beyond, the organization is also exploring the possibilities for setting up plants for producing new value-added products having their applications in pharmaceuticals, cosmetics, personal care products, detergent, epoxy resins etc and many such fields.

The GACL Product Basket:

Caustic Soda Lye, Caustic Soda Flakes, Caustic Soda Prills, Hydrochloric Acid, Liquid Chlorine, Compressed Hydrogen Gas, Sodium Hypochlorite, Methyl Chloride, Methylene Chloride, Chloroform, Carbon Tetrachloride, Hydrogen Peroxide, Phosphoric Acid, Caustic Potash Lye, Caustic Potash Flakes, Potassium Carbonate, Sodium Chlorate, Anhydrous Aluminium Chloride, Poly Aluminium Chloride (Virgin Grade), Stable Bleaching Powder, Chlorinated Paraffin, Benzyl Chloride, Benzyl Alcohol, Benzaldehyde, Scalewin, Biowin, Bleachwin, Anhydrous Sodium Sulphate. ■

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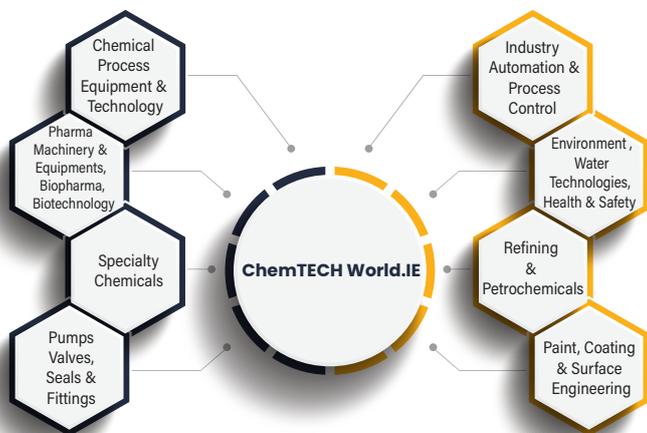
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