March 2025

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Oil Gas & Power

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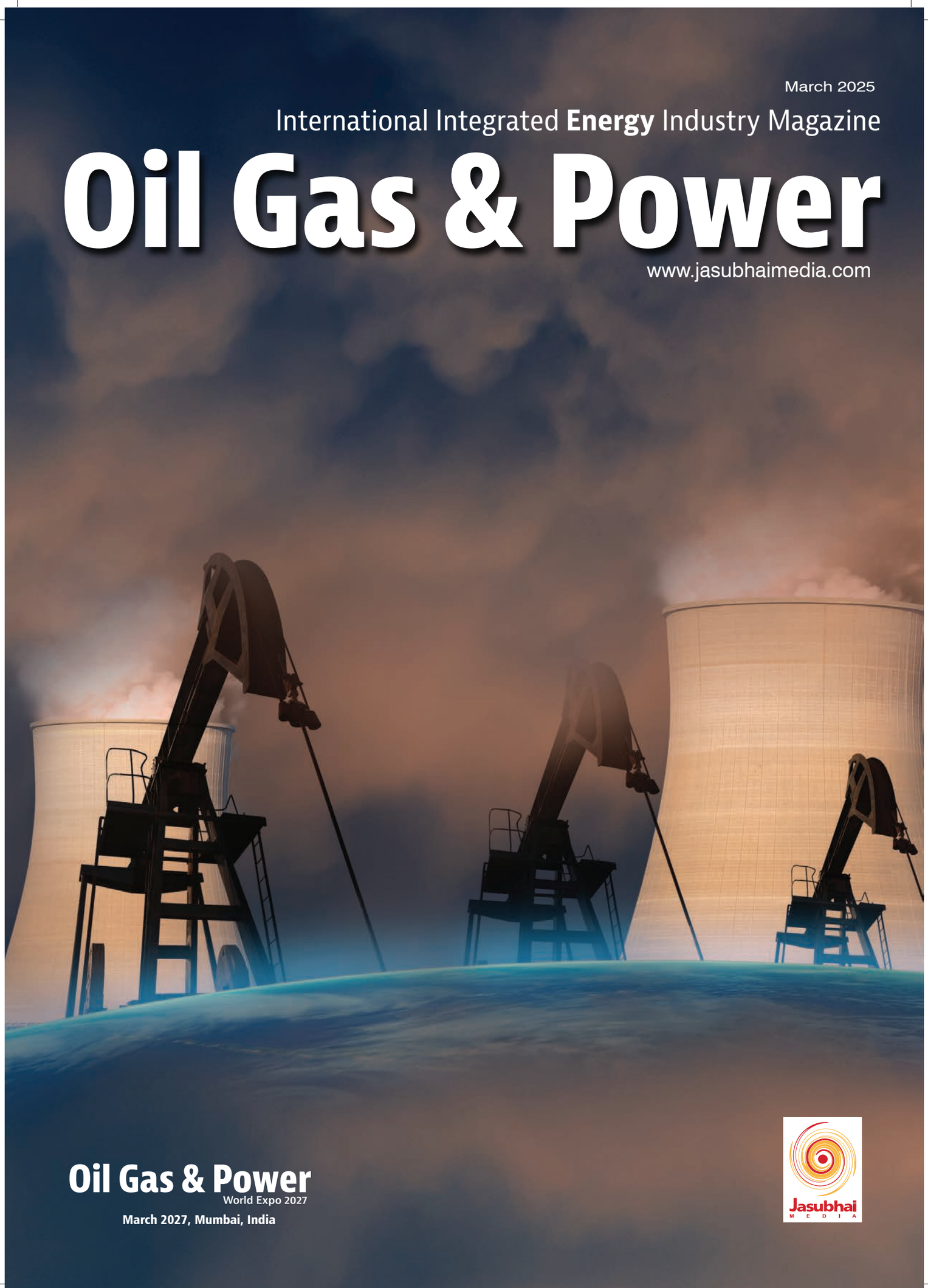

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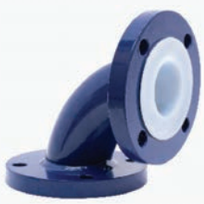

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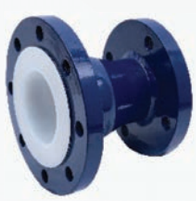
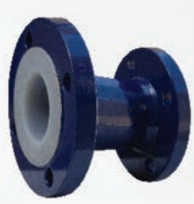


CONCENTRIC REDUCER



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

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

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

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

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

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

Hindalco unveils new identity

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

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

Speaking at the launch, Mr. Kumar Mangalam Birla, Chairman, Aditya Birla Group, said, "Today, Hindalco is

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a mini conglomerate in itself, with 52 plants across 10 countries producing a diverse portfolio of high-quality products that contribute to the global economy. We are committing ₹45,000 crore across aluminium, copper, and specialty alumina businesses to deliver both upstream and next-generation high-precision engineered products".

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

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

DG - International Atomic Energy Agency Inaugurates S N Bose Building

Rafael Mariano Grossi (centre), Director General of the International Atomic Energy Agency during the inauguration of S N Bose Building.

Mumbai, India: The Director General of the International Atomic Energy Agency (IAEA), Rafael Mariano Grossi, inaugurated S N Bose Building at Global Centre for Nuclear Energy Partnership (GCNEP) at Sushma Swaraj Bhavan in New Delhi. He also introduced the Certificate Course on Nuclear Engineering during the event. The newly inaugurated S N Bose Building, named in honour of the eminent Indian physicist Dr. Satyendra Nath Bose will serve as an advanced hub for research and training in nuclear science and technology. The facility houses state-of-the-art laboratories catering to GCNEP's specialised schools, enhancing its capabilities in nuclear security, reactor technology, radiation safety, nuclear material characterisation, and radioisotope applications.

The Certificate Course on Nuclear Engineering, introduced during the event, is a six-month programme designed to provide in-depth knowledge on reactor physics, nuclear fuel cycle, radiological safety, nuclear safeguards, and emerging applications of nuclear technology. The course is planned to be opened to all the signatories of GCNEP globally and would cater to 40 international and 10 national participants in a batch. The course aims to foster a new generation of nuclear professionals equipped to contribute to the safe, secure, and sustainable use of nuclear energy.

GCNEP Member countries reaffirmed their commitment to global nuclear collaboration, emphasising advanced reactor technologies, workforce development, education and training, and public outreach. Discussions highlighted international partnerships, non-proliferation, and expanding bilateral cooperation. The role of nuclear energy in ensuring energy security while mitigating climate change was underscored, alongside its contributions to healthcare, cancer care, technical cooperation, and global health research.

Diplomats of GCNEP partner countries, senior officials of the Ministry of External Affairs and the Department of Atomic Energy (DAE) were present at the event.

Government Initiatives help promote Gas based Power Generation

New Delhi, India: Gas-based plants in the country are operating at very low Plant Load Factor (PLF). To enhance the availability of natural gas for power generation, Government have placed Liquefied Natural Gas (LNG) under the Open General License (OGL) category, thereby allowing power plants to import LNG as per their requirements on mutually agreed commercial terms with suppliers. The gas imported by power plants during 2024-25 (Apr-Jan), is about 9.58 MMSCMD.

Various steps taken by the Government for increasing the share of natural gas in the energy basket, inter-alia, include expansion of National Gas Grid Pipeline, expansion of City Gas Distribution (CGD) network, setting up of Liquefied Natural Gas (LNG) Terminals, allocation of domestic gas to Compressed Natural Gas (Transport)

/ Piped Natural Gas (Domestic) CNG(T)/PNG(D) on priority, allowing marketing and pricing freedom with a ceiling price to gas produced from high pressure/ high temperature areas, deep water & ultra-deep water and from coal seams, Sustainable Alternative Towards Affordable Transportation (SATAT) initiative to promote Bio-CNG, etc.

SECL's CSR Scheme becomes first coal PSU initiative listed on DBT portal

'SECL Ke Sushrut', flagship educational initiative under SECL's CSR programs, is designed to provide free medical coaching to 40 students preparing for the National Eligibility cum Entrance Test (NEET).

Bilaspur, Chhatisgarh: South Eastern Coalfields Limited (SECL), subsidiary of Coal India, has achieved a significant milestone with its Corporate Social Responsibility (CSR) initiative, 'SECL Ke Sushrut.' The latter has become the first and only CSR scheme of any coal PSU under the Ministry of Coal to be listed on the Direct Benefit Transfer (DBT) portal of the Government of India.

The DBT initiative, launched by the Government of India, aims to reform the delivery of benefits and subsidies by directly transferring funds to beneficiaries' bank accounts, minimizing leakages, and ensuring effective utilization of resources. At present, the DBT portal features approximately 325 schemes from 55 ministries, covering diverse sectors such as health, education, agriculture, and social welfare.

Started in 2023, 'SECL Ke Sushrut' is a flagship educational initiative under SECL's CSR programs, designed to provide free medical coaching to 40 students preparing for the National Eligibility cum Entrance Test (NEET). The scheme aims to support meritorious and underprivileged students from the coal belt regions of Chhattisgarh and Madhya Pradesh, equipping them with the necessary resources and guidance to pursue careers in the medical field.

BCCL achieves successful monetization of 2 MTPA Dugda Coal Washery

New Delhi, India: Under the guidance of Ministry of Coal, Bharat Coking Coal Limited (BCCL), a CIL subsidiary, has achieved a historic milestone by successfully monetizing the 2 MTPA Dugda Coal Washery located in Bokaro, Jharkhand. This first-ever monetization of a coal washery in India marks a transformative step in coal sector reforms. The monetization of the Dugda Coal Washery is expected to have a significant impact on energy sector in India. With improved coal washing capabilities and enhanced beneficiation processes, this initiative will contribute to higher efficiency in domestic coal utilization. More importantly, it will play a crucial role in reducing India's dependence on imported coking coal, leading to foreign exchange savings. The strategic importance of the monetization include optimizing underutilized assets; encouraging private participation; enhancing coal beneficiation and revenue generation.

This achievement is part of the broader reforms initiated by the Ministry of Coal to modernize Coal sector in India and ensure the optimal utilization of its vast coal resources. The successful auction of BCCL's Dugda Coal Washery represents a significant shift towards a more dynamic and efficient coal sector, aligning with the Government's policy of asset monetization. The monetization of the Dugda Coal Washery is expected to generate significant economic benefits for the region. Involvement of private sector leaders will not only improve supply chain efficiency, enhance coal-washing capabilities but also create employment opportunities, and boost industrial growth in Jharkhand and adjoining areas.

Nuclear Energy is critical for India's Net Zero Goal: Dr. Jitendra Singh

New Delhi, India: Addressing a post-budget webinar organized by NITI Aayog, Union Minister of State (Independent Charge) for Science and Technology; Earth Sciences, and Minister of State for PMO, Department of Atomic Energy, Department of Space, Personnel, Public Grievances and Pensions, Dr. Jitendra Singh emphasized that Nuclear Energy is critical for India's Net Zero goal. He highlighted the Union Budget 2024-25's vision for India's nuclear power expansion, which sets a target of achieving 100 GW by 2047.

Pointing out the crucial role of nuclear energy in India's transition to clean energy and achieving Net

Zero emissions by 2070, he called for private sector participation, regulatory reforms, and sustained public engagement.

Highlighting the growing energy demand, Dr. Jitendra Singh stated that India's electricity needs are expected to increase four to five times by 2047. While renewable energy sources are expanding, they alone cannot meet the base-load demand, making nuclear power a key component of India's energy strategy. "Achieving 100 GW of nuclear power will require a focused and determined approach, adding around 4 GW annually from now onwards," he said, expressing confidence in meeting the goal with proper planning and execution.

A major shift in India's nuclear policy is the proposed involvement of the private sector in designing, building, and operating nuclear power plants. Dr. Jitendra Singh acknowledged that legislative amendments to the Atomic Energy Act, Civil Liability for Nuclear Damage Act, and Electricity Act would be required to enable this participation. "Opening up the nuclear sector will send a strong policy signal to industry players, boosting investor confidence and encouraging long-term investments," he noted.

He also highlighted that NPCIL, along with its subsidiaries, aims to contribute nearly half of the 100 GW target by leveraging domestic and international partnerships. Meanwhile, NTPC's joint venture, Ashwini, has already taken the lead in constructing four 700 MWe PHWRs at Mahi-Banswara.

The Minister further announced the launch of a Small Modular Reactor (SMR) R&D Mission, with the objective of developing five SMRs by 2033. These reactors, known for their adaptability, could be deployed in industrial zones, remote areas, and hard-to-abate sectors like cement and steel manufacturing.

India achieves milestone in coal production

New Delhi, India: India has achieved a momentous milestone in coal production, surpassing one billion tonnes (BT) on March 20, 2025, in the fiscal year 2024-25. This remarkable achievement comes 11 days ahead of last fiscal year's coal production of 997.83 million tonnes (MT). The coal sector's success is attributed to the tireless efforts of Coal Public Sector Undertakings (PSUs), private players, and the dedicated workforce of around 5 lakh mine workers across more than 350 coal mines. These coal miners, who have defied numerous challenges with unmatched dedication, have played a pivotal role in achieving this historic milestone.

India relies on coal for approximately 55 per cent of its energy mix, and around 74 per cent of the country's electricity is generated by coal-based power plants. The record-breaking coal production reflects the Government's strategic reforms and policies, such as amendments to the Mines and Minerals (Development and Regulation) Act and the opening of the coal sector to private players through the commercial auctioning of coal blocks. These initiatives have led to a marked increase in the availability of domestic coal, progressively substituting imports and significantly contributing to foreign exchange savings.

Lok Sabha passes Oilfield (Regulatory and Development) Amendment Bill 2024

New Delhi, India: Lok Sabha passed the Oilfield (Regulatory and Development) Amendment Bill, 2024. The Bill was earlier passed by the Rajya Sabha on 3rd December, 2024. The Bill intends to reform the legal framework to meet the current needs and market conditions and to make the sector more attractive to investors so that exploration and production of oil and gas could be increased further. The Bill will play a key role in India's quest for ensuring energy availability, accessibility, affordability and security for the citizens and fulfilling the Hon'ble Prime Minister's vision of Viksit Bharat by 2047.

Over the last decade, the Government has brought several path breaking reforms including a landmark shift from 'production sharing' regime to 'revenue sharing' regime for awarding contracts, simplified processes and reduced regulatory burden to promote exploration and production of oil and gas in India, release of previously No Go areas for new exploration, deregulation of crude as well as marketing and pricing freedom for natural gas. A crucial outcome of these major reforms, more than 76% of the active acreage under exploration in India today have been awarded post 2014.

While introducing the historical amendment Bill, the biggest of such path breaking legal reforms, Hon'ble Minister of Petroleum and Natural Gas Sh. Hardeep Singh Puri stated that the present regime, focusing mainly on licensing, regulatory control and collection of royalties, needed reorientation to promote Ease of Doing Business and collaboration between the Government and the

Contractors. He stated that exhaustive discussions with industry leaders, potential investors and stakeholders were held to understand the pain points in the system. Given the long gestation periods and very high project risks involved, investors need a legal framework that is simple, stable, predictable and provides access to efficient expeditious dispute resolution mechanism. The amendments proposed in the Bill are designed to meet investor expectations whilst promoting, protecting and prioritizing the interests of India.

The Amendment Bill seeks to do away with the historical erroneous practice of putting mining and petroleum operations in the same bucket. It also introduces a single permit system namely, petroleum leases, which will substitute the extant system which requires the Contractors to take multiple licenses for carrying out various types of activities for different types of hydrocarbons. The Bill will facilitate development of comprehensive energy projects and adoption of new technologies like Carbon Capture utilization and sequestration (CCUS), green hydrogen etc.

Post 2014, MoPNG has embarked on an accelerated path towards monetising discoveries. Towards this goal, the discovered small fields policy had been notified in 2015 and many small operators have been awarded fields unmonetised by previous operators. Many of these isolated fields have been suffering for want of infrastructure. This Bill seeks aid small operators by enabling sharing of resources and infrastructure between different operators to improve viability of oil blocks.

The Bill also aims to resolve one of the biggest grievances of global oil companies interested in investing in India by providing stability in operations, both in terms of tenure of the lease and conditions therein. It emphasizes efficient alternate dispute resolution mechanisms which will ensure disputes can be resolved in a timely, fair and cost-effective manner.

Government takes steps to strengthen Strategic Petroleum Reserves

New Delhi, India: Suresh Gopi, Hon'ble Minister of State for Petroleum and Natural Gas stated that Government, through a Special Purpose Vehicle called Indian Strategic Petroleum Reserve Limited (ISPRL), has established Strategic Petroleum Reserves (SPR) facilities with total capacity of 5.33 Million Metric Tonnes (MMT) of crude oil at 3 locations namely Vishakhapatnam (1.33 MMT), Mangaluru (1.5 MMT) and Padur (2.5 MMT) capacity.

To further augment the SPR capacity, Government, in July 2021, had also approved the establishment of two additional commercial-cum-strategic petroleum reserve facilities with total storage capacity of 6.5 MMT at Chandikhol (4 MMT) in Odisha and Padur (2.5 MMT) in Karnataka, on a Public Private Partnership mode. Government and OMCs evaluate, from time to time, the possibility of augmentation of storage capacities based on technical and commercial feasibility. Assessment of new sites for establishing additional petroleum reserves is a continuous process.

To ensure security of crude supplies and to mitigate the risk of dependence on crude oil from single region, Indian Oil Public Sector Undertakings (PSUs) have diversified their crude basket and are procuring crude from countries located at various geographical locations viz. Middle East, Africa, North America, South America etc. Further, Government has already diversified the import of LNG by adding Australia, USA and UAE as sourcing destinations. India has also signed various long term agreements for procurement of LNG for ensuring uninterrupted supplies and safeguarding from price volatility.

CCI approves acquisition of O2 Power Midco Holdings & O2 Energy by JSW Neo Energy

Mumbai, India: The Competition Commission of India (CCI) has approved the proposed acquisition of 100% shareholding of O2 Power Midco Holdings Pte. Ltd. and O2 Energy SG Pte. Ltd. by JSW Neo Energy Limited. The Proposed Combination involves the acquisition by JSW Neo Energy Limited of 100% shareholding of O2 Power Midco Holdings Pte. Ltd. (O2 Midco) and O2 Energy SG Pte. Ltd. (O2 Energy).

JSW Neo Energy Limited (JSW Neo/Acquirer), is a wholly owned subsidiary of JSW Energy Limited (JEL) (a listed entity) which belongs to the JSW Group. JEL (through its subsidiaries) is inter alia engaged in power generation and transmission through conventional and nonconventional sources.

BPCL to develop hydrogen-powered VTOL aviation ecosystem

New Delhi, India: Bharat Petroleum Corporation Limited (BPCL) has entered into a quadripartite Memorandum of Understanding (MoU) with BluJ Aerospace, the Agency for New and Renewable Energy Research and Technology (ANERT), Government of Kerala, and Cochin International Airport Limited (CIAL) to develop the first hydrogen fueled Vertical Take-off and Landing (VTOL) aircraft ecosystem globally.

This pivotal agreement aligns with India's goal of attaining Net Zero emissions by 2070 and represents a significant stride in aviation innovation. The project aims to transform urban and regional air mobility through the integration of green hydrogen-powered VTOL aircraft, enhancing speed, reducing noise, and improving efficiency while substantially cutting down carbon emissions.

In its crucial role, BPCL will establish hydrogen refueling infrastructure for VTOL aircraft developed by BluJ Aerospace via its forthcoming Hydrogen Refueling Stations (HRS) in Kochi and Trivandrum. Furthermore, BPCL will engage in R&D endeavours focused on designing and developing an Indigenous Proton Exchange Membrane (PEM) Hydrogen Fuel Cell characterized by high power density to facilitate vertical lift-off, thereby advancing India's hydrogen technology capabilities.

G. Krishnakumar, Chairman & Managing Director, BPCL, remarked, "Green hydrogen holds the potential to transform aviation and urban mobility. This partnership reflects our resolve to lead in clean energy solutions that are innovative and practical for a sustainable future."

Tata Power Energy signs MoU with AP Govt for renewable energy projects

Mumbai, India: Tata Power Renewable Energy Limited (TPREL), a subsidiary of The Tata Power Company Limited and a leading player in India's renewable energy sector, has signed a Memorandum of Understanding (MoU) with the Government of Andhra Pradesh to collaborate and explore opportunities in the development of renewable energy projects in the state. The MoU was signed at Amaravati in Andhra Pradesh, and marks a significant step towards advancing the state's renewable energy ambitions.

Under this strategic agreement, TPREL and the Government of Andhra Pradesh will jointly explore renewable energy (RE) development opportunities of up to 7,000 MW (7 GW), including Solar, Wind, and Hybrid projects with or without storage solutions. The estimated investment in these projects stands at approximately upto ₹ 49,000 crore, making it one of the largest renewable energy investments in the state. This partnership aligns with the State's vision to enhance its renewable energy portfolio and accelerate the transition towards a sustainable and green energy future.

Additionally, beyond contributing to Andhra Pradesh's clean energy targets, this MoU will provide a boost to the local economy, foster skill development and support livelihoods, ultimately contributing to the socio-economic growth of the state. The proposed capacities would be set up under Andhra Pradesh's Integrated Clean Energy (ICE) Policy, a landmark clean energy framework that that aims for State to develop over 160 GW of renewable energy with an investment potential of ₹10 lakh crore.

bp completes drilling at El Fayoum-5 Gas Well

London, UK: Oil and Gas Major BP has announced the successful completion of drilling operations at the El Fayoum-5 gas discovery well in the North Alexandria Offshore Concession, marking the final well in its four-slot drilling campaign in the West Nile Delta.

Drilled using the Valaris DS-12 rig, El Fayoum-5 was spudded on February 14, 2025, and encountered four prospective Messinian gas reservoirs, with a total sand thickness of 50 meters at a measured depth of approximately 2,900 meters.

William Lin, EVP gas & low carbon, commented: "This reinforces bp's commitment to Egypt and its growing energy needs. With Raven Infills Phase 2 already contributing to production, we're now fast-tracking the El King and Fayoum discoveries to tie into our West Nile Delta infrastructure. The delivery of Raven Infills is fully in line with our priority to grow the upstream and high grade our portfolio across the world."

The WND Gas Development consists of a series of gas condensate fields located offshore Egypt, within the North Alexandria and West Mediterranean Deepwater concessions. The Raven field, the final phase of the WND project, has been in production since early 2021. Its initial phase included the development of eight subsea wells, located up to 65 km offshore, at water depths ranging from 550 to 700 meters. bp, the project operator, holds

an 82.75 per cent stake, while Harbour Energy owns the remaining 17.25 per cent.

India's R&D spending more than doubles in last decade

One of the key highlights of Dr. Jitendra Singh's address was India's policy shift in allowing private sector participation in strategic fields such as space technology and nuclear research

New Delhi, India: "India R&D spending (GERD) is double in last one decade during the government headed by Prime Minister Narendra Modi, from ₹60,196 cr in 2013-14 to ₹1,27,381 cr and is shaping the future economy of India which will be defined by home-grown innovations in artificial intelligence, biotechnology, and quantum computing," Dr. Jitendra Singh said, underscoring the role of government-backed initiatives in catalyzing scientific advancements.

Speaking at the DISHA event at India Habitat Centre, the Union Minister of State (Independent Charge) for Science and Technology; Earth Sciences and Minister of State for PMO, Department of Atomic Energy, Department of Space, Personnel, Public Grievances and Pensions highlighted the government's multi-pronged strategy to position India as a global leader in deep-tech innovation and commercialization.

Dr. Jitendra Singh reiterated that India is making significant strides in fostering an intellectual property (IP)-driven innovation ecosystem, with academia, industry, and start-ups playing a pivotal role. He noted that the government's emphasis on research and development (R&D) funding has led to India's Gross Expenditure on Research and Development (GERD) more than doubling in the last decade, from ₹60,196 cr in 2013-14 to ₹1,27,381 cr. "The government is not only investing in research but also ensuring that these innovations are seamlessly transitioned from labs to industries, strengthening the foundation of Atmanirbhar Bharat," he added.

One of the key highlights of Dr. Jitendra Singh's address was India's policy shift in allowing private sector participation in strategic fields such as space technology and nuclear research. "What was once solely the domain of government institutions is now open to private enterprises, enabling faster technological advancements, higher efficiency, and global competitiveness," he stated.

The space sector, in particular, has witnessed a surge in innovation, with start-ups actively contributing to satellite development, launch services, and space-based applications. The government's decision to open up the nuclear energy sector to private players is another transformative step aimed at leveraging indigenous expertise to drive energy security and sustainability. ■

GAIL signs MOU with Cummins for collaboration on clean energy

New Delhi, India: GAIL (India) Limited, a Maharatna CPSE under MoPNG and India's leading Natural Gas company, and Accelera by Cummins, the zero-emissions business segment of Cummins Inc. have signed a Memorandum of Understanding (MoU) to collaborate broadly in sustainable, green energy and energy transition technologies in India. The MoU was signed yesterday at the ongoing India Energy Week 2025 here.

The collaboration will leverage Accelera's expertise in New Energy businesses and GAIL's established Natural Gas infrastructure to explore opportunities in New Energy Businesses such as hydrogen production, blending, transportation and storage. GAIL has already advanced its Scope 1 and Scope 2 "Net Zero" Targets from 2040 to 2035.

Cummins Inc is Cummins a global power solutions leader. Cummins is committed to sustainability and helping its customers successfully navigate the energy transition with its broad portfolio of products. The products range from advanced diesel, natural gas, electric and hybrid powertrains and power train related components, electric power generation systems, batteries, electrified power systems, hydrogen production technologies and fuel cell products.

GAIL which always has been promoting clean energy, commissioned a 10 MW Green Hydrogen unit at its plant at Vijaipur, Guna Distt. M.P in April 2024. The Electrolyser was of AcceleraTM by Cummins make. GAIL, through its JV Avantika, also conducted pilot scale studies in Indore CGD network by blending 2 per cent Hydrogen in CNG/ PNG and later scaled up to 5 % in PNG network. As part of energy transition, GAIL has already set up 5 TPD CBG plant at Ranchi and is on course to set up 26 plants across India in the next 3-4 years. A JV with Leafiniti Bioenergy is aiming to set up 10 CBG plants. Also a JV has been formed to set up 1G, 500 KLPD capacity Grain based ethanol plant at Rajasthan and a JV agreement has been signed with Coal India for the production of Synthetic Natural gas at West Bengal.

The MOU will help in exploring opportunities in areas such as application and adoption of hydrogen in various sectors such as transport, power, steel and other industry as mono fuel or dual feed such as LNG / Hydrogen/ CNG and blends, blending of hydrogen in natural gas pipeline, Infrastructure, production, transportation and storage of hydrogen.

Jaitapur nuclear project to house six nuclear reactors

Union Minister Dr. Jitendra Singh

New Delhi, India: Union Minister Dr. Jitendra Singh reaffirmed the government's commitment to the Jaitapur Nuclear Power Project, calling it a critical step toward India's clean energy future. He clarified that environmental clearance for the project is under renewal and that necessary safeguards are in place to address ecological and safety concerns.

He further emphasized that the government remains confident in the safety of the project despite objections from conservation groups and concerns about its location in a seismic zone. He stated that concerns about risks to marine life and local livelihoods have been raised repeatedly, and every time, the government has "tried to allay all these apprehensions that there is no such risk to the marine life, the fisheries, or the people living around, there are ample number of evidence-based studies to prove that."

Dr. Singh further clarified that the environmental clearance had expired in December 2022 due to procedural delays, not because of any new environmental objections. "If there were very serious environmental hazards or any apprehension or evidence, then we would not have got the environment clearance even earlier," he explained.

The Jaitapur plant, once operational, will house six nuclear reactors, each with a capacity of 1,730 MW, totaling 10,380 MW — accounting for 10 per cent of India's 100 GW nuclear energy target by 2047. Dr. Jitendra Singh also highlighted the upcoming Gorakhpur Nuclear Power Plant in Haryana, marking India's first nuclear project in North India.

GSPL Board approves proposal to lay Anjar-Palanpur pipeline

New Delhi, India: The Gujarat State Petronet Limited (GSPL) Board has approved GSPL's proposal to lay Anjar - Palanpur pipeline as an expansion of GSPL's High Pressure Gujarat Gas Grid proposal under Regulation 12 (2) of NGPL Authorization Regulations. The starting point will be Anjar, Gujarat emanating from 36" Mundra - Anjar pipeline of GSPL's High Pressure Gujarat Gas Grid and the termination point will be at Palanpur, Dist. Banaskantha, Gujarat connecting MBPL. The pipeline diameter will be 30 Inches (Anjar - Palanpur Spurline), with a length of 274 km.

The capacity of GSPL's high pressure Gujarat Gas Grid shall be ~44.76 MMSCMD*, after subject expansion of ~12 MMSCMD. (*This capacity is accepted as provisional and the final capacity shall be determined as per the regulation on capacity determination for natural gas pipeline as notified by the Board). The project completion schedule of the above expansion is 3 years from the date of this communication.

Govt initiates five pilot projects for using Hydrogen in buses and trucks

New Delhi, India: As part of the National Green Hydrogen Mission, the Government has initiated five pilot projects for using Hydrogen in buses and trucks. Earlier the Ministry of New and Renewable Energy had issued guidelines for implementing Pilot projects in the Transport Sector under this Mission.

Accordingly, the proposals were invited for different types of hydrogen-based vehicles, routes, and hydrogen refueling stations. After detailed scrutiny, the Ministry of New and Renewable Energy has sanctioned five pilot projects consisting total of 37 vehicles (buses and trucks), and 9 hydrogen refueling stations. The vehicles that will be deployed for the trial include 15 hydrogen fuel cell-based vehicles and 22 hydrogen internal combustion engine-based vehicles. These vehicles will run on 10 different routes across the country viz., Greater Noida – Delhi – Agra, Bhubaneshwar – Konark – Puri, Ahmedabad – Vadodara – Surat, Sahibabad – Faridabad – Delhi, Pune – Mumbai, Jamshedpur – Kalinga Nagar, Thiruvananthapuram – Kochi, Kochi – Edappally, Jamnagar – Ahmedabad, and NH-16 Visakhapatnam – Bayyavaram. The above projects are awarded to major companies like TATA Motors Ltd, Reliance Industries Limited, NTPC, ANERT, Ashok Leyland, HPCL, BPCL, and IOCL.

The total financial support for selected projects made available will be around ₹208 crore from the Government of India. These pilot projects are likely to be commissioned in the next 18-24 months, paving the way to the scaleup of such technologies in India.

The thrust area for providing support under the scheme is the development of commercially viable technologies for the utilization of hydrogen in the transport sector as fuel in buses and trucks and supporting infrastructure like Hydrogen refueling stations.

One of the objectives of the Mission is to support the deployment of Green Hydrogen as fuel in buses and trucks, in a phased manner on a pilot basis. These pilot projects can demonstrate safe and secure operations, assess the effectiveness of hydrogen-based vehicles and refueling stations, validate technical feasibility and performance, and evaluate their economic viability, thereby leading to hydrogen-based vehicles and hydrogen refueling stations under real-world operational conditions.

ONGPL signs Share Purchase agreement for 100% Acquisition of Ayana Renewable Power

Mumbai, India: ONGC NTPC Green Private Limited (ONGPL), a 50:50 joint venture between ONGC Green Limited (OGL) and NTPC Green Energy Limited (NGEL), has signed a Share Purchase Agreement (SPA) on 12 February 2025 to acquire a 100 per cent equity stake in Ayana Renewable Power Private Limited (Ayana). The agreement was signed with National Investment and Infrastructure Fund (NIIF), British International Investment Plc (BII) and its subsidiaries, and Eversource Capital. The transaction is valued at ₹195 billion (USD 2.3 billion).

Ayana, a leading renewable energy platform, has approximately 4.1 GW of operational and under-construction assets, strategically located across resource-rich states. Its portfolio is backed by high-credit-rated off-takers such as SECI, NTPC, GUVNL, and Indian Railways.

This acquisition marks ONGPL's first strategic investment since its inception in November 2024, underscoring its commitment to accelerating the renewable energy transition. The deal aligns with the broader vision of its parent companies—ONGC and NTPC—to achieve net-zero targets by 2038 and 2050, respectively. ONGPL will

now leverage Ayana's platform for further expansion and growth.

India has committed to achieving Net Zero emissions by 2070 and developing 500 GW of renewable energy capacity by 2030. NIIF has played a pivotal role in scaling Ayana as one of India's premier renewable energy platforms, supporting the Government of India's vision for clean energy transition. Established by BII in 2018, Ayana attracted investments from NIIF and Eversource Capital in 2019, expanding its portfolio across solar, wind, and round-the-clock (RTC) projects while achieving best-in-class ESG ratings.

KEC International wins orders worth ₹ 1,267 crores

Mumbai, India: KEC International Ltd., a global infrastructure EPC major, an RPG Group Company, has secured new orders of ₹ 1,267 crores across its various businesses: Transmission & Distribution (T&D).

The business has secured NOAs/ Comfort letter for T&D projects in India and Americas such as 800 kV HVDC & 765 kV Transmission line orders, from Power Grid Corporation of India Limited (PGCIL) for Supply of towers, hardware and poles in Americas Cables, such as orders for supply of various types of cables and conductors in India and overseas.

Vimal Kejriwal, MD & CEO, KEC International Ltd. commented, "We are delighted with the substantial orders secured in our T&D business, particularly in the prestigious HVDC and 765 kV segments from PGCIL for green energy evacuation. These wins have further strengthened our T&D order book in India. We have a strong positive outlook on the growth of India's T&D market, fueled by the nation's rising energy needs and the government's unwavering drive to enhance renewable power capacity and transmission infrastructure. With these new orders, our YTD order intake stands at over ₹23,300 crores, a growth of 35 per cent vis-à-vis last year."

CIL joins hands with IIT, Hyderabad for R&D in clean coal tech

G Kishan Reddy, Union Minister of Coal & Mines (Sitting) during the signing of the agreement in the presence of P M Prasad, Chairman, CIL and Prof. B S Murty, Director, IITH in Hyderabad

Hyderabad, Telangana: Coal India Limited (CIL) has inked a memorandum of understanding (MoU) with Indian Institute of Technology, Hyderabad (IIT-H), for establishing a Centre of Clean Coal Energy and Net Zero (CLEANZ) at Hyderabad.

The joint initiative between CIL and IITH aims to develop clean coal technologies and diversification in coal utilization. Both the entities will synergize their efforts in developing cutting edge technology readiness level (TRL) for sustainable utilization of Indian coal. This is in line with the country's Net Zero commitments. The Coal Ministry is also keen in developing research capabilities in coal sector and advised to take up research projects relevant to India's coal and energy sectors.

CIL's management has green flagged a grant of Rs.98 Crores to IITH for a duration of five years for setting up this Centre of Excellence. It is anticipated that the project will be financially self-sustainable beyond the initial five year funding received from CIL.

CIL's Board earlier in July 2024 has given its nod to focus on providing grants to reputed government institutions and research organizations under R&D expenditure. The objective is to enhance research capabilities and establishment of Centres of Excellence.

The current collaborative model is an R&D endeavour under the umbrella of National Centre for Coal and Energy Research (NaCCER). This is an independent R&D unit of CMPDI, the mine development and consultancy arm of CIL.

CLEANZ envisions net zero utilization with special emphasis on low grade and rejected coal. The thematic areas under CLEANZ are enhanced coal bed methane and coal mine methane recovery, carbon capture technologies, coal gasification and syngas utilization, energy efficiency and conservation, artificial intelligence and machine learning among others.

Other salient features are training and assisting CIL officials in tech adoption, skill and capability enhancement, extraction and beneficiation technologies for critical minerals.

WABAG bags order for BAPCO Refining Industrial Wastewater Treatment Plant

Chennai, India: VA TECH WABAG, a leading pure-play water technology multinational Group has secured an order worth ~USD 14 Million (~₹121 Crores) from BAPCO Refining B.S.C (BAPCO) towards operation (O&M) of Industrial Wastewater Treatment Plant (IWTP) located in the Kingdom of Bahrain, for a period of 7 years. This state-of-the-art IWTP treats 4,400 US gallons per minute (USGPM) of Wastewater and is based on advanced Membrane Bioreactor (MBR) technology, which ensures superior treatment efficiency, meeting stringent environmental and industrial standards.

It is worth noting that WABAG is already performing the O&M of the 40 MLD Madinat Salman Sewage Treatment Plant in the Kingdom of Bahrain, since November 2018. Commenting on this order win, Mr. Srinivasan K, General Manager - Middle East Regional Headquarters (RHQ), said, "This order win is a testament to our technological excellence and our unwavering commitment to delivering world-class water solutions to the oil and gas sector globally."

Aramco completes acquisition in Blue Hydrogen Industrial Gases Company

Dhahran, Saudi Arabia: Aramco, one of the world's leading integrated energy and chemicals companies, and Air Products Qudra (APQ) has announced that Aramco has completed the acquisition of a 50 per cent equity interest in the Jubail-based Blue Hydrogen Industrial Gases Company (BHIG). The agreement brings together experts in their respective fields with the aim of providing the Jubail Industrial City area with hydrogen, including lower-carbon hydrogen, at scale.

BHIG targets the production of hydrogen, including lower-carbon hydrogen from natural gas, also referred to as 'blue hydrogen', through the capture and storage of carbon dioxide. BHIG is expected to commence commercial operations to produce blue hydrogen in coordination with Aramco's carbon capture and storage (CCS) activities in Jubail.

Ashraf Al Ghazzawi, Aramco Executive Vice President of Strategy & Corporate Development, said, "Aramco's investment in BHIG is expected to contribute to the development of a hydrogen network in the Kingdom of Saudi Arabia's Eastern Province. This network, along with our CCS hub in Jubail, can help us capitalize on emerging opportunities both domestically and globally to reduce carbon emissions, support growth, and diversify our energy portfolio."

Mohammad Abunayyan, Air Products Qudra Vice-Chairman, said, "We are proud of this partnership with Aramco and pleased to see one of the world's leading integrated energy and chemicals companies and the world's leading hydrogen supplier conclude this strategic partnership focused on generating lower-carbon intensity energy solutions guided by the Kingdom's Vision 2030."

■

"The Giga factory in Bangalore is planned to be set up in two phases"

Ashu Shinghal
Managing Director
Mahanagar Gas Limited

The Government of India is promoting the use of LNG to reduce pollution from its trucking industry which are responsible for one third of transport related CO_2 emissions. CO_2 emissions from trucks are estimated to reach 800 million tons by 2050 with current trajectory, out of which Heavy Duty Trucks will account for over 50 per cent of these emissions. Mahanagar Gas Limited, one of the India's leading Natural Gas Distribution Company, has taken various steps towards India's Net Zero commitment. In a free-wheeling interview with **Oil Gas & Power,** ***Ashu Shinghal, Managing Director, Mahanagar Gas Limited,*** talks about the various measures undertaken and also reveals expansion and growth plans.

How would you describe the journey of India in pursuance of its transition to green energy?

India is actively striving to achieve net-zero emissions by 2070 and is taking significant strides towards this goal through various initiatives. The government's ambitious target of achieving 500 GW of non-fossil fuel-based energy capacity and 5 MMT of green hydrogen production by 2030 underscores India's commitment to combating climate change. India has made significant progress in its renewable energy journey with more than 200 GW (including large hydro and nuclear) of installed non fossil fuel energy capacity by Nov 2024. Additionally, the country's focus on promoting green mobility through incentive schemes is a crucial step towards a sustainable future. India's journey in energy transition is not only contributing to mitigate the climate change but also generating employment opportunities and boosting the economy. However, with India's growing energy demand, we need a balanced energy mix, incorporating both renewable and conventional energy sources to ensure energy security.

Mahanagar Gas Limited City Gas Station

What according to you are the main challenges in building a sustainable and resilient LNG infrastructure?

The Government of India is promoting the use of LNG to reduce pollution from its trucking industry which are responsible for one third of transport related CO_2 emissions. CO_2 emissions from trucks are estimated to reach 800 million tons by 2050 with current trajectory, out of which Heavy Duty Trucks (HDT) will account for over 50 per cent of these emissions. In this direction, the Oil Ministry plans to encourage the conversion of a third of existing long-haul trucks to LNG from diesel and mandate that a third of new trucks run on LNG according to a draft policy. To achieve this target, the following are key challenges for a sustainable and resilient LNG infrastructure:

- OEM's readiness to produce and sell LNG vehicles at competitive prices to ensure a reasonable Total Cost of Ownership (TCO) for transporters and logistics companies to make the switch from diesel to LNG.
- Lending facility at competitive rates by banks and financing companies
- Inconsistent state-level taxes on LNG fuel which creates pricing disparities and hinders market growth.
- Slow regulatory approvals for LNG fueling stations leading to delayed development of LNG infrastructure.

What are the various measures being taken by MGL towards India's commitment to attain the goal of Net Zero by 2070?

We, at MGL have taken various steps towards India's Net Zero commitment, some of them are as under:

- Roof Top Rainwater Harvesting System at our City Gate Stations to significantly mitigate water scarcity challenges in the region.
- Sustainable water management through the implementation of two Sewage Treatment Plants (STPs) at CGS Savroli and CGS Taloja each having installed capacity of 5 Kilo Liters per Day (KLD). Installation of Sewage Treatment Plant at two additional CGS (Mahape & Ambernath) is also being planned.
- Installed Wind Power turbine of 5KW at CGS Taloja.
- More than 90 per cent employees have been trained in Safety. More than 110 employees are trained w.r.t ESG & BRSR requirements marking a step towards Sustainable practices back home.
- Solar panels have been installed at various location of MGL offices / CNG ROs and City Gate Stations
- 1,000 TPD CBG plant to be installed at Mumbai is in discussion stage with Govt. of Maharashtra
- MGL has planned the installation of Solar Canopy at 2 CNG Stations viz., Vile Bhagad and Usarghar in FY 24-25
- MGL uses 100 per cent CNG/LNG powered CTVs/ LCVs for CNG Transportation.
- MGL has planned to develop Miyawaki forest with the help of Savali Trust for ecosystem restoration that acts as a protection against global warming. It aims at creating an accelerated forest equivalent to a 100-year-old indigenous forest within 10 years.

MGL has also disclosed its Scope 1, 2 & 3 emission for FY 23-24.

For thorough analysis of MGLs Emissions and further define the roadmap for Net Zero, MGL will shortly

Mahanagar Gas Limited CNG station

announce its Net Zero road map in line with India's commitment.

MGL had announced a partnership with Baidyanath LNG Pvt Ltd to form Mahanagar LNG Pvt Ltd. How would you describe the growth of this collaboration?

Mahanagar Gas Limited (MGL) and Baidyanath LNG Private Limited (BLNG) have formed a joint venture, Mahanagar LNG Private Limited (MLPL), to leverage their combined expertise in the LNG sector. MLPL's initial goal is to establish 6 LNG stations across Maharashtra and neighboring states. The first station, located in Aurangabad, began operations in October 2024 and expect to commission a few more outlets by the end of this FY.

In the second phase, MLPL aims to expand its network nationwide, focusing on regions with significant manufacturing, mining, and logistics activity to accelerate the adoption of LNG as a cleaner fuel.

Could you throw more light on the recent venture by MGL into cell manufacturing following the tie up with IBC US?


Mahanagar Gas Limited LNG Storage Tank

MGL entered into Share Subscription Agreement (SSA) and Shareholders Agreement (SHA) on 7th November 2024 with International Battery Company, Inc and International Battery Company India Pvt. Ltd to form a joint venture company for establishing a Giga factory in Bangalore, Karnataka for manufacture of prismatic Li-ion battery cells. MGL plans to hold around 40 per cent shareholding in the JV company. The project is planned to be executed in two phases with 500 MWh line in each phase. To start with, the cells produced will primarily cater to the two-wheeler market. The product has been designed and developed with a focus on the specific requirements of the Indian market such as long warranty, fast charging, safety and reliable performance at high temperatures, recyclability, and easy integration into battery packs.

When will the state-of-the-art giga factory at Bangalore be commissioned? Can you share details about the upcoming factory?

The Giga factory is planned to be set up in two phases with 500 MWh line in each phase. Phase I is likely to be commissioned by H1 of FY27 and the second phase by FY28. The Giga factory will be a technology agnostic plant which would be compatible with manufacturing other chemistry cells like LFP, Sodium ion and Solid state in addition to NMC. This Giga factory will be established with a total capex outlay of approx. ₹825 crores.

What are the future plans of MGL, and investments earmarked for the same?

MGL is progressively taking steps to diversify its portfolio into newer forms of energy and molecule while simultaneously strengthening its core business. The company is constantly evaluating opportunities and may plan to invest as and when it finds such opportunities worthy of investment. However, a sizeable chunk of such future investments may go into each of the new businesses that MGL has ventured into where significant opportunities exists for further business expansion across the value chain and MGL has right to win in such areas. ■

Expanded PTFE Gasket-Tape: All You Need to Know for Effective Sealing Solutions

Expanded polytetrafluoroethylene (ePTFE) tape is a robust and adaptable sealing material. The choice between mono-axial and multi-directional ePTFE tape is a critical decision that can significantly influence sealing performance. Each type has distinct advantages that cater to specific application needs, making a well-informed selection essential. Understanding these differences is key, as the correct choice can enhance sealing, minimise maintenance costs, and prolong the service life of equipment — factors that are integral to maintaining process safety and reliability.

While several industries utilize ePTFE tapes, the benefits of this sealing technology are often overlooked. Although one-piece cut gaskets are an ideal choice in many instances, there are several scenarios where ePTFE tape is the chosen sealing method.

What are ePTFE Tapes

Made from 100 per cent virgin PTFE that has been expanded or stretched in either one or two directions, ePTFE gasket-tapes exhibit outstanding chemical resistance, making them suitable for use with various aggressive chemicals and corrosive substances. Their low friction coefficient reduces wear and allows components to move freely, which is crucial for applications with dynamic parts.

Additionally, ePTFE gasket-tapes are non-reactive and inert, ensuring compatibility with sensitive environments such as food processing or pharmaceuticals, where contamination must be avoided. These tapes, which typically come with a pressure-sensitive adhesive strip on one side, are available in various sizes and spool lengths. They have the ability to conform to irregular surfaces, seal narrow or uneven spaces, and be easily used in flanges in dynamic systems where there is movement, such as a shaft or stem passing through the flange.

One of their key advantages is that they can be applied without needing to remove components like shafts or stems. Their flexibility allows them to be wrapped around these elements, ensuring a reliable seal without the need for complete disassembly, making it especially convenient for equipment where a shaft passes through the flange.

Given their versatility and effectiveness in various applications, it is essential to consider the different types of ePTFE gasket-tapes available, as well as the unique value that each provides.

Types of Tapes

Expanded PTFE gasket-tapes are available in two main styles: mono-axial and multi-directional. Each form has a distinct advantage that makes it suitable for different applications.

Mono-Axial ePTFE Tape: Mono-axial ePTFE tape, such as Teadit's 24B Tape, is extremely conformable, making it very easy to install in any flange, including those with complex geometries. Often referred to as joint sealant, its flexibility allows it to be shaped and applied with minimal effort, ensuring a reliable seal in various configurations.

Because mono-axial ePTFE tape is expanded in only one direction, it naturally spreads laterally (increases in

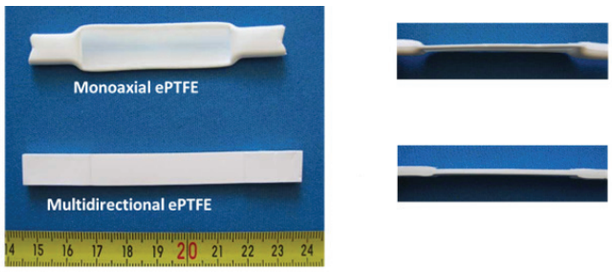

Fig 1: 10x3 ePTFE tape compressed with 30N/mm².

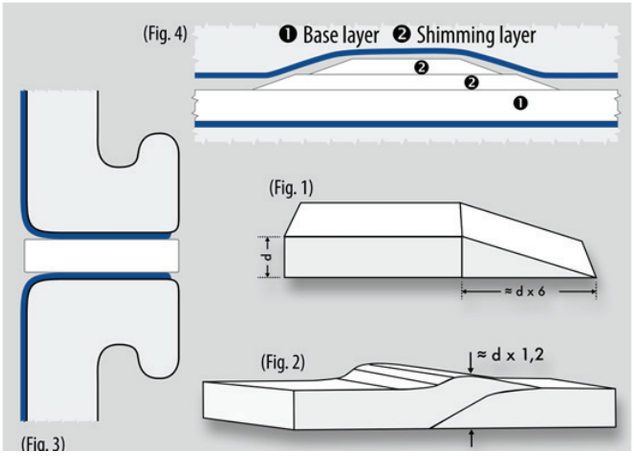

Fig 2: Instructions on how to install 25BI with shimming.[1]

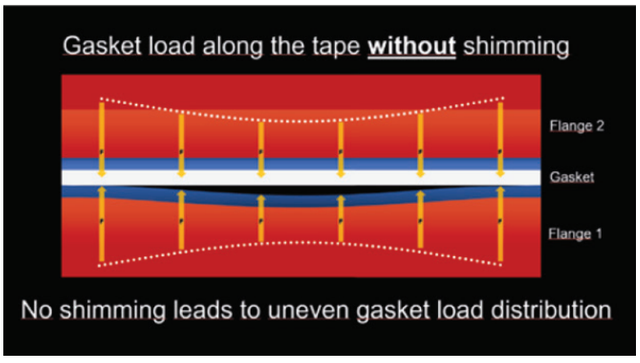

Fig 3.

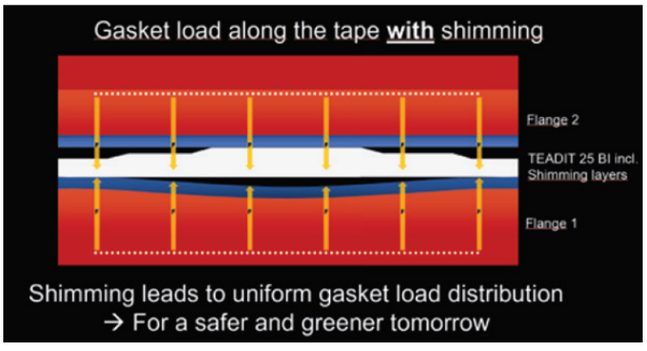

Fig 4.

width) when compressed, typically expanding to 200-300 per cent of its original width. This characteristic should be factored into sizing and installation to ensure a proper fit, as shown in Fig 1. Mono-axial ePTFE gasket tape remains an ideal solution for applications where ease of installation and adaptability are crucial.

Multi-Directional ePTFE Tape: Multi-directional ePTFE tape offers excellent strength and stability because it is expanded in two directions. This bi-axial orientation provides more consistent compression without a significant change in width, making it ideal for applications where dimensional stability is critical. For example, Teadit's 25BI tape has a unique manufacturing process that results in high tensile strength in both the longitudinal and cross directions. As a result, the tape's width does not change significantly under compression, see Fig 1. This is in stark contrast to many expanded PTFE tapes.

Glass-lined piping and equipment often have warped surfaces with significant variations that need to be compensated for by the gasket. In these cases, Teadit's 25BI multi-directional ePTFE tape is an excellent solution. Its ability to be layered (shimming) in specific areas of the flange allows it to accommodate variable warping and uneven surfaces, ensuring a reliable seal. Additionally, its resistance to creep at high temperatures makes it ideal for protecting the glass lining and maintaining an effective seal.

Customization & Versatility

One of the primary advantages of ePTFE tape is its versatility in accommodating a wide range of flange shapes and sizes. This reduces the necessity of maintaining an inventory of multiple pre-cut gasket sizes. A single roll of tape can be used for various dimensions and complex configurations. This adaptability is particularly valuable for maintenance engineers, where time constraints are often critical during repairs.

For flanges of dynamic applications, such as pumps, where internal components can pose challenges during installation, ePTFE tape provides a highly flexible sealing option. It can be applied without the need to dismantle intricate internal parts, thus significantly reducing downtime.

While ePTFE gasket-tape's unique flexibility greatly enhances its usability in various applications,

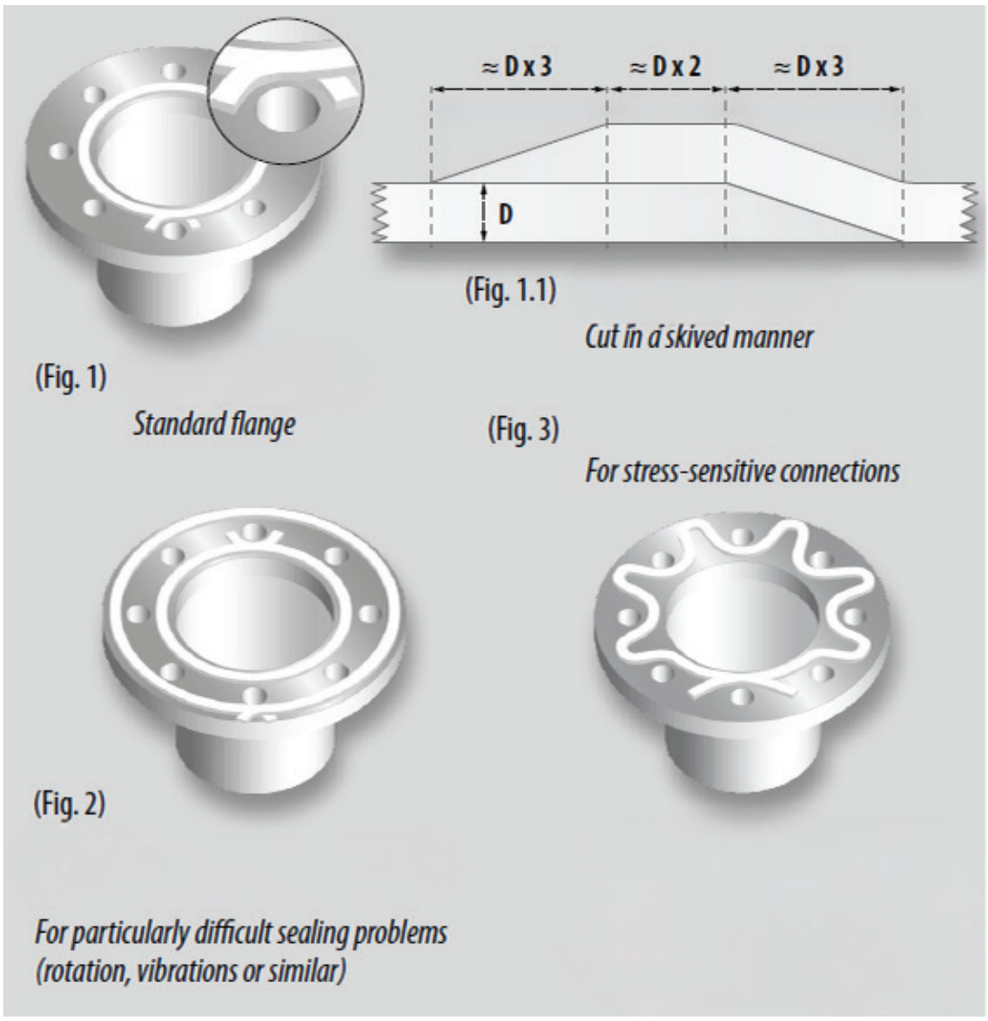

Image 1: Depiction of mono-axial tape installation.

understanding the installation techniques—particularly the distinctions between mono-axial and multi-directional tape—is also essential for achieving optimal sealing performance.

Installation & Strength Considerations

Although the installation of ePTFE tape is relatively straightforward, several important factors must be considered when using mono-axial and multi-directional tapes.

For instance, mono-axial tape can be easily crossed or overlapped at the ends, making installation simple. In contrast, the compression behavior of multi-directional material means that installers must ensure the tape's ends are correctly skived at specific angles and overlapped to avoid gaps in the seal. While this makes installation slightly more complex, it offers high durability and is especially important in sensitive applications.

It is always best to follow recommended procedural guidelines when installing ePTFE tapes. The following are examples of installation guidelines for both styles of ePTFE tape.

A Closer Look at Installation Processes

Installation Instructions for Mono-axial gasket-tape, such as Teadit style 24B:

- The sealing area must be clean and free of grease. Damaged parts must be repaired or replaced. All bolts and nuts should be well greased.
- Gradually remove the backing paper from the adhesive strip and affix sealant tape inside the bolt circle, beginning at a bolt hole.
- Complete the gasket by overlapping both ends in front of a bolt either crossed (approximately 20 mm, 1 inch – Image 1, Fig. 1) or straight with a cut in skived manner (Image 1, Fig. 1.1).
- Torque bolts in the correct sequence to the desired load. Recommended load: 25 to 30 N/mm².
- If the sealing surfaces are damaged and uneven, use the next bigger joint sealant tape size.
- For particularly difficult sealing problems (flange rotation, vibrations or similar) two strips of tape can be used (Image 1, Fig. 2).
- To avoid distortion of thin flanges and/or to avoid damage to stress-sensitive connections, apply Teadit 24B in an irregular pattern as shown in Image 1, Fig. 3.

Installation Instructions for Multi-directional tape,

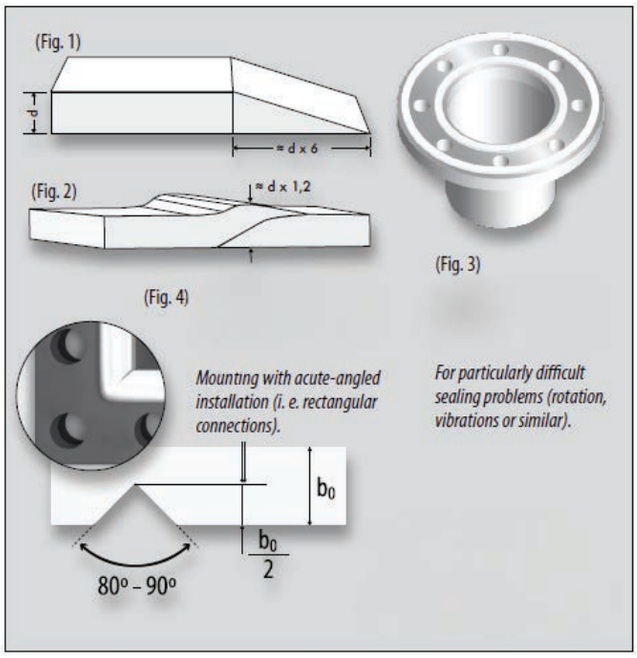

Image 2: Depiction of multidirectional tape installation.

such as Teadit 25BI:

- The sealing area must be clean and free from grease. Damaged parts must be repaired or replaced. All bolts and nuts should be well greased.
- Cut the beginning of the tape with a sharp knife in a skived manner (Image 2, Fig. 1).
- Remove the backing paper from the adhesive strip and stick the tape onto the sealing area, beginning at a bolt hole.
- Join the two ends as shown in the sketch (Image 2, Fig. 2). The bolts should be torqued in a star pattern. This should be done in three stages, torquing to approximately 25% of the total required torque value with each round. The fourth and final adjustment should be made in a circular direction to the full torque value.
- Two tape strips can be used for particularly difficult sealing problems (flange rotation, vibrations, or similar) (Image 2, Fig. 3).

Final Thoughts

Expanded PTFE gasket-tape offers significant benefits across various industrial applications, particularly when custom dimensions or emergency repairs are required. The choice between mono-axial and multi-directional ePTFE tape depends on the application's specific needs. Mono-axial tape provides flexibility and ease of installation, while multi-directional tape excels in environments where strength and dimensional stability are paramount. By understanding each ePTFE tape's unique properties, engineers can select the right one for their specific sealing requirements, improving both efficiency and safety. ■

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1. Installation Manual 25BI.pdf

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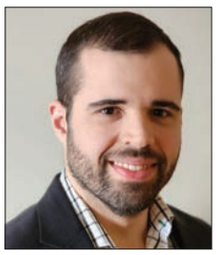

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Octamax®: For Olefinic C4 Valorization into High Octane Gasoline Blending Stream

The Octamax® technology is an innovative technology for the production of BS VI regular and premium Gasoline. In the Ethanol Blended Motor Spirit (EBMS) scenario, the synergy between Octamax® and ethanol blending aligns with the government's vision of promoting clean and sustainable fuel while ensuring the economic viability of refineries in the evolving energy landscape.

Octamax® is a state-of-the-art indigenous technology developed by IndianOil for the conversion of C4 streams from catalytic cracker or naphtha cracker to a high-octane gasoline blending stream. Octamax® is a cutting-edge technology for the production of BS-VI gasoline and to augment gasoline volume owing to the very high blending RON of its product. The first Octamax® unit with a product capacity of 55 kTA was successfully commissioned in Mathura Refinery in January 2018.

Introduction

In the recent times, environmental regulations on fuel specifications forced refiners to search for sustainable and greener technologies. Presently, Indian refineries are producing Bharat Stage (BS) VI quality fuels as per the Auto Fuel Policy mandate effective from April 2020. In the past 20 years, the fuel specifications have become stringent evident from the reduction in the sulfur content from 2000 ppm to 10 ppm in BS-VI while the RON requirement enhanced by 4 units from 87 to 91 for normal-grade gasoline and 95 for premium-grade gasoline in BS-VI.

The requirement of meeting the sulfur levels indicated above in the overall gasoline pool maintaining other parameters such as research and motor octane number (RON and MON), total aromatics, total olefins, Reid vapour pressure (RVP), etc. is quite challenging due to the associated RON loss on deep desulfurization. More specifically the production of premium-grade gasoline may not be possible with the existing processes in refineries. Hence, some additional streams with high octane will be required to bridge the gap.

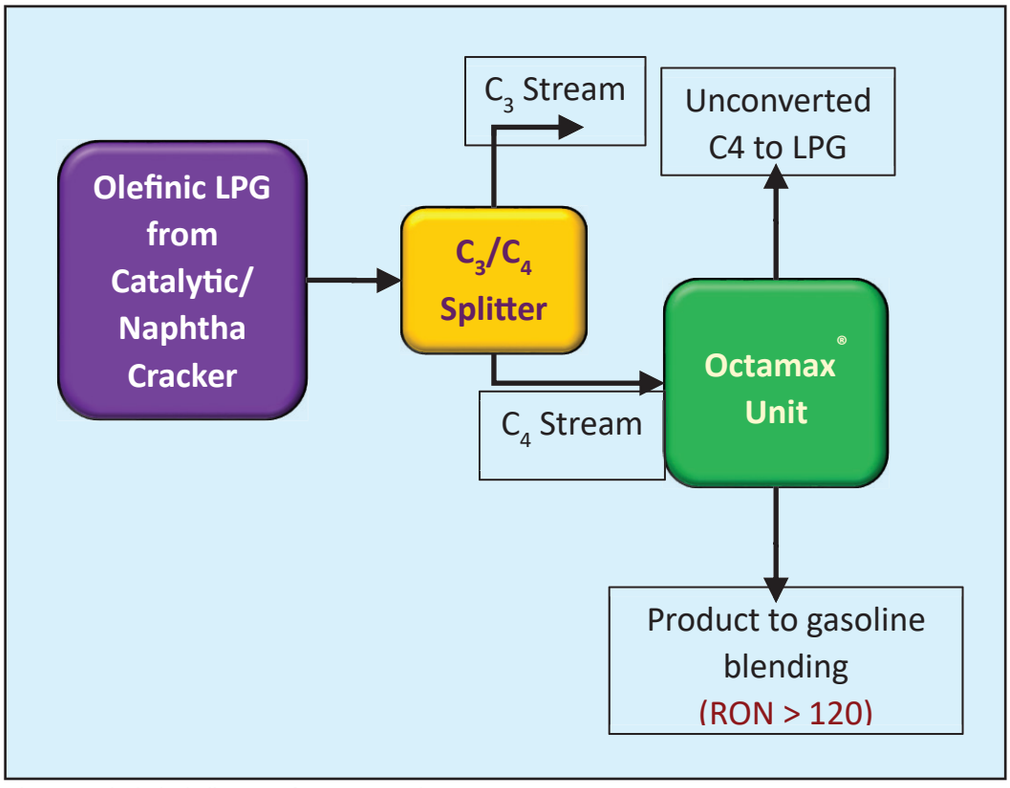

Fig. 1: A typical Block diagram of Octamax® unit

Considering the above, IOCL R&D has developed Octamax® process for the conversion of C4 streams from Cat Cracker and/or Naphtha Cracker to produce a high-octane stream (blending RON > 120), which can be directly blended into a gasoline pool. Figure 1 shows the typical block diagram for Octamax® unit. Owing to such high blending RON of Octamax® product, it gives tremendous flexibility to the refiners in meeting the stringent specifications of gasoline as well as increasing the gasoline production by blending low octane naphtha.

Process Chemistry

In Octamax® Technology, C4 olefins present in the stream from Cat Cracker and/or Naphtha Cracker are oligomerized into corresponding C8 and higher olefins. Dimerization of iso-butene to iso-octene is a predominant reaction that takes place in this technology. The reaction takes place in the presence of a heterogeneous catalyst under mild temperature and pressure conditions. The product contains predominantly iso-octene and some co-dimers and C12 oligomers. The selectivity of the desired dimer product is improved through the addition of polar compound(s) into the reactor as an additive, which suppresses the formation of higher oligomers like trimers (C12 olefins) and tetramers (C16 olefins). One of the key features of Octamax® technology is in-situ production of the polar compound(s) in a separate fixed bed Hydration reactor using a part of C4 stream as a feed.

Fig. 2: 55 kTA Octamax® Unit at Mathura Refinery

Deployment at Mathura Refinery

Octamax® unit has been successfully commissioned at Mathura Refinery in January 2018 (Fig 2). The Octamax® unit at Mathura Refinery is a true showcase of indigenous technology as all the activities, from concept to technology development followed by preparation of BDEP, cost estimation, and commissioning, are based on the in-house efforts by IndianOil. The performance of the Octamax® unit with respect to blending RON and yield of the product is found to be better than design estimates since commissioning. A product blending RON of 122 is obtained consistently since commissioning. Figure 3 shows the time on stream vs. Blending RON of the product for Octamax® unit at Mathura Refinery since its commissioning. The consistent production of such a high RON stream since commissioning has enabled Mathura Refinery to augment its gasoline pool with respect to both quality and quantity. Owing to its high RON and its blending in the gasoline pool, a significant quantity of low RON naphtha, typically 2.0 – 2.2 tons per ton of Octamax® product, is upgraded to the gasoline pool.

Distinctive Advantages

The Octamax® technology accepts wider range of cracked feedstocks C4 stream from FCC as well as naphtha cracker. It employs simple configuration including fixed bed reactors and a product separation column. The product obtained is a high RON and low RVP gasoline blending stream which can be utilized for direct blending without any further treatment. It is seen that cushion with respect to olefins (maximum limit 21 vol per cent) exists in the gasoline blend of the majority of Indian refineries as typically FCC gasoline is the only source of olefins in MS and there is a reduction in the olefins content of FCC gasoline due to deep desulfurization. Octamax® technology enables refiners flexibility to produce premium gasoline or augment gasoline quantity by the upgradation of low RON naphtha. In the Ethanol Blended Motor Spirit (EBMS) program, the Indian Government has targeted 20 per cent renewable ethanol blending in the gasoline pool by 2025-26. The blending of ethanol into gasoline also increases the RON, as ethanol possesses a high octane number. However, EBMS specifications require a 4-unit higher RON (95) compared to unblended gasoline (91) to meet the performance, emissions, and durability standards of

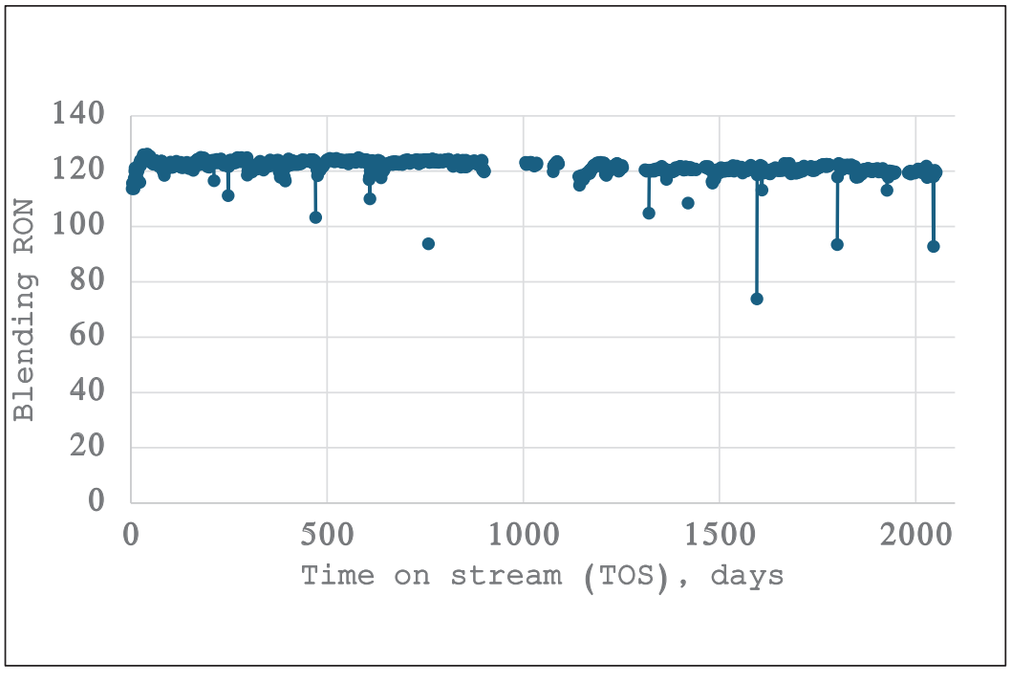

Fig.3: Performance of Octamax® Unit at Mathura Refinery in terms of its' product BRON

modern engines. Additionally, ethanol increases the Reid Vapor Pressure (RVP) of the gasoline blend, which can affect volatility and drivability. The Octamax® product, with its high RON and low RVP, will continue to play a pivotal role in the EBMS scenario by augmenting gasoline volume, particularly by increasing the base gasoline pool before ethanol blending, thereby helping refiners meet the desired fuel quality and regulatory requirements.

Octamax® is a promising environment-friendly technology as it doesn't use any hazardous chemicals and produce any effluent having adverse impact on the environment. It is superior to conventional Alkylation technology as it is green and environmentally benign with lower CAPEX and OPEX. It enables production of cleaner Gasoline meeting BS-VI specifications and thus contributes towards vehicular emission reduction. Since the technology employs moderate temperature and pressure, the energy consumption per unit quantity of feed is significantly lower resulting in low carbon footprint.

Conclusion

The Octamax® technology is an innovative technology for the production of BS VI regular and premium Gasoline. The Octamax® product can be directly blended in the MS pool depending on the cushion in olefin content. The Octamax® product is derived from upgrading the low-value cracked C4 stream, which is otherwise typically blended into the LPG pool. Additionally, it upgrades low RON naphtha into gasoline, enabling refiners to significantly boost their Gross Refining Margin. Along with the augmentation of gasoline quantity, Octamax® product is also playing a key role in producing niche products such as XP100 (100 RON gasoline).

In the Ethanol Blended Motor Spirit (EBMS) scenario, the synergy between Octamax® and ethanol blending aligns with the government's vision of promoting clean and sustainable fuel while ensuring the economic viability of refineries in the evolving energy landscape. Octamax® not only augments gasoline volume but also provides an increased base gasoline pool, facilitating maximum renewable ethanol blending while meeting the desired fuel quality specifications.

Following the success of Octamax® Technology at Mathura Refinery, two grassroots units of capacity 110 kTA and 102 kTA are in the advanced stage of implementation in India with scheduled commissioning by 2026. ■

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GUEST COLUMN

The Social Cost of Carbon and its impact on Carbon Price

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Understanding the Social Cost of Carbon (SCC) in monetary terms is key to evaluating the economics of decarbonisation polices. This article explains the concept of SCC, its calculation methodologies and its significance in the policy formulation towards decarbonisation by any government. It also highlights how a governing dispensation can change the calculation methodologies to suit their line of thinking on decarbonisation i.e do less in this area if they want to.

Commentariat have gone to town with their views around the total cop out of COP29 at Baku, Azerbaijan. USD300b per year by 2035 was the agreed figure for climate finance goal against an estimated requirement of USD2-2.3 trn per year by 2030 and USD3-3.5 trn per year by 2035. Mechanisms for raising these funds were also not clearly laid out. Operationalization of the Internationally Transferred Mitigation System (ITMOs) to make the cross border trade in carbon credits expedient and thus establish a bumpless cross border climate related flow of finance is still in the lurch.

Baku is only the latest in the failures of COPs'. COP21's promise of the "New Collective Quantified Goals" to go beyond Paris' USD100b/year did not actually go anywhere. The narrative is always stuck at "North is encouraged to help the South". Nothing more really!

Moral of the story – the South needs to help itself!

We need to set our own house in order as far as climate financing is concerned. India is one of the most deeply impacted countries. We were ranked as the 5th most vulnerable country to climate change by the Global Climate Risk Index 2019. Millions of dollars are spent every year in dealing with the impacts of climate change – floods, heat waves, avalanches, landslides etc. and yet, we struggle to put into place a Social Cost of Carbon, which would help shape (and justify) our decisions to pro-activatively fund preventatives schemes against climate change.

So what is the Social Cost of Carbon (SCC)? Beyond our understanding of the social cost of carbon in kind, we need to understand and determine a dollar value for it. There are established mechanisms to establish this figure.

Social Cost of Carbon is an estimate of the cost to society of an incremental ton of CO_2. It is expressed as USD/ton of CO_2. 80-90 per cent of the CO_2 continues to lurk in the atmosphere for centuries. The social cost of carbon is calculated as the net present value of the discounted stream of dollar impacts caused by an additional ton of CO_2 for any period far out into the future.

The SCC helps policy makers justify their climate legislations through a cost-benefit analysis. For example, under its Fit for 55-climate package, EU would ban all cars with IC engines by 2035. The legislation estimates 55 per cent emissions cut in the transport sector. The dollar value of the benefit from multiplying the SCC with the tonnes of CO_2 that is equivalent to the 55 per cent emission cuts, would far outweigh the regrets of stranded assets and job losses. Re-purposing the factories to manufacture EVs and reskilling of worker for re-employment would only add to the benefits. Legislation is thus justified in cost-benefit terms.

William Nordhaus (Nobel Prize, 2018) developed the first meaningful Social Cost of Carbon using a Dynamic Integrated Climate Economy (DICE) model that made an integrated assessment of the cost of climate change to the society. While DICE (and RICE – Regional ICE) are still in extensive use, more versatile models have now been developed.

Two key components of the models for computing the SCC are the Damage Function and the Discount Rate.

Damage function: This captures the economic reality of climate change due to global warming. It defines the relationship between temperature rise and GDP loss. GDP loss could be from the impacts on various sectors - infrastructure, human health and mortality, agricultural productivity (and multi factor productivity), land use, biodiversity etc. Effect of temperature rise on all these sectors are estimated and rolled up as the overall impact on the GDP.

There are significant variations/uncertainties in outcomes from different models. For example, Nordhaus predicts a 1-2 per cent decline in GDP from a 3ºC rise in temperature; Burke et al predict ~12-13 per cent decline for the same temperature rise. Multiplier impacts of the "tipping points" (thawing permafrost, melting glaciers, reduction in Earth's albedo etc.) may be modelled differently, or not at all, by various damage functions, which may lead to different outcomes.

Discount Rate: A high future damage prediction would mean the Present Value of damage is high and, therefore, the discount rate used in the model would be low. Applying a higher discount rate would mean that that future damages/impacts are discounted more and so they are shown as smaller in Present Value.

For instance, the Obama administration had kept the discount rate at 3 per cent and had computed the SCC at USD43/tCO_2. The previous Trump administration increased the discount rate to 7-10 per cent. As a result, the SCC came down to a range of USD3-USD5/tCO_2. Further, his team limited the damage function to only consider the American landmass/population, thus effectively decoupling the impact of American emissions on the rest of the world.

The SCC @USD3-5/tCO_2 helped the Trump administration discontinue some of the climate legislations that were promulgated by the Democrats, particularly the legislations regarding coal fired power plants and vehicle emissions.

At present, the Biden administration uses an SCC of USD51/tCO_2. In 2022, EPA (Environmental Protection Agency) suggested an upward revision to USD190/tCO_2 using an average SCC of its own modelling / meta-analysis, Climate Impact Lab model and the Give Model (Greenhouse Gas Impact Valuation Estimate). Averaging does help with reduction of the uncertainties from a single model.

It will be interesting to watch what view Trump 2.0 takes on Social Cost of Carbon. A repeat of the stance that the Trump administration had taken in its 2017-2021 term will make many of Biden administration's policies on CO_2 reduction uneconomic. The world will watch, and indeed hope that science will inform decision making in this regard by Trump 2.0!

Two approaches to fixing the discount Rate: Economists use two approaches to choose a discount rate: the descriptive approach and the normative approach.

In the descriptive approach, discount rates are based on the average interest rate prevalent in the economy over the last 10-30 years. While economically robust, this

approach has morality issues; the future generations who would eventually suffer the damage have no say in it!

Some economists have, therefore, propounded the normative approach or the ethical approach to fixing the discount rates. It takes into consideration intergenerational equity, imposes the burden of morality on the current policy makers, and forces them to consider discount rates they ought to take to save the future generations rather than just an economic number generated by historical analysis. This makes sense because of the "nonlinearity and transience in the damage caused by global warming". As early as in 2006, Nicholas Stern in his famous Stern Review of Climate Change, considered a discount rate of 1.4 per cent.

Impact of Social Cost of Carbon on the carbon price

Carbon pricing is an efficient way of dealing with a negative externality like climate change as it provides a price signal that helps internalize the negative externality and change behaviours while creating a revenue stream that can fund green initiatives.

In theory, the carbon price should be equal to the social cost of carbon – if the society incurs a damage worth USD50 for one ton of additional CO_2 emission, it should also cost USD50 to emit that same ton of CO_2. In practice, however, this is difficult to achieve. Carbon pricing – Carbon Tax or Emissions Trading Scheme (Cap and Trade), today covers only 23-25 per cent of the global emissions.

Hoel and Kverndokk (1996) came up with a model to explain the relationship between SCC and Carbon pricing and recommended considering the dynamic nature of SCC. The authors described the time progression of two curves (Emissions versus Time) as the economy continues to grow:

- "Business as Usual" with no carbon tax. This path has a higher peak (hump) of emissions but considers the end of the fossil fuel era at some finite time when the cost of technology (the backstop technology) to do so become economic.

- The second scenario is with a carbon tax. This has a lower peak emissions' hump but has a long drawn tail of fossil fuel use.

The benefit of the path with carbon tax is better because it does not rely upon "a technology" which would help the world stop the use of fossil fuels completely when such a technology indeed becomes economically feasible to deploy. The probability of such a breakthrough, even if not completely absent, would be very low. Further, up until that happens, the emissions would be spewed unabated as the fossil fuel use grows with a growing economy.

For developing countries like India, the high tax based on SCC would make it difficult to resolve the trilemma of energy security, energy equity and environmental sustainability in ways that do not expose the population at large to higher levels of poverty and misery.

That said, it should never be the case that there is no disincentive at all against emitting CO_2 without a cap for various player in the economy, especially when the Social Cost of Carbon is estimated to be the highest for India .

One estimate has put the Social Cost of Carbon for India at USD86/tCO_2 (Ricke et al., 2018). It is difficult to say if this is the right number unless bodies like Niti Ayog and/or TERI carry out a deep analysis. The sooner we did it, the easier it will be to justify the government policies framed for spending on projects in Carbon Capture and Storage, Green Hydrogen, 2nd/3rd/4th generation biofuels etc. At present, these projects that are so needed for CO_2 abatement, are NPV negative without considering a Social Cost of Carbon. Government funding of research in possible technologies that can prevent climate change and, indeed, generate preventative and control barriers against its impacts will be justifiable if we can factor in a Social Cost of Carbon in the economics of these initiatives. ■

Challenges in Inspections for Small Modular Reactors

The nuclear reactor technology has been evolving over time. While the design and construction of all types of Small Modular Reactors (SMRs) can be taken care of by the existing Codes, Standards and Regulatory guides developed by many countries, Inservice Inspection poses significant challenges to SMRs and especially Non-LWR SMR designs in order to ensure as a minimum, at least the same degree of protection of the environment and public health and safety and the common defense and security that is required for current generation of light-water reactors.

A detailed and effective regulation of the design, siting, construction, and operation of commercial nuclear power facilities across the world, have been protecting public health and safety and the environment for more than 50 years.

The nuclear reactor technology has been evolving over time, and continuing, requiring review of the current approach of regulations and making requisite changes when needed. For example, when the passive features were introduced, more than decade ago, in reactors such as AP1000, terming them as Advanced Reactors, it required changes in regulatory approach with respect to safety classification of Structures, Systems and Components (SSC). These were with a caution that such changes are expected to ensure as a minimum, at least the same degree of protection of the environment and public health and safety and the common defense and security that is required for the current generation of Light-Water Reactors (LWR). It was further emphasised that advanced reactors will provide enhanced margins of safety and/or use simplified, inherent, passive, or other innovative means to accomplish their safety and security functions. It was made clear that advanced nuclear power reactor designs will address all current regulations, including those related to severe accidents, beyond-design-basis accidents, defense in depth, and probabilistic risk assessment requirements. Depending on the design attributes of the SMRs, (SMRs typically have a power capacity of up to 300 MW(e) per unit) especially those belonging to different non-LWR technologies, regulations and policies may be addressed in a different manner than for traditional LWRs.

Most of the code, guides and standards for nuclear power plants existing as on date have been developed and evolved over the last 40 to 50 years, with a primary focus on the technology of large light water reactors. However in the last few years, the market is shifting towards Small Modular Reactors (SMR) technologies. As SMRs use innovative safety technologies, including passive and inherent safety features, various types of fuel and coolant, and various approaches to all aspects of a reactor lifetime, such as construction, operation, waste management, decommissioning and transportation, the SMRs are quite different compared with the current fleet of large, land based water cooled reactors.

Therefore, the existing regulatory, design and construction codes and standards need to be adopted, where needed, to meet the specific requirements of SMR design, construction & operational requirements. One specific area, in this regard is the deployment of Non Destructive Examinations (NDE) to be carried out on the structure systems and components of SMR both during construction, preservice inspection and Inservice inspection.

This paper examines the challenges and current status of works carried out by US NRC and ASME in this regard, as since inception, US NRC & ASME have been leading organisations in the development of codes, guides, and standards for nuclear technology and what is way forward for designers and constructor of SMRs.

Current Status of SMR Designs

Apart from the units already deployed in China and the Russian Federation, there are more than 68 active designs of SMRs, according to the IAEA's Advanced Reactor Information System Database (ARIS), at different stages of development around the world. They are being developed across various reactor technologies, including water cooled, gas cooled, liquid metal cooled and molten salt designs. Following is the distribution in terms of numbers:

- Land-based water-cooled reactors - 14

Table-1: Current ISI CODES in use for LWR and PHWR			
USA	ASME Section XI	First published in 1970. Applicable for Light water Reactors (PWR and BWR)	
Canada	CSA 285.4	▪ First published in 1978. Applicable to CANDU (PHWR) Reactors	Similar to the ASME Section XI
		▪ Defines inspection requirements for fuel channel pressure tubes, feeder pipes and steam generator tubes at CANDU plants.	
		▪ Uses risk–informed approach to establish the scope due to large number of pressure retaining components in PHWR plants	
France	RSE–M code Surveillance and Operation of PWR Mechanical Components Code	▪ First published in July 1990	
		▪ Covers pressure-retaining components and their supports classified in safety classes 1, 2 and 3 of the safety analysis report	
		▪ Objective to ensure the integrity and leak tightness	
		▪ Defines the rules applicable to maintenance operations in order to ensure the integrity and leak tightness of these components.	
Russia	Federal Nuclear and Regulatory Authority of Russia, PNAE G-7-008, 010 and NP-089-15 codes	▪ First Issued in early 1970s and the second, upgraded series from 1987–1990	Some similarities with ASME Section XI; but content not as detailed as ASME Section XI
		▪ No standalone Russian ISI code existed until March 2016	
		▪ NP–084–15: Rules for in–service inspection of base metal, welds and cladding of equipment, pipelines and other elements of NPPs was published in 2016	
		▪ A separate structure, methodology of preparation, acceptance and validity in comparison with codes and standards of other countries.	
		▪ Interval of ISI changed from the previous 4 years to 10 years (except the beginning and the end of the design life time).	
		▪ Allows distributing the examinations within the interval.	
Germany	German Safety Standard KTA 3201.4 the Inservice Inspections and Operational Monitoring of Components of the Primary Circuit in NPP	First published in 1982,	
		▪ Deals with the primary circuit components, mainly but not exclusively Class 1 components.	
		▪ Monitor the presumed consequences of potential operational damage mechanisms.	
		▪ The inspection interval is typically 5 years.	
		▪ First occurrence of an indication or growth of an existing indication requires the cause must be determined and a safety analysis performed.	
		▪ The safety analysis comprises stress analysis, fracture mechanics evaluation, laboratory experiments, checks on similar components in the case of indication of systematic defects, and the evaluation of experience gained from other plants.	

Table 2: US NRC Applicable Documents on PSI and ISI of NPP: LWR Design (PWR and BWR)	
Document	**Description**
10 CFR 50.34 (b) (6) (iv)	Requires an application for an operating license to include, in the final safety analysis report, plans for conducting normal operations, including maintenance, surveillance, and periodic testing of structures, systems, and components (SSCs).
10 CFR Part 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants	Establishes quality assurance requirements for the design, manufacture, construction, and operation of those SSCs that prevent or mitigate the consequences of postulated accidents that could cause undue risk to public health and safety
10 CFR 52.79 (a) (29) (i)	Requires an application for a combined license to include plans for conducting normal operations, including maintenance, surveillance, and periodic testing of SSCs.
10 CFR Part 50, Appendix A, GDC 1, "Quality Standards and Records,"	Requires, in part, that SSCs important to safety be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety function to be performed. Where generally recognized codes and standards are used, GDC 1 requires that they be identified and evaluated to determine their applicability, adequacy, and sufficiency and be supplemented or modified as necessary to assure a quality product in keeping with the required safety function.
10 CFR 50.55a	Incorporates by reference ASME Code Sections III, "Rules for Construction of Nuclear Facility Components", Section XI, and the ASME Operation and Maintenance (OM) Code, mandates that systems and components of boiling and pressurized water-cooled nuclear power reactors meet these codes, and provides conditions on their use. Although 10 CFR 50.55a is not currently applicable to non-LWRs, these codes and the NRC's conditions on their use may be relevant guidance for non-LWRs, similar to the GDCs in Appendix A to 10 CFR Part 50.
RG 1.28, "Quality Assurance Program Criteria (Design and Construction)"	Provides guidance for the establishment and execution of Quality Assurance programs for nuclear power plants during their design and construction.
RG 1.193 "ASME Code Cases Not Approved for Use"	Lists the Code Cases for ASME Code, Section III, Section XI, and the ASME OM Code that the NRC has not approved for generic use in 10 CFR 50.55a.

- Marine-based water-cooled reactors - 6
- Gas cooled reactors-14
- Microreactors -13
- Molten salt reactors -11
- Liquid-metal, fast-neutron reactors – 10

SMR Construction Code & NDE

Many SMR designs employ a single pressure vessel which serves multiple functions like it houses a reactor vessel, steam generator, pressuriser etc.

They are also made of the same materials that are given in the ASME Section- II. As all these are nuclear pressure vessels, they can be designed, fabricated, inspected and tested using existing ASME Section III code. Some other SMR designs have high-temperature operating conditions, and for such SMRs, ASME Section 3 NH, code which is meant for Elevated Temperature Service, can be readily deployed.

As SMRs are expected to be mainly shop fabricated and transported as modules, the typical inspection regime carried out for the structure and components of existing large water reactors would be easy to implement for

SMRs including Non LWR SMRs structures and components and meeting the existing requirements would not pose any problem. Hence no change is envisaged in the existing construction and inspection codes used for large LWR and PHWR technology in this regard.

In Service Inspection (ISI) Codes for Current LWR & PHWR Reactors

As the components during the operation of a Nuclear Power Plant (NPP) begin to age and degrade, and may eventually require repair or replacement, periodic inspections of components are required for detection of degradation and thereby maintaining the safety of operating nuclear power plants. Codified procedures for

inspecting nuclear power plant components have been developed by many countries and have been in use ever since Section XI of the ASME BPVC was first published in 1970. Following are some of the major features, and as a typical ISI Code include:

Access for Inspection: Designing the system to permit inspection and possible repairs.

Preservice Inspection (PSI) Requirement: A complete examination prior to start-up to serve as a baseline for future examinations.

Periodicity: The establishment of inspection periods and levels of inspection for given components or sections of components.

The following table provides the brief details about ISI codes currently used in some of the major countries for carrying out ISI of components of large LWR and PHWR power reactors.

Most of the requirements in above ISI Codes are weld centric and cover only three methods of examination — visual, surface, and volumetric — and the type used depends on the safety significance of the component.

Table 2 provides the list of US NRC documents which necessitates the development and execution of Pre-Service Inspection (PSI) and ISI programs for current large size LWRs as part of mandatory regulatory requirement.

In Service Inspection of SMR Challenges

As stated above, the design and construction of SMR structures and components is not much challenging and at the best would need a small innovative approach. However, the integrated vessels etc., of LWR type SMRs could be very small for the currently available ISI inspection tools and regulatory approved techniques. Further, ASME Section-1 Division -1 rules are meant only for LWR reactors and are not applicable for Non-LWR SMRs such as liquid metal molten salt and high-temperature gas designs. Following are the major concerns:

Design: SMRs, especially Non LWR SMR designs are radically different from current LWR or PHWR and their system, structure and component, have different safety functionalities and different risk consequences that need to be evaluated on a case-by-case basis for the particular design.

Fuel Cycle: Current LWR Fuel Assembly designs, having a typical fuel cycle of 18 to 24 months, are perfect for meeting the 10-year in-service inspection cycle as required by ASME Section-XI Division-1. However, SMR designs are going for fuel cycles of four years or more which will be difficult to implement Section-XI Division-I requirements.

Deterministic Approach: Current Division I rules of Section XI, in-service inspections were developed in a deterministic approach which may be difficult to implement in many SMR designs, especially Non LWR SMRs which are radically different in the current designs of LWR and PHWR which are having more or less standard arrangement of Primary side system, structure and components.

Creep: Many SMR designs will operate at much higher temperatures than current LWR or PHWR, effectively putting them into creep range. There are no LWR plants currently operating today that have to deal with creep, though in PHWR, Coolant tubes (which are in reactor pressure vessels) face creep issues and a provision for periodic creep adjustment is provided. Nevertheless, NDE cannot effectively take care of Creep.

Current Solution

Long back, ASME Section XI, Division 2 was written and published for mainly to be used for the Pebble Bed Modular Reactor. However, the Pebble Bed Modular Reactor, after initial enthusiasm, could not progress much, hence this seminal work remained in the cold all along. However, with the recent shift in focus ASME has rewritten this code titled "ASME XI Division 2 Reliability Integrity Management (RIM)" for providing solutions to Inservice Inspection challenges of SMR technologies to manage and maintain new technological processes and to ensure their operational safety. Following are the main features of this code:

- RIM is a detailed process to establish operational monitoring criteria for expected degradation mechanisms that are expected to occur, regardless of the reactor technology, (e.g., Molten Salt, HTGR, Liquid Metal, etc.)
- Technology neutral process, therefore applicable to all reactor designs and technologies.
- RIM criteria may be established by both deterministic or probabilistic methods.
- RIM requires Monitoring and NDE (MANDE) to be assigned to SSC, based on expected credible degradation mechanisms in concert with an individual SSC's contribution to risk for safe plant operation.
- Any SSC that could affect plant reliability must be scoped into the RIM program.

Table 3: US NRC Applicable Documents on PSI and ISI of NPP : Non LWR Design	
Document	**Description**
RG 1.232, "Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors"	Describes the NRC's proposed guidance on how the GDCs in 10 CFR Part 50, Appendix A, may be adapted for non-LWR designs. This guidance may be used by non-LWR reactor designers, applicants, and licensees to develop principal design criteria (PDC) for any non-LWR designs, as required by the applicable NRC regulations, for nuclear power plants. The RG also describes the NRC's proposed guidance for modifying and supplementing the GDC to develop PDC that address two specific non-LWR design concepts: sodium-cooled fast reactors (SFRs), and modular high temperature gascooled reactors (MHTGRs).
RG 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors"	Describes the NRC's proposed guidance on using a technology-inclusive, risk-informed, and performance-based methodology to inform the licensing basis and content of applications for non-LWRs, including, but not limited to, molten salt reactors, high-temperature gascooled reactors, and a variety of fast reactors at different thermal capacity.
(ASME Code), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," Division 2	Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants.

- RIM is an on-going "Living Program" and applies over the entire plant life cycle for risk significant SSC. It also substitutes for plant ageing management programmes.
- Non-Safety Related SSC classified under historic SSC classification guidance as Non Safety Related, but are deemed risk significant for SMRs, are required for inclusion in the RIM program.

Further Table 3 provides a summary of the US NRC Applicable Documents on PSI and ISI of NPP: Non LWR Design.

Conclusion

While the design and construction of all types of SMRs can be taken care of by the existing Codes, Standards and Regulatory guides developed by many countries, Inservice Inspection poses significant challenges to SMRs and especially Non-LWR SMR designs in order to ensure as a minimum, at least the same degree of protection of the environment and public health and safety and the common defense and security that is required for current generation of light-water reactors. Reliability Integrity Management (RIM), published in Division II of BPV XI, is one such solution. However, the RIM programs for one design may not be appropriate for another reactor design which will be a new experience for Inspection agencies which plan and execute current ISI for LWRs and PHWRs, where, in general, large similarity exists from one plant to another with respect to ISI. The role of inspection agencies is expected to be significantly different because of the necessity of having specialised & some specific individualised knowledge required for each particular SMR design. ■

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Hydrogen Storage and Transportation: An overview

Hydrogen can be stored in various physical and chemical forms. We can decipher following class of materials for storage of Solid Hydrogen, viz. Reversible Metal Hydrides (LaNi5H6, FeTiH2, Mg2NiH4), Complex Hydrides (NaAlH4, LiAlH4, NaBH4), and Porous Materials, i.e. nanotubes of carbon and zeolites. These technologies are fast emerging to fulfil the requirements of the vehicle industry.

Cryogenic vessels have been commonly used for more than 40 years for the storage and transportation of liquefied gases including liquid hydrogen. To manage storage at - 253°C, for large inventories (> 100 m^3 volume) double-walled vacuum-insulated pressure tanks are used. Such vessels consist of an inner pressure vessel and an external protective jacket. The volume between inner vessel and jacket is filled with compressed perlite under vacuum. Perlite is an inorganic amorphous volcanic glass that represents a good trade-off between cost and insulation properties. For smaller cryostats (< 100 m^3) a multi-layer insulation MLI is used instead. This insulation is composed of several layers of a metallic coated plastic sheet, separated by a grid like spacer.

Hydrogen can be stored in various physical and chemical forms. Three techniques for hydrogen storage in transport vehicles are in vogue: storage in compressed gas (35 MPa or 70 MPa), storage as cryogenic liquid (20 K), and solid storage.

We can decipher following class of materials for storage of Solid Hydrogen, viz. Reversible Metal Hydrides (LaNi5H6, FeTiH2, Mg2NiH4…), Complex Hydrides (NaAlH4, LiAlH4, NaBH4…), and Porous Materials, i.e. nanotubes of carbon and zeolites. These technologies are fast emerging to fulfil the requirements of the vehicle industry.

Hydrogen tanks are typically made using filament winding processes, which highly depend on the kind of materials. Hence, varied scope is available in material selection for resin matrix systems and liner systems. Depending on the tank size and volume, carbon fibre accounts for approximately 70 per cent of the tank cost. Also, notwithstanding the environmental impact of hydrogen, mobility ought to be assessed and weighed against other modes of transportation, including the recycling of hydrogen system components at the end of their useful lifecycle like that of Fuel Cells.

To tackle such issues, thermoplastic offers a promising solution regarding hydrogen compatibility. Nano-composites have aroused keen interest amongst material scientists and physicists due to their superior mechanical, electrical, electronic, optical, magnetic, and surface properties. As such materials do have a high surface area to volume ratio, they have far-reaching implications for energy storage.

As depicted in Fig 1, the present-day scenario for hydrogen storage, include compressed hydrogen gas, cryogenic and liquid hydrogen, sorbents, metal hydrides, and chemical hydrides. The by-far established hydrogen storage technology is compressed gas storage in high-pressure tanks.

As shown in Fig 2 below, there are four conventional forms of hydrogen storage vessels with a fifth type whose design work is underway: Type I, Type II, Type III, and Type IV. The Type I vessels are all-metal (generally steel) and thus the heaviest; they are primarily used in industry for fixed use.

At 200–300 bar, Type I vessels store around 1 per cent of hydrogen globally. Type II vessels have a composite sleeve (hoop direction) over a metal liner that weighs less than Type I. Both Type I and II vessels are unsuitable for vehicle applications due to their low hydrogen storage density, caused by high mass and hydrogen embrittlement issues. A fully wrapped composite cylinder with a metal liner that functions as a hydrogen permeation barrier is used in Type III vessels. The metal liner is generally aluminium (Al), eliminating embrittlement and providing more than 5

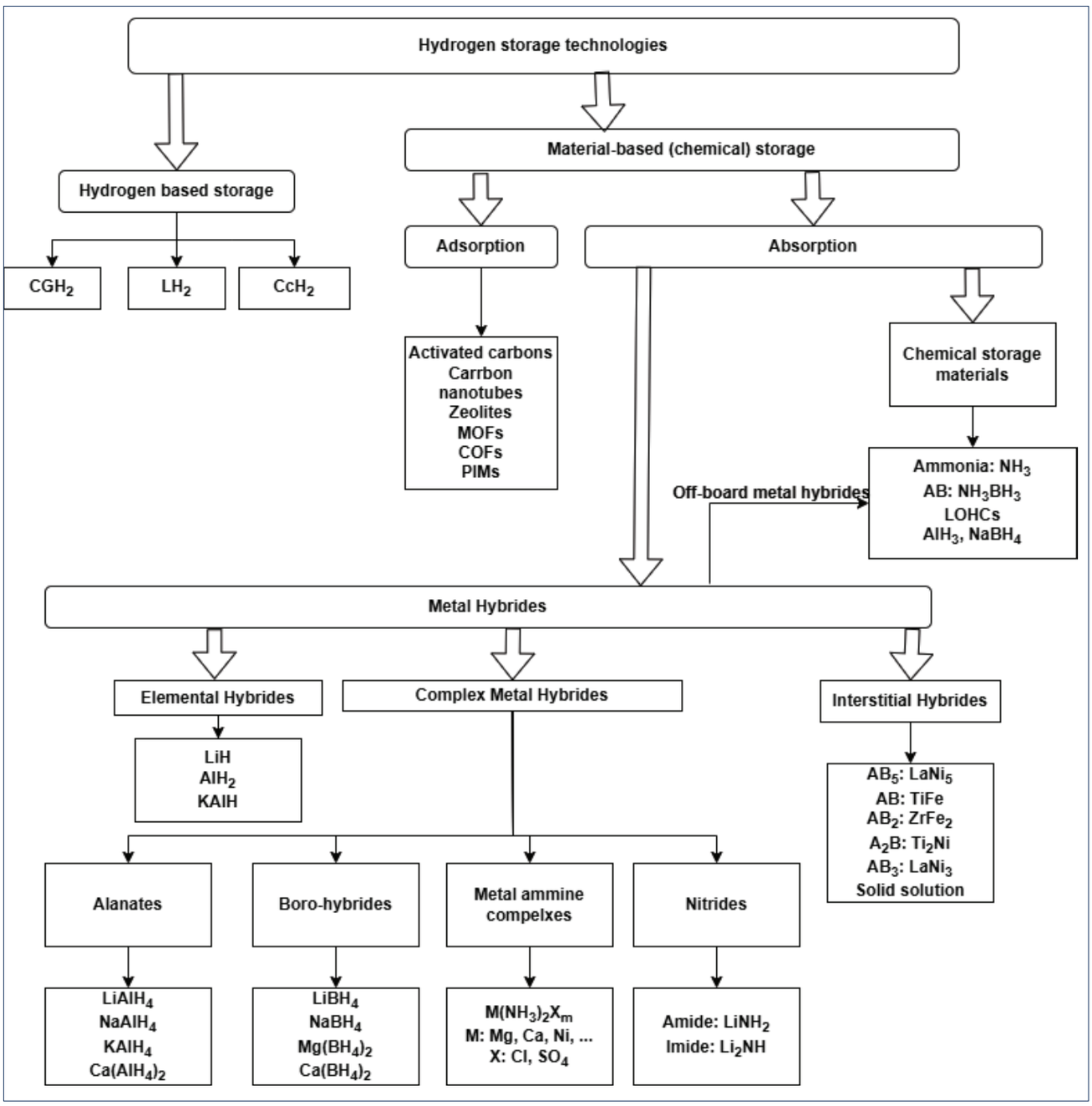

Fig 1: Different types of hydrogen storage technologies

per cent mechanical resistance.

Type III vessels have a mass increase of 25-75 per cent over Types I and II vessels, making them more suited for vehicle applications; evidently, they are quite expensive. Type III vessels have also been proven reliable at pressures up to 450 bar; however, pressure cycling tests over 700 bar continue to be a problem and a cause for concern. A fully wrapped composite cylinder with a plastic liner (usually high-density polyethylene) that serves solely as a hydrogen permeation barrier is used in Type IV vessels.

The load-bearing structure is the composite overwrap comprising carbon fibre or carbon/glass fibre composite in an epoxy matrix. Type IV pressure vessels are the lightest of the pressure vessels, making them ideal for vehicles. Hydrogen storage at 700 bar in these tanks provides a definite pathway to fuel cell vehicle application because physical storage as a compressed gas applications can hold pressures of up to 1000 bar.

Designing work for Type V tanks is underway with the incorporation of a thermoplastic liner and composite structure that are far more closely linked; the composite

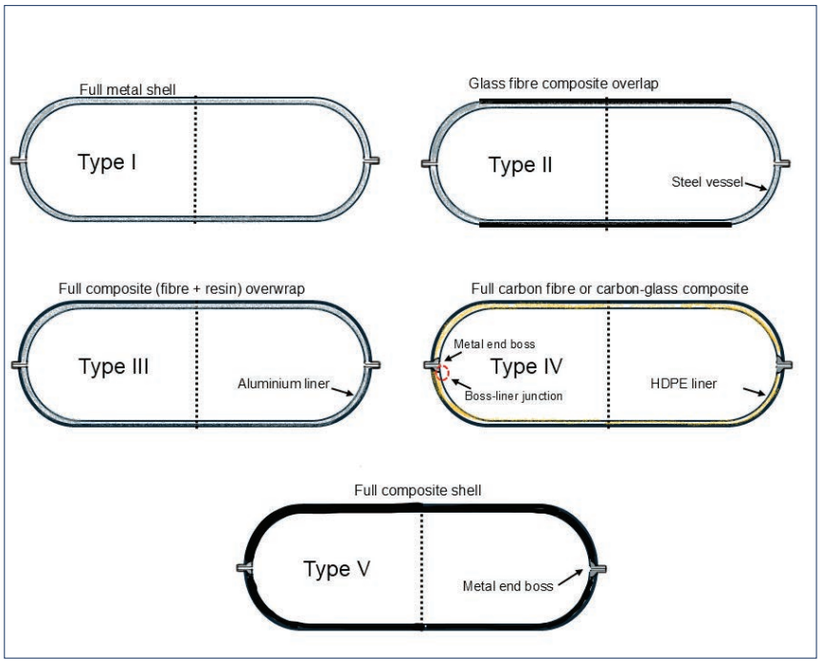

Fig 2: Types of hydrogen storage vessels (of which Type V Design is underway)

and the liner will be made from carbon/glass fibre. It eliminates the internal polymer gas barrier used in Type IV vessels and instead relies on carbon fibre laminate to provide structural properties and prevent gas leakage. Typically, the cost of storing one kilogram of hydrogen in a compressed gas storage system deduces to $500. However, the tanks become heavy and bulky, and frequent refilling is required.

Liquid hydrogen storage is a more expensive option, with higher initial costs for the custom-built tanks and insulation required to maintain low temperatures.

Metal Hydride and Chemical Hydride storage are newer technologies with higher storage densities and safety, but are prohibitively expensive than compressed gas or liquid hydrogen storage.

Hydrogen can also be stored as a cryogenic liquid at atmospheric pressure and in compressed hydrogen. Cryogenic hydrogen storage is better than compressed hydrogen gas storage because it is safer and takes up less space. When hydrogen is stored as a liquid, its volumetric density goes up. At the boiling point of hydrogen (253 °C) and atmospheric pressure, the theoretical volumetric density of liquid hydrogen (LH_2) is 70 g L1, while it is 24 g L1 and 40 g L1 for compressed hydrogen at 350 bar and 700 bar, respectively, at room temperature.

Since hydrogen has a low boiling point, it can only be stored as a liquid at low temperatures. Therefore, expensive cooling must be used. LH_2 cryogenic vessels are thus vacuum insulated to maintain such low temperatures. They typically have two walls and a vacuum between them to prevent heat from escaping, akin to jacketed piping as in 'Dowtherm' in a Process Plant of a polyester staple fibre. However, boil-off losses cannot be avoided since the heat from the environment flows into the LH_2 and moves through other parts. When making vessels for cryogenic hydrogen, one of the main goal-posts is to ensure the surface area of the liquid is at a miniscule level, so as to prevent heat from entering the liquid from the atmosphere. In the same breath, Boil-off losses pose danger if the vessel is in a confined space.

In addition to LH_2 trailers that can hold about 4000 kg of H_2, LH_2 ships can also transport H_2 worldwide. It may be noted that Cryogenic hydrogen contains a fairly low adiabatic expansion energy and thus, can mitigate implications of a sudden pressure vessel failure. However, one of the drawbacks of compressed hydrogen storage is the enormous volume and high pressures required. Furthermore, the unavoidable boil-off losses are one of the drawbacks of cryogenic hydrogen storage.

Chemical storage of hydrogen may offer higher energy densities and the plausibility of being easier to use. Several chemical systems that release hydrogen in both exothermic and endothermic ways are attracting attention for deepening studies. In order to maximise the amount of H_2 that can be stored while staying within the allowed volume range, weight, and maximum operating pressure, hydrogen storage tanks need to be made using complex methods.

Following factors ought to be borne in mind during development of Hydrogen Storage Vessels - The technical factors of HSVs is a critical factor in determining their effectiveness as a hydrogen storage solution. Several key design elements impact the technical performance of HSVs, including the materials used, the pressure rating, Alloy Steel and Aluminium are widely used materials in HSV construction due to their strength and durability. However, composite materials, such as fibre-reinforced plastics, are increasingly being used due to their lighter weight and improved resistance to corrosion.

The pressure rating of an HSV refers to the maximum pressure that the vessel can safely contain. High-pressure HSVs typically have a pressure rating of 700 bar or more, while low-pressure HSVs have a rating of 350 bar or less. The pressure rating of an HSV impacts its overall storage capacity and efficiency. The size and shape of an HSV also impacts its technical performance. HSVs come in various shapes, viz. spherical, cylindrical. The shape of an HSV can impact its hydrogen storage capacity and stability, with some shapes providing improved performance over others.

Several integrated characteristics, including progressive failure qualities, burst pressure, and fatigue lifetime, are incorporated into the design of a composite vessel. Classical Laminate Theory (CLT), thick cylinder theory, or netting analysis could be used to determine the preliminary sizes of the composite profile of hydrogen tanks. The burst pressure of the composite vessel inversely determines the strength value.

A key challenge to enabling the use of hydrogen is storing it with high volumetric and gravimetric density. Although various methods for storing hydrogen whether in solid, liquid or gas forms exist around the world, with each method having specific benefits for respective industries, the storage of hydrogen as a gas has emerged as the leading form of hydrogen storage universally. The challenge here is that because hydrogen is the lightest element, it must be held at very high pressure (350-700 bar) to achieve practical densities. ■

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"Net Zero target will be met much before 2070"

Adwait Dharmadhikari
Managing Director
Electronica Tungsten

The global tungsten market is projected to grow at CAGR of ~8 per cent by 2033. Although the domestic tungsten carbide market has limited growth, significant growth is projected in the international market. Electronica Tungsten, a Nashik-based company, which produces premium tungsten carbide goods, has set ambitious plans to tap on this potential and achieve higher growth. The company is also gearing up to achieve its net zero goals through various measures. In an interview with **Oil Gas & Power,** ***Adwait Dharmadhikari, Managing Director, Electronica Tungsten,*** shares the company's future plans.

How would you describe the growth of tungsten carbide goods in the past few years?

Tungsten Carbide consumption in the country has considerably increased in the past few years. The reasons could be attributed to some factors like more industrialization, growth of the existing customers and problems in imports due to logistical delays. The key growth factors for the growth of industry are – increased mining activities, growth in automotive sector and government's thrust on infrastructural development.

Tungsten carbide sales are closely aligned with countries industrial development, particularly in construction and mining sectors. The global tungsten market is projected to grow at CAGR ~8 per cent by 2033. Tungsten Carbide powder market for industrial applications is expected to rise due to growing infrastructure development and industrialization. The construction industry segment is exhibiting an impressive growth (~45 per cent).

Although the domestic tungsten carbide market has limited growth, significant growth is projected in the

international market. Electronica has been consistently exploring the overseas market. We have an impressive list of customers in our basket. Since, we have end-to-end production facilities and the foot print of our products is in a large area, the product basket is almost complete.

Internationally, there is a perceptible shift in the awareness about India. This is due to acknowledged Indian strength in the manufacturing sector, coupled with the government's support and its motivation for the manufacturing sector. Even the availability of capital is good as compared to the scenario about two decades ago. Our location falls in the triangle of Mumbai, Pune and Nashik.

With going green being topmost priority, how has the process and R&D at Electronica Tungsten evolved over the years?

Many international customers source their requirements from India. This has especially gained impetus post COVID. These customers are very sensitive about sustainability and green technologies. These customers have set their own targets for going green. Obviously they expect the same initiatives from the supply chain. Electronica has experienced this through various discussions with our customers. We are responding to these demands with alacrity. We have internally set the target of year 2030 for going green. In the effort, we modified all the key processes. The process is dynamic and we are sure to become green before the set target.

Electronica has given a huge importance to R&D activities since inception. We respond to the customers' continuously changing quality and product requirements quickly and effectively. This has become possible because of our continuous R&D efforts. A novel technology like Solvent Extraction has been implemented with 100 per cent in-house efforts. The development of this technology proved to be a game changer for us. The re-cycling of any kind of tungsten scrap to make a pure basic raw material (Tungsten-Tri-Oxide) became possible because of this. This is an efficient green technology. Management invested ~₹10 crore to develop the technology. Even the equipment required are developed indigenously.

Various grades and products are developed in the last 20 years which have completely replaced the import of these products. The management exhibited the deep involvement and tenacity in the process. The required resources were made available swiftly. Today Electronica can produce almost all the products in bulk tungsten carbide. This also enabled to counter the ups and downs in the market and company's sustainability through the odds.

Can you throw more light on the closed-looped manufacturing supply chain for tungsten carbide?

Electronica has commenced working with circular supply chain in production and distribution system. This is being done by cycling back the production and distribution system, reducing the waste and adhering to sustainable practices.

We reuse and recycle our materials at different stages, to the maximum extent possible. Special processes

are designed for recycling/reusing. The effort is on for eliminating the possibility of creation of Tungsten Waste. Different technologies have been developed consciously over the years.

The employees are trained, motivated and empowered to identify the wastes and eliminate the same by using 7 wastes elimination program. We have also created supply chain collaborations with our suppliers and customers to facilitate sharing of resources, expertise and risks. Effective usage of ERP system enabling real time monitoring and optimization of decision making is already in place. The decision making is data driven.

What are the company's targets and implementation plans to go net zero?

In line with the requirements of the overseas customers and country's goals, the organization has taken the steps to implement net zero by 2030-31. We have identified areas to reduce carbon emission. The employees are educated about the target and have involved them in achieving the set targets. Efforts are being taken to imbibe a culture among employees for active participation and work towards net zero. We are trying to use clean energy technologies using solar power, commissioned very effective STP to treat domestic sewage. This treated water is used for gardening. We have been promoting adoption of electric vehicles and use of public transportation. There have been continuous efforts to reduce energy, conserve water consumption and encouraging employees to eat plant based diet.

What are your views on India's goals to achieve net zero vision by 2070?

I sincerely see a bright future for India on net zero. The government and private companies are very effectively working on the achievement of net zero. I am sure that this will happen much before 2070. India INC has been striving to achieve this through transitioning to renewable energy sources, improving energy efficiency and electrifying transportation – these are some of the prominent measures being taken. These will be expedited in the coming years. This will offset emissions. The implementation of advanced technology to remove CO_2 will happen through reforestation and sustainable land use.

What are the future plans of Electronica Tungsten?

Electronica is poised to take leap in near future. We have ambitious plans for the growth – both organically and inorganically. The export market is being continuously tapped for increased sales. Hi-tech products of superior quality with competitive pricing, will find a way to increase share in domestic market. Aggressive investment plans are being carried out from the last four years. This will be translated into higher sales in the future. Strategic measures are in process in marketing and at the same time vigorous measures are being undertaken to strengthen the brand value of the company. ■

Schmalz launches JumboFlex Vacuum Tube Lifter

The tried-and-tested JumboFlex optimizes handling processes thanks to smart adaptations. Its handle fits perfectly in the hand - regardless of its size. The redesign makes the vacuum tube lifter intuitive to use and significantly reduces the training time for new skilled workers. It is simpler, more efficient and more ergonomic.

The new control handle is now better suited to different hand sizes, allowing small hands to grip just as safely and fatigue-free as larger ones. The two operating buttons are also new, replacing the single-button control. They control the up and down movement in opposite directions and are intuitive to use, allowing new employees to work productively even faster and direct the tube lifter even more precisely. If required, loads can be brought to a standstill in a floating position at any height, enabling further process steps to be carried out on the workpiece being handled. For example, labels can be easily applied or workpieces checked.

Thanks to the double-speed gripper change, employees handle different workpieces without interfering with handling processes. The employee can simply slide the end effector into the holder with a flick of the wrist. A simple tweezer handle for releasing the gripper enables really quick changes and prevents accidental release. If the new gripper is not properly engaged, employees receive a visual warning. A rotating mechanism, which is operated via a simple and intuitive slider, allows the workpiece being handled to be rotated 360 degrees or fixed in 90-degree increments. ■

Huntsman develops New Anti-static Wheels

Elastomers experts at Huntsman have been working closely with the team at wheel and castor manufacturer RÄDER-VOGEL to develop a new generation of polyurethane-based, anti-static PEVOTEC® wheels. The wheels – which are available now and utilize Huntsman's TECNOTHANE® hot cast elastomers – have been designed for use in industrial applications where the use of trolleys, carts, pulleys, and automatically guided vehicles (AGVs) is vital to the smooth running of operations.

Using Huntsman's TECNOTHANE® materials, RÄDER-VOGEL has developed a range of PEVOTEC® anti-static wheels, with a variety of options available ranging from 55 to 97 shore A hardness. The materials also give RÄDER-VOGEL the flexibility to tailor make customized solutions for customers to meet specific needs. Initially, RÄDER-VOGEL will be targeting the new range of wheels at four application areas including warehousing and logistics for automated guided vehicles that move thousands of products; space-saving automated car park systems in cities where vehicles are parked using lifts; clean rooms where wheels are used in trolleys and overhead pulleys and mining for lift shafts that must function with no risk of sparks that could ignite coal dust. ■

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