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As on 5th Jan. 2022

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From the Desk of the

Director General

Greetings from the Federation of Indian Petroleum Industry (FIPI)!

Dear Members,

As I look back over the past quarter, the global economic recovery is continuing, even as the pandemic resurges. The first signs of a strong economic recovery from the COVID-19-induced crisis are evident with declining unemployment, business optimism, stock market valuations, and quarterly growth rates seen among many economies. The International Monetary Fund (IMF) has projected the global economy to grow at 5.9% in 2021 and 4.9% in 2022. In the same report, IMF has retained its projection for India's economic growth in the current financial year at 9.5 %, and estimates for next financial year at 8.5 %. Economic activity will benefit from policy support, including higher spending on infrastructure, rural development, and health, and a stronger-than expected recovery in services and manufacturing. However, over the last quarter and particularly in December, there have been concerns about Omicron variant with further reports that current vaccines may not be as effective at preventing infection as they have been for other variants. This has created doubts about global economic resurgence.

On another environment related issue, our Hon'ble Prime Minister, Shri Narendra Modi attended the G-20 Summit and the COP26 UN Climate Change Conference. In one of the most ambitious targets by a developing country to combat climate change, Prime Minister Shri Narendra Modi at the COP26 climate summit in Glasgow said that India will achieve net-zero emissions by 2070. This was one of the five major commitments or "Panchamrit" he made on behalf of India, to mitigate climate change.

The rest are as follows:

- To bring its non-fossil energy capacity to 500 GW by 2030
- To bring its economy's carbon intensity down to 45 per cent by 2030
- To fulfil 50 per cent of its energy requirement through renewable energy by 2030
- To reduce 1 billion tonnes of carbon emissions from the total projected emissions by 2030

Further, India is meeting all other global commitments including living up to its climate mitigation promises. It is also well ahead of target to achieve other ambitious commitments such as making renewables 40% of its energy mix by 2030 and managing the sequestration of 2.5 billion tonnes of carbon. A recent report from the World Economic Forum - Mission 2070: A Green New Deal for a Net-Zero India - outlines how India's path to net zero will have an estimated economic impact of over $1 trillion by 2030 and around $15 trillion by 2070. In addition, India has prioritized cooperation, technology, and digitalization as part of its efforts to support the achievement of the United Nation's Sustainable Development Goals (SDGs).

In addition, India is also expeditiously moving forward on its energy transition journey: the government's plan to establish a National Hydrogen Mission is a step in the right direction. Further, government is also working to promote low carbon technologies through renewables-solar and wind; biofuels and increasing ethanol blending to 20% by 2025.

In the Indian upstream sector, the E&P Investment opportunities in North Eastern Region (NER) was organized by DGH & MoPNG on 24th September 2021 at Guwahati. It was attended by Hon'ble Minister Sh. Hardeep Singh Puri & Hon'ble Minister of state Sh. Rameswar Teli along with Chief Ministers of all the North Eastern states and participated by large number of Industry captains. While addressing the audience, Hon'ble Minister mentioned that the exploration acreage in North East will be doubled from existing 30,000 sq.km to 60,000 sq.km by 2025 out of which 20,000 sq.km area was already awarded under OALP over last 3 years. He also informed that the plan is to double the Oil & Gas production from current 9 MMTOE to 18 MMTOE by 2025. Plan is also to set up a Service Provider hub in NER.

The government has raised the price of domestically produced natural gas from October 1, 2021, to March 31, 2022 by 62% from $1.79 per million British thermal units (MMBtu) to $2.9 per MMBtu under the domestic gas price regime, which was introduced in 2014. Also, the ceiling price for gas from difficult fields such as deep water, ultra-deep water and high pressure-high temperature areas for October-March was increased to $6.13 per MMBtu from the earlier price of $3.62 per MMBtu. The domestic gas price increase was driven by the significant run up in the prices of gas at global gas hubs in the relevant period. This increase in price both from conventional and Deepwater fields have somewhat eased the upstream gas producers.

In the Indian downstream sector, fuel consumption totalled 17.13 million tonnes, down 4% from October and was 11.4% lower than a year before as festive demand moderated after Diwali. Diesel sales dropped 8% and petrol 1% year-on-year in November. Diesel sales eased 1.7% month-on-month to 6.51 million tonnes and were 14% lower compared to the pre-pandemic month of November 2019. Sales of petrol decreased by about 0.7% to 2.65 million tonnes year on year, but was 4.4% higher from November 2019. Jet fuel sales have sharply recovered in November, rising 29% from a year ago. Sales of cooking gas, or liquefied petroleum gas (LPG), decreased nearly 0.4% to 2.34 million tonnes year-on-year, while naphtha sales fell 19.4% to 1.13 million tonnes. Sales of bitumen, used for making roads, were down 21.5%, while fuel oil use rose 3.9% in November. Despite the above trend, with, robust growth outlook on continued reopening momentum, fuel demand outlook remains upbeat going into 2022.

Further, Petroleum and Natural Gas Regulatory Board (PNGRB) had launched the 11th CGD bidding round for 65 GA's covering 208 districts. This round attracted overwhelming response from investors with more than 430 bids received against 61 GA's. This initiative would help in creating a robust CGD infrastructure and play a significant role in transforming to a gas-based economy. This would bring investment of more than ₹80,000 crore and generate employment. The push for city gas expansion is part of the government's plan for raising the share of natural gas in the country's energy basket to 15% by 2030.

During the quarter, FIPI had participated in 2 international events and conferences:

FIPI pavilion at ADIPEC-2021: ADIPEC from 15th to 18th November 2021 at Abu Dhabi where FIPI came up with India exhibition hall consisting of ten Indian Oil & Gas operating & Service companies. All oil and gas players in the industry participated and took part in different meetings with other international companies. FIPI stall was inaugurated by Hon'ble Minister of Petroleum and Natural Gas and Minister of Housing & Urban Affairs on 15th November 2021.

Dubai Expo 2021: Ministry of Petroleum & Natural Gas has organized exhibition and meetings on investment opportunities & technology scouting from 17th to 20th November 2021. Hon'ble Minister, MoPNG addressed the investors on 17th Nov in a roundtable meeting where senior leadership from Ministry, DGH, IOC, GAIL, ONGC and Cairn Vedanta etc. were also present.

Federation of Indian Petroleum Industry (FIPI) along with the Knowledge Partner the Boston Consulting Group (BCG) organised a one-day workshop on **"WINNERS: Women in India's Energy Sector"** on September 28, 2021. The event talked about how the role of women in the oil industry have evolved substantially and focussed on the range of challenges and recommendations that can be developed to address gender imbalances in oil and gas sector. The workshop was attended by more than 300 delegates (physically and virtually) and was appreciated in terms of content by one and all.

The fifth India Energy Forum by **CERAWeek** was organized in a hybrid format from 20-22 October 2021. The Honourable Minister of Petroleum & Natural Gas and Minister of Housing & Urban Affairs, Shri Hardeep Singh Puri inaugurated the forum.

The forum held strategic dialogues which emphasized upon India's energy future in a global context, with new challenges and opportunities as the world emerges from Covid-19 pandemic. The India Energy Forum generated global outreach and a regional impact with more than 7,000 delegates (511 physically and 6550 virtually) representing over 450 organizations and 45 countries.

FIPI Annual Oil & Gas Award 2021 ceremony was organized on 26th November 2021. The programme was graced by Hon'ble Minister of Petroleum & Natural Gas and Minister of Housing & Urban affairs , Minister of State of Petroleum & Natural Gas & Minister of Labour & Employment, Secretary MOP&NG, Chairman FIPI and other senior leadership of oil and gas industry and awardees from oil & gas companies. The FIPI Oil and Gas Awards have been created to recognise the leaders, innovators and pioneers in the oil and gas industry. The objective of the FIPI Oil & Gas Awards is to celebrate the industry's most outstanding achievements.

FIPI in association with Hydrogen Association of India (HAI) organized a **webinar on "Hydrogen Storage & Transportation"** on December 15, 2021. The speakers through presentations, shared their insights on various hydrogen storage and Transportation options, upcoming storage technologies and the future of hydrogen storage & transportation and its economics. The webinar witnessed an overwhelming response from both Indian and International delegates.

As we can see from the current quarter, India is already emerging fast from the Covid related slow down and is on the path to be one of the fastest growing economies in the World. The strong economic growth is driven by capital expenditure on infrastructure expansion, Government stimulus of of Rs. 6.3 lakh crores, kick starting the manufacturing under production linking incentive schemes across sectors, encouraging FDI inflows, and favourable export demand. I am certain that India's continued industrialisation and urbanisation will create huge energy demand thereby setting the country on a high growth trajectory.

I have now completed my tenure at FIPI with a great sense of satisfaction and would be retiring on 31st December 2021. I feel honoured to be part of this esteemed organisation since its inception on 2nd December 2016 after the amalgamation of the erstwhile Petrotech and Petrofed. We at FIPI always tried our best to serve our members thereby stimulating growth of Indian oil and gas sector.

I would like to take this opportunity to inform that Mr. Gurmeet Singh will be taking over the charge at FIPI as its new Director General. I am confident that under his able leadership, FIPI would progress further and continue to strive towards resolution of the issues being faced by our industry. I would like to place on record the support which I received from officials of MoP&NG, Governing Council and all members of FIPI including my dear colleagues during my stint at FIPI.

I hope with the onset of a new year, we would have left behind the viral pandemic and the things would move towards normalcy for the entire human race as we progress in 2022. Given the preventive measures including massive vaccination drive undertaken by the Government, we are confident that we will overcomes this crisis soon and will emerge stronger on a sustainable development path.

I wish you all the best and a very happy new year 2022!

Dr. R. K. Malhotra

Gurmeet Singh takes over as the Director General of the Federation of Indian Petroleum Industry (FIPI)

Mr. Gurmeet Singh has taken over as the Director General of the Federation of Indian Petroleum Industry (FIPI) from 1st January, 2022. A Petroleum industry veteran, Mr Singh holds close to four decades of wide and rich experience of petroleum industry.

Prior to joining FIPI, he was member of the esteemed Board of Indian Oil Corporation Limited as Director (Marketing) and headed various strategic initiatives under his leadership. He also held additional responsibilities as Chairman of Indian Oil Mauritius Limited and Chairman of Indian Oil Middle East , Dubai, UAE.

As Director (Marketing) of IndianOil Mr. Singh ensured energy security by ensuring product availability with best logistic practices. He was instrumental in expansion of required infrastructure of storage, distribution and marketing of all grades of petroleum products to meet challenging cross sectional business customer and demands of different verticals and geographies.

He immensely contributed to the path breaking initiative of PMUY (Prime Minister Ujjwala Yojana) to support the national goal of taking LPG to remotest of areas with an aim to reach LPG to each and every household. PMUY has been highly acclaimed nationally and internationally for its mammoth reach and impact. His vision brought in impactful technology and digitalization improvements in operating systems, business processes and delivery mechanisms like Retail Outlet Automation, VTS, e-transactions to name a few.

As Head of Marketing Division of IndianOil, He led a team of 15000 plus strong work and brought in HR initiatives of Learning and Development, welfare schemes and health care specially during the COVID pandemic. Under his leadership, IndianOil was recipient of several accolades and awards such as featuring as of the top brands in Brand Finance and Brandz ranking, Supply chain and Logistics Excellence award, SERVO and INDANE being conferred the super brand status, Global HR excellence award and lot more.

He has also been business head of critical verticals like Engineering and Projects, State Head and Retail Head of large territories like Rajasthan, Punjab, Himachal and J&K. He played stellar role as Executive Director (Engineering and Projects) heading several Engineering initiatives and leading several path-breaking projects, known for his skills in astute project management.

A mechanical engineer from Punjab University, Mr. Singh is widely travelled and has been part of several national and international energy related projects and events such as CERAweek, World LPG Conference, Aviation Conference.

Basin Centered Gas Accumulation (BCGA): Key Elements, Issues and Way Forward

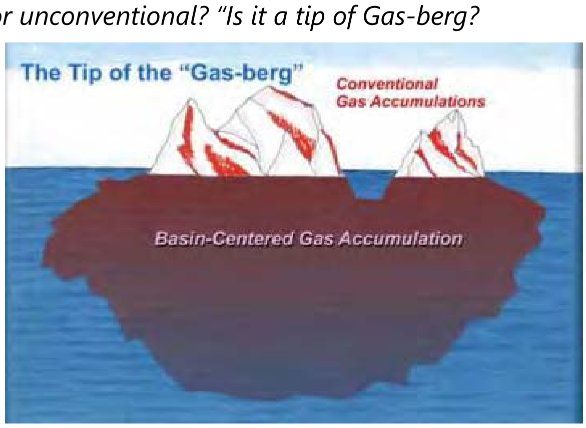



A. Borthakur **J. Tikku** **G. Dikshit** **Shilpi Gupta**

Oil and Natural Gas Corporation Limited

Primer:
Basin Centered Gas (BCG) is commonly an abnormal pressured, regionally pervasive gas accumulations, in low permeability reservoirs lacking down-dip contact. The HC locales of BCG accumulation exists in basinal low encompassing hundreds of thousands of kilometer. Exploration efforts with respect to such reservoirs is unique as they have their own up-dip edge. Associated gas bearing reservoirs may be single, isolated or multiple stacked body. In this regard, quite a large basinal area akin to global producing field exists in Indian sedimentary basin. The objective of the study is to establish BCG discovery under OALP and develop way forward for a new "Contract Area".

Masters (1979), for the first time identified low permeably gas province commonly associated with BCG as Cretaceous sandstones of Western Australia, the San Juan basin in New Mexico and Wattenberg field in Denver basins of Colorado. *The question remains whether "BCGA is a conventional subtle traps or unconventional? "Is it a tip of Gas-berg?*



Schematic illustration of BCG set up showing normal pressure/water bearing, transitional water-gas bearing and abnormally pressure gas bearing zones for (A) direct BCGA and (B) indirect BCGA shown here as. Fig.1

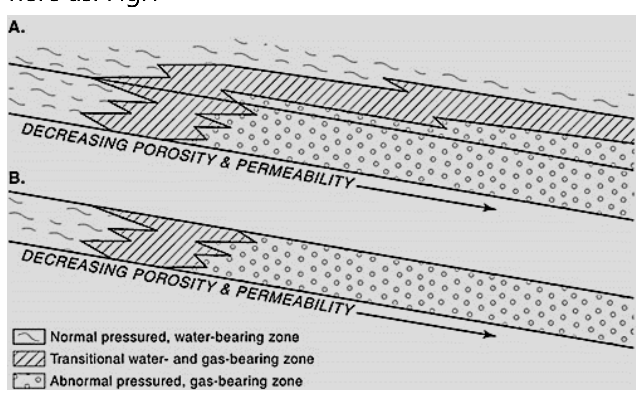


Fig.1: Schematic Diagram depicting (A) Direct and (B) Indirect types of BCGA

In Indian sedimentary basin, considerable prospective BCGA setup akin to global producing field exists, e.g. Kavittam Low and Bantumilli Low (KG Basin), Wamaj Low, Tankari Low and Warson Low (Cambay Basin), Ariyalur –Pondicherry (Cauvery Basin) exists in terms of high envisaged inplace volume. In the light of commercial hydrocarbon accumulation established in Mandapeta sandstone (Permo-Triassic) in onland to Pleistocene channel levee complex in deep water, presence of effective source facies and multiple Petroleum System, Krishna-Godavari basin to be a suitable candidate for first field trial to harness BCG. However as an alternative study suggests that together a pilot both KG and Cauvery require to formulate as both the acreages witness direct BCG attributes.

Basin Setup of Study Area and Envisaged BCG Envelop:

A. Krishna Godavari: The KG basin is a passive margin pericratonic rift basin originated along the eastern continental margin of Indian craton during early Mesozoic covering basinal area approximately 40,000 sq.km of both onland and offshore. A series of horst and graben set up cascading down to ocean are aligned along the trend of Eastern Ghat (Pre-Cambrian). The basin encompasses through Rifting, Syn Rift, Drift and Late Drift stages. The commercial hydrocarbon accumulations are established in Permo-Triassic (Mandapeta Sandstone in onland) to Pleistocene Channel levee complex in deep offshore. The basin witness two different petroleum system i.e.Pre-Trappean and Post-Trappean.and having three different types of source facies that was generated at Cretaceous, Paleocene and Eocene respectively. In the basin the HC resource base already established in the tune of 1130 MMT, of which, 555 MMT are assessed for the offshore region (upto 200 m isobath and 575 MMT are assessed in Onland (After DGH).In the light of current perception the resource base of the basin is realistic and envisaged to be in higher order.

Basin centered gas prospective area is envisaged based on global scenario, HC success there on and the preliminary G&G analysis in similar set up in KG and Cauvery basin. In this regard, Time thickness map of Nandigama Formation along with seismic analysis suggests a total of 51 sq.km area of Bantumilli Graben require detail integrated study to establish BCGA Discovery. Similarly, a total of 150 sq.km area is envisaged as BCGA prospective area in Kavitam Low. In Kavitam, the area covers about 500 to 1800m thick of Golapalli-Mandapeta Formation. Both the acreages warrant detail analysis to work out geological model. TWT map and regional seismic section prepared showing the set up for Bantumilli Low shown here as *Fig.2* and *Fig.3.* Similar map and regional seismic section for Kavitam Low shown as *Fig.4* and *Fig.5*.

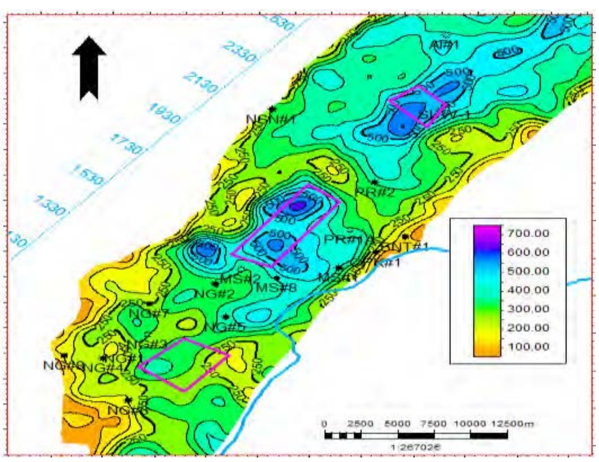


Fig. 2: TWT Map of Nandigama Formation (Bantumilli Low Area ~ 51 sq. km)

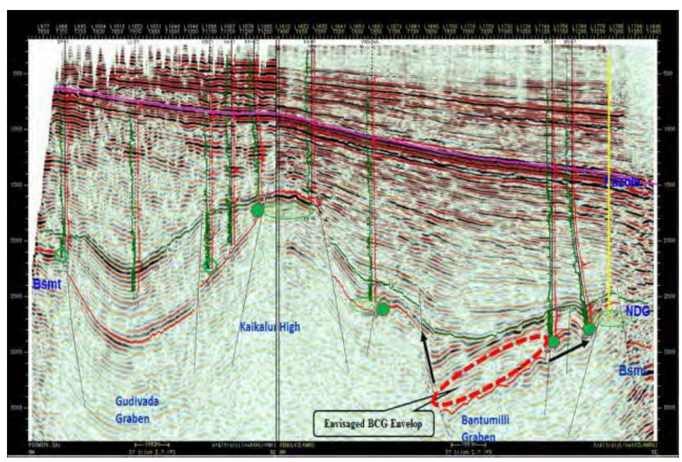


Fig. 3 Regional Seismic Section across Bantumilli Low showing BCGA envelop

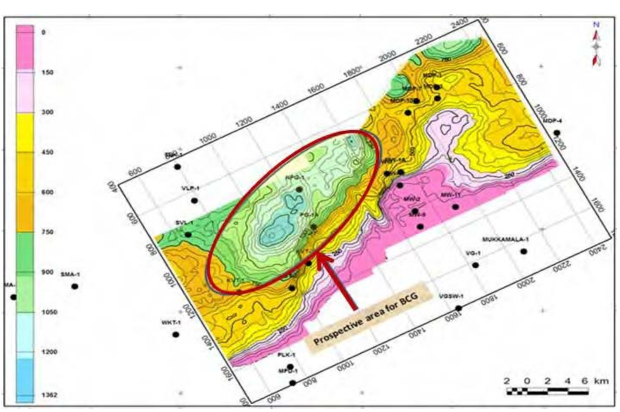


Fig 4: TWT Thickness Map of Gollapalli-Mandapeta Formation. (Kavitam Low Area ~ 150 sq. km)

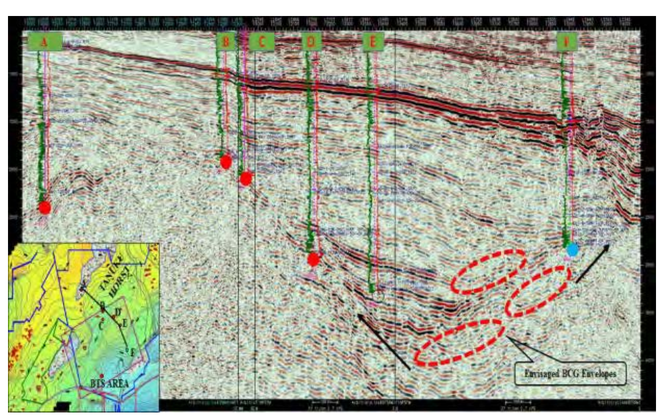


Fig. 5: Regional Seismic Section across Kavittam Low showing BCGA envelop

B. Cauvery: Tectonically, it is pericratonic rift basin covering 1.5 lakhs sq.km.covering onland and offshore. The sediments thickness witnessed 5 to 6 km.ranging from late Jurassic to Recent time. It is a proven petroleferous basin where prognosticated resources estimated in the order of 700MMT (After DGH). However, current ongoing study of HC Resource estimation in totality under the directive of GoI will enhance additional HC volume in the acreage. The established play types of the basin are (1) structural and combination entrapment of Early Cretaceous to Paleocene, (2) Stratigraphic traps such as, pinch out/wedge out and lenticular sand bodies in Early to late cretaceous. For BCGA in the low of Ariyalur –Pondicherry acreage, envisaged the geological set up having likely direct BCG attribute. Representative seismic sections are shown below, *Fig. 6* and *Fig.7*

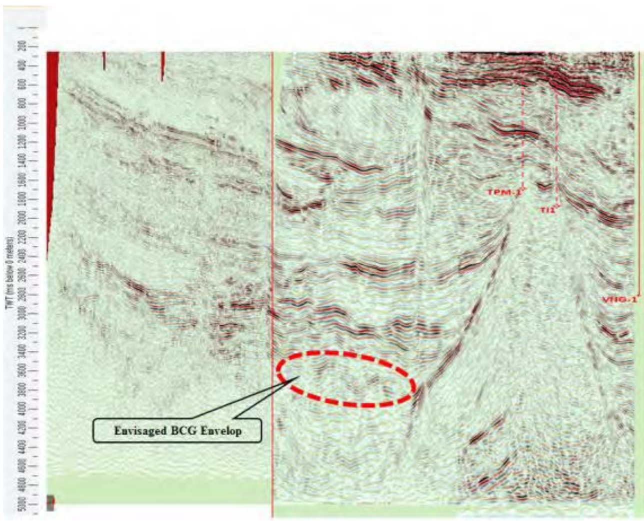


Fig.6: NW-SE Regional Seismic Section across Ariyalur – Pondicherry low showing envisaged area for BCG

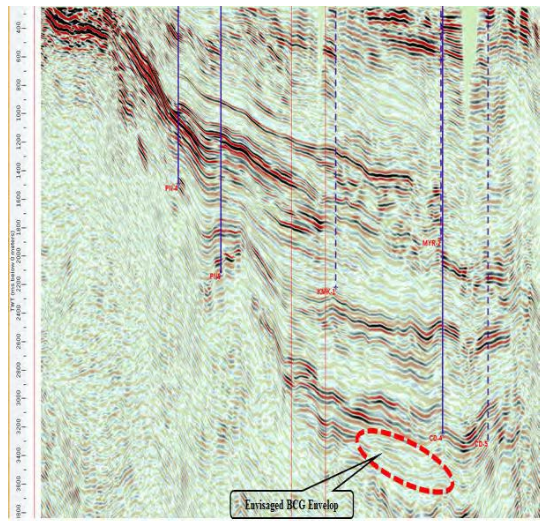
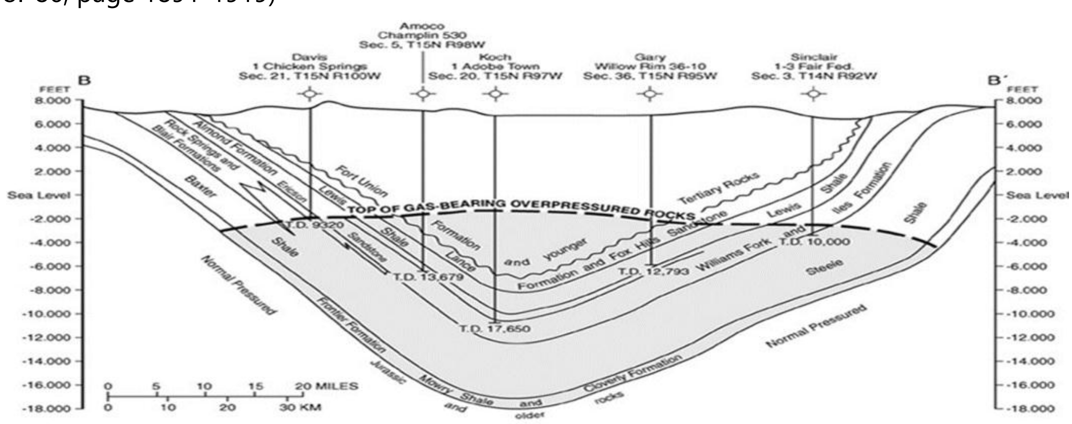


Fig.7: SW-NE Regional Seismic Section across Ariyalur –Pondicherry low showing envisaged area for BCG

The fundamental characteristics of BCG and difference with Shale gas:

- Shale gas commonly is trapped within shale in adsorbed state both in flanks as well as in basinal low.
- However, BCG target exists normally proximal to basinal Source area (Basinal Low) that essentially trapped HC in conventional reservoir unit. Global examples recorded: tight Cretaceous and Tertiary Sandstone, Raton Basin, South Colorado, Jonah field-Green river basin
- Targets: common reservoir. Discovery success are subject to mainly presence of conventional reservoir. Statistics witnessed that BCG wells shows few dry holes and minimal water production except Coal bed gas. Water commonly found up dip from gas is an inherent characteristic of BCGA
- Sweet Spots mainly occur at upper boundary of BCG confirms the presence of hydrocarbon.
- To understand the BCG setup, a cross section showing BCGA of Washakie Basin akin to identified low of Indian acreage enumerated here as Fig. 8.

Fig. 8: Cross section BB' showing spatial distribution of BCGA superimposed on structure through the Washakie basin (modified from Law et al., 1989). Shaded pattern shows over pressured, gas-saturated BCGA. Location of cross section shown on Figure 3. (After Law, Ben E., 2002, Basin-centered gas systems: AAPG Bulletin, vol-86, page 1891-1919)



Common attributes of BCG:

- Spreading large aerial extent, witnessed high in place volume and characterize "Sweet Spot ".
- Gas dissolved in abnormally pressured reservoir. Over-pressured in subsiding basin. Under pressured in uplifted and erosional basin. Reservoirs located very close to source at basinal low area.
- Evident of low matrix permeabily.
- Existing fields commonly merge in to a regional accumulation.
- Basin centered Oil (BCO): due to very few global disproportionate accumulation, it is not yet known.
- Elements of direct attributes: Gas prone source, Pressure mechanism, under/over pressured, relative permeability/ Capillary block seal is common, seal strength is variable, gas migrates short distance, Nature of upper boundary is cuts across the stratigraphy, top of BCG commonly shows > 0.7% Ro.
- Elements of indirect BCG attributes: Oil prone source, Pr. mechanism through oil cracking, more likely under pressured, long temporal integrity of seal, upper boundary is conformable, gas migration short or long, top of BCG commonly shows >1.3-1.4 % Ro.
- Occurrence of BCG always down dip from water bears an unique characteristic
- Migration loss is minimal.

Issues:

- To understand BCG/tight gas acreage as on date, there is no report/ resource estimation data available in public domain/DGH site.
- High resolution Seismic imaging, special processing and study of reservoir characterization is inevitable to understand "Sweet Spot" and identify the presence BCG locales at basinal part.
- Witnessed low ultimate recovery.
- Validation of prospectivity in terms of entrapment condition, Sweet Spot, identification of reservoir sequence, its extent and evaluation of petrophysical properties needs integrated study in comparison with successful global acreage.
- Artificial stimulation at these depths is quite expensive.
- Issue on technological aspects on simulation/production completion needs more technical deliberation.
- Though BCGA holds high Inplace volume covering entire areal extent in basinal low such as the San Juan basin of Colorado and New Mexico, commercial production from entire area is a challenging task
- As the BCG prospects are located proximal to source indicate large Inplace HC volumes, it is easy to find but require committed approach to develop due to low permeability and deeper depth. Commonly shallow pay established relatively are small in volumes, however easy to develop.

Way forward and identification of target:

- Preliminary study is carried out and approach is discussed. Potential component of YTF (BCG) in Indian acreage is possible to establish. Pilot project in identified area of KG and Cauvery basin needs attention.
- There have been significant improvements in drilling, hydrofrac and completion technologies within the past 20 years. Continued advancement of technologies are essential to tap these large gas resources at greater depths. Quality imaging of deeper sequence, identification of "Sweet Spot" and mapping of HC bearing reservoir sequence ,emerging logging technology to establish thin sand and reservoir characterization project is a must that may lead to benefit the approach.
- The Jonah field (One of the largest Gas Discovery in USA) of Green River basin is an established BCG acreage. The completion practices of Jonah field is successful in terms of commingling production from multiple, lenticular reservoirs. As many as 28 Sandstones are perforated and fractured.
- In lenticular, fluvial-dominated reservoirs, such as those in the Jonah field (Foreland Basin) in the northern part of the Green River basin of Wyoming or the Rulison field in the Piceance Basin of Colorado, it is imperative to stimulate as many reservoirs as possible to attain commercial rates of gas production. Similar approach to be successful in KG and Cauvery basin too.
- The Permian succession in the Nappamerri Trough covering 1,000 m thick (Cooper Basin, South Australia), comprising gas-prone source facies with interbedded sand witnessed BCGA. Excluding the Murteree and Roseneath shales, the succession comprises up to 45% carbonaceous and silty shales and thin coals deposited in flood plain, lacustrine and coal swamp environments. Drilling in the Nappamerri Trough has confirmed the presence of gas saturation through most of the Permian succession, including the Roseneath and Murteree shales. Basin Centered Gas (BCG), shale gas and deep CSG plays in the Cooper Basin are now the focus of popular drilling and evaluation campaign that encourage to establish BCG Discovery in identified area of KG and Cauvery basin under OALP.

- In USA and Canada, exploration and production of this huge gas resource has experienced considerable success.
- In the San Juan basin and Mesozoic rocks of Alberta basin formation resistivity and SP curves measured on well logs have been used to indicate the presence of BCGA. In Upper Cretaceous resistivity greater than 20 Ω were reported to be gas saturated. Creation of G&G database specially data of source facies /docket of deeper wells drilled in basins needs attention
- In this regard at the deeper level, for identification of "sweet spot" require integrated study.
- The occurrence of Sweet Spots may be structural or stratigraphic in nature and always occur within the abnormal pressure envelope. Presence of "Sweet Spot" most commonly established in other global acreage near the upper boundary of the BCGA envelope is an area of importance for KG and Cauvery.
- Quite a number of BCG prospective areas available in Indian sedimentary basin. The preliminary study reveals that KG and Cauvery basin witnessed "direct BCG attributes". Bantumilli and Kavittam Low of KG basin require to prioritize first. However as an alternative, together a pilot in both the basin may be a holistic approach
- For robust G&G effort and commercial production , dedicated Center of Delivery (COD) require.
- On inherent issues and key elements of BCGA, G&G brain storming needs attention. The approach may lead to identify new "Contract Area" and establish BCG hub in India.

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Advancing Sustainability towards 2030 with Digital Twins at BPCL Mumbai

Ron Beck
Senior Director, Industry Marketing

Lawrence Ng
Vice President of Sales, Asia Pacific & Japa

AspenTech

According to Béla Kelemen, Vice President of Business Excellence at MOL Group, and former president of the European Refining Association at an executive dialogue broadcasted by AspenTech in November 2021,***"The opportunity for additional energy use reduction in refining is limitless."*** The key message for industry executives is clear. Beyond strategic energy transition opportunities in bio-feedstock integration, hydrogen, and carbon capture – energy optimization remains one of the most important tools available.

Reducing energy usage by 2030

Contributing 15% to India's refining capacity and ranked 44th position in Platts Top 250 Global Energy, Bharat Petroleum Corporation Limited (BPCL) Mumbai refinery aims to reduce energy usage by 37% in 2030. To achieve this goal, BPCL Mumbai has taken an innovative approach. For example, by reducing the usage of steam within the context, whereby the refinery uses over 90 different crudes, with varying sulfur content. This article will describe the significant energy reductions achieved already by BPCL Mumbai towards that goal through use of an online digital twin, integrated with advanced process control (APC) software in one of the most significant steam usage areas in the refinery, namely the amine stripping and regeneration process.

Digitalization key in reducing energy usage and emissions

Digital technology will be a strategic asset as the industry navigates the energy transition. In the case of the refining operations, it will help provide a granular understanding of where in the refinery (or petrochemical plant), emissions originate, and which are the "bad actors," or biggest sources, that should be focused on for mitigation. It will help in evaluating and optimising production when considering the multiple objectives of economics, greenhouse gas mitigation, water conservation and energy conservation. In doing so, digitalization helps in automating the operation to an increasingly complicated and dynamic set of objectives.

Digital Twins Work

A digital twin is a virtual ***model of the physical plant. It provides a valuable model of the physical asset, its behavior and performance,*** so plant knowledge workers can safely explore what-if scenarios without putting people or the asset at risk. It provides a valuable model of ***asset health***, forecasting and recommending action to avoid degradation and asset failure events. Perhaps most important, it creates a ***business model*** representing scenarios for product creation, operations, sustainability, effective asset utilization, risk, customer satisfaction, and profit.

The digital twin is an evolving digital profile of the historical, current, and future behavior of a physical object or process that helps optimize business performance. It is based on models and real-time data across multiple dimensions, including business performance, asset planning, the physical asset, equipment condition and reliability, chemical process performance, safety and risk, energy, and sustainability, operating and project timespans and more.

The digital twin creates an evolving profile of the object or process that provides insights on system performance, guiding actions in the physical world such as changes in operating strategies, regulations and business objectives, safety, and maintenance. The digital twin may be updated in real time or periodically, taking advantage of asset data to stay up to date, and increasingly made intelligent by AI agents. In the case study we will focus on here, the digital twin has been implemented online and is used in an integrated way with an associated advanced process control (APC) solution, such that the optimization engineer uses the digital twin on an hourly basis to inform the adjusting of the APC levers for optimum steam use efficiency and amine utilization effectiveness.

Capitalizing the Opportunity in Amine Stripping and Regeneration

Optimizing the performance of the sour gas removal process at the BPCL Mumbai Refinery is complicated, as crude compositions are variable and dynamic – with respect to both sulphur content and API gravity.

Additionally, in terms of steam use, and therefore overall energy consumption, this process areas was identified as a "bad actor." This means that improving energy efficiency of these units afforded an important opportunity to make progress towards BPCL Mumbai refinery 2030 energy reduction targets. Furthermore, this significant energy reduction could be achieved solely through application of optimization technology as opposed to capital expenditure on plant equipment or configurations.

To achieve this improvement, four main parameters must be controlled concurrently: lean amine input, rich amine extraction, steam input, and reflux ratio. (See figure 1). If those are successfully controlled and optimized, then steam use can be reduced (achieving the energy use reduction goal) and the lean amine ratio can be optimized (achieving the asset integrity and maintenance goal). While the steam reduction goal has been the easiest to measure quantitatively, and thereby show immediate ROI success, the asset integrity goal is equally important in terms of long-term asset reliability and safety.

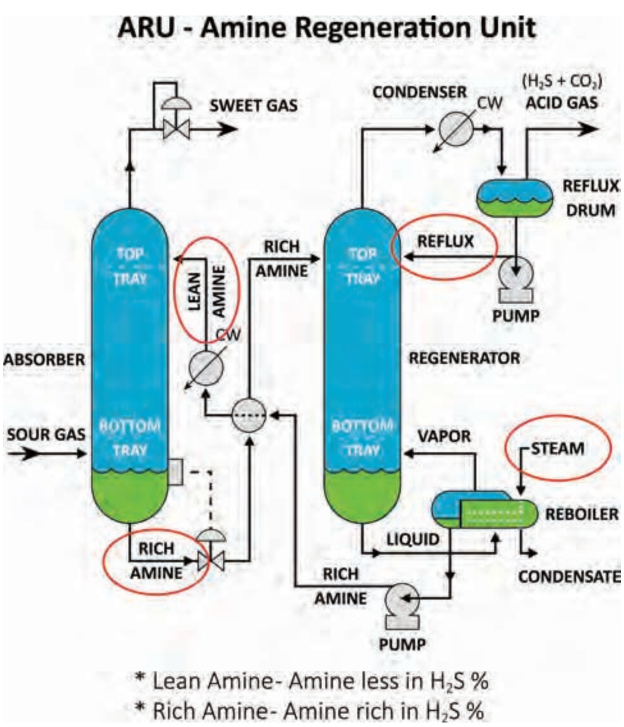

Figure One: The target amine absorption and regeneration processes at BPCL Mumbai. The key parameters to control are shown by red circles. (Source for all figures: Suresh R., BPCL Mumbai, October 2021)

The Advanced Process Control Models

Advanced Process Control (APC) was implemented in two areas, using adaptive process control technology from AspenTech. This software product, Aspen DMC3, featuring a patented adaptive control technology, was selected in part because of its "smart step" technology, which enables faster building, testing, and commissioning of APC controllers. In addition, the "adaptive" technology with Aspen DMC3 provides crucial advice to the optimization team and APC team for required adjustments to the controller logic as conditions change.

For example, the first area is in the amine stripper columns, in order to control rich amine loading in real-time and thereby, optimizing lean amine circulation. APC was deployed in six amine absorber columns.

The second area is in the amine regenerator unit, to optimize steam use in the amine regenerator process. This is the first implementation of APC in Indian refineries for this amine regeneration application. The goal of these APC controllers is to operate the ARU columns at reduced pressure, optimize the reflux-feed ration, and maintain bottom temperature and lean amine loading between specified limits.

For this application, because of the dynamic nature of the feed composition in general, and the sulfur content in particular, as well as the complexities of the process relationships, a digital twin model was implemented accompanying the APC, to constantly determine the optimal APC setpoints, based on real time plant data and the optimal result based on the process digital twin model used in monitoring and "what-if" optimization mode.

The Digital Twin Model

The goal of the digital twin model in this application is to improve the inferential prediction of the needed APC settings, required on an ongoing basis because of changing and dynamic feed conditions (see Figure Two). A key aspect of the digital twin is to present the near real time results in an intuitive fashion that is readily and intuitively usable by the APC operator and optimization engineer. The power and complexity of the actual, rigorous digital twin model is hidden from the operations team (see Figure Three).

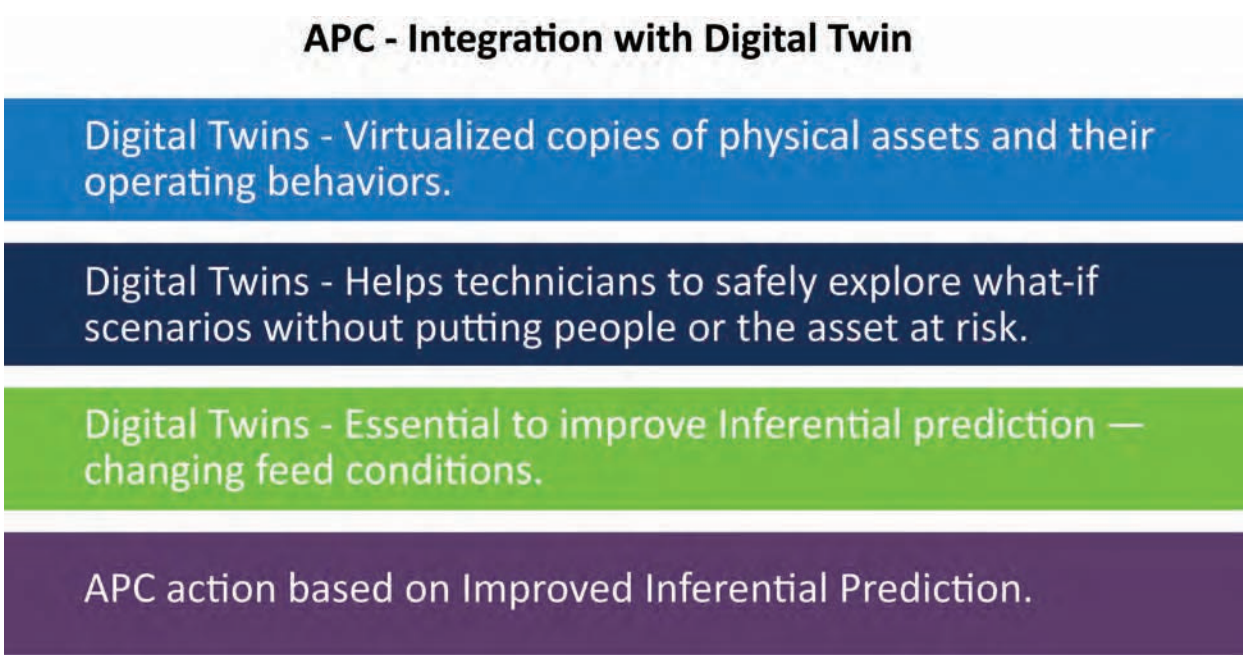

Figure Two: Summary of the role of the Digital twin in the amine regeneration APC implementation (BPCL, October 2021)

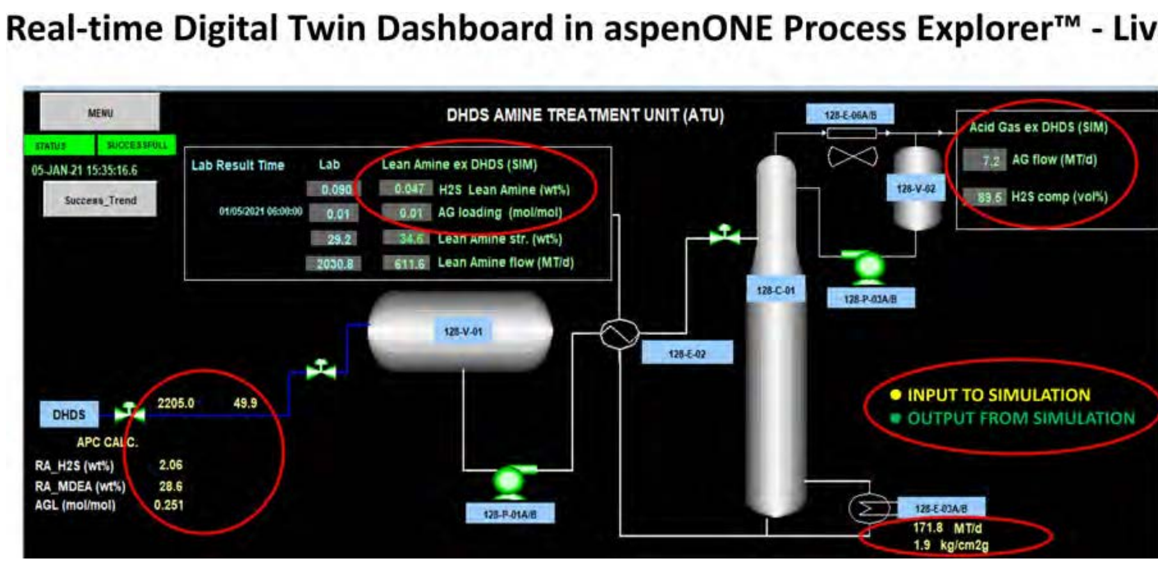

Figure Three: Operator interface to the HYSYS digital twin model, providing a clear and actionable view of the key parameters modelled every five minutes by the online digital twin. (BPCL, October 2021)

The digital twin is implemented for the amine regeneration unit using a simple and straightforward architecture (see Figure Four). Using an automation software tool, Aspen Online, the digital twin model (which was built using the rigorous Aspen HYSYS process simulator) is constantly calibrated against the flows of process data every five minutes – by polling the process historian system. In setting up the digital twin, the Aspen Online tool can rapidly link the plant historian 'tags' to elements of the process model and perform the data conditioning required to ensure that the model is being run employing good data. After calibration, the digital twin is then run against that current plant data to provide calculations of the key process parameters that are being controlled, and to provide inputs to any APC controller adjustments that the model recommends the optimization engineer (see Figure Four for the digital twin architecture).

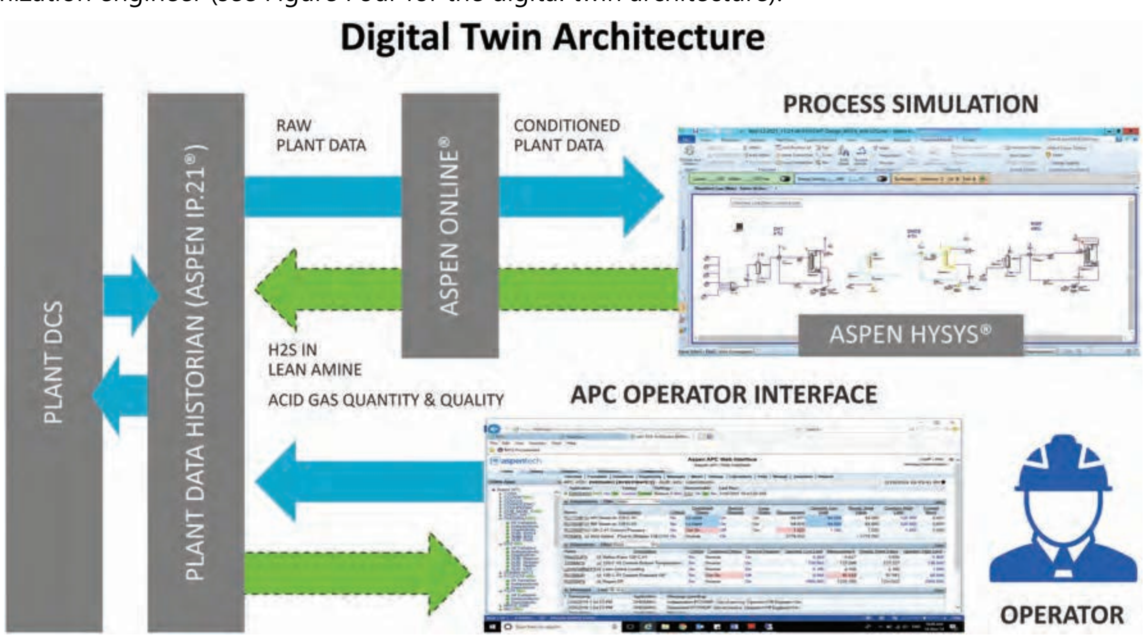

Figure Four: The open, easy to maintain architecture used to implement the digital twin model online. (BPCL, October 2021)

Benefits in Energy Reduction

This solution achieved two main areas of benefit. First, by optimizing the six amine stripper columns in the dynamic situations where crudes and therefore sulfur content is changing, the APC implementation there optimizes the ration of lean-to-rich amines. By optimizing lean amines, this avoids process scenarios where corrosion would occur.

Second, through the integrated digital twin and APC, the system is constantly running in the most efficient amine regeneration mode in the three regeneration columns, to reuse most or all of the amines and minimize steam consumption.

This has already reduced steam consumption by 14%, (100 MT/day of steam), reducing energy use a proportional amount and saving $1 million dollars per year just on the sour crude stripping unit (see figure five). This is a step towards BPCL Mumbai's target of 37% energy reduction by 2030.

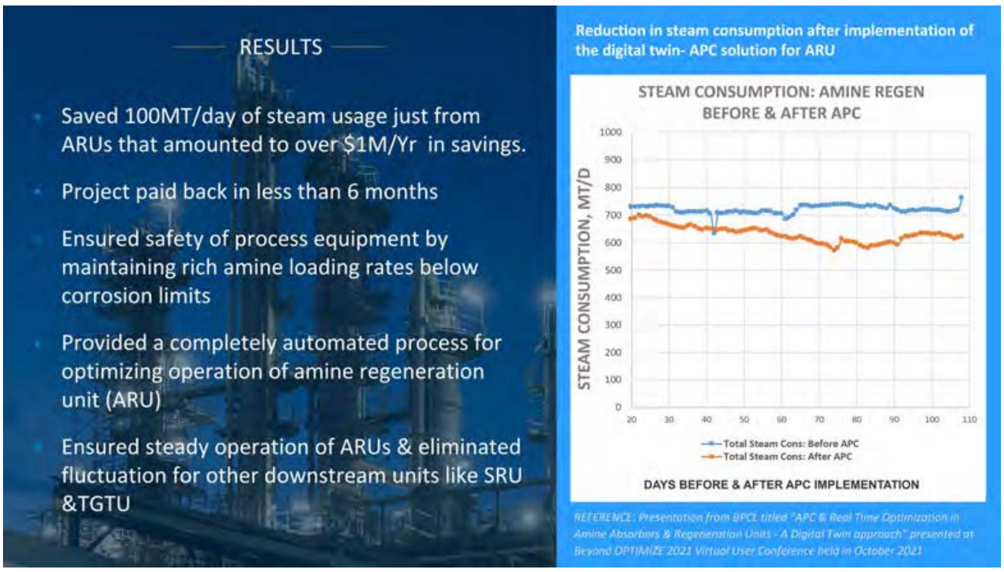

Figure Five: Summary results and benefits of applying an integrated APC – digital twin solution at BPCL Mumbai for amine adsorption and regeneration. (BPCL, October 2021)

Industry Recognition

This high-impact and innovative approach to improving the energy performance of the amine absorption and regeneration processes has broad applicability for India's refineries, and for any refinery operating with dynamic crude selections (or embarking on mixing bio-feedstocks in with conventional crudes). As an outcome of this project, from a technology and sustainability point of view, as well as due to the collaboration between technology supplier and refinery operator, Aspen Technology was awarded the prestigious Federation of Indian Petroleum Industry (FIPI) 2021 Digital Technology Provider of the Year Award, which recognizes companies for implementing the most cutting-edge digital technologies in the industry.

This award win underscores AspenTech's role in accelerating digitalization initiatives for the process industry in the past four decades.

Next Steps

BPCL is now in planning phase for implementing this successful and impactful digital twin – APC solution across the amine stripping and regeneration units for all of BPCL's refineries. There will also be other opportunities to apply this combination of APC and digital twins for further reduction of energy use across the BPCL refineries, taking BPCL closer to its overall 37% energy reduction goal for 2030.

Scaling Impact and Benefits of this Digital Twin Approach Across BPCL

BPCL has implemented several other digital twins at their Kochi and Mumbai refineries which contribute to emissions reduction, energy optimization, and refining performance optimization.

A second digital twin, implemented at BPCL Kochi, is a virtual emissions modeling and monitoring solution, that provides digital sensors calculating BPCL's compliance with air emission standards in India, and devises optimal operating strategies.

This powerful digital twin, which reduced CO_2 emissions, was accepted for use in place in installing physical measurement and sampling devices, saves time in the reporting process, provides more immediate, actionable information, and leads to better achievement of abatement goals while running their main units closer to the economic optimum. The model incorporates detailed models of the most important CO_2 emitter units, with shortcut models for the remainder of the refinery. It is online and calibrated against plant data streams every five minutes. Accurate calculations of fuel efficiencies are calculated for the main fuel consumption areas in the plant. This provides a much better and accurate real measure of CO_2 emissions, higher granularity, much faster, of CO_2 and N_2 and SO_X emissions, and the ability to operate optimally in light of this knowledge. This model, which has achieved concrete and measurable CO_2 and SO_X abatement results, has won the ASSOCHAM Innovation award in India for technology in October 2020.

A third digital twin, at BPCL Mumbai, provides a virtual model of a 28-train heat exchanger network associated with the CDU units. This digital twin is used offline to predict heat exchanger fouling build-up and improve maintenance strategies and schedules. This model has improved energy efficiency 3% within that unit, improved CDU yields 3% and reduced maintenance frequency and costs.

A fourth digital twin, also at BPCL Mumbai, provides a very similar integration of advanced process control and digital twin models, as has been described in this article, to optimize the sulfur recovery unit. For that innovative implementation, similar in approach to the approach described in this article, there were two main economic objectives. One is the reduction of energy (fuel) costs in the process, with associated CO_2 reduction and the second is reduction of SO_X emissions and increase in economic recovery of saleable sulfur. For this digital twin, implemented during 2019, energy costs in the process unit were reduced by 50%. The BPCL Mumbai refinery is currently the lowest SO_X emitting refinery in India (currently emitting less than 10 tons per day SO_X.

All of these digital twin models share a few key characteristics. They were built focused on very specific business objectives closely related to the core initiative of energy use reduction by 37% by 2030. They all had a very clear scope, and their benefits were closely monitored. Each proved relatively simple to implement, in most cases involving one or at the most two model builders over a few months timespan. Two of them have won innovation awards in India.

As MOL Group's Béla Kelemen highlighted, the further opportunities to achieve increased energy efficiency in refineries and petrochemical plants is large and in front of us. Bearing even more strategic significance, the incremental margin earned through these energy optimization initiatives will fund, within the energy companies, the investment capital required to pursue the equally important energy transition initiatives.

Team AspenTech receiving the Digital Technology Provider of the Year Award

CO_2-EOR as CCUS: Benefit with a Noble Cause



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Summary

With the enhanced focus on decarbonisation of globe, the world has rekindled the flame of implementation of technologies capable to absorb Carbon from air and sequestrate it into the depths of Earth. In this endeavour ONGC in collaboration with IOCL has formulated implementation of CO_2-EOR first time in India to reap double benefits of enhanced oil production from its mature field as well as abetment of climate change by storing CO_2 in the reservoirs, which otherwise would have been emitted into atmosphere. This article is aimed to discuss WHAT, WHY, HOW of CO_2-EOR for a broad sensitization.

Introduction

During the recently held COP-26 meet, which was held to define critical milestones in terms of de-carbonization targets of globe, India has pledged to be net carbon zero by 2070. Today, global power and industry sectors account for about 50% of all greenhouse gas (GHG) emissions. Though contribution of India in cumulative global emission stands at 3.21% in 2020 with 2,411.7 million tonnes. Over the last 50 years, CO_2 emissions of India grew substantially from 214.7 to 2,411.7 million tonnes rising at an increasing annual rate that reached a maximum of 11.40% in 2009 and then decreased to -5.93% in 2020. The success of India in starting the reversal the trend can be attributed to the number of facts including increasing awareness among general masses, wider shift to greener sources of energy and many more alike. Now, India is moving ahead to further rein in this emission of CO_2 adopting various measures aiming to reduce carbon emission by either storing or reusing it so that captured carbon dioxide does not enter the atmosphere.

In this voyage, ONGC has always frontrunner when it comes to embracing low carbon technologies and imbibing them in our processes. ONGC has cut down its carbon emission intensity by 13.67 per cent over the last five years as part of making its operations more sustainable through diverse emissions reduction initiatives. As a part of this effort and considering the strategic significance of CCUS technology towards transition to Net-Zero Emissions, ONGC is partnering with IOC for setting up a CCUS project for Enhanced Oil Recovery (EOR) from mature oil fields. The project will utilize CO_2 captured from IOC's Koyali refinery for injecting in to the mature reservoirs of Gandhar oil field in Gujarat.

CCUS and CO_2-EOR:

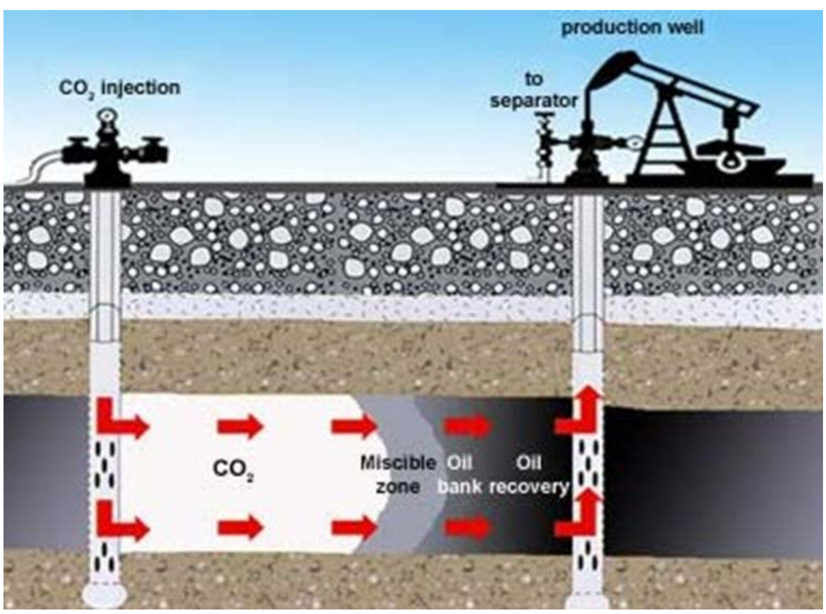
Carbon capture, utilisation and storage (CCUS) is a mature technology with more than five decades of existence. In popular terminology, it is an array of technologies, which are being implemented on the theory that if one can be able to capture the emitted CO_2 either from neurogenic or anthropogenic sources, the same can be taken away from the atmosphere by sequestration into the deeper layers of soil. In this way, the temperature of the earth can be retained in a prescribed manner. With the advancement of knowledge, other benefits of CO_2 sequestration emerged; notable among them is CO_2-EOR.

Key Words: CCUS, CO_2-EOR, Climate Change

Oil field development goes through two or three recovery stages. The field in primary recovery is exploited with the use of natural drive mechanisms supported by the reservoir's natural energy. This exploitation causes decline in pressure, and so does in oil production rates. To prolong the duration of production, secondary recovery methods are employed, where a fluid, most commonly water, is injected not only to maintain reservoir pressure but also to displace oil toward producing wells. Even after secondary recovery stage, on average, only 30–50% of the oil is recovered after and 50–70% of the oil remains in the reservoir (Stalkup, 1984). Extracting the remaining oil requires more advanced and costly technologies; which are considered tertiary recovery (Lake et al., 2014). EOR is often considered a tertiary phase of recovery for this reason, even though it can be applied at any stage of petroleum field development. In an EOR process, the oil is recovered by the injection of a material that is not originally present in the reservoir; in the case of CO_2-EOR, carbon dioxide is the injected material.

How it works

When CO_2 is injected into an oil reservoir, it becomes mutually soluble with the residual crude oil, because, the light hydrocarbons from the oil dissolve in the CO_2 and CO_2 dissolves in the oil. When the CO_2 density is high, i.e., CO_2 is compressed, and the oil is "light", this phenomenon occurs most readily. On the other side, as the temperature inside the reservoir increases, the oil density decreases or as the oil density increases, the miscibility goes down. Due to this very reason, the selection of reservoir with proper pressure and temperature conditions is very critical for successful implementation of CO_2-EOR.Now, when injected CO_2 and residual oil attain miscible phase, the interfacial tension effectively disappears, promoting a mass transfer (extraction/ vaporization) of light and intermediate hydrocarbons, which reduces the residual immobile oil saturation. Additionally, the CO_2 rich oil phase expands/swells regaining mobility.



Because CO_2-EOR is a displacement process, CO_2 is injected into the deep subsurface rock reservoir through an injection well to displace oil toward a production (extraction) well. CO_2 is produced along with reservoir fluids, separated at the surface, and commonly, re-injected/recycled into the reservoir. The cycle repeats throughout the operation. Although CO_2 is injected in supercritical (dense) phase, it remains significantly less viscous than reservoir fluids and thus highly mobile. When mobility contrast is high, an unstable displacement results in the form of viscous fingering (the uneven advance of CO_2 -resembling fingers in a profile image- toward a producing well), which adversely impacts oil recovery (Juanes and Blunt, 2007).

Where it works

Now, the natural question arises regarding the most suitable reservoir for CO_2 EOR. Theoretically, any oil reservoir could be suitable provided that the minimum miscibility pressure can be reached, substantial amount of oil is still left and geological complexity does not hinder the contact of CO_2 to crude oil.

Ideally, a reservoir with successful water flooding jacked-up pressure is the most promising candidate for CO_2 EOR, but in reality, number of factors like rock and fluid characteristics, past production behaviour and detailed geological assessments are other key players, which come into picture, while screening the best candidate. Various studies and field experiences have led to devise broad criteria for Screening Reservoirs for CO_2 EOR suitability (Table 1).

Depth (m)	<3,000 and >600
Temperature (DegC)	< 120
Pressure (psia)	>1,200 to 1,500
Permeability (md)	>1- 5
Oil Gravity (Deg API)	>27-30
Viscosity, cp	<10-12
Residual oil saturation after water flood, fraction of pore space	>0.25 to 0.30

(Source: National technology lab, Department of Energy U.S)

What are the challenges?

Making CO_2 available for EOR process is a cumbersome effort. In addition to risk of encountering unexpected geologic heterogeneity, even for CO_2 sources sitting at few hundred kilometres, the cost of sending to the field and injection is significant. In USA, where the CO_2 –EOR is in mature state, the typical cost is around 0.8-2.5 $/thousand meter. In addition, drilling or re-working of wells to serve as injectors and producers, installing a CO_2 recycle plant and corrosion resistant field production infrastructure and laying CO_2 gathering and transportation pipelines collectively turn CO_2-EOR a capital-intensive enterprise. Though, higher oil prices may significantly improve the economics of CO_2 EOR, the oil field costs may reduce economic margin. Total CO_2 cost (purchase price +recycle costs) can amount to 25-50% of the cost of oil produced. These all factors make CO_2 EOR less lucrative process as a gradual, long-term EOR.

To make CO_2 EOR process a techno-economically viable venture, incentives from government and other funding agencies is highly desirable. Most of the CO_2 EOR in U.S. came into existence due to tax credits and other fiscal incentives to help offset the financial risks. With the introduction of U.S. Federal EOR Tax Incentive, 1986, which gave 15% tax credit applying to all costs associated with installing a CO_2 flood, the purchase and injection cost of CO_2 can be given credit for subsequent rapid growth of CO_2 EOR production in U.S. In addition, numbers of states have also provided various types of tax incentives to the value of the incremental oil produced. For example, the largest oil producing state in US, Texas provides a severance tax exemption on all the oil produced from a CO_2- flooded reservoir.

Conclusions

CO_2-EOR has the potential of reaping double benefits of decarbonisation to abate climate change along with improved production from mature reservoirs. It is the only commercially established carbon utilization option that provides large-scale permanent storage for captured CO_2 through which industries like steel, cement, and petrochemicals can be decarbonized. As part of an already established market, carbon storage paired with EOR can be a profitable activity that also reduces greenhouse gas emissions. Until other utilizations for carbon under CCUS become more widely adopted than CO_2-EOR, emerging carbon removal technologies will require the reservoir knowledge gleaned from CO_2-EOR projects will prove worthwhile even if oil production and use slows.

As CO_2-EOR becomes a more appealing and viable entryway to scale up CCS infrastructure, regulatory frameworks need to be reconciled with a fresh look so that the storage achieved during CO_2-EOR is supported by robust documentation and procedure. With the economy refocusing on a low-carbon future, climate mitigation option may become the basis of a large, multi-pronged market under a carbon capture, storage, and utilization framework. EOR is one way that existing infrastructure can best leverage carbon prices to develop a climate mitigation technology for a shifting energy landscape.

Acknowledgement
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Fire onboard VLCC vessel MT New Diamond & Arrangement of Liquid Oxygen Containers – Challenges and Achievements


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In the year 2020 the crisis management of MT New Diamond was the mother of challenges in the history of Shipping Department at IOCL. How the incident was tackled and major catastrophe was averted is worth sharing.

The incident was on MT New Diamond, a Very Large Crude Carrier (VLCC) Panama flagged ship, chartered by IndianOil on Voyage Charter basis in early August 2020, loaded with 2 million barrels of Kuwait Export Crude Oil (valuing 91 million USD) that sailed from Mina-Al-Ahmadi in Kuwait on 23rd August 20 and was proceeding to Indian Oil's Paradip Refinery. A fire broke out onboard the ship at 02:18 hrs GMT on 03rd September 2020 nearly 38 nautical miles off the Sangamankanda Point in Sri Lanka.

Figure 1. MT New Diamond caught fire on 3rd Sep'20

The incident had the potential to wreak havoc of spreading highly volatile Crude oil spilling into the sea. It would have been an environmental disaster of unprecedent scale and it would also have created major diplomatic issues.

Figure 2. Shot from first evening of the incident

The incident made international headlines with Indian Oil being the key stakeholders. An incident that could have been a major environmental and diplomatic catastrophe was averted by 24X7 monitoring from day 1 i.e 3rd September 2020 to 24.01.2021 till the time the cargo reached Paradip Refinery safely.

Major challenges faced and how were tackled: This was the first such major incident onboard a crude tanker in the history of IOCL. There were no documented guidelines to handle such situation. Once the incident came to our knowledge, we informed the incident to higher ups in the organization and the Ministry of Shipping and Ministry of Petroleum and Natural Gas. Communication channels were opened with DG (Shipping), the nodal agency handling such crisis situation in India.

Fire which was initially looking not so major spread to many areas of the ship and was turning out to be a potential major fire. We came to know that Sri Lankan Navy was already at site trying to control the fire, however, with limited resources. On assessing the situation, it was clear that Indian Coast Guard and Indian Navy had the capabilities of handling such fires. Accordingly, assistance of Indian coast guard and Indian navy was immediately sought for deploying their vessels/tugs for firefighting at site. Chairman IOC personally met Chief of Navy and DG Indian Coast Guards.

The national and international media was flooded with News of fire onboard the vessel MT New Diamond. Sri Lankan media was flashing negative news highlighting the potential threat to their coast. The fire visuals were also frequenting on their channels making the issue internationally sensitive. By the time the Indian vessels reached the site, it was clear that the fire had grown in size.

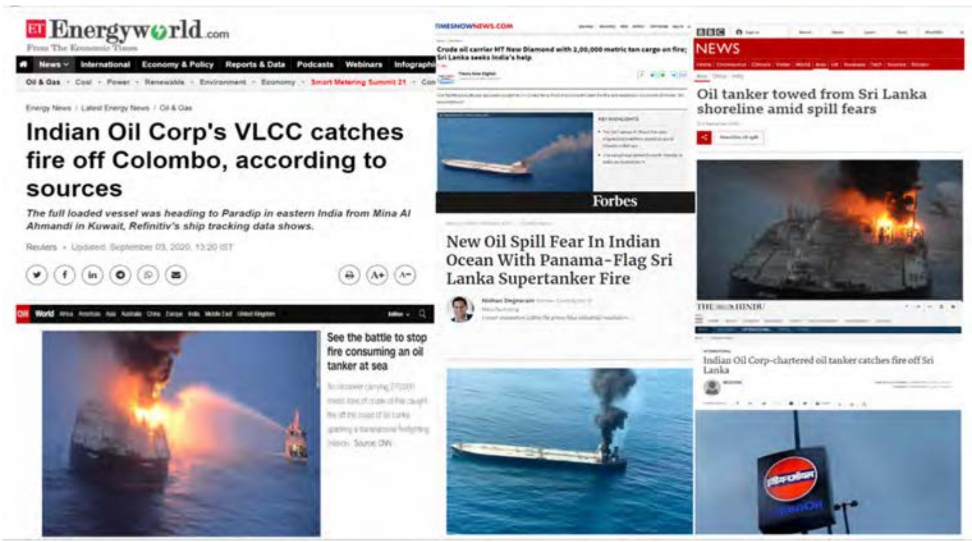

Figure 3. Global media cried foul as fire waged on the MT New Diamond

Fire fighting - Material/ resources mobilized

All the possible resources were mobilized by close coordination with Indian Coast Guard(ICG), Indian Navy, DG Shipping, IOC Sri Lanka Office and Chennai Office of IOC. IndianOil and Lanka IOC arranged 19,600 litres of foam and 6,500 kg of DCP fire-extinguisher powder during the operation.

An expert group of salvors from Smit Salvage was flown in from Netherlands. In a swift Sea and Air Coordinated (SAR) operation Indian Coast Guard immediately deployed ICG ships Shaurya, Sarang, Sujoy and Dornier Aircraft for fire-fighting. 02 tugs Rawana and Wasamba from Hambantota port and the Alp Winger, an anchor handling/fire-fighting tug were deployed by the salvage company of the accident-stricken vessel. The mission was joined by Indian Navy Ship, Sahaydri, Shakti and 02 Sri Lankan naval ships ICG Pollution Response ship Samudra Paheredar joined with pollution response gear and Oil spill dispersant.

Figure 4. Fire-fighting, boundary cooling and monitoring of the MT New Diamond

The DG Shipping also deployed two tugs, Ocean and Water Lily. Two more ICG vessels Ameya and Abheek were deployed, carrying oil spill dispersant chemicals & DCP/ AFFF. 2 Dornier Aircrafts carrying 10 members & Oil depressants was flown out from Chennai. The Alp Winger carried out the towing operation of the vessel to prevent her from running aground. Anchor handling vessel the TTT1 was deployed by the salvors. Another vessel, POSH Commander, deployed by salvors sailed from Singapore with salvage team, breathing apparatus, 32 ton AFFF, hell beaters and inert gas generator to join the rescue operations. A six member salvage team including Marine Chemist, Naval Architect and Lawyer was on board Tug ALP Winger.

Shipping team was continuously following up with the Salvors for deployment of sufficient resources. Finally, with the combined efforts of all the fire was put off late afternoon of 8th September, 2021.

Co-ordination

Minute to minute coordination with various stake-holders involved and boundary management was the key to success in this incident.

Immediate assistance was sought from of Indian Coast Guard (ICG), Indian Navy, MoP&NG, MEA, Ministry of Shipping and DG Shipping.

We engaged into active communication with the vessel Owner in spite of Owner's initial hesitance to comment in this matter. With continual pressure on Owners, they finally lined up a Dutch salvage company by the name of SMIT to save the ship and the cargo. The salvage company lined up is one of the best in the business.

Once salvage company swung into action, coordination with salvage company was initiated by Indian Oil. An expert group of salvors and naval architects were flown in from Netherlands by the salvage company. These experts kept close watch on the vessel's integrity under the raging fire and inclement weather conditions thereby helping us avoid any untoward situation. Daily report was sought from Salvors to keep tab on the situation.

Figure 5. Incident briefing to Chairman IndianOil, leading from the front

Various other nodal agencies including MoP&NG, MEA, MoS, IAF, Sri Lankan Sri Lankan Marine Environment Protection Agency and other authorities played major role in all decision making processes to keep situation under control and remove bottlenecks and red-tapes.

A high level meeting was co-chaired under the aegis of Hon'ble Ministers of External Affairs, Petroleum & Natural Gas, MoS (I/c) of Shipping with relevant stakeholders. Subsequently a high-powered committee was formed comprising of –

DG Indian Coast Guard (ICG), DG (Shipping), Chairman, IOCL, Joint Secretary (IOR), MEA, JS I/c MoP&NG as Co-ordinator

High powered group had a meeting with Smit Salvors and other port authorities to arrive at final destination of the casualty ship. Co-ordination was maintained with LIOC (Sri Lanka) and the High Commissioner of Sri Lanka.

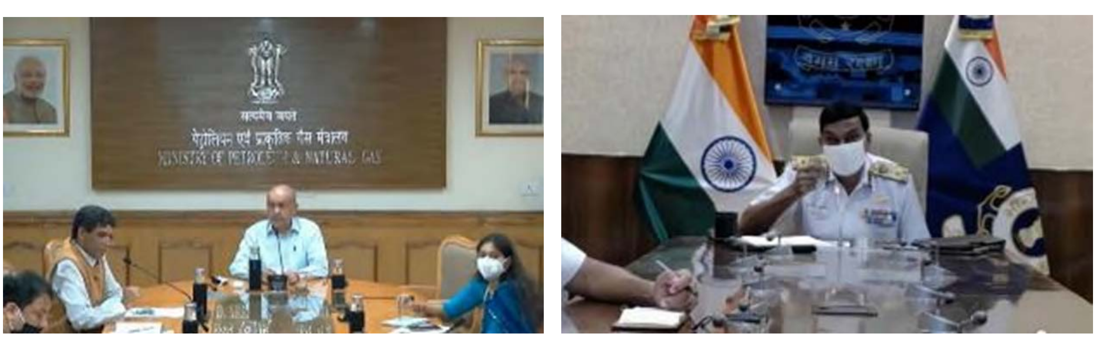

Figure 6. High-Level meeting co-chaired by Senior Govt. Officials

Minute to minute situation update and proper liaison maintained with cargo insures to keep them abreast of the developments and avoid any information gap that can adversely affect our claims owing to the incident.

Choosing destination port for casualty vessel

The engine room of the casualty vessel was totally destroyed and the vessel needed to be towed to a safe port for STS. Meeting of various technical experts (Fender Care , Brand Marine etc) in this field from renowned operators was arranged for understanding the feasibility of on situ STS as well as taking to safe port. In the meanwhile High Powered Committee also took Opinion of various port authorities and Smit Salvors and after many round of deliberations decided to choose Kalba as Port of Refuge considering the legal provisions and technicalities involved w.r.t availability of equipment and manpower.

Figure 7. Towage route distance and risk optimization analysis

Herculean task of release vessel from Sri Lankan waters

After the fire was doused off another challenge was to get the vessel released as Sri Lankan authorities refused to release the casualty vessel from Sri Lankan waters unless all claims were settled.

Vessel Owners and salvors were persuaded to expeditiously settle pending issues with the Sri Lankan authorities to secure release of the vessel. After great difficulty and closed coordination with Salvors and their legal representatives the compensation amount was settled at 442 million SLR. Help of MEA was also taken to secure release of the vessel through diplomatic channels. This was the most difficult task however, after repeated diplomatic discussions with Sri Lankan authorities clearance was secured to tow the vessel out of Sri Lankan waters.

En-route Kalba (UAE)

The towage of the vessel started on the 01st of Oct with the tug Boka Expedition. The vessel was joined by 8 support vessels from Indian Cost Guard, DG Shipping, Sri Lankan Vessels & Vessels from SMIT Savlors. The route approval was taken from Sri Lankan Authorities and the other countries following en-route i.e. Maldives & Oman.

The movement of the ship was regularly monitored by us and hourly report were sent to JSIC, Chairman IOC, DG Shipping and ICG. Help of MEA was sought for safe passage through Maldives and Oman. ICG, DG Shipping and Ministerial authorities also continuously monitored the movements and ship finally reached its destination on 08th November, 2020.

Figure 8. Towage of vessel under escort

STS and line-up of Daughter vessel for STS

Evacuation of cargo from the dilapidated vessel called for one of the most unique Ship to ship operations that the tanker fraternity has ever witnessed.02 daughter vessels of huge size (Suezmax category) to be moored to the casualty ship for almost 10-15 days each while cargo from the New Diamond's tanks was to be transferred through portable pumps by an over-the –top arrangement. This arrangement had major risks associated with it and called for major deliberations and technical study to render the proposal viable. Further, getting Owners of 02 good Suezmax vessels to agree to undertake this risky and one-of-its-kind operation was a major challenge. In spite of all odds, IOC managed to line up two good daughter vessels (MT Jag Lalit and MT Mogra) for this operation well within the STS deadlines decided by the salvor and Kalba port authorities. Both the vessel safely loaded cargoes from the casualty vessel.

Figure 9. The unique over-the-top STS operation in progress

Figure 10. Daughter vessel along-side casualty ship MT New Diamond

Freeing of the DVs

Both the daughter vessel were detained after the respective STS operations at the port of Kalba. The 1st daughter vessel MT Jag Lalit was detained by SMIT salvors on grounds of security of salvage money. Though constant pressure on port agents, harbor master and salvage company through legal channels the release of the MT Jag Lalit laden with cargo ex-New Diamond was secured.

MT Mogra was released after major resolution of issues with SMIT on one hand for the entangled security issues and on the other hand with the Kalba port authorities who had earlier refused to get the vessel sailed without any security money/bond. Same was achieved through legal channels and major arm twisting with port agents and harbour master.

Legal challenges:

Besides technical difficulties there were legal challenges w.r.t. insurance claims and any other claim arising out of any accident. The services of an expert legal company M/s Clyde & Company from UK were hired. There were multiple discussions with our insurer UIIC, Reinsurers M/s WE COX and the legal team of the owners. Arranging insurance for a casualty vessel before it depart from Sri Lanka was a herculean task. However, this was achieved before departure of the vessel from Sri Lanka. The legal issues are still going on with the vessel owner.

This incident was one which was a first for IOC and had things turned for the worse the world would have witnessed the most horrific oil spill incident in history – a fully laden VLCC going down with 2 million barrels in its belly. Taking the incident head-on required immense courage and aplomb. The brand IOC was in peril. The situation was salvaged through the courageous and dynamic leadership of Chairman Indian Oil who not only led from the front but also liaised with all stake-holders involved and instilled in them confidence that Indian Oil is capable of handling a calamity of this scale. The onus was also on the Shipping department to play a pivotal role throughout the incident and its aftermath and ensure all that needed to be done in the technical front, in the front of information flow and in ensuring bridging of gaps between various coordinating agencies was done and done perfectly. While IOC will draw inspiration from the achievements in this incident, the lessons learnt from the incident will enrich us in future.

Arrangement of Oxygen Containers during 2nd Wave of COVID

The second wave of COVID-19 in India worsened during the month of April, 2021. The country faced one of the worst medical emergencies in history with death toll setting new records with each passing day. Besides the unprecedented burden on the medical infrastructure of the country, the nation faced another major challenge – acute shortage of medical grade oxygen in hospitals.

Every challenge for the nation is a challenge for Indian Oil, our core philosophy being "Pehle Indian Phir Oil". Thus, Indian Oil came forward for the noble cause of sourcing medical grade oxygen and arranging for quick logistics of the same. A high-level committee comprising of IOCL Chairman, Director (BD) and Divisional EDs Marketing Division, ED (BD) & ED (Shipping) was constituted to handle this emergency. While oxygen from Indian Oil refineries were already being diverted to some demand centers, given the unprecedented scale of the situation it was envisaged that much more needed to be done in terms of sourcing additional volumes of oxygen and facilitating quick and efficient cross-country logistics of the same. It was decided that Indian Oil would mobilize empty and filled liquid oxygen (LOX) ISO tank containers from India and, if required, from across the world to mitigate the situation. Liquid oxygen tanks would serve as an efficient storage and transportation media for oxygen in bulk in this time of crisis.

Shipping Department took the challenge of sourcing liquid oxygen tanks. Although Shipping department had no prior experience of handling this kind job, Department took up the challenge without affecting the department's core activity of chartering ships for meeting the energy requirements of the nation.

Shipping team initiated the exercise on an emergency scale. Within a day most domestic oxygen suppliers and liquid oxygen tank suppliers were contacted for supply. But the domestic inventory of tanks was exhausted due to the unprecedented demand. Thus, there was no option left but to import these tanks from foreign land. Atleast a dozen of highly reputed and renowned tank suppliers from UK, Holland, Denmark, Belgium, Italy, USA, China, Qatar, UAE, Kuwait, Singapore and Australia were contacted with. The list included parties like SSB, Albatross, Smart Gas, Goldfleet Management, Bofort, Global Gases, BIU Plants, Jacko Gases, Iwatani Group, Brother Gas, Techno Gas, BNF Industries, etc. Due to the effects of the pandemic worldwide, there was a shortage of LOX tanks on a global scale. Due to this high demand, suppliers had an upper-hand and they were very tough in negotiating rates and lease terms and conditions. Major hurdles were faced in communication with the parties due to time difference and language barrier. Suppliers were slow in their response and it was a difficult task to win the trust of the suppliers to get the deal finalized. Several video conferences had to be organized with the suppliers for discussion on their proposals. However, within 02 days a lease agreement was negotiated with BNF Industries of Singapore for supply of 19 nos. of empty and oxygen filled LOX tanks to Indian Oil.

The next challenge was to transport these tanks into India. Due to acute pressure on private shipping lines during this period, there were chances of delays in shipping these tanks into India. Thus, assistance of Indian Air Force and Indian Navy was sought. The committee was in close interaction with MoP&NG, MoHFW, IAF, Indian Navy, Defense Attache', Singapore and daily progress review was conducted by Chairman, Indian Oil. On 1st May, 2021, that is in a record time of 7 days, the first batch of LOX tanks landed at Panagarh (W.B.) in Indian Air Force flight IL76. Subsequently, 11 LOX tanks were transported to India from Singapore by Indian Navy ship INS Jalashwa also. These tanks were leased for six months each.

Containers at Changi airport, Singapore

Containers being loaded on IAF cargo Carrier

Containers loaded on Indian Navy Ship at Changi Port, Singapore

Containers loaded on Trucks for Distribution

Home

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The @IAF_MCC has employed an IL-76 transport aircraft to carry 3 cryogenic liquid #Oxygen tanks from Singapore to Panagarh, West Bengal.

This consignment is part of an agreement between @IndianOilcl & BNF Industries.

@MEAIndia @DrSJaishankar @IndiainSingapor

: ANI

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News clips in Media

Containers of SSB loaded in IAF cargo carrier

The order placement was on done at record pace and the delivery to India was as per strict schedule decided by Govt of India. To make the process smooth and efficient, a freight forwarder was also lined up to look after custom clearance/ freight handling job at Singapore air & sea ports and Indian air & sea ports. Thus, the entire process was seamlessly managed.

The department not only sourced the 19 LOX tanks in record time but also extended major support to IOCL-BD group in transporting 10 ISO containers under lease agreement with SSB, Singapore. All these 10 tanks were brought to India by Shipping team after custom clearance and related terminal handling at Singapore and India.

The above containers were utilized across the country including New Delhi, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, Jharkhand, Bihar & Assam as per the guidance of Health Ministry and helped India breathe back to normalcy after the devastating second wave of COVID-19.

Ms. Archna Bhardwaj - The recipient of FIPI 'Woman Executive of the Year Award' for the year 2021.

She has a diversified experience of working across various departments. She exceptionally handled the Crisis management of MT New Diamond ship and averted potentially monumental environmental disaster. She arranged the import of 19 oxygen tank-containers & 222 TMT of oxygen in record time of 7 days for handling Covid-19 second wave.

This award honours Archna Bhardwaj for her courage, grit and determination in pursuing a professional career path with competence and balance in other walks of life.

FIPI Innovator of the Year Award (Team) 2021

IndianOil XtraFlo Drag Reducing Additive (DRA) Technology for Improving Pipeline Flow & Efficiency

IOCL (team led by Dr. SSV Ramakumar) receiving the FIPI Innovator of the Year - Team Award

Indian Oil Corporation Limited
Research & Development Centre

Awardees:
Dr Sukhdeep Kaur, Mr P K Sharma, Dr Gurmeet Singh, Mr Q M Amir, Mr Sunil Das (IOCL Pipeline Division), Dr C Kannan, Dr G S Kapur and Dr SSV Ramakumar

Introduction:

Drag Reducing Additives (DRA) are formulations containing ultra high molecular weight polymers (having molecular weight ranging from 10 to 100 million), which enable oil and pipeline industries to reduce the frictional pressure within the flow of a pipeline or conduit. These long-chain hydrocarbon polymers are added in the pipeline fluid only in parts-per-million levels that decrease the amount of energy lost in turbulent formation. Their addition during the pipeline transportation of crude & products helps to:

- Increase throughput
- Saves Energy
- Provide Flexibility
- Safe Operations
- Increased capacity

DRA works by suppressing the formation of turbulent bursts in the buffer region. These in turn suppress the formation and propagation of turbulent eddies. Hence so the hydraulic energy is now more focused on moving the fluid down the pipeline rather than in a chaotic, random motion.

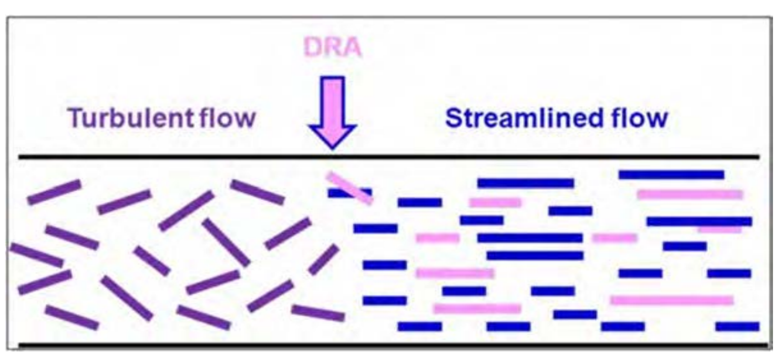

Figure 1. Pictorial representation of the DRA action

When DRA dissolves (Figure 1) in pipeline fluid, the long chain polymer molecules begin to uncoil and outspread as they interact with the pipeline flow. This interaction is quite complex, the long chain molecules dampen turbulent bursts near the pipe wall as if they were acting as tiny shock buffers. This dampening effect reduces frictional pressure loss resulting in a decrease in energy consumption or an increase in flow rate.

DRA market is controlled by few foreign global players like Lubrizol Specialty Products Inc., Baker Hughes, Flowchem to name a few.

DRA is being used by IOCL and in the country since 1995. This product was imported from the above multinational companies from the part 30 years. Recently, IOCL entered the league of above players and licensed the in-house developed patented DRA technology to M/s Dorf Ketal Chemicals India Pvt Ltd for manufacturing in India and supply worldwide.

Development of drag reducing additives at IOCL

The laboratory scale developmental project was initiated in the R&D Center of IOCL for creating Drag Reducing Agent portfolio for IOCL way back in 2012. Attaining this was not easy task, as all skilled in this art acknowledges that establishment of any chemistry is challenging. With all support from top management and a team of highly dedicated polymer scientist, DRA chemistry was developed and optimized.

There were many challenges envisage for DRA development, few of which were as follows:

- Handling of the pyrophoric and corrosive chemicals
- Establishing & maintaining inert and moisture free reactants and environment
- Designing of experiments to attain ultra high molecular weight polymer on consistently
- Catalyst development and polymerization process development
- Preparation of reactants, raw material, selection of reactor systems and reaction conditions
- Handling of ultrahigh molecular weight polymer
- Designing of the process for polymer recovery and converting the solid polymer to DRA slurry formulation
- Development of in-house methods and tests for characterization and performance evaluation of the DRA

The developmental project was started with extensive patent, open literature search and white space analysis. The literature search gave good insight to the intricacies involved in DRA synthesis, scaleup and evaluation etc.

1. Synthesis of ultrahigh molecular weight polymer at lab scale

To develop the process for synthesizing ultra high molecular weight polymer, a novel catalyst system consisting of catalyst, cocatalyst and organic compounds was developed and optimized among the substituent. The catalyst system was then evaluated for polymerization of the selected monomer under the optimized conditions for achieving ultra high molecular weight polymer. The optimization was executed using "Plan-Do-Check-Act (PDCA)" approach, as the polymerization to reach ultrahigh molecular weight was unique and thus required comprehensive examination. After the "Planning", which involved the crucial parameters to be taken into consideration was over, the "Do" phase was quite a challenge as it involved the preparation of reactants, raw material accumulation, selection of reactor systems, and preparing of the reaction conditions. More crucial was the product analysis along with the reproducibility and repeatability. All this was achieved through large number of experiments and constant perseveration to achieve and understand the polymerization.

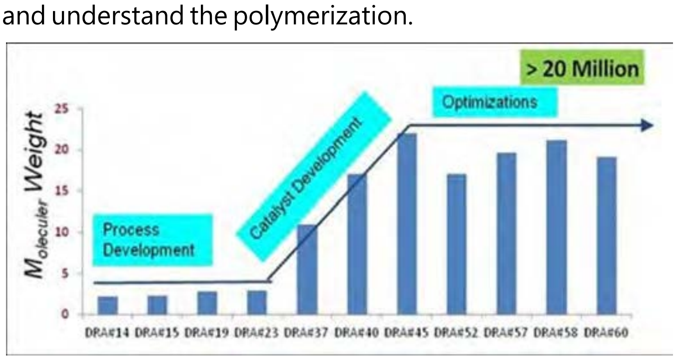

Figure 2. Catalyst and process optimization

The success of any experimentation depends upon the technical expertise and how the experimentations are carried out. The scientists of IOCL R&D possess requisite technical expertise and the labs are well equipped and versatile to conduct such challenging experimentations with success The precision of both gravimetric as well as volumetric manipulations were automated and under controlled atmosphere.

2. Characterization of polymer:

As the conventional tools like Gel Permeation Chromatography is not suitable for handling such highly viscous and ultra-high molecular weight polymers, and in-house method for molecular weight determination of the synthesized polymers was developed based on the viscosity average molecular weight (M_v) of the synthesized polymers.

With the help of this in-house developed method, the molecular weight of the lab synthesized DRA samples were measured successfully and found to be consistent in the rage of 10 to 15 million.

3. Scaling up of polymerization process to Kiloscale

After successful optimization of the lab scale process, scale up studies were undertaken at Kiloscale level The level of the scale up was decided considering the various technical and engineering aspects of the process.

4. Converting polymer into DRA Slurry

The commercial form of DRA is slurry form but the formation of slurry itself is an art, which has been mastered by IOCL-R&D.

Figure 3. Slurry of Indigenous DRA

Third Party Evaluation

The initial evaluation of the IOCL DRA product was quite challenging as there was no such lab scale facility available in India. The available pipeline test loop at R&D was not found to be too small for assessing the efficacy of these high performance DRAs. Therefore, initial performance evaluation was undertaken through a third party in Germany using a Turbulent Rheometer. The performance of the IOCL DRA was found to be at par with the commercial DRA product.

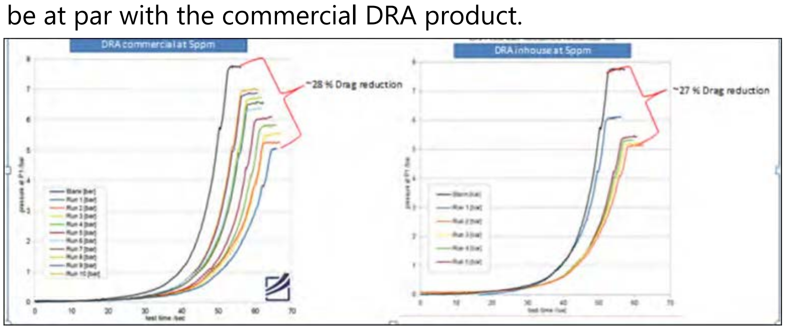

Figure 4. Rheometer analysis of IOCL DRA vs Commercial DRA

Commercial Trials IOCL DRA

The first commercial trial was conducted in the 150 KM 8" pipeline in Bongaigaon-Betkuchi pipeline section of GSPL in HSD flow. The flow rate achieved with the optimized dosage rate was 45% more as compared to base line flow rate, as well as commercial DRA.

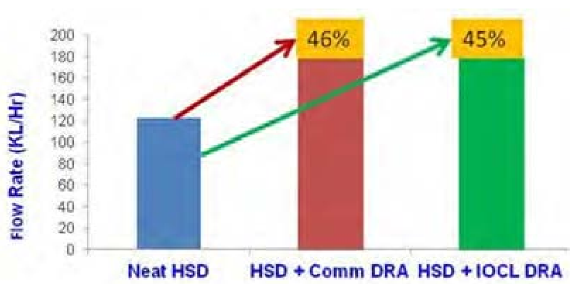

Figure 5. Graphical representation of flow rate during the trial run of IOCL DRA

The second commercial trial was conducted in the 200KM 12" pipeline in Patna- Mughalsarai section of BKPL in HSD and equivalent performance in terms of increase in flowrate was observed in both IOCL and commercial DRA. For both the trails, all the required quantifies were prepared at IOCL-R&D.

Intellectual Property on IOCL DRA

IOCL DRA technology has 5 granted patents in important global jurisdictions i.e India, US, Russia, Korea and Saudi Arabia with maximum market potential. Further a detailed Freedom to Operate (FTO) study has been performed. The IOCL DRA technology has FTO for Indian jurisdiction.

The following figure depicts the journey of development and commercialization of indigenous DRA by IOCL:

Figure 6. Graphical representation of summary of work done on IOCL DRA

Licensing of IOCL Patented DRA Technology

As a strategic decision, it was thought prudent to license IOCL DRA patented technology to a suitable chemical manufacturer in India. This licensing decision had multiple advantages for IOCL:

- IOCL contribution to fulfils Govt of India "AtmaNirbhar Bharat" and "Make in India" missions
- Provide financial benefits to IOCL - availability of DRA manufactured locally at reduced cost for IOCL captive consumption
- Royalty payments to IOCL for sale to IOCL/non-IOCL units in India and abroad
- Speedy commercialization and proliferation of IOCL DRA technology not only in India but globally.

Trade Name protection

The IOCL DRA been registered as XtraFlo for different grades of DRA to be used in different applications as depicted below:

IndianOil XtraFlo-P IMPROVING PIPELINE FLOW AND EFFICIENCY
IndianOil XtraFlo-C IMPROVING PIPELINE FLOW AND EFFICIENCY
IndianOil XtraFlo-L IMPROVING PIPELINE FLOW AND EFFICIENCY

Post Licensing-Commercial Production, Trials and Marketing

Post licensing, the regular production at the manufacturing unit has been started under IOCL supervision. Before putting into actual usage on regular basis, two more commercial trials have been undertaken for the manufactured IOCL DRA.

The first commercial trial was conducted in May 2021 in Salaya-Viramgam section of SMPL crude carrying pipeline, where IOCL-DRA gave 30% increase in pipeline flow as compared to 29% increase achieved by commercial DRA. The second commercial trial in multiproduct pipeline in August 2021 in Panipat-Rewari of NRPL provided ~50% increase in flow, better than the commercially used DRA.

Currently, indigenous developed DRA is under regular manufacturing at M/s Dorf Ketal for supplying not only to IOCL and few other companies in India. Similarly, active discussions are on with few companies abroad for trials and commercial production.

Conclusions

While India Celebrating 75 Years of Independence, Azadi ka Amrit Mahotsav – the successful development and commercializing of Drag Reducing additive (DTA) technology is a humble tribute from IOCL, which will help achieving Self-Reliance and meeting Government of India's mission of Make in India.

The technology has recently received FIPI Innovator of the Award-Team (2021)

Acknowledgements:
All the awardees greatly acknowledge the support & contribution of other members of IOCL-R&D and IOCL-PLHO in this project.

Awardees:
Dr Sukhdeep Kaur, Mr P K Sharma, Dr Gurmeet Singh, Mr Q M Amir, Mr Sunil Das (IOCL Pipeline Division), Dr C Kannan, Dr G S Kapur and Dr SSV Ramakumar


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Averting Unplanned Shutdowns during Utility Pipeline Ruptures- Line Stop Technique Application at Refinery

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Introduction:

To stay competitive and thrive in today's uncertain and volatile energy market that is characterized by major shifts in supply and demand dynamics, refiners must find ways to increase operational efficiencies, maximize productivity and produce refined products at lower costs. A major consideration for boosting a refinery's profitability and improving operational safety is to keep operating units running and available for service. Further any unplanned shutdowns are not desirable as such interruptions can have a profound impact on the company production planning activities as well as integrity of equipment's which undergo mechanical shock. Vigilance in operating rigor, quickly determining or even predicting negative impacts, and being able to efficiently correct deviations from the operating process plan are keys to maintaining high equipment reliability. Wisely investing in monitoring tools, training, catalyst and chemical treatment programs is a proven strategy for consistent top performance.

Utility supply systems in a refinery are the lifelines for units to operate. Any interruptions in utilities such as steam, cooling water, boiler feed water or DM water can have potential to bring the unit down causing serious production losses. During Pandemic, there has been shutdown of several units due to lack of demand of products and in case systems are not preserved adequately during such time, can also lead to failures.Among all utilities, circulating cooling water system is highly prone for corrosion and failures. In a modern refinery, where treated effluent to recycled back to cooling towers, there can be often leakages and even failures of the pipeline. Keeping pipelines at their best operating condition is every refiner's objective, however, it's not as easy as it sounds due to various constraints Mangalore Refinery and Petrochemicals Ltd., operates a 2.20 MMTPA Petro-FCC unit (PFCC), produces propylene which is feedstock for valuable Poly-Propylene product. Any interruptions can seriously hamper the profitability of the company. The scenarios can be severe, as the refining industry wakes up on setting of Pandemic with increased product demand. It was observed that there was a rupture of cooling water pipeline supplying to a critical exchanger in the PFCC Unit. Line stop/Flow stop technique method is method of plugging which is used to isolate system components for repair or replacement and provides a shut-off option for pressurized pipes and vessels. And this is normally planned on long distance transfer pipe lines with well in advanced plans and executed accordingly. However, this paper shall discuss the experience of using this technique for emergency scenario of arresting Cooling water leak online within short duration of time and avoiding the unplanned shutdown of Propylene fluid catalytic cracker at Mangalore refinery &Petrochemicals limited. This paper shall definitely help and guide other Indian refineries also to venture and check into the feasibility of opting this method during emergency leak scenarios especially in the main header utility lines which if unattended could lead to specific unit or complex shutdowns.

Experience of Cooling water leak at Propylene Fluid catalytic cracker unit at MRPL:

PFCC unit at MRPL is a major margin driver for the refinery as it produces valuable products such as Propylene, LPG and Motor Spirit. Therefore, any production interruptions to PFCC can result in a significant impact on refinery profitability. It was observed, the cooling water return header line of the Propylene Recovery Unit (PRU) within the PFCC unit sheared while leak attending was attempted. The cooling water return header operates at 4 kg/cm^2 pressure, and due to higher spray of cooling water, the approach towards the leak for arresting was not possible. The entire area was flooded with water making it unsafe to do any repair work. Due to leakage from the header, the water makeup in the cooling tower increased by around 400 m^3/hr. considering the criticality of the situation, an emergency meeting and a brainstorming discussion was carried out to avoid the shutdown of the Plant.

Among the various options "Line Stop/Flow Stop" technique was chosen and execution process was started for the same. Line plugging is used to isolate system components for repair or replacement and provides a shut-off option for pressurized pipes and vessels. The plugging of a pipeline is accomplished by first performing a hot tap and then using a special plugging machine. By inserting a line-plugging head into the line flow and using a special sealing element attached to the plugging head, the flow is stopped.

Fig 1: Representative schematic of "Line stop" Operation

Line pressure was optimized by taking additional cells in the cooling tower. Further all necessary measures were in place to ensure a large amount of water leak would not overload ETP. The vendors were quickly approached the line tapping & plugging vendors and arranged the related requirements on an emergency basis. The site was prepared with necessary scaffoldings, tools and tackles for carrying out the hot tapping, followed by a line stop. Pre-mobilization and post-mobilization (i.e. all Hot Tap and line stop Equipment along with its related accessories were tested prior to mobilization at work base and on site prior to commencing operations) checks & function tests were carried out to ensure that the equipment supplied is suitable for the work scope. Equipment were calibrated and fully certified before the usage at site. The entire process was carried out safely with all required PPE's usage and all priority given to work site safety and procedures. During the procedure the surrounding area around off point access was restricted by use of barricade.

On a brief procedure following points were followed for attending the leak:

1. **Welding of 8" Line stop fitting and ancillary fittings:** 8" Line stop tees were welded on the main 8 inch line. (one on the upstream and other downstream) Along with these 2" fittings were provided for pressure equalization and Product draining.

2. Installation of sandwich valve: 8″ Sandwich valves were fitted on 8″ line stop fittings which serves the purpose as a control valve throughout the operation and 2″ Ball Valve were fitted on the pressure equalization fittings and on drain fittings and the valves were made sure for 100% open

3. Hot tapping operation: Hot Tapping Operation was done on all Line stop points, pressure equalization points & drain points

4. Installation of line stop assembly: pre-fabricated 8″ bypass line was fitted on to the line stop housing to divert the flow & One line stop assembly which consists of line stop head with 8″ sealing element, actuating hydraulic cylinder and the line stop housing was fitted on 8″ sandwich valve on each side.

5. Line stop operation: After ensuring leak proof joint in all flange connections, the pressure in 8″ stopple housing was equalized with the pressure in header pipeline and After confirming the pressure equalization on top and bottom side of the 8″ sandwich valve, it was then opened at both upstream and downstream side and 8″ line stop head was inserted by actuating the line stop cylinder on both the side. After both the upstream and downstream line stop heads were in place, product from the isolated section was drained from Drain Point.

6. Line modification work: After the draining was complete and 100% stopple seal ensuring, Water was purged into the isolated section using the vent plug opening from 2″ TOR fitting. And the line modification works were completed.

7. Line stop equipment retrieval: After the completion of line modification works, the line was recommissioned by using 2" pressure equalization connection and both Line Stop heads on upstream and downstream location was retrieved and 8″ Sandwich valve was closed followed by depressurize the product from the Line Stop assembly and retrieving line stop assembly.

The above jobs were swiftly & continuously carried out with clock-work precision and the heavy cooling water leak on the return was arrested within short duration and the system was restored . The entire process was successfully done without shutting down the Propylene fluid catalytic cracker which was very critical for the refinery operations.

Conclusion and Future uses:

Keeping pipelines at their best operating condition is always the refiner’s objective, however, it’s not as easy as it sounds due to various constraints within the complex refineries where all the units & utility sections are also interrelated. Line stop/Flow stop is safe and cost-effective approach for such utility leaks and can be important part of the overall “pipeline intervention system” for keeping a refinery processing system up and running sustained operations. Line stop technique has been predominantly used/applied in the long-distance transfer lines with thoroughly planned executions and very rarely during emergency short duration scenarios.

Mangalore refinery and petrochemicals limited has successfully demonstrated that Line stop/flow stop method can be effectively executed within short duration for emergency scenarios of attending heavy utility cooling water line leaks and avoid unplanned shutdown of critical units.

References: “Plant-Tech project method statements”: Courtesy: Plant tech Industrial services. Mangalore. (https://www.youtube.com/watch?v=5uj5Ky9YhA0- Plant Tech power)

Utilization of Natural Gas and Hydrogen Blends in Existing Industrial Furnaces

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Jacopo Longhi Vienna, GIVA Group and G. Rampinini, Forgiatura A. Vienna

Abstract

Green hydrogen is considered one of the most promising alternative energy vector for the substitution of fossil fuels in the road map of the deep decarbonization.

Snam, with the participation of RINA and GIVA Group - with its subsidiary company Forgiatura A. Vienna (FAV) - launched a dedicated project with the aim to investigate the feasibility of using Hydrogen (H_2) and Natural Gas (NG) blends in existing industrial burners for forging metallic materials as Grade F22V and Inconel® 625. The feasibility study was focused on technical aspects and main criticalities relevant to the use of H_2NG blends in industrial processes, looking at the effect on burner efficiency and emissions and heat-treated material quality in terms of oxidability and susceptibility.

The evaluation of combustion system performance was carried out in RINA laboratory using an existing burner not designed for the use with hydrogen. Finally, a trial in the FAV industrial plant was carried out with 30%vol of hydrogen in NG: the test was successful, highlighting as hydrogen in blends can be safely used without any furnace/burner modification for the selected industrial scenario, thus being a quite easy step to kickstart a gradual roadmap of CO_2 emissions reduction.

The overall NG demand of the steel factory is about 11.5 MNm3/year, which in turns is responsible for about 22500 t/year of CO_2 emission. The utilization of 30% of Hydrogen in the Natural Gas mixture may lead to a saving of 2500 t CO_2 per year, without significant plant modifications.

The analysis of effects on material quality showed a moderate scale increase (8-14%) for high concentration of hydrogen in the blends, which is however considered to be not a problem from the materials descalability perspective.

Introduction

The green hydrogen is considered one of the most promising alternative energy vector for the substitution of fossil fuels in the road map of the decarbonization. The partial or overall substitution of fossil fuels with hydrogen allows to achieve deep decarbonization although it requires the development of a hydrogen-ready value chain – including transport, storage, distribution and applications for final consumption. In this context, SNAM is verifying the opportunity to supply the customers of its network with Natural Gas added with gradually increasing concentrations of hydrogen (H_2). Among the various actions undertaken, great importance is the understanding if existing industrial furnaces (that is equipment that were not specifically design to work with H_2) can be used with H_2NG mixtures. To understand if this opportunity should be effectively pursued, two steps have been identified and launched by Snam:

- First step: evaluate the technical aspects and the criticalities associated with the application of a hydrogen-natural gas blends in industrial processes, by means of both engineering and testing activities carried out in RINA laboratories.
- Second step: perform the proof test with the selected H_2NG blend within an industrial plant, which in this project is a heat treatment furnace of the forging Company "Forgiatura A. Vienna (FAV)"

First step - Technical feasibility

The technical feasibility study evaluates the use a blend of H_2/NG considering the effects on the combustion (flame stability, offgas composition) and steel product (formation and removal of scale during steel reheating). In particular:

o The evaluation of performance of burner allows to select the chemical composition of the H_2NG blend that guarantees the ignition and the stability of burner without heavy hardware modifications with tests at pilot scale (real burner installed on the RINA combustion station) and at industrial scale, on real reheating furnace (FAV plant)

o The evaluation of the effect on the steel product has the aim to guarantee that the selected H_2NG blend composition is not detrimental for the final quality of the material, with lab tests of scale growth and removal, under controlled conditions simulating the atmosphere of H_2 combustion.

The reference industrial scenario used for the feasibility analysis is the one used for the industrial application: it is a heat treatment furnace employed for steels & alloys forging with a capacity of 15 t, equipped with six high speed burners with diffuser in SIC and feed by cold air. The furnace typically treates materials as A/SA 336 Grade F22V and Inconel® 625 that present different susceptibility to the oxidation and can be considered representatives of the FAV production mix.

Experimental burner tests in RINA laboratory

The FAV industrial burner was tested at the RINA Combustion Studies Experimental Station (Figure 1) with two different levels of hydrogen in the NG: 30% and 50% vol. The burner was a 300 kW high speed burner, designed for Natural Gas only, and works in flame mode with cold air.

To understand if the current combustion system (burner) is able to work with a H_2/NG blend, it was necessary to verify its range of ignition and stability and its behavior at high temperature in terms of emissions, with specific focus on NOx emissions. In fact, the higher reactivity of hydrogen respect to NG is expected to cause an increase of NOx formation. In particular, this effect is expected to be larger for an anchored flame burner, as that considered in the project, than for burner that operates in flameless combustion.

The output the experimentation was the composition of the blend at which the burner works without hardware modifications and with acceptable level of emissions as CO and NOx.

A test rig was arranged in RINA laboratory in order to evaluate the behaviour of the FAV burner; in particular the burner was installed in a furnace with adequate maximum thermal power. During the experimental campaign a supervisor controlled the temperature, flow rate, pressure, and flue gas composition (oxygen, carbon dioxide, carbon monoxide and NOx emissions). The supervisor also checked the burner status and acted to keep safe the plant. Figure 1 shows the layout of system monitoring and test rig.

Figure 1: RINA layout of test rig

The experimental campaign showed that in terms of ignition and stability the burner works without problems up to a 30%vol. of hydrogen, whereas at 50% vol. of hydrogen the burner tends to become instable and needs specific adjustment of the burner set and modifications of the operating settings. Figure 1 reports the pictures of the burner during the cold and hot working for the selected blends.

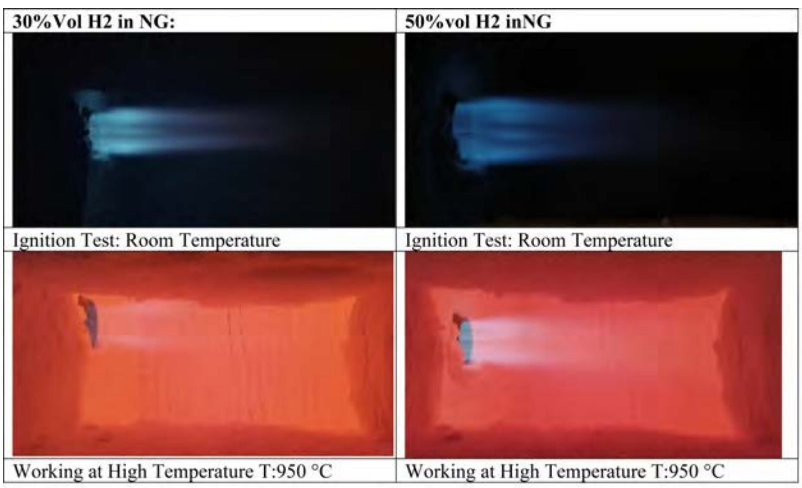

Figure 2: Ignition tests and working at High temperature (furnace temperature: 950 °C)

In terms of NOx emissions, it was not observed a significant difference between the blends with the 30 and 50%vol. of hydrogen; in both cases the values are 10% higher than the natural gas case at the maximum thermal load (300 kW) and 15% for lowest rate. Figure 4 reports the values of NOx emission for NG and both blends.

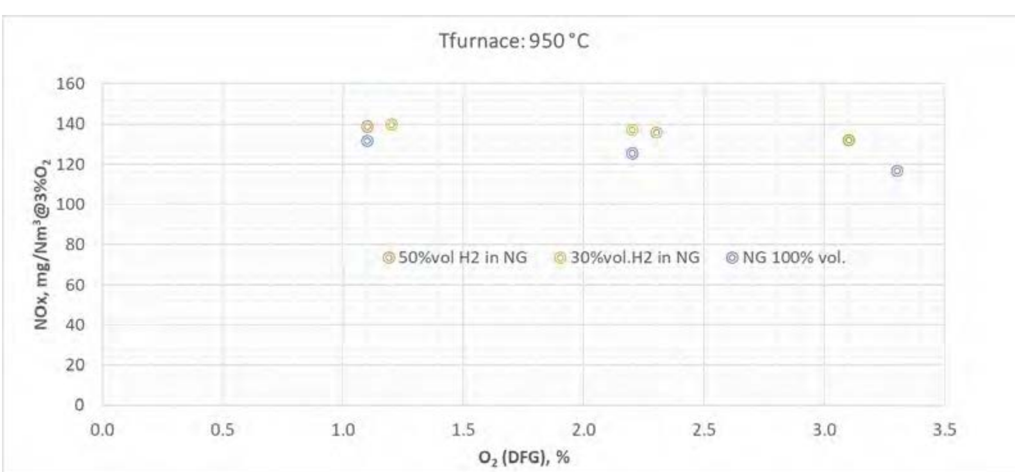

Figure 3: NOx emission, 100% Rate, furnace temperature 950 °C

Summarizing, the experimental campaign carried out at RINA laboratory allowed to verify that with the 30%vol of H_2 in the blend the burner is stable and the emissions increase with an acceptable level (not more 10% at maximum thermal load). Moreover, the correct working conditions with heat output comparable to use with 100% NG (300 kW) has been individuated.

Effect on quality product: oxidability and scale removal susceptibility

The evaluation of the effects on oxidation rate of steel was performed by ThermoGravimetric Analysis (TGA) that measures the weight gain under controlled thermal gradient and the atmosphere composition. The materials used for the test are A/SA 336 Grade F22V and Inconel® 625, characterized by different oxidation behavior due to different content of Cr and Ni. The chemical composition range is reported in table 1.

Table 1 Chemical composition of studied materials. (in case of Inconel Ni is the balance to 100%)

	C	Mn	P	S	Si	Cr	Mo	V	Fe	Nb+Ta
A/SA 336 Grade F22V	≤0.15	≤0.60	≤0.007	≤0.004	≤0.10	2.0 - 2.50	0.9 - 1.1	0.25 - 0.35	Balance	
Inconel 625	≤0.1	≤0.5			≤0.5	20 - 23	8 - 10		≤5	3.15 – 4.15

The reference temperature used for the tests were 1230 °C and 900 °C, values that simulate a re-heating and a heat treatment process. The atmospheres used are the ones referred to the flue gas composition of combustion of natural gas, 50%vol of H_2 in NG and 100% H_2 with of oxygen excess of 1%. The results of oxidation tests, reported in Table 2, indicate that the oxidation increase for INCONEL material is acceptable at both temperatures. In case of Grade F22 the scale growth is relatively significant at 1230°C (+14%) but is still acceptable.

Table 2. Oxidation tests results: the scale growth reported as percentage increase respect to value with NG

Steel grade	H2 50%vol T: 1230 ° C	H2 100% vol. T: 1230 ° C	H2 50%vol T: 900 ° C	H2 100% vol. T: 900 ° C
A/SA 336 Grade F22	+6%	+14%	0	7
INCONEL 625	0	+8%	0	0

The descaling susceptibility was evaluated by descaling tests in a pilot plant that allows to reheat the sample at high temperature and removes the scale by water nozzle at high pressure (up to 400 bar). The set of descaling parameters had to be modified in order to identify the conditions that allowed to remove the scale.

Figure 4: RINA descaling experimental facility

The descaling-ability of the heated samples were assessed using NG and 50%vol of H_2 in NG vol. The threshold level was defined in relation to two main parameters representative of the control of the descaling-ability: the impact pressure represents the mechanical actions in the removal of the oxide, whereas the specific water impingement represents the thermal shock in the removal of oxide. The results showed that the material has the same descaling susceptibility using an atmosphere deriving form 50%H_2-50%NG in comparison to NG.

Second Step - Industrial trial in FAV plant

Final part of the project was the trial test in the selected industrial plant. Test has been carried out at the steel factory "Forgiatura A. Vienna" (FAV), which is a company specialized on medium and large heavy-rolled and open dye forged products. This test has been carried out using H_2 concentration of 30% vol in the gas mixture, based on the results previously obtained (see First Step section).

Furnace description and adaptation

For the industrial test a chamber furnace (Figure 5) for heat treatments of steels & alloys with total capacity of 15ton has been selected. The furnace employs six high speed burners with diffuser in SIC and feed by cold air. Looking at the results achieved in the First Step, a mixture of 30%H2 in NG was identified as potentially applicable for the trial in the plant.

Figure 5: FAV industrial furnace selected for the H_2NG trial

In order to allow the industrial test some preparatory activities have been carried:

• Design and implementation of a gas mixing station, able to mix at controlled pressure the blend of H2 (provided by a wagon tank) and NG provided by the existing plant pipeline
• Design and installation of all supplementary pipelines connections to ensure safe connection of wagon tank to gas mixing station and connection with the furnace
• ATEX requirement assesment
• Permitting and authorization by local Fire Department
• Burner set up for the combustion with the H_2NG blend

Industrial trials and achieved results

The trial has been carried out performing a preliminary heating run with 100%NG in order to collect a set of data to be used as baseline for comparison with the ones obtained with the blend with 30%vol. of H_2 in NG. Both tests have been performed with the same heating programme. The values used for comparison and analysis of the test were O_2, NOx, CO and CO_2 concentrations in the offgas. Figure 6 below reports the furnace during the test run with the six burners working.

Figure 6:Image of the FAV industrial furnace during the test run with the six burners working

Moving to the test with 30% of H_2, as expected there was an increase of NOx from 5% up to 30% in relation to the furnace temperature and the operating conditions modality of the furnace. During the test with H_2 the burner operated quite regularly and in general the flame remained stable for the whole test duration. About NOx emissions (see table below) it has been observed an increase of 10% at temperature of 600°C and a higher increase (about 40%) at temperature of 800°C. Such increase resulted higher respect to what observed at tests carried at RINA combustion station (15%), and it has been attributed to the regulation of the temperature, that in case of industrial furnace is managed by thermocouples close to the burner, which determines fast switching on and off of the burner with subsequent turbulences, air mixing and NOx formation. An improvement of positioning of the thermocouples (for example close to the furnace roof) would determine a more regular burner working condition and in turn lower impact on NOx formation.

Table 3 Values of NOx emissions recorded during industrial trials

Furnace temp	600 °C		800 °C	
Combustible	NG	H2/NG	NG	H2/NG
NO_x, mg/Nm^3@3%O_2	94.6	99.6	103.9	145.0

The trial indicated in any case that blend of 30% H_2 can be used in the existing furnace, with quite stable flame condition and acceptable increasing of NOx. Minor furnace adaptation may contribute to limited increase of NOx formation.

General discussion and conclusion

The experimental campaign on existing burner, that is not designed for H_2, using the selected H_2NG blends has highlighted that it is possible to successfully operate the burner with 30% H_2. In the industrial furnace test, it was noticed an increase of NOx emissions up to 40%, which could be lower down with minor furnace adaption. It was confirmed the analysis of operating conditions of the furnace is fundamental to correctly evaluate the industrial application of any H_2 blends. Considering the aspects relating to product quality, an acceptable scale growth was observed for both materials, while the scale removal was not significantly affected.

The application of the blend with the 30% of H_2 in NG should be considered conservative to maintain same quality on the product. On the base of these evidence, it is possible to concludes that, for this reference industrial scenario, the burner was positively tested with a 30% H_2 in volume with no need of hardware modifications.

The overall NG demand of the steel factory is about 11.5 MNm3/year, which in turns is responsible for about 22500 t/year of CO_2 emission. The utilization of 30% of Hydrogen in the Natural Gas mixture may lead to a saving of 2500 t CO_2 per year.

Green Energy – The Future of Energy Market in India

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A. Backdrop and Prevailing Scenario

Economic growth, increasing prosperity, a growing rate of urbanization and rising per capita energy consumption is contributing to increased energy demand in India. The rising demand creates new challenges as higher consumption of energy leads to emission of greenhouse gases contributing to global warming.

India being, world's third-biggest emitter, is making visible efforts to reduce global warming and remains committed to substantially reducing its carbon footprint in the future. As a part of Nationally Determined Contributions as per the Paris Accord on Climate Change, India has made a pledge that by 2030, 40% of our installed power generation capacity shall be from non-fossil fuel sources and also by 2030, reduce emission intensity of GDP by 33-35 % from 2005 level. [1]With the accomplishment of these ambitious targets, India will become one of the largest Green Energy producers in the world, surpassing several developed countries.

The country's aim to install 450 gigawatts (GW) of renewable energy capacity would be one of the major drivers of its economic growth. However, a sustainable energy future shall require innovative solutions for transforming the way energy is produced, delivered and consumed. As one of the cleanest forms of energy in the world, green hydrogen is one of the ultimate solutions to achieve net-zero emissions.

Governments around the world have included green hydrogen as of utmost importance in their decarbonization plans, allocating billions of dollars to stimulate this nascent market. Producing hydrogen is an energy intensive process, and there is a need to exploit more and more of non-greenhouse gas producing energy sources like wind and solar power to generate electricity required for the purpose. India has an advantage here due to its geographical location, climate conditions and abundance of renewable sources of energy like solar, wind and hydro making it ideal for becoming the world's cheapest hub for Hydrogen.

B. Three Shades of Hydrogen

Hydrogen is abundantly available on earth right from fossil fuels to water to plants. However, hydrogen is not readily or naturally available in pure form and requires isolation from other elements through chemical processes.

Typically, the hydrogen produced is characterised as 'grey,' 'blue,' or 'green,' depending upon the extraction procedures.

Grey hydrogen is derived from fossil fuels and natural gas, however, it emits a significant amount of carbon dioxide. Most of the hydrogen produced today is grey.

'Grey' hydrogen becomes 'blue' hydrogen when carbon dioxide released during its creation is not escaped into the environment but captured and stored separately. In other words, while chemical processing technique for both grey and blue hydrogen is same, the only difference is management of carbon dioxide.

The 'green' hydrogen (often referred to as Clean Hydrogen) is produced using renewable energy electrolysis wherein water is segregated into hydrogen and oxygen molecules. It uses entirely different technique as compared to grey and blue hydrogen wherein no harmful gases are emitted at any point during the production cycle and only byproduct of this process is oxygen. Green hydrogen can be utilized to produce electricity for domestic, transportation, commercial, and industrial purposes. Green hydrogen could play a vital role in global efforts to reach net-zero emissions by 2050.

Though environment advantages of green hydrogen are far reaching, however, given the current high costs and lack of supporting infrastructure, the government will have to overcome several challenges to build a sustainable eco-system for this new form of energy.

At present, the country's entire production of hydrogen comes from fossil fuels. However, by 2050, three-fourth of all hydrogen is projected to be green.

C. Positive Policy Environment

Policy support and financial allocation by the Government is of utmost importance for moving towards clean energy. The Government announced various policy incentives to further boost the investment and provide an impetus to Green Hydrogen such as -

- The government in its Union Budget has allocated INR 15 Bn for Indian Renewable Energy Development Agency (IREDA) and the National Hydrogen Mission in 2021-22 for generating Hydrogen from green energy sources.

- 100% Foreign Direct Investment is allowed under the automatic route in the power segment and renewable energy. According to the data released by Department for Promotion of Industry and Internal Trade (DPIIT), the cumulative FDI equity inflow in the Non-Conventional Energy industry is USD 10.28 billion during the period April 2000 to June 2021 constituting 1.88% of the total equity inflow received in all the sectors during the same period[2].

- Launch of National Hydrogen Mission is a big step towards creating greener future that will lay down the map for generating hydrogen from green power sources. The government is currently charting the 'National Hydrogen Energy Mission' to create a hydrogen value chain in the country and bring down the costs of hydrogen production.

- Ministry of Petroleum and Natural Gas has asked Oil Public Sector Undertakings to explore alternate fuels like Green Hydrogen

- The Government is mulling Renewal Purchase Obligation to promote Green Hydrogen (Mandatory Purchases etc)

- A scheme for boosting research and development of electrolysers is expected to be rolled out soon. An electrolyser is a system that uses electricity to break water into hydrogen and oxygen.

- IREDA is planning to Create a Green Window for Green Energy Finance. Green windows, like green banks, are public entities created to work with the private sector to increase investment in green energy and bring clean energy financing into the mainstream. They are innovative and new tools that have been successful in the United Kingdom, Australia, Japan, Malaysia and the United States[3].

The above initiatives are welcome move and shall provide much needed impetus to the country in achieving its green Hydrogen Target.

D. Potential Tax Incentives

While certain policy measures have already been announced by the Government, the industry would view Budget 2022 as another opportunity for the Government to announce tax reforms and rationalization measures. The following tax incentives/ benefits could act as catalyst for investment in the sector -

- Production of green Hydrogen could be provided with tax incentives as:

- tax holiday for a certain period of time coupled with removal of Minimum Alternate Taxation;

- reduced rate of taxation of 15%, - under the current incentive scheme for manufacturing entities, this benefit is available only if the entity commences manufacturing or production by 2023 and meets certain other conditions. The Government may consider relaxing these conditions;

- Investments in Hydrogen related activities as energy carrier to be considered as investment in infrastructure and applicable for similar tax benefit such as eligibility of weighted deductions ;

- Accelerated depreciation in the first year on new investments, in production and development of fuel cell and hydrogen technologies;

- Research & Development tax incentives, such as weighted deductions;

- Further, special Tax regime may be considered for foreign service providers who assist in building Green Hydrogen plants, whereby an option can be provided to a opt for taxation on gross payments, with a reduced rate of tax. This could help in reduction of cost in building plants and facilities for green hydrogen production.

In addition, the state and central governments may offer incentives as capital subsidy, stamp & electricity duty exemptions, subsidies on interest payments, etc. Further, MSMEs could explore added incentives such as interest subvention, collateral free loans, etc.

E. Current Projects in India

Fuel cell technologies and hydrogen energy are being commercialized in the US and other countries. Governments in Asia and the European Union, in coordination with industry, are now investing more than $2 billion every year in hydrogen as a promising energy carrier[4]. The Indian government is not far behind. As green power takes precedence in the global scheme of things, the environment friendly gas has recently caught the fancy of some of the largest firms run by Indian Private sector to state-owned oil refiner IndianOil and electricity producer NTPC as they try to pivot to a more sustainable source of energy.

While 50 buses have been put out in Delhi as part of a trial project that uses blended hydrogen in compressed natural gas (CNG), several other green hydrogen projects are underway, some of which are discussed hereunder:

(a) Tamil Nadu project

Fusion Fuel Green, which has offices in Portugal and Ireland, has signed an agreement with BGR Energy Systems, an engineering, procurement, and construction (EPC) company based in Chennai, to install green hydrogen production facilities in Tamil Nadu[5].

(b) Hydrogen Fuel Cell Train project

The Indian Railways Organization for Alternate Fuels (IROAF) has invited bids to develop a hydrogen fuel cell-based hybrid power train for retrofitting the 700 HP diesel-hydraulic locomotives running on the Kalka-Shimla narrow gauge section in Himachal Pradesh[6].

(c) Hydrogen Fuel bus and car project – Leh and Delhi

NTPC Ltd, India's largest power producer and a central PSU under the Ministry of Power has invited Global Expression of Interest (EoI) to provide 10 Hydrogen Fuel Cell (FC) based electric buses and an equal number of Hydrogen Fuel Cell-based electric cars in Leh and Delhi[7].

(d) Construction major Larsen & Toubro (L&T) and leading renewable energy company ReNew Power (ReNew) signed an agreement to tap the $60 billion emerging green hydrogen market in India[8].

(e) Hydrogen electrolysers

Reliance (RIL) partnered with Danish company Stiesdal A/S to develop and manufacture hydrogen electrolysers[9].

(f) GAIL plans to build India's largest green hydrogen plant[10].

(g) Bharat Petroleum Corporation Ltd. (BPCL) has collaborated with Bhabha Atomic Research Centre (BARC) to scale-up alkaline electrolyzer technology for green hydrogen production[11].

F. Road Ahead

Decarbonising the planet is a goal set by the world to be for achieved by 2050. New technologies are required to replace existing fossil fuels in order to move towards a net carbon neutral economy at the earliest. Green Hydrogen is an upcoming technology, which can function as a viable alternative for energy-intensive industries such as refining, steel, cement, fertiliser, mining, and industrial heating.

The Government is committed to increased use of clean energy sources and is already undertaking various large-scale sustainable power projects and promoting green energy heavily. In addition, renewable energy has the potential to create many employment opportunities at all levels, especially in rural areas.

International collaboration, Development of PPP projects, Investments in R&D, technology up-gradation, and capacity building are the key to a cleaner future.

Considering the changing dynamics, policies and thrust of Indian Government on clean energy, Hydrogen is today enjoying unprecedented momentum. Foreign and Indian energy players have this unique chance to re-align their strategy to capitalise on the opportunities and would expect the Indian Government to support this momentum through tax and policy measures.

[1] *https://www.pib.gov.in/PressReleasePage.aspx?PRID=1598948*

[2] *https://dpiit.gov.in/sites/default/files/FDI_Factsheet_June2021.pdf*

[3] *https://www.pib.gov.in/PressReleasePage.aspx?PRID=1595888*

[4] *https://cafcp.org/sites/default/files/Road+Map+to+a+US+Hydrogen+Economy+Full+Report.pdf*

[5] *https://www.livemint.com/news/india/pm-modi-s-focus-on-green-hydrogen-gets-a-boost-new-facility-to-come-up-in-tamil-nadu-11615535421313.html*

[6] *https://mercomindia.com/bids-invited-hydrogen-fuel-cell/#:~:text=The%20Indian%20Railways%20Organization%20for,gauge%20section%20in%20Himachal%20Pradesh*

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[8] *https://www.larsentoubro.com/pressreleases/2021-12-02-lt-and-renew-announce-partnership-to-focus-on-the-green-hydrogen-business-in-india/*

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Oil & Gas in Media

PM inaugurates Bina (MP)-Panki (UP) Multiproduct pipeline project

The Multiproduct pipeline from Bina Refinery (MP) to POL Terminal at Panki, Kanpur (UP) was dedicated to the nation by the Prime Minister Shri Narendra Modi on 28th December 2021. 356 Km long project has a capacity of around 3.45 million metric tonne per annum. This Project also includes augmentation of Tankage capacity and construction of Rail Loading Gantry at Panki POL Terminal.Total cost of the project is Rs.1524 crore (Rs. 1227 crore in UP and Rs. 297 crore in MP). project will cover 5 districts of UP: Lalitpur, Jhansi, Jalaun, Kanpur Dehat and Kanpur Nagar, and 2 of MP: Sagar and Tikamgarh.

The project has been completed and commissioned one month ahead of approved completion schedule of December 2021 (3 years from PNGRB authorisation) and within the approved cost.It will provide for safe and efficient evacuation of products from Bina Refinery and also improve availability of products in Eastern U.P, Central U.P., Northern Bihar and Southern Uttarakhand.

The project includes laying of 18 inch dia, 356 km long multi-product pipeline (283 km in UP and 73 km in MP) with design capacity of 3.5 MMTPA from Bina Dispatch Terminal at Bina (MP) to POL Terminal at Panki, Kanpur (UP) for transporting MS, HSD & SKO and also includes following facilities;

A. Construction of Pipeline Dispatch Terminal at Bina
B. Pipeline Receipt Terminal at Panki (Kanpur) with augmentation of tankage capacity from 30400 KL to 167200 KL
C. Rail Loading Gantry
D. 11 nos. SV stations and 1 no. Intermediate Pigging station along pipeline route.

The Project provided direct & indirect employment of close to 5 lakh man-days during construction phase. The Project will also provide employment to approx. 200 people for operation and maintenance. Pipelines are the safe & environment friendly mode of transporting large quantity of petroleum products in an economical and reliable manner, reducing carbon foot prints by avoiding tank wagon and tank lorry movements.

Shri Hardeep Singh Puri delivers the 3rd Memorial Lecture on Dr . A. P. J. Abdul Kalam

Minister of Petroleum and Natural Gas & Housing and Urban Affairs Shri Hardeep Singh Puri delivered the 3rd memorial lecture on Dr. A. P. J. Abdul Kalam on 16th October 2021.

Shri Puri said that Dr Kalam represented the best of India who was able to successfully bring along diverse traditions, disciplines, and peoples to create a life story that inspired the 1.3 billion people of India. He said that wherever he went and whomever he spoke with, he exuded optimism and positivity. In today's environment of cynicism and hyper-polarisation, it may do us all some good to remember Dr. Kalam.

Describing his association with Dr Kalam, Shri Puri said that he had the privilege of working with the Dr Kalam when he was the Scientific Advisor to the Raksha Mantri and he was a Joint Secretary in the Ministry of Defence. The Minister said that Bharat Ratna Dr. A. P. J. Abdul Kalam personified the ideals of diversity and cooperation, apart from having been one of India's leading defence scientists and spearheading our nation's missile programme, among many other achievements.

Shri Puri said that Dr Kalam was a humble man, who achieved great professional successes that helped shape the nation and chart its course in the 21st century. At the same time, his personal story of integrity, intellect, and charm influenced the lives of so many Indians directly and indirectly. Dr. Kalam received the admiration, respect, and love from all, and continues to receive even today.

Shri Puri said that today, in India, the Modi Government, guided by the philosophy of 'Antyodaya Se Sarvodaya' is delivering direct cash transfers and subsidies for food, cooking gas, ration, and displacement and disaster relief, among other social benefits. Using the shared digital infrastructure of JAM (Jan Dhan, Aadhar, Mobile), this Government has revolutionised social welfare programming by creating leakage-free mechanisms that promote delivery to the needy. More than Rs. 1.78 lakh crores have been saved by adopting the direct transfer model, and the efficacy of this scheme was realised during the COVID-19 pandemic when millions of Indians benefitted from the Government's proactive interventions. He said that 100 Crore vaccinations mark will be soon achieved.

Remembering Dr Kalam for the clarity of leadership that he brought to the table, Shri Puri said he deftly handled stakeholders from the political, scientific, and administrative streams in making 'Operation Shakti' a success. Dr. Kalam was instrumental in unshackling the defence sector. His ardent support for being self-sufficient and developing indigenous technologies to strengthen our defence capabilities was a catalyst in the Government reducing its dependence on the imports of defence equipment, and in essence, refusing to kowtow to the international diktat of the time that frequently ignored India's interests. Shri Puri said that in many ways, what Dr. Kalam advocated was the 'AatmaNirbhar' path that we are on now. Dr. Kalam strongly endorsed increasing India's self-sufficiency in important aspects of nation-building. He laid out this vision in his 'India 2020' roadmap which identified five areas where India had to build core competencies: Agriculture and Food Processing; Education and Healthcare; Information and Communication Technology; Infrastructure, reliable and quality electric power, and surface transport for all parts of the country; and Self-reliance in critical technologies.

Release of Crude Oil from Indian Strategic Petroleum Reserves

India strongly believes that the pricing of liquid hydrocarbons should be reasonable, responsible and be determined by market forces. India has repeatedly expressed concern at supply of oil being artificially adjusted below demand levels by oil producing countries, leading to rising prices and negative attendant consequences.

India has agreed to release 5 million barrels of crude oil from its Strategic Petroleum Reserves. This release will happen in parallel and in consultation with other major global energy consumers including the USA, People's Republic of China, Japan and the Republic of Korea.

Hon'ble Prime Minister Modi has been consistently reviewing the high petroleum/diesel prices domestically. In a bid to control inflationary pressures, Government of India had reduced the 'central excise duty' on petrol and diesel by Rs. 5 and Rs. 10 respectively on 3 November 2021. It was followed by reduction in VAT on fuel by many state governments. These difficult steps, despite the high fiscal burden on the Government, were taken in order to provide relief to citizens.

Ministry of Petroleum and Natural Gas launches Open Acreage Licensing Programme Bid Round-VII

In continuation of its aggressive programme for exploration and adhering to the prescribed timelines, the Government has launched the Open Acreage Licensing Programme(OALP)Bid Round-VII for International Competitive Bidding.The bids can be submitted through a dedicated online e-bidding portal till 1200 hrs. onFebruary 15, 2022. Award of these blocks is likely be completed by the end of March 2022. Successful award of Round-VII Blocks would add further 15,766 sq. km of exploration acreage and cumulative acreage under OALP will be increased to 207,692 sq. km.

The Hydrocarbon Exploration and Licensing Policy (HELP) was approved in March 2016. In continuation to its determination for reduction in import dependency of oil and gas and accelerating E&P activities, the Government notified the further policy reforms in Exploration and Licensing Policy in February, 2019. The focus was shifted from 'revenue' to 'production' maximization'. There is continued focus on greater transparency and streamlined procedures.

Since the launch of HELP on 30 March 2016, five rounds of OALP have been concluded for 105 E&P blocks; award of 21 blocks under sixth round of OALP is under progress. These 126 blocks comprise about 191,926 sq.km. of area spread across 18 sedimentary basins.

Eight blocks under present bid round are spread across 6 Sedimentary Basins and include five Onland blocks (four in Category-I Basins and one in Category-III Basin), two shallow Water blocks (both in Category-I Basin) and one Ultra Deep Water block (Category-I Basin). It is expected that OALP Round VII would generate immediate exploration work commitment of around USD 300-400 million. The bidding documents and details of this bid round are available on https://online.dghindia.org/oalp.

The Hydrocarbon Exploration & Licensing Policy (HELP), which adopts the Revenue Sharing Contract model, is a significant step towards improving the 'Ease of Doing Business' in the Indian Exploration and Production (E&P) sector. It comes with attractive and liberal terms like reduced royalty rates, no Oil Cess, marketing and pricing freedom, round the year bidding, freedom to investors for carving out blocks of their interest, a single license to cover both conventional and unconventional hydrocarbon resources, exploration permission during the entire contract period, and an easy, transparent and swift bidding and awarding process.

EVENTS

India Pavilion at ADIPEC-2021

The Abu Dhabi International Petroleum Exhibition & Conference (ADIPEC-2021) was held from 15th – 18th November 2021 at Abu Dhabi. In line with the previous exhibitions, this year also FIPI had set up the exhibition stall as India Pavilion having theme 'Synergy in Energy - Partnership for a Sustainable Future', to accelerate India's efforts to increase the contribution of sustainable fuels in the energy landscape.

A total of 10 Indian Oil & Gas Companies, viz. IOCL, ONGC, BPCL, HPCL, GAIL, Petronet LNG, OIL, L&T, EIL and Cairn Oil & Gas had participated in the exhibition and set up their stall under India Pavilion to showcase the advanced technology and opportunities for global investors in the Indian Oil & Gas sector and the new energy initiatives. This year DGH stall was also a part of India Pavilion set up by FIPI.

The India Pavilion was inaugurated by Hon'ble Minister of Petroleum & Natural Gas and Housing & Urban Affairs Shri Hardeep Singh Puri on 15th November 2021.

The inaugural ceremony was witnessed by CEOs of Indian Oil & Gas Companies, senior officials from Govt. of India and several other dignitaries from India and global oil & gas industries.

Hon'ble Minister and few CEOs also participated in different Strategic Sessions and shared their thoughts on India's energy scenario and the opportunity for investments in the sector.

During the four-day event, global Ministers, CEOs, policymakers and energy professionals discussed the mission to meet the global demand for cleaner energy


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EVENTS

FIPI Oil and Gas Awards 2021

The Federation of Indian Petroleum Industry (FIPI) organised the Annual Awards 2021 on 26th November, 2021 at New Delhi. The FIPI Oil and Gas Awards have been created to recognise the leaders, innovators and pioneers in the oil and gas industry. The objective of the FIPI Oil & Gas Awards is to celebrate the industry's most outstanding achievements.

In the award evening's inaugural address, Shri S.M. Vaidya, Chairman IOCL & FIPI highlighted the role of FIPI as a partner in growth of the Indian oil and gas industry and the federation's contribution towards development of a supportive policy ecosystem for the industry. He pointed out that the oil and gas industry will have to play a crucial role in making cleaner fuel accessible to all at affordable prices.

Shri Hardeep Singh Puri, Hon'ble Minister of Petroleum & Natural Gas and Housing & Urban Affairs addressing the august gathering of industry leaders and winners of FIPI Oil and Gas Awards 2021

Shri S.M. Vaidya, Chairman FIPI and Chairman Indianoil delivering the Welcome Address

The special address at the awards ceremony was delivered by Shri, Tarun Kapoor, Secretary, MOP&NG. He highlighted the indomitable spirit of oil and gas industry with its commitment, resilience, and a strong sense of purpose, that has kept the pace ahead to energize the nation and strengthen the four pillars of India's energy future as envisioned by the Hon'ble Prime Minister - Energy access, Energy efficiency, Energy sustainability, and Energy security; at the same time ensuring Energy justice with the objective of access to safe, affordable and sustainable energy for all citizens.

Shri Rameswar Teli, Minister of State for Petroleum & Natural Gas, Labour & Employment, delivering the special address

Shri Tarun Kapoor, Secretary, MoP&NG delivering the Special Address

The Guest of Honour, Shri Rameswar Teli, Hon'ble Minister of State for Petroleum & Natural Gas & Labour and Employment mentioned that Oil and gas continue to play a pre-eminent role in meeting the energy requirements of the country with 45% of the total energy needs would be met by the oil and gas sector. He said that Government aims for improving energy access to all its citizens and continue to support the use of liquefied petroleum gas (LPG) for this purpose helping to make the fuel as affordable as traditional biomass. Ujjwala Scheme which has benefited 8.5 crores households, has been extended to cover 1 crore more beneficiaries under Ujjwala 2.0.

The FIPI Oil and Gas Awards 2021 ceremony was graced by the presence of, Shri Hardeep S. Puri, Hon'ble Minister for Petroleum & Natural Gas and Housing & Urban Affairs. The Minister awarded individuals and companies under 19 different categories for their outstanding contribution to the Indian oil and gas sector. He highlighted the role of the oil & gas sector in meeting the country's energy demand and the efforts made by FIPI to advocate conducive policies for the sector. In his key note address, he highlighted that the oil and gas sector will play a crucial role in achieving the Prime Minister's vision of USD 5 trillion economy. He mentioned that with India's incredible growth story, strong fundamentals of Indian economy and various measures taken by Government, it has made it a favourable destination for investments and doing business. He further pointed out that country is accelerating its efforts to move towards a gas-based economy and adopting cleaner use of fossil fuels such as biofuels, Increasing the contribution of electricity to de-carbonize mobility, moving towards emerging fuels such as hydrogen, and emphasizing on digital innovation across all energy systems. He said that with our continued efforts, the energy sector will be growth-centric, industry friendly and environment conscious.

Dr. R. K. Malhotra, Director General, FIPI extended the vote of thanks to all the jury members, award committee members and the dignitaries who were present at this event. The occasion witnessed overwhelming participation by industry leaders from across the oil and gas value chain and several eminent personalities.

FIPI

WINNERS OF FIPI AWARDS 2021

November 26, 2021

Award Category	Winner
Young Achiever of the Year in the Oil & Gas Industry (Female)	Sujatha Danthuluri L&T Hydrocarbon Engineering Ltd.
Young Achiever of the Year in the Oil & Gas Industry (Female) (Special Commendation)	Neha Shah Sinha Cairn Oil & Gas - Vedanta Ltd.
Young Achiever of the Year in the Oil & Gas Industry (Male)	Manu Khanna Cairn Oil & Gas - Vedanta Ltd.
Young Achiever of the Year in the Oil & Gas Industry (Male) (Special Commendation)	R Suresh BPCL (Mumbai Refinery)
Woman Executive of the Year in Oil & Gas Industry	Archna Bhardwaj Indian Oil Corp. Ltd.
Woman Executive of the Year in Oil & Gas Industry (Special Commendation)	Papia Mandal Engineers India Ltd.
Innovator of the Year – Team	IOCL (team led by Dr. SSV Ramakumar, Director, R&D & P&BD)
Innovator of the Year – Team (Special Commendation)	RIL (team led by Dr. Virendrakumar Gupta, Sr. Vice President)
Special Award (For significant increase in Gas Production)	Reliance Industries Ltd.
Special Award (For Urja Ganga Gas pipeline & Associated CGD networks)	GAIL (India) Ltd.
Digitally Advanced - Company of the Year	Indian Oil Corporation Ltd.
Digitally Advanced - Company of the Year (Special Commendation)	Reliance BP Mobility Ltd. & L&T Hydrocarbon Engineering Ltd.
Digital Technology Provider of the Year	AspenTech India Pvt. Ltd. & Deloitte Touche Tohmatsu India LLP
City Gas Distribution – Growing Company of the Year	THINK Gas Distribution Private Ltd.
City Gas Distribution – Established Company of the Year	Indraprastha Gas Ltd.
Engineering Procurement Construction (EPC) - Company of the Year	McDermott
Service Provider - Company of the Year	Schlumberger Asia Services Ltd.
Oil/Petroleum Products Pipeline Transportation - Company of the Year	HPCL - Mittal Pipelines Ltd.
Natural Gas Pipeline Transportation - Company of the Year	Gujarat State Petronet Ltd.
Oil & Gas - Exploration Company of the Year	Oil and Natural Gas Corp. Ltd.
Oil Marketing - Company of the Year	Hindustan Petroleum Corp. Ltd.
Sustainably Growing Corporate of the Year	Bharat Petroleum Corp. Ltd. & GAIL (India) Ltd.
Excellence in Human Resource Management – Company of the Year	GAIL (India) Ltd.
Oil & Gas Production Company of the Year (Production more than 1 MMTOE)	Cairn Oil & Gas - Vedanta Ltd.
Best Managed Project of the Year	Reliance Industries Ltd. (E&P) (For R-Cluster project located in Block KGD6)
Refinery of the Year (Capacity up to 9 MMTPA)	IOCL – Mathura Refinery
Refinery of the Year (Capacity higher than 9 MMTPA)	IOCL – Panipat Refinery
Initiatives in Clean Energy Company of the year	Indian Oil Corp. Ltd.

Dr. R.K. Malhotra Director General, FIPI delivering the vote of thanks

Sujatha Danthuluri, L&T - receiving the Young Achiever of the Year Award (Female)

Young Achiever of the Year (Female) - Special Commendation-Neha Shah Sinha, Cairn Oil & Gas - Vedanta Ltd.

Manu Khanna, Cairn Oil & Gas - Vedanta Ltd. receiving the Young Achiever of the Year Award (Male)

Young Achiever of the Year (Male) - Special Commendation - R. Suresh, BPCL

Archna Bhardwaj, IOCL - receiving the Woman Executive of the Year Award

Woman Executive of the Year - Special Commendation - Papia Mandal, EIL

IOCL (team led by Dr. SSV Ramakumar) receiving the Innovator of the Year - Team Award

Innovator of the Year (Team) - Special Commendation to RIL (team led by Dr. Virendrakumar Gupta)

Special Award to RIL for significant increase in Gas Production

Special Award to GAIL for Urja Ganga Gas Pipeline and associated CGD network

Team IndianOil recceiving the Digitally Advanced Company of the Year Award

Digitally Advanced Company of the Year - Special Commendation to Reliance BP Mobility Ltd

Digitally Advanced Company of the Year - Special Commendation to L&T Hydrocarbon Engineering Ltd

AspenTech India - recipient of Digital Technology Provider of the Year Award

Deloitte Touche Tohmatsu India LLP- recipient of Digital Technology Provider of the Year Award

THINK Gas Distribution Pvt Ltd- recipient of CGD - Growing Company of the year Award

CGD - Established Company of the Year Award to Indraprastha Gas Ltd

Team McDermot receiving the EPC Company of the year Award

Schlumberger Asia Services Ltd - recipient of Service Provider Company of the year Award

Oil / Petroleum Products Pipeline Transportation Company of the Year Award to HPCL-Mittal Pipelines Ltd

Gujarat State Petronet Ltd receiving the Natural Gas Pipeline Transportation Company of the Year Award

Team ONGC receiving the Oil & Gas Exploration Company of the Year Award

HPCL - the recipient of Oil Marketing Company of the Year Award

Recipient of Sustainably Growing Corporate of the Year Award - BPCL

Recipient of Sustainably Growing Corporate of the Year Award - GAIL

Team GAIL receiving the Excellence in Human Resource Management Company of tye Year Award

Cairn Oil & Gas - Vedanta Ltd. recipient of Oil & Gas Production Company of the Year Award

Team RIL receiving the Best Managed Project of the Year Award

Refinery of the Year Award (Capacity upto 9 MMTPA) - IOCL Mathura Refinery

IOCL Panipat Refinery - Recipient of Refinery of the Year Award (Capacity higher than 9 MMTPA)

Team IOCL receiving the Initiatives in Clean Energy Company of the Year Award

NEW APPOINTMENTS

Dr Alka Mittal takes additional charge as CMD ONGC

Dr Alka Mittal

Director (HR) of Oil and Natural Gas Corporation Limited (ONGC) Dr Alka Mittal took additional charge as the Chairman and Managing Director (CMD) of the Energy Maharatna on 4 January 2022. She has become the first woman to head one of India's most valuable public sector companies. Dr Mittal has been serving as Director (HR) since 27 November 2018 and was the senior-most Director on the Board of the energy company.

A post graduate in Economics, MBA (HRM) and Doctorate in Commerce and Business Studies, she had joined ONGC as a Graduate Trainee in 1985. She brings with her an extremely rich experience spanning over three and a half decades. Dr Mittal was the first woman to hold the charge of a full-time Director in ONGC's history. She has also been on the Board of ONGC Mangalore Petrochemicals Limited (OMPL) as ONGC nominee Director since August 2015. She is also on the boards of IIM Tiruchirappalli and NHRDN.

As Director (HR), she has been conferred with the Silver Stevie Award in Woman of the Year category at the International Business Awards 2021 for adopting best-in-class HR practices and making ONGC a great place to work. She is an icon for women empowerment and lays special emphasis on retraining and reskilling workforce to be responsive to the changing scenario. Dr Mittal has been the mind behind the People's Connect Initiative to facilitate knowledge sharing from superannuating employees to young professionals of the organization.

Mr. V Satish Kumar takes over as Director (Marketing), IndianOil

V Satish Kumar

Mr V Satish Kumar has taken charge as Director (Marketing) of Indian Oil Corporation Ltd. on 28th October 2021. Mr. Satish Kumar is a Mechanical Engineer and holds a post graduate degree in Management from University of Lubljana, Slovenia. Mr. Kumar has over 3 decades of rich experience in marketing of petroleum products in various geographies of the country.

Prior to assuming charge as Director (Marketing), he was heading the marketing network in the States of Madhya Pradesh & Chhattisgarh as Executive Director and State Head, Madhya Pradesh State Office. During his career, he has been instrumental in implementing key business initiatives like Direct Benefit Transfer for LPG consumer (DBTL), Pradhan Mantri Ujjwala Yojana (PMUY), BS-VI fuel implementation, etc. which have been widely acknowledged for their social and environmental impact.

Mr. Satish Kumar was also the Chief Executive Officer of IndianOil Petronas Pvt. Ltd. (IPPL), a Joint Venture of IndianOil and Petronas, Malaysia. During his tenure, record volumes of LPG Imports were handled by IPPL, which helped the country in meeting the increase in the LPG demand under the Govt. of India's ambitious PMUY Scheme. Mr. Satish Kumar is also on the Board of "Beximco IOC Petroleum & Energy Ltd.", a Joint Venture of IOC Middle East FZE (a wholly owned subsidiary of IndianOil in Dubai) and Beximco, Bangladesh, which is setting up infrastructure for import and marketing of petroleum products in Bangladesh. Mr. Satish Kumar has widely travelled and has addressed many National as well as International Energy conferences.

NEW APPOINTMENTS

Mr D.S. Nanaware takes over as Director (Pipelines), IndianOil

D.S. Nanaware

Mr DS Nanaware has taken charge as Director (Pipelines), Indian Oil Corporation Limited on 28th December 2021. Mr. Nanaware is a Mechanical engineering graduate from Walchand College of Engineering, Sangli under Shivaji University, Kolhapur with a rich and varied experience of over 36 years. He is also the Chairman of IHB Ltd. a JV of IndianOil, HPCL and BPCL which is building the world's longest LPG pipeline from Kandla to Gorakhpur.

Before he assumed the office of Director (Pipelines), he was Executive Director (Projects) at the Pipelines Division Head Office. Earlier, as the head of Southern Region Pipelines (SRPL), he was instrumental in starting the prestigious Ennore-Tuticorin Gas Pipeline Project and successfully commissioning its Ennore-Manali and Ramanathapuram-Tuticorin sections.

Mr Nanaware is a keen proponent for ushering a gas-based economy in the country and has played a key role in the formation of two JV companies - GSPL India Gasnet Limited (GIGL) and GSPL India Transco Limited (GITL)- both SPVs promoted by GSPL, IndianOil, BPCL and HPCL to create a pan India gas pipelines infrastructure.

Mr. Rakesh Kumar Jain takes over as Director (Finance) of GAIL

Mr. Rakesh Kumar Jain assumed charge as Director (Finance) of GAIL (India) Limited on 1st December 2021. A Cost and Management Accountant by profession, Mr. Jain started his career in the company as a Management Trainee and gathered a rich experience of nearly 30 years as he rose through the ranks to his present position.

Rakesh Kumar Jain

Prior to his appointment as Director (Finance), Mr. Jain held the position of Executive Director (Finance & Accounts) in GAIL. Additionally, Mr. Jain holds the position of Director in Indraprastha Gas Limited. He joined GAIL in 1992 and has been a part of the growth trajectory of the Company. As Executive Director (Finance & Accounts), he headed Corporate Finance and Treasury section in large mobilisation of funds from domestic and international markets and took investment decisions in large infrastructure projects.

Mr. Jain has worked in the areas of Corporate Finance and Treasury including Forex Risk Management, Capital Budgeting, Corporate Budgets, Corporate Accounts, Finalization of Long Term international LNG and Gas Agreements, Pricing, Liquefaction and Regasification Terminal Service Agreement, Mergers & Acquisitions, Taxation, Regulatory aspects etc. Besides serving a long tenure at GAIL, he was on deputation to Petroleum and Natural Gas Regulatory Board (PNGRB), as Jt. Director (Commercial and Finance).

STATISTICS

INDIA: OIL & GAS

DOMESTIC OIL PRODUCTION (MILLION MT)

		2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - Sept 2021 (P)	% of Total
Onshore	ONGC	5.8	5.9	6.0	6.1	6.1	5.9	2.9	38.1
	OIL	3.2	3.3	3.4	3.3	3.1	2.9	1.5	19.6
	Pvt./ JV (PSC)	8.8	8.4	8.2	8.0	7.0	6.2	3.2	42.3
	Sub Total	**17.8**	**17.6**	**17.5**	**17.3**	**16.2**	**15.1**	**7.6**	**100**
Offshore	ONGC	16.5	16.3	16.2	15.0	14.5	14.2	6.8	93.3
	OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Pvt./ JV (PSC)	2.5	2.1	1.9	1.9	1.5	1.1	0.5	6.7
	Sub Total	**19.1**	**18.4**	**18.1**	**16.9**	**16.0**	**15.4**	**7.3**	**100.0**
Total Domestic Production		36.9	36.0	35.7	34.2	32.2	30.5	14.9	100.0
	ONGC	22.4	22.2	22.2	21.0	20.6	20.2	9.7	65.0
	OIL	3.2	3.3	3.4	3.3	3.1	2.9	1.5	10.0
	Pvt./ JV (PSC)	11.3	10.5	10.1	9.9	8.4	7.4	3.7	25.0
Total Domestic Production		**36.9**	**36.0**	**35.7**	**34.2**	**32.2**	**30.5**	**14.9**	**100.0**

Source : PIB/PPAC

REFINING

Refining Capacity (Million MT on 1st November 2021)

Indian Oil Corporation Ltd.	
Digboi	0.65
Guwahati	1.00
Koyali	13.70
Barauni	6.00
Haldia	8.00
Mathura	8.00
Panipat	15.00
Bongaigoan	2.35
Paradip	15.00
Total	**69.70**

Chennai Petroleum Corp. Ltd.	
Chennai	10.50
Narimanam	1.00
Total	**11.50**

JV Refineries	
DBPC, BORL-Bina	7.80
HMEL,GGSR	11.30
JV Total	**19.10**

Bharat Petroleum Corp. Ltd.	
Mumbai	12.00
Kochi	15.50
Total	**27.50**

Hindustan Petroleum Corp. Ltd.	
Mumbai	7.50
Visakhapattnam	8.30
Total	**15.80**
Other PSU Refineries	
NRL, Numaligarh	**3.00**
MRPL	**15.00**
ONGC, Tatipaka	**0.07**
Total PSU Refineries Capacity	**142.57**

Private Refineries	
RIL, (DTA) Jamnagar	33.00
RIL , (SEZ), Jamnagar	35.20
Nayara Energy Ltd. , Jamnagar #	20.00
Pvt. Total	**88.20**

Total Refining Capacity of India 249.9 (5.00 million barrels per day)

Nayara Energy Limited (formerly Essar Oil Limited)

Source : PPAC

CRUDE PROCESSING (MILLION MT)

PSU Refineries	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - Sept 2021 (P)
IOCL	58.01	65.19	69.00	71.81	69.42	62.35	32.00
BPCL	24.10	25.30	28.20	30.90	31.53	26.22	13.72
HPCL	17.20	17.80	18.20	18.44	17.18	16.42	5.04
CPCL	9.60	10.30	10.80	10.69	10.16	8.24	3.98
MRPL	15.53	15.97	16.13	16.23	13.95	11.47	6.17
ONGC (Tatipaka)	0.07	0.09	0.08	0.07	0.09	0.08	0.04
NRL	2.52	2.68	2.81	2.90	2.38	2.71	1.32
SUB TOTAL	**127.03**	**137.33**	**145.22**	**151.04**	**144.71**	**127.50**	**62.26**

JV Refineries	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - Sept 2021 (P)
HMEL	10.71	10.52	8.83	12.47	12.24	10.07	6.51
BORL	6.40	6.36	6.71	5.71	7.91	6.19	3.39
SUB TOTAL	**17.11**	**16.88**	**15.54**	**18.18**	**20.15**	**16.26**	**9.90**

Pvt. Refineries	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - Sept 2021 (P)
NEL	19.11	20.92	20.69	18.89	20.62	17.07	10.03
RIL	69.50	70.20	70.50	69.14	68.89	60.94	31.09
SUB TOTAL	**88.61**	**91.12**	**91.19**	**88.03**	**89.51**	**78.01**	**41.12**

	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April - Sept 2021 (P)
All India Crude Processing	**232.90**	**245.40**	**251.90**	**257.25**	**254.38**	**221.77**	**113.29**

Source : PIB Release/PPAC

CRUDE CAPACITY VS. PROCESSING

	Capacity On 01/11/2021 Million MT	% Share	Crude Processing April-Sept 2021 (P)	% Share
PSU Ref	142.6	57.1	62.3	55.0
JV. Ref	19.1	7.6	9.9	8.7
Pvt. Ref	88.2	35.3	41.1	36.3
Total	**249.9**	**100**	**113.3**	**100**

Source: PIB/PPAC

POL PRODUCTION (Million MT)

	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April-Sept 2021 (P)
From Refineries	227.9	239.2	249.8	257.4	258.2	229.2	117.3
From Fractionators	3.4	3.5	4.6	4.9	4.8	4.2	2.1
Total	**231.2**	**242.7**	**254.4**	**262.4**	**262.9**	**233.4**	**119.3**

DISTILLATE PRODUCTION (Million MT)

	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (P)	April-Sept 2021 (P)
Light Distillates, MMT	67.1	71.0	74.7	75.4	76.8	71.4	36.1
Middle Distillates , MMT	118.3	122.5	127.5	130.8	130.2	110.5	56.0
Total Distillates, MMT	185.4	193.5	202.2	206.1	206.9	182.0	92.1
% Distillates Production on Crude Processing	**78.5**	**77.8**	**78.8**	**78.6**	**79.9**	**80.5**	**79.9**

Source: PIB/PPAC

PETROLEUM PRICING

OIL IMPORT - VOLUME AND VALUE

	2015-16	2016-17	2017-18	2018-19	2019-20 (P)	2020-21 (P)	April-Sept 2021 (P)
Quantity, Million Mt	202.9	213.9	220.4	226.5	227.0	198.1	101.4
Value, INR ₹000 cr.	416.6	470.2	565.5	783.2	717.0	463.0	381.1
Value, USD Billion	64.0	70.2	87.8	111.9	101.4	62.7	51.5
Average conversion Rate, INR per USD (Calculated)	65.1	67.0	64.4	70.0	70.7	73.8	74.0

OIL IMPORT - PRICE USD / BARREL

	2015-16	2016-17	2017-18	2018-19	2019-20 (P)	2020-21 (P)	April-Sept 2021 (P)
Brent (Low Sulphur - LS-marker) (a)	47.5	48.7	57.5	70.0	61.0	44.3	71.0
Dubai (b)	45.6	47.0	55.8	69.3	60.3	44.6	66.9
Low sulphur-High sulphur differential (a-b)	1.8	1.7	1.6	0.7	0.6	-0.3	4.1
Indian Crude Basket (ICB)	46.17	47.56	56.43	69.88	60.47	44.82	69.80
ICB High Sulphur share %	72.28	71.03	72.38	74.77	75.50	75.62	75.62
ICB Low Sulphur share %	27.72	28.97	27.62	25.23	24.50	24.38	24.38

INTERNATIONAL PETROLEUM PRODUCTS PRICES EX SINGAPORE, ($/bbl.)

	2015-16	2016-17	2017-18	2018-19	2019-20 (P)	2020-21 (P)	April-Sept 2021 (P)
Gasoline	61.7	58.1	67.8	75.3	67.0	47.5	78.2
Naphtha	48.5	47.1	56.3	65.4	55.1	43.9	70.1
Kero / Jet	58.2	58.4	69.2	83.9	70.4	45.8	73.1
Gas Oil (0.05% S)	57.6	58.9	69.8	84.1	74.1	50.0	75.1
Dubai crude	45.6	47.0	55.8	69.3	60.3	44.6	66.9
Indian crude basket	46.2	47.6	56.4	69.9	60.5	44.8	69.8

CRACKS SPREADS ($/ BBL.)

	2015-16	2016-17	2017-18	2018-19	2019-20 (P)	2020-21 (P)	April-Sept 2021 (P)
Gasoline crack							
Dubai crude based	16.1	11.1	12.0	5.9	6.7	2.9	11.2
Indian crude basket	15.6	10.6	11.4	5.4	6.5	2.6	8.4
Diesel crack							
Dubai crude based	12.0	12.0	13.9	14.8	13.8	5.5	8.2
Indian crude basket	11.5	11.4	13.4	14.2	13.6	5.2	5.3

DOMESTIC GAS PRICE ($/MMBTU)

Period	Domestic Gas Price (GCV Basis)	Price Cap for Deepwater, High temp Hingh Pressure Areas
October 15 - March 16	3.82	-
April 16 - September 16	3.06	6.61
October 16 - March 17	2.50	5.30
April 17- September 17	2.48	5.56
October 17 - March 18	2.89	6.30
April 18 - September 18	3.06	6.78
October 18 - March 19	3.36	7.67
April 19 - September 19	3.69	9.32
October 19 - March 20	3.23	8.43
April 20 - September 20	2.39	5.61
October 20 - March 21	1.79	4.06
April 21 - September 21	1.79	3.62
October 21 - March 22	2.90	6.13

Source: PIB/PPAC/OPEC

GAS PRODUCTION

Qty in MMSCM

	2017-18	2018-19	2019-20	2020-21 (P)	April-Sept 2021 (P)
ONGC	23429	24667	23746	21872	10256
Oil India	2881	2722	2668	2480	1434
Private/ Joint Ventures	6338	5477	4770	4319	5200
Total	**32648**	**32875**	**31184**	**28671**	**16891**

		2017-18	2018-19	2019-20	2020-21 (P)	April-Sept 2021 (P)
Onshore	Natural Gas	9904	10046	9893	9601	5186
	CBM	735	710	655	477	345
	Sub Total	**10639**	**10756**	**10549**	**10078**	**5531**
Offshore		22011	22117	20635	18428	11360
	Sub Total	**22011**	**22117**	**20635**	**18428**	**11360**

Total	**32649**	**32873**	**31184**	**28506**	**16891**
(-) Flare loss	918	815	927	721	422
Net Production	31731	32058	30257	27785	16469

	2017-18	2018-19	2019-20	2020-21 (P)	April-Sept 2021 (P)
Net Production	31731	32058	30257	27785	16469
Own Consumption	5806	6019	6053	5736	2879
Availabilty	25925	26039	24204	22049	13590

AVAILABILTY FOR SALE

	2017-18	2018-19	2019-20	2020-21(P)	April-Sept 2021 (P)
ONGC	18553	19597	18532	16972	7919
Oil India	2365	2207	2123	1930	1112
Private/ Joint Ventures	5007	4235	3549	3147	4559
Total	**25925**	**26039**	**24204**	**22049**	**13590**

CONSUMPTION (EXCLUDING OWN CONSUMPTION

	2017-18	2018-19	2019-20	2020-21 (P)	April-Sept 2021 (P)
Total Consumption	53364	54779	58091	54910	29268
Availabilty for sale	25925	26039	24204	22049	13590
LNG Import	27439	28740	33887	32861	15678

GAS - IMPORT DEPENDENCY

	2017-18	2018-19	2019-20	2020-21 (P)	April-Sept 2021 (P)
Net Gas Production	31731	32058	30257	27785	16469
LNG Imports	27439	28740	33887	32861	15678
Import Dependency (%)	46.4	47.3	52.8	54.2	48.8
Total Gas Consumption*	**59170**	**60798**	**64144**	**60646**	**32147**

* Includes Own Consumption

Source:PIB/PPAC

SECTOR WISE DEMAND AND COMSUMPTION OF NATURAL GAS

Qty in MMSCM

		2019-20	2020-21 (P)	April-September 2021 (P)						
				April	May	June	July	Aug	Sept	Total
Fertilizer	R-LNG	9556	11336	877	893	964	1048	1084	1020	5886
	Domestic Gas	6559	6331	539	521	538	568	541	415	3122
Power	R-LNG	3554	3630	286	263	281	343	329	285	1787
	Domestic Gas	7526	7289	560	584	554	489	527	551	3265
City Gas	R-LNG	5146	4169	431	409	351	415	396	444	2446
	Domestic Gas	5737	4899	455	404	517	575	592	620	3163
Refinery Petrochemical Others	R-LNG	13130	12505	1030	904	928	1007	785	784	5438
	Domestic Gas	5285	5920	682	797	845	906	807	954	4991

Source:PPAC

1. CGD INFRASTRUCTURE

		As on 31st March 2018	As on 31st March 2019	As on 31st March 2020	As on 31st Oct 2021 (P)
PNG	Domestic	42,80,054	50,43,188	60,68,415	83,73,661
	Commercial	26,131	28,046	30,622	33,556
	Industrial	7,601	8,823	10,258	12,680
CNG	CNG Stations	1,424	1,730	2,207	3,532
	CNG Vehicles	30.90 lakhs	33.47 lakhs	37.10 lakhs	41.68 lakhs

Source: PPAC/Vahan

2. MAJOR NATURAL GAS PIPELINE NETWORK As on 31.06.2021

Nature of pipeline		GAIL	GSPL	PIL	IOCL	AGCL	RGPL
Operational	Length	8,242	2,265	1,459	132	105	312
	Capacity	167.2	43.0	85.0	20.0	2.4	3.5
Partially commissioned#	Length	4,407			166		
	Capacity						
Total operational length		**12,649**	**2,265**	**1,459**	**298**	**105**	**312**
Under construction	Length	6,185			1,265		
	Capacity	23.2					
Total length		**18,834**	**2,265**	**1,459**	**1,563**	**105**	**312**

Nature of pipeline		GGL	DFPCL	ONGC	GIGL	GITL	Others*	Total
Operational	Length	73	42	24				**12,653**
	Capacity	5.1	0.7	6.0				**337.3**
Partially commissioned#	Length				441	365		**5,379**
	Capacity				0			**-**
Total operational length		**73**	**42**	**24**	**441**	**365**	**0**	**18,032**
Under construction	Length				2,239	1,446	3,550	**14,685**
	Capacity						149.0	**-**
Total length		**73**	**42**	**24**	**2,680**	**1,811**	**3,550**	**32,717**

*Includes AGCL, DFPCL, ONGC and excludes CGD pipeline network
Source: PPAC/PNGRB

3. EXISTING LNG TERMINALS

Location	Companies	Capacity (MMTPA) As on 01st Dec'21	Capacity Utilisation (%) April- Nov 2021
Dahej	Petronet LNG Ltd	17.5	91.4
Hazira	Shell Energy India Pvt Ltd	5.2	70.1
Dabhol*	Konkan LNG Ltd	5	52.3
Kochi	Petronet LNG Ltd	5	22.1
Ennore	Indian Oil LNG Pvt Ltd	5	14.0
Mundra	GSPC LNG Ltd	5	20.5
Total Capacity		**42.7 MMTPA**	

*To increase to 5 MMTPA with breakwater. Only HP stream of capacity of 2.9 MMTPA is commissioned
Source: PPAC

Member Organizations

S No	Organization	Name	Designation
1	Antelopus Energy Pvt Ltd	Mr. Suniti Bhat	Chief Executive Officer
2	Axens India (P) Ltd.	Mr. Philippe Bergault	Managing Director
3	Baker Hughes, A GE Company	Mr. Neeraj Sethi	Country Leader
4	Bharat Oman Refineries Ltd.	Mr. Abhairaj Singh Bhandari	Chief Executive Officer
5	Bharat Petroleum Corporation Ltd.	Mr. Arun Kumar Singh	Chairman & Managing Director
6	BP Group	Mr. Sashi Mukundan	President, bp India & Senior Vice President, bp group
7	Cairn Oil & Gas, Vedanta Limited	Mr. Sunil Duggal	Group CEO, Vedanta Ltd.
8	Chandigarh University	Mr. Satnam Singh Sandhu	Chancellor
9	Chennai Petroleum Corporation Ltd.	Mr. Arvind Kumar	Managing Director
10	Chi Energie Pvt. Ltd	Mr. Ajay Khandelwal	Director
11	CSIR-Indian Institute of Petroleum	Dr. Anjan Ray	Director
12	Decom North Sea	Mr. Will Rowley	Interim Managing Director
13	Deepwater Drilling & Industries Ltd.	Mr. Naresh Kumar	Chairman & Managing Director
14	Dynamic Drilling & Services Pvt. Ltd.	Mr. S. M. Malhotra	President
15	Engineers India Ltd.	Ms. Vartika Shukla	Chairman & Managing Director
16	Ernst & Young LLP	Mr. Rajiv Memani	Country Manager & Partner
17	ExxonMobil Gas (India) Pvt. Ltd.	Mr. Bill Davis	Chief Executive Officer
18	GAIL (India) Ltd.	Mr. Manoj Jain	Chairman & Managing Director
19	GSPC LNG Ltd.	Mr. Anil K. Joshi	President
20	h2e Power Systems Pvt. Ltd.	Mr. Siddharth R Mayur	Managing Director & CEO
21	Haldor Topsoe India Pvt. Ltd.	Mr. Alok Verma	Managing Director
22	Hindustan Petroleum Corp. Ltd.	Mr. M.K. Surana	Chairman & Managing Director
23	HPCL Mittal Energy Ltd.	Mr. Prabh Das	Managing Director & CEO
24	HPOIL Gas Private Ltd.	Mr. Arun Kumar Mishra	Chief Executive Officer
25	IHS Markit	Mr. James Burkhard	Managing Director
26	International Gas Union	Mr. Luis Bertran	Secretary General
27	IIT (ISM) Dhanbad	Prof. Rajiv Shekhar	Director
28	IMC Ltd.	Mr. A. Mallesh Rao	Managing Director
29	Indian Gas Exchange Ltd.	Mr. Rajesh Kumar Mediratta	Director
30	Indian Oil Corporation Ltd.	Mr. S.M. Vaidya	Chairman
31	Indian Strategic Petroleum Reserves Ltd	Mr. H.P.S. Ahuja	Chief Executive Officer & MD
32	Indraprastha Gas Ltd.	Mr. A.K. Jana	Managing Director
33	Indian Oiltanking Ltd.	Mr. Rajesh Ganesh	Managing Director
34	IPIECA	Mr. Brian Sullivan	Executive Director

S No	Organization	Name	Designation
35	Invenire Petrodyne Ltd.	Mr. Mannish Maheshwari	Chairman & Managing Director
36	IRM Energy Pvt. Ltd.	Mr. Karan Kaushal	Chief Executive Officer
37	Jindal Drilling & Industries Pvt. Ltd.	Mr. Raghav Jindal	Managing Director
38	LanzaTech	Dr. Jennifer Holmgren	Chief Executive Officer
39	Larsen & Toubro Ltd	Mr. S.N. Subrahmanyan	CEO & Managing Director
40	Maharashtra Institute of Technology (MIT) Pune	Dr. L.K. Kshirsagar	Principal
41	Mangalore Refinery & Petrochemicals Ltd.	Mr. M. Venkatesh	Managing Director
42	Megha Engineering & Infrastructures Ltd.	Mr. P. Doraiah	Director
43	Nayara Energy Ltd.	Mr. Tony Fountain	Chairman
44	Numaligarh Refinery Ltd.	Mr. S.K. Barua	Managing Director
45	Oil and Natural Gas Corporation Ltd	Dr. Alka Mittal	Director (HR) & CMD (Addl. Charge)
46	Oil India Ltd.	Mr. Sushil Chandra Mishra	Chairman & Managing Director
47	Petrofac International Ltd.	Mr. Paolo Bonucci	Head of Business Development & Senior Vice President
48	Petronet LNG Ltd.	Mr. Akshay Kumar Singh	Managing Director & CEO
49	Pipeline Infrastructure Ltd.	Mr. Akhil Mehrotra	Chief Executive Officer
50	Rajiv Gandhi Institute of Petroleum Technology	Prof. A.S.K Sinha	Director
51	Reliance BP Mobility Ltd.	Mr. Harish C. Mehta	Chief Executive Officer
52	Reliance Industries Ltd.,	Mr. Mukesh Ambani	Chairman & Managing Director
53	SAS Institute (India) Pvt Ltd.	Mr. Noshin Kagalwalla	CEO & Managing Director-India
54	Schlumberger Asia Services Ltd	Mr. Vinay Malhotra	Managing Director
55	Scottish Development International	Mr. Kevin Liu	Head of Energy Trade, Asia Pacific
56	Secure Meters Ltd.	Mr. Sunil Singhvi	CEO - Energy
57	Shell Companies in India	Mr. Nitin Prasad	Country Chair
58	Siemens Limited	Mr. Gerd Deusser	CEO (Siemens Energy - India)
59	SNF Flopam India Pvt. Ltd	Mr. Shital Khot	Managing Director
60	South Asia Gas Enterprise Pvt. Ltd.	Mr. Subodh Kumar Jain	Director
61	Tecnimont Private Limited	Mr. Sathiamoorthy Gopalsamy	Managing Director
62	THINK Gas Distribution Pvt. Ltd.	Mr. Hardip Singh Rai	Chief Executive Officer
63	Total Oil India Pvt. Ltd.	Mr. Alexis Thelemaque	Chairman & Managing Director
64	University of Petroleum & Energy Studies	Dr. S.J. Chopra	Chancellor
65	UOP India Pvt. Ltd.	Mr. Mike Banach	Managing Director
66	VCS Quality Services Private Ltd.	Mr. Shaker Vayuvegula	Director
67	World LPG Association	Mr. James Rockall	CEO and Managing Director

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