FIPI

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Oil & Gas - International Focus

During Prime Minister Mr. Narendra Modi's recent visit to the US, Mr. Prabhat Singh, MD & CEO, Petronet LNG signed an MoU with Tellurian to invest USD 2.5 billion in its Driftwood LNG project. The two companies will finalize the transaction agreement by 31 March, 2020.

Minister of Petroleum and Natural Gas (MoPNG) & Minister of Steel during his recent visit in September met Mr. Igor Sechin, Chairman of the Management Board and CEO Rosneft and Former Prime Minister of the Russian Federation to discuss the possibilities of increasing the import of Russian crude oil for Indian refineries.

WORDS OF WISDOM

Narendra Modi
Prime Minister of India

"Energy is a key driver of socio-economic growth and energy justice is a top priority for India"

Dharmendra Pradhan
Minister of Petroleum & Natural Gas and Steel

"The incremental requirement of fuels will have to be met through a combination of BS VI grade petrol and diesel, CNG and biofuels alongside EVs"

Sanjiv Singh
Chairman, FIPI and Chairman, IndianOil

"With new technologies like Electric Vehicles (EVs) and LNG driven vehicles on the horizon, the new generation of oil and gas professionals need to view these fuel technologies in combination as they will coexist in the near future"

Mohammad S Barkindo
Secretary General, OPEC

"The importance of oil and the crucial role that it plays globally, makes it perhaps the most strategic growth engine of the global economy"

Bob Dudley
CEO, BP

"Our focus has to be on developing an energy system that is cleaner, better and kinder to the planet"

Fatih Birol
Executive Director,IEA

"Humanity's future, to say nothing of its prosperity, will depend on how the world tackles two central energy challenges: securing reliable supplies for affordable energy and switching to efficient low carbon energy"

D K Sarraf
Chairman, PNGRB

"In the growth story of natural gas in India, PNGRB wants to play the role of a facilitator rather than a regulator"

Dr. R K Malhotra
DG, FIPI

"With the developing world growing faster and countries aiming for double-digit Gross Domestic Product (GDP) growth, the role of energy in economic growth is taking center stage"

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From the Desk of the

Director General

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

Over the last few months, oil supplies took centre stage in all discourses. Concerns that started with US sanctions on Iranian oil exports, heightened post 14 September, when Saudi Aramco's oil facilities were attacked by drones. The attacks not only escalated geo-political tensions in South Asia but also took away around 5.7 mbpd of supplies from the global crude oil market. Though the oil prices did not rise as much as was feared and soon recovered after some initial spike, this incident has certainly raised serious questions about the security of energy assets and supplies across the world.

Hon'ble Prime Minister of India's recent visits to the US and Russia will go a long way in strengthening energy cooperation with these countries and diversifying the sources of supply for India. During the Prime Minister's visit to the US, Petronet LNG signed an MoU for investing USD 2.5 billion for an 18 per cent stake in Tellurian's Driftwood LNG terminal – making it one of the biggest foreign investment in the US in recent years. In Russia, India's H-Energy and Russian gas major Novatek signed an MoU to set up a joint venture to market Russian LNG in India, Bangladesh and other neighbouring markets. Additionally, GAIL India is also considering to acquire minority stake in the Arctic LNG-2 project led by Novatek.

At a time when the major Indian cities are grappling with dangerous levels of PM 2.5 and other pollutants and prominently feature among the most polluted cities in the world, shifting part of the heavy duty transportation fleet to LNG could alleviate the situation considerably. In this regard, FIPI conducted a study on 'Viability Assessment of LNG as a Fuel for Long Distance Transportation in India' which suggests that India has potential to develop a sizeable fleet of LNG vehicles and LNG fuelling stations. Petronet LNG is in the process of developing the LNG refuelling network and currently engaged in setting up pilot projects at few key locations.

To increase the access of natural gas in the country, PNGRB had launched the Xth round of CGD bidding. Post implementation, it will cover 70% of the country's population and 53% of the geographical area with expansion of CNG network to 10,000+ stations. Use of CNG and LNG in transportation could emerge as a key driver towards achieving India's CoP 21 commitments and the Prime Minister's vision of a gas-based economy.To further increase thegas share in total energy mix, the Government of India has set a target of completing the gas grid comprising of 30,000 Kms by 2022. More than USD 60 billion is expected to be invested in gas infrastructure over the next few years.

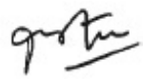
Pricing of natural gas has long been an issue of contention in the Indian oil and gas industry and has bottlenecked the development of natural gas sector in India. To address the situation, the Government is planning to setup a natural gas trading hub in the country. The proposed hub will provide a single

reasonable price for all natural gas, agnostic to the source of supply, through gas on gas competition. To further streamline the sector, the Government must also consider providing marketing and pricing freedom for gas produced from pre-NELP and NELP fields that presently constitute over 2/3rd of the domestic gas production.

The Government of India has launched the fourth round of bidding under Open Acreage Licensing Programme (OALP) in August 2019. The upcoming round of OALP bidding is expected to generate an immediate investment of USD 200 – 250 Million for exploration work. The OALP, since its introduction, has attracted much attention from both national and international oil and gas companies. Features such as marketing and pricing freedom for natural gas and revenue sharing has brought the Indian licensing rounds at par with international oil and gas contracts. Over USD 58 billion of investment is planned in the E&P sector over the next few years.

During the last quarter, the ongoing trade war between the US and China had visible impacts on the world economy and India was no exception. Issues in banking sector and a fall in manufacturing sector remained a reason of much anxiety. However, India still managed to emerge as the second fastest growing economy in the world. Taking account of the situation, the Government has introduced a flurry of policy interventions over the last few months. A recent report by global brokerage firm Goldman Sachs suggests that riding on the policy and regulatory measures taken jointly by the Government and RBI, the Indian economy will start showing signs of recovery from the economic slowdown by early 2020.

Over the next few months, geo-politics will have a considerable impact in shaping the future of the world in general and oil markets in particular. While the outcomes of the ongoing tariff war between the US and China and the long anticipated Brexit will dampen the global business climate and investor sentiments, tensions in the Middle-East, that produces over 20 per cent of the world oil output, could have multi-layered economic implications for the world. In India, as the festive season approaches, with increase in consumer spending,all apprehensions over a cyclical slowdown of the Indian economy are expected to subside as the fundamentals of the economy are strong enough to propel the country to a high growth future.



Dr. R. K. Malhotra

LEADERSHIP

Role of Leadership in Driving Innovation

B. Ashok
CEO Ratnagiri Refinery & Petrochemicals Ltd. (RRPCL)
(Former Chairman, IndianOil)

Governments and global community in several ways are trying to address the challenge of poverty, providing the benefits of a reasonable standard of living for many who are still way below the standard. In other words, a better life for all. However, more than the desires of the governmental organizations, it's the drive of the billions of individuals around the world themselves to create a better material life, i.e. associated with food, housing, healthcare, sanitation and effective transportation, for their families.

These demands for a better life inevitably lead to increasing energy needs. The challenge is to balance the supply of this energy with the emission challenge thereby ensuring a healthy planet.

A common measurement of energy is a "gigajoule". A physical laborer may deliver work i.e. roughly the equivalent of a gigajoule per year. In the US, the current primary energy consumption is around 300 gigajoule per person per year. A more modest and energy efficient Europe or Japan averages around 150 gigajoules per person per year. As we consider the future development of economies and assume significant energy efficiency improvements, it is estimated that an average of above 100 gigajoules of primary energy per person is approximately what is required to fuel the energy-based services that support a decent quality of life that people aspire for.

With this sort of estimate, the global energy need would be roughly twice the size of the current energy system when the global population moves towards the 9 to 10 billion mark.

Indian Demand story:

India represents a sixth of humanity with the largest additional energy needs. It is one of the fastest growing major economies in the world and poised to continue growing at around 7 to 8% for the next 2 to 3 decades, if one were to be optimistic about the future. The Indian economy is projected to grow to US $ 5 trillion in the next few years as emphasised in the recent budget and US$ 10 trillion by 2040, which is nearly 5 times of the current size. As Indians, we need to have conviction in this growth story, to provide its huge population with good living conditions and opportunities for the youth, a good 50% below the age of 25 and 65% below the age of 35.

One of the key requirements for this economic trajectory would be availability, access and affordability of energy. The international agencies such as IEA and OPEC project that almost 40% of the incremental demand for oil would come from India. There is considerable drive and effort by both the Government and the industry to reign in the import dependence through increased use of renewables, bio

fuels and other alternatives besides energy efficiency improvements. However, the rapidly growing economy, emphasis on manufacturing sector and road infrastructure besides providing energy access to the millions who were deprived of their energy needs and a growing population means that theneed for energy would continue to grow. Hence, it is more likely that different forms of energy including some futuristic, would grow and find its space in the energy market of the country. Renewables, alternatives, gas as well as conventional fossils including oil, thus must grow. Their proportion in terms of a percentage of the energy basket may change, but in absolute terms, it is believed that every form of energy will have to grow in a galloping India.

Obviously, the prognosis above is bound to be seen as an O&G industry perspective. Having said that, there is certainly a need to interlink the various energy forms, the transportation models and the entire eco system of the electric options especially EVs instead of a silo slant. A rounded and coordinated approach would no doubt clear some of the contradictions in policy prescriptions and sustained development of the different industries. I believe FIPI can play a proactive role in this regard.

Researchers are also well positioned to give their own views, more importantly on pollution and emissions, which can then enable a holistic appreciation of the issues on hand.

Thus, Research and Development and Innovation will be the key to not only sustain our development but also to ensure that our Sustainable Development Goals are met.

Leadership for Innovation:

Leadership needs to create a culture of innovation in an organisation where development of new ideas and processes is encouraged. The critical thing that leaders do is to motivate and inspire people. Leadership also needs a long-term Scientific Vision. The leader needs to define problems and outcomes as well as clearly espouse a mission. Creative people it is believed, work best when they believe in the mission.

Strong leaders are aware of the need to change and to get new technologies, processes and products into the pipeline. They must be willing to make the changes even when things seem to be going well. Three leadership imperatives that provide the essential support to Research and Innovation are:

1. Demonstrate the trust to empower, which allows the researcher -innovator to trust themselves amidst the ambiguity of their work. Many would be familiar with the experiment on Scientific management thorough the Hawthorne experiment in Western Electric Company in 1920 where increase in lighting in the work area increased the productivity of the employee. More than the increased lighting, it was the socio-psychological aspect of human behaviour in organizations, and this is also somewhat the case with an empowered researcher.

   It may not be out of context to mention that demonstration of leadership trust in implementing critical R&D technologies including the much acclaimed IndMax as a Make in India initiative, had a big impact on the motivation and self- belief of the entire R&D division of theorganization.

2. Keeping purpose at the core for inspiration. Providing the message that what they are doing is important and valuable, focusing on the benefits that can ultimately come from the innovation project.

3. Act as equal partner to share risk and the outcome. Especially when translating research into commercial propositions, there is a need for risk appetite and Leadership would be well advised to provide the comfort of risk sharing, thereby risk mitigation to the researchers. Examples abound as to why good research work does not translate into valuable commercial propositions due to absence of this intention.

At the same time the Researchers must also show the self-confidence to take on things that they firmly believe in and convince the Leadership for support. I can recall an instance when the R&D having developed catalysts for refining was finding it difficult to commercialise it without a manufacturing partner and were inclined to sell the technology for a small royalty. The Leadership was forced to question as to why the manufacturing could not happen within the organisation even though it was not a part of the existing business line. Further evaluation lead to the decision for the first plant to be set up for manufacture of the indigenous catalysts by an oil company.

Some Personal Experiences :

I have had the good fortune of being associated with the R&D activities of IndianOil right from the days when I was a young lube engineer, without being a professional researcher per se. The emphasis in those years used to be on indigenization of lubricants for imported equipment which invariably carried an overseas OEM recommended formulation. The seed of innovation was probably planted then since the system made it difficult for us to recommend a lubricant for import, which as a Technical Advisory Committee we were expected to do, unless strongly justified. Many of the Indian products thus got established with matching of physico-chemical characteristics, along with understanding of applications, field trials and a lot of common sense. So sometimes specialized synthetic lubricants got replaced with mineral oils much to the consternation of pure researchers! But going blindly with OEM recommendations also did not make sense when seen from the environment and conditions of use eg: a hot country vs a cold country. Knowledge gained on the process of development of automotive, railroad, marine and industrial lubricants and engaging in creative problem solving of technical issues of the customers with the assistance of R&D not only built self confidence but also helped in appreciating the strength of the research organization.

Similar experiences with innovation, which was as simple as a new way of doing things resulting in value for the organization and the customer, got firmly entrenched while growing in the organization. Key learnings being asking the right questions, critical reasoning, openness to new ideas, creative thinking and awareness of business environment both external and internal.

This R&D association continued over the years which reinforced the belief that the research and innovation could be a key differentiator besides being a competitive and sustainable advantage for improving the bottom line of an organization. Fortunately, the opportunity to lead the organization and in those years play a major role in co-creating a strategic vision for R&D was a huge sense of personal satisfaction.

While there is a wealth of information and research on business leadership, much less attention is there on nurturing R&D leadership. There is a perception, which may or may not be real, that R&D Managers are typically less effective than those outside R&D on many leadership skill measures except in areas which are technical, though I can personally vouch for the significant value a Research Leadership brings to the table in Board's of large companies. Occasionally, a remarkable researcher finds the management side boring because it is more of an art rather than a science. However, for R&D leadership while its necessary to maintain the technical insight, there is a definite need for expanding on inter-personal skills. The leaders need to establish an environment in which researchers can be most productive. There is a need for both a) Cognitive mentoring of researchers that values and encourages ideas and b) Emotional mentoring of researchers, that values and encourages the person.

I can quote a personal experience in this regard when one very senior R&D Scientist submitted his resignation and it was duly forwarded for approval. A deeper examination of the case revealed that while it was not in the organization's benefit to lose such an experienced researcher, there was no conceivable reason mentioned as to why the said individual wanted to give up the job and all the associated post retirement benefits. In addition there was a concern on whether he was being poached. A one to one interaction brought out that it was an emotional reaction to his perceiving seniors of not being fair to him, that forced the employee to take such a crucial decision, without even evaluating his own future personal loss. Naturally the interaction made him not only toretract his decision but served to motivate him for the few years of his remaining tenure besides the huge sense of relief for his disturbed family.

Future Direction:

While this conference addresses in detail, critical areas of R&D across the value chain of the Oil & Gas industry, to my mind the following themes may have broad relevance to all of these areas:

1. **Innovations in energy transition:**

   In the field of energy transition, decarbonization, improving energy efficiency and use of renewable energy are the major themes for the country and for the organizations. It is necessary that technology and innovation as well as Research and development activities must lay greater emphasis in support of these objectives.

2. **Commercialization:**

While there is always a debate about the freedom to research, there is a need for an effective balance between the themes of fundamental and applied research. Moreover, the measure of commercialization of such research activities is also important especially in organizations which by nature are commercial. This would not only give confidence to the leadership about the contribution, but also give confidence to the researchers who can see the value of their efforts.

3. **Speed of Research:**

We are in a world which whether we like or not, is moving much faster. Hence, patience is not seen as a virtue, but speed is. There needs to be a recognition of this fact of life amongst researchers. Research work like others also need to work on a much tighter schedule compared to yesteryears.

Industry 4.0, technological innovation is transforming every industry. From visualization to artificial intelligence, IOT, robotics, digitalization and analytics, capabilities have enabled industrial organizations to evolve their operations faster, drive profitability and turn those that were earlier inconceivable to standard practice.

The fact is when people normally converse about technology, it is about these digital technologies. It is sometimes difficult for the businesses like ours to be perceived as technology companies in terms of our technologies. Having said that, it is important for us to recognize that digital technologies, which are different to even the Information Technology need to be used to the advantage by us technologists. Besides the manufacturing activities, I am sure there are enough applications in the R&D areas for these technologies to be used to improve speed and productivity, knowledge and learning, simulation and testing and much more.

4. **Emissions and recycling:**

Minimization of emissions and discharges are extremely important in the context of doing business in today's world. Zero emissions and zero discharge should be the ideal targets for any business. These are areas where R&D establishments can truly bring value to all its stakeholders. The world, more so India, is moving to increasing use of convenient plastics. In-fact, the integration effort of refiners the world over, to produce more of chemicals and petrochemicals is not only in the context of staying relevant, but also to satisfy the burgeoning demand for these materials. However, producers need to be responsible in terms of products that are produced and also focus on efforts to recycle and re-use such materials. In my view, recycling and re-use of plastic materials needs to be seen as a natural extension of a petrochemical and polymer production facility.

5. **Circular economy:**

R&D efforts should embrace the theme of circular economy to ensure a sustainable future. There are some very wonderful initiatives in this regard pertaining to not only waste to energy models, but also in many other areas. I am inspired to share an example which was screened in the SatyamevaJayate programme hosted by noted Film Actor, Aamir Khan in March, 2011. This talks of the entrepreneur, Mr. C. Srinivasan and his Vellore model of solid waste management. He has spoken about how cows, hens, frogs, ducks and earthworms are some of his "workers" helping to convert garbage to gold. In short, he collects vegetable waste from the market, feeds them to the cows, gets additional milk, uses the cow dung for methane generation and vermicompost, feeds the worms to the chicken, gets larger eggs, in the nights the worms are eaten by frogs. Similarly he feeds fish market waste to ducks and gets larger eggs. The compost is sold to farmers to get better quality farm products and the larger eggs fetch him a better price. I believe that in our field too we should look at the entire chain of products and ensure that everything which gets generated gets recycled and re-used. In this context I am also happy to see therecent initiative of the refiner's to supply CO_2 to the upstream companies for EOR in Assam and Gujarat. I am sure with a demonstration of the feasibility, there would be more opportunities in the west coast and Rajasthan. This would not only reduce the emissions but has the potential to improve domestic production of O&G.

Harnessing renewable energy, continuing economic growth and raising standards of living of people will require more and more resources. Meeting the resource needs is a challenge. There is a need to decouple resource use from economic growth to minimize waste generation. It is hence necessary to develop a vision of circular economy in which resources once accessed continue to be used in perpetuity or given back to nature. India used to be a frugal society eschewing wastefulness and re-using and recycling products. Advent of consumerism, however, has increased wastefulness. Technology will play an important role in promoting circular economy and thereby sustainable development.

6. Creating an environment for Innovation

A great deal of thought has been given to office design. Company leaders are constantly trying to create a workplace that improves employee happiness, productivity, and creativity. It is also important to recognize the aspirations of the young generation of researchers. Needless to say that the new research environmentincluding the infrastructure should be supportive and conducive to the needs of the next generation of researchers in sync with what is happening in other lines of business.

In summary I would like to emphasise that in a world that is increasingly turning complex and uncertain, Research & Development, Innovation and technology emphasis is a key for continued relevance of organisations and businesses. Leadership support is hence an imperative from strategic and competitive perspectives. While retaining this strategic intent, Leadership would keep in mind the themes of social relevance, sustainability as well as commercial considerations for differentiating their organisations with their peers.

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DIGITALISATION

Smart Pump Stations in Cross Country Oil Pipelines

T. J. Sampath Kumar
General Manager – Engineering

C.Pratap
DGM-Technical Services

V.I Shiyas
Manager- Projects

Hindustan Petroleum Corporation Ltd

Cross country pipeline transportation is the safest and most economical mode of transportation of Petroleum and Petroleum Products. Due to many advantages of pipeline mode of transportation, major oil refiners and Oil marketing companies are building pipeline infrastructure across the length and breadth of the nation. Cross country Pipelines passes through some of the most difficult to access terrains and routes.

The major components in cross country pipelines are Mainline Pump station, Intermediate Booster Stations, Intermediate Pigging Stations, Tap off Stations and Receiving stations. Based on the volumes transported and the terrain, there would be requirement of intermediate booster stations enroute the cross country pipeline.

The pipeline stations are manned by 10-11 officers and manual interventions are required for certain operational and maintenance activities in intermediate pump stations. In pipeline operations, close to 27% of expenditure is towards manpower expenses. To reduce the complexity of operation and for manpower optimization, the booster stations of cross country pipeline can be converted to smart pump stations which will enable operation of pump station from remote location, thereby eliminating the requirement of manpower at these remote pump stations.

Philosophy of Design

To understand the concept of smart pump station, it is imperative to know the current mode of operation of existing pump station. In present manned station, the major activities of operator is to start, monitor and stop the various equipments in the booster station including pumps. The operation activity includes venting and draining of mainline pumps before start up. The operation activity also involves monitoring the various parameters like flow, pressure, vibration, energy consumed and health of equipments. The operator also has to take necessary action to perform planned and emergency shut down including bypass of booster stations.

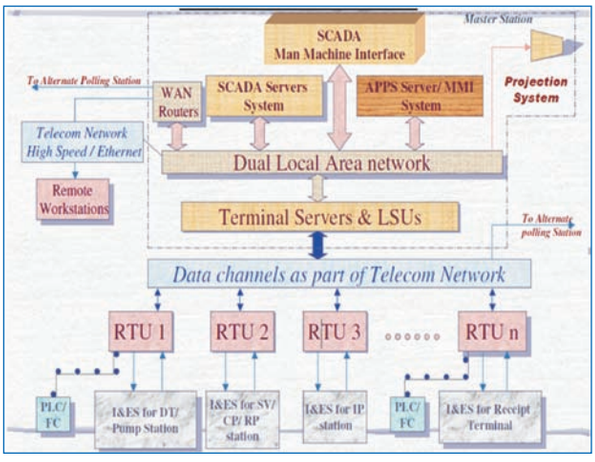
The smart pump station is designed to carry out these activities remotely from a different location without human intervention. This is achieved through a range of instruments and controls through SCADA & PLC system that constantly monitors the equipments, fetch the details and provide them to the remote location from where the operation processes are controlled.

Smart pump stations includes a set of devices and equipments that are capable of receiving commands from remote location through a SCADA enabled server and control the operations of the booster station.

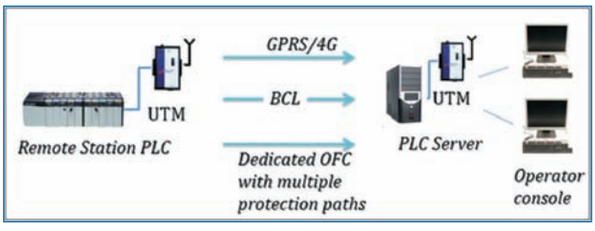
Remote Operation of Station

The remote pump station shall be operated from remote location. To ensure effective and reliable control, management and supervision of the pipeline, the entire pipeline network is monitored and controlled by a Supervisory Control and Data Acquisition (SCADA) system.

The SCADA system is a computer based system for gathering and analyzing real time data. SCADA system monitors & controls the pipeline facilities in a timely manner and provide centralized alarm and event management and operation &management reports for all distributed pipeline facilities. A dedicated Optical Fibre Cable telecommunication system is provided as a medium for SCADA data communication.



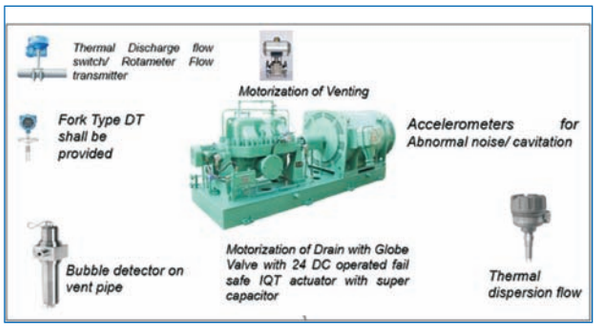
As communication is of absolute criticality in smart pump station, the station shall be connected with remote location through Optical Fibre Cables through multiple protection paths. The communication shall also have dual redundancy in the form of 4G/ GPRS connectivity and dedicated back up link in case of failure of main OFC cable.



Process Aspects

All the valves, vents & drains of mainline pumps, basket filters, minor barrels of PIG launchers shall be motorized and provided back up power through UPS. SIL rated actuators shall be mounted on the valves for ensuring the integrity of the critical application valves like station isolation valves, Fire water pumping systems etc.

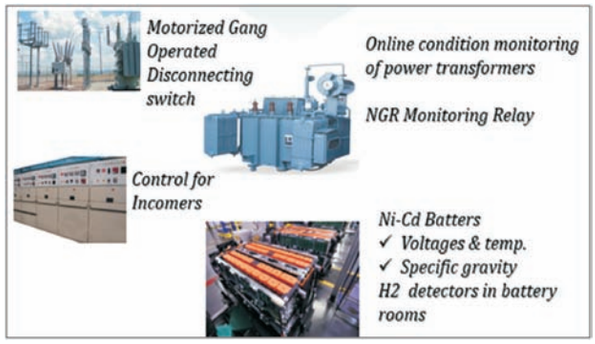
Measurement and control instruments like density transmitters, flowmeters, inductive proximity switches, accelerometers, Thermal discharge flow switches, Hydrocarbon detectors, Guided Wave Radar Level transmitters shall be used for monitoring and controlling the various parameters in remote pump stations.



Electrical Aspects

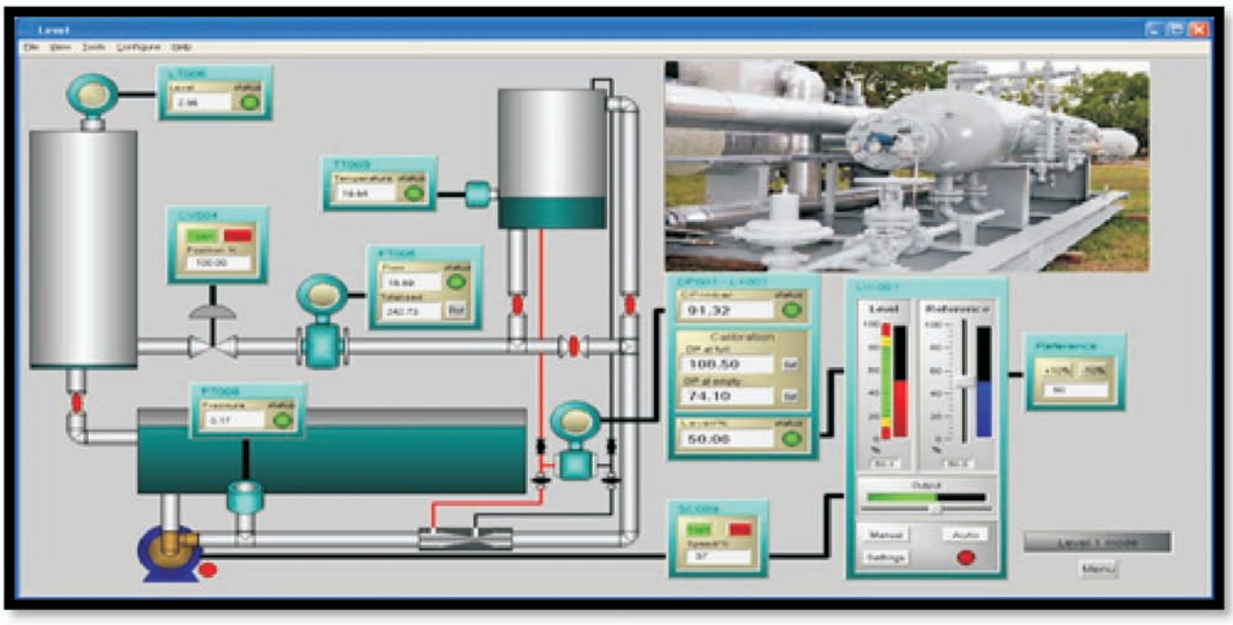
All critical electrical equipments shall be mounted with HMI with Virtual Networking Connectivity for remote monitoring and controlling of equipments. All the feeders shall be provided with intelligent overload protection relay, phase sequence cum phase loss monitoring relay with MODBUS TCP/IP communication protocols.

Highly reliable Ni-Cd batteries fitted UPS shall be installed at stations for providing back up power.



CCTV Surveillance

Elaborate surveillance shall be used in Mainline Pump house , Fire water pump house, electrical substation including VFD room, process area, control room and VFD room. Live visual feedback shall be made available to the operator in remote station to have visual conformation of the various activities that are happening inside a remote pump station.



Advantages of Smart Pump Stations

Smart pump stations are intelligent and can carry out operations in a safe manner with minimal human intervention. They can be operated remotely and avoids the need for human manual intervention. The system is robust and cost effective. Manpower costs are reduced and placing of manpower in remote hardship locations can be eliminated.

Smart pump station also uses artificial intelligence systems and machine learning to improve the reliability in pipeline operations. The monitoring and analysis of parameters can be successfully used for implementing preventive maintenance based on previous learnings. Smart pump stations are also safe as they can quickly take necessary actions and make decisions after following SOPs without human interventions.

In conclusion it is evident that smart pump stations are the future for safe and economical method for carrying out pipeline operations.

OUTLOOK

MARPOL 2020 – Transition to a New Era

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1.0 PREFACE

Come January 1st 2020 and shipping community across the globe will be required to follow the MARPOL regulation of using bunker fuels of up to 0.5 % sulfur m/m. The current specification is 3.5 % max. This regulation , well adopted by the nations signatory to IMO protocols has the potential to change international consumption pattern of Oil & Gas and thus impact on trade.

2.0 MARPOL 2020

The term MARPOL (short name of 'Marine Pollution') is used for 'The International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978' of International Maritime Organisation (IMO) , is one of the most significant international convention on marine environment management.

In 1973, the International Maritime Organisation (IMO) agreed a series of measures to prevent pollution from marine and shipping operations (MARPOL Convention). The Convention was modified in 1997 to address sulfur emissions from ships by introducing a global cap on the sulfur content of marine fuel oil and an additional limit in specific waters, referred to as emission control areas (ECAs).

The sulfur limit in marine fuels has been reduced over time for both the global limit and within the ECAs. In 2012, the maximum sulfur level in open sea was reduced to 3.5 % from 4.5%.
The next step of change as adopted by IMO on 27th October 2016, will reduce the global cap on sulfur

content of bunker fuels on board for general shipping (outside ECAs) from 3.50%wt. to 0.50%wt. from 1st January 2020(Regulation 14 of IMO, Annex VI). This mandate is commonly referred to as MARPOL 2020. The interpretation of "fuel oil used on board" includes use in main and auxiliary engines and boilers.
Below is the summary of quality change of bunker fuel.

Outside an ECA established to limit Sox and particulate matter emissions	Inside an ECA established to limit Sox and particulate matter emissions
4.50% m/m prior to 1 January 2012	1.50% m/m prior to 1 July 2010
3.50% m/m on and after 1 January 2012	1.00% m/m on and after 1 July 2010
0.50% m/m on or after 1 January 2020	0.10% m/m on and after 1 January 2015 (NW Europe, US , US – Caribbean) 0.5% China Coast 2016-2019, Taiwan 2019

Source: Technical circular 027/2018 of Indian Register of Shipping; Oil & Gas Journal

3.0 OPTIONS FOR COMPLIANCE

IMO 2020 mandate is different from the traditional practice of implementing the changes in fuel specifications previously.

Earlier,compliance with respect to reduction in sulfur content of fuels was sole action of fuel manufacturer that is refiners and blenders. In present case, the reduction is deep with practically no effective and viable technology to de-sulfurize high sulfur heavy residues to this low level. Blending of low sulfur gas oil is also expected to hit technical and economicsissues. Use of low sulfur heavy residues from low sulfur crude may be one wayfor liquid fuels.Use low sulfur gas oil in limited regions / routes offers some hope.

Shipping industry also has the option to use liquefied natural gas (LNG) which is in use at present with very small percentage in the entire mix. It is evident that whatever is the adaptation of one sole or a hybrid approach, the global trade pattern will see major changesin short and mid term before an equilibrium is achieved. Freights will also see uptrend in similar pattern.

MARPOL 2020 offer options to USERS (read Shippers) as well. They can continue to buy HSFO as long as they install scrubbers on a ship to maintain emission at the same level as with low sulfur fuels.

Above base analysis throws three options for compliance for ship operators by 1st Jan. 2020:

a) Use a fuel with a sulfur content of 0.5% (VLSFO).

b) Use high-sulfur fuel (HSFO) and process the emissions through an exhaust gas cleaning system beforerelease. These systems are routinely called 'Scrubbers'.

c) Use an alternative fuel like LNG, Methanol, LPG, or even batteries.

In case the equivalent arrangement (option-c above) has been chosen as a method to comply with the requirements, an approval has to be obtained from the Flag Administration.

Fourth approach, which can not be termed as 'OPTION' is Non- Compliance to the regulations. The trend depends on the effective regulatory mechanism of Port States and Flag States.

Uncertainty surrounding fuel availability, quality, and price, as well as regulatory issues and costs related to alternative fuels, will impact the decisions of suppliers and users both and market trends.

3.1 USE OF VLSFO

This option will cause upsurge in the VLSFO demand leaving high sulfur residues surplus for disposition in the other markets. Assuming 100 % compliance, this shift will affect almost 3.5 million barrel per day (mbpd) of HSFO bunker fuel consumption which is about 4% of global oil demand. This statement is ideal and in fact, impact in the overall context will be less as LS residues which may also form the part of HSFO will shift to VLSFO. Blending HS residues with gas oil distillates to cut sulfur may not be technically viable due to deep cut in sulfur in MARPOL2020 fuel.

This option is the least disruptive from shipping point of view as long as the quality parameters, specially 'Viscosity' are maintained. From the Refinery side, this shift will alter the product pattern significantly andhence growth rate depends on demand of distillates in other sectors where heavy fuels can not be substituted. It also depends on emerging price pattern of low sulfur crude oils and products specially cracks in HSFO and VLSFO in the international market.

Market news in media indicate that China Petroleum and Chemical Corp, Sinopec is raising its capacity to produce VLSFO for marine use to 10 million MT (0.2 mbpd) by 2020 and 15 (0.3 mbpd) million MT by 2023 with related expansion in global sales network to 50 key overseas ports including Singapore.

Oil major ExxonMobil has announced that it will make IMO 2020 compliant low sulphur fuels available by the third quarter of 2019.ExxonMobil has named the ports of Antwerp, Rotterdam, Genoa, Marseilles, Singapore, Laem Chabang and Hong Kong, where compliant fuels would be available, with locations in North America to follow. Singapore is highlighted as the obvious choice to get the drive going. Shell also has given its plans to supply MARPOL compliant fuels to meet the deadline.

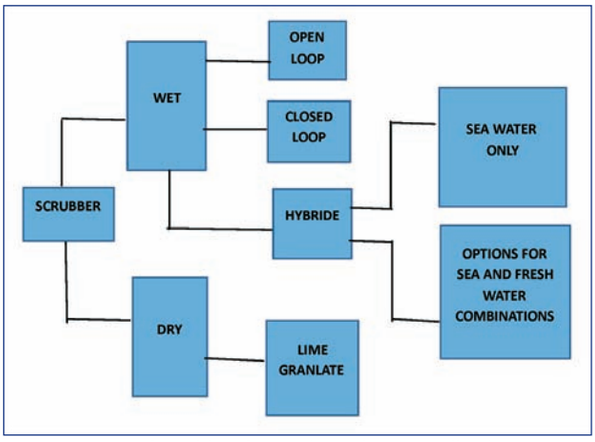
In India also, Indian Oil Corp. (IOCL) announced its plans to produce 1.0 MillionMT per annum VLSFO from its Gujarat refinery and make it available along Indian coast.

Availability of approx.3.5 mbpd of VLSFO by 1st Jan. for present global demand is highly unlikely. IEA Oil Market Report 2019 estimates that HSFO demand will fall to 1.4 mbpdfrom 3.5mbpd after Jan. 2020 with rise in demand for marine gasoil (MGO) to double from 900 kbpd to 2 mbpd. VLSFO is estimated to reach up to 1 mbpd in 2020 but initial pick up may be slow due to availability of blending stock and technical compatibility issues among components which may impact quality (stability, catalyst fine particles , pour point and flash point)

IEA further estimates that these challenges will be overcome quickly. VLSFO is the fastest growing marine fuel in 2020-24, increasing from 1 mb/d in 2020 to 1.8 mb/d, due to its price advantage over gasoil. MGO demand reaches a peak in 2020 then eases to 1.8 mb/d by 2024, keeping a solid base ofusage in smaller vessels and due to its wide availability.

3.2 USE OF HSFO

This scenario is the least disruptive for the Refiners. For Shippers, it however means installation of exhaust Gas Cleaning Systems (Scrubbers) and release the emissions at the same SOx level as from the use of VLSFO. Provision of scrubbers again bring different options before the shippers 9 see figure given below) and selection may have to be made for each individual case considering tanker size, age, route coverage , cost of scrubbers, retrofit scope, facilities at port to discharge scrubbed water, local marine pollution regulations etc.



Types of scrubber for marine exhaust application

IHS Markit is of the view that scrubbers will be a preferred solution for very large size ships which accounts for most of HSFO bunker consumption. Investment in scrubbers started to increase from mid 2018 and it is estimated that around 2760 ships, out of total fleet of 12000 will have scrubbers fitted by 2020. IEA projects 4000 numbers of ships with scrubbers by 2020. Shipyard space may be key constraint in expediting the process.

The cost of installation of scrubbers is around 1.5 to 3.5 million USD even with retrofit (KBC PTQ Q2 2019). With the predicted crack of about 40$ per barrel between HSFO and VLSFO in the first year of regulation (Oil & Gas Journal – July 2019) and the small OpenX for a scrubber with use of caustic soda or lime with sea water, the payback for a ship consuming 250 bpd fuel and operate 250 days in sea, will be much less than 2 years or even closer to one year. Even with crack squeeze in subsequent period, the proposition to install a scrubber will remain attractive for ship having life more than five years.

Though economic to install scrubber appears attractive, shippers may exercise caution while selecting the type of scrubber as some of the nations like China and Singapore have indicated their intentions to ban discharge scrubbed sludge from the ships in their maritime regions.

3.3 NON - COMPLIANCE

Trends of non compliance, specially in the initial period depends on the availability of compliant fuels across the globe, enforcement mechanism of the member states and some other technical issues like delays in retrofits etc.

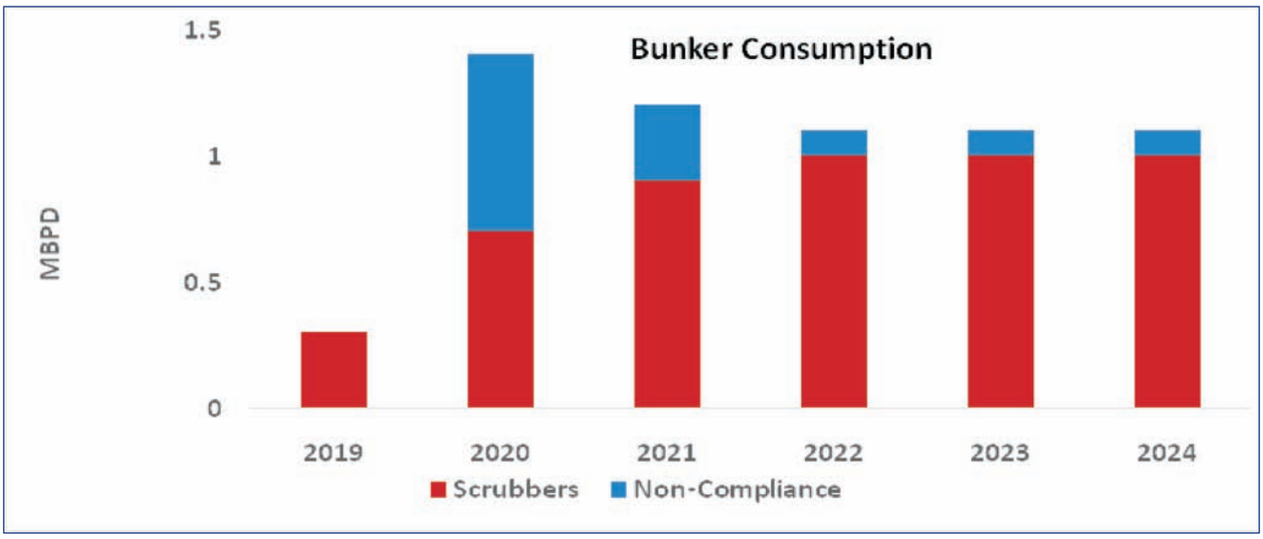
Compliance in the European ports is expected to be the highest because of enforcement, traffic and political will for implementation. The same is expected in Singapore and China. US, though expressed its reservation about MARPOL 2020 as it will increase the price of diesel in 2020, the election year in USA. Since US coasts are already in ECA, this policy even if not adopted, will not impact MARPOL 2020 future across globe. much adverse impact on global In the rest of the world, initial compliance levels may be low but are expected to improve considerably with time which may be up to 3-5 years.

3.4 BUNKER FUEL CONSUMPTION – GLOBAL SCENARIO

Considering the impact of scrubbers, use of VLSFO, MGO and non-compliance factor, IEAOil Market Report 2019 forecast the bunker fuel consumption given here.

(Figs. in mbpd)

Fuel	2019	2020	2021	2022	2023	2024
High Sulfur FO	3.5	1.4	1.2	1.1	1.1	1.1
Of which : Scrubbers	0.3	0.7	0.9	1.0	1.0	1.0
Of which : Non- Compliance	0.0	0.7	0.3	0.1	0.1	0.1
Very Low Sulfur FO	0.0	1.0	1.4	1.6	1.7	1.8
Marine Gas Oil	0.9	2.0	1.9	1.9	1.8	1.8
Total Bunker Fuels	4.4	4.4	4.5	4.6	4.6	4.7



4.0 LNG AS BUNKER FUEL

Excluding LNG carriers, use of LNG as bunker fuel is a niche market, currently an estimate base of only 10 Kbpd. According to IEA estimates, less than 200 vessels using LNG bunker fuel were in operation at the end of 2018. Ships used in passenger, car and container transportation operating in NW Europe, Mediterranean and Central America constitute majority among LNG users.

Rise in environmental sensitivity in some regions may be key driver impacting use of LNG. The European Union is considering proposals to extend the Emission Control Area (ECA) s in Europe to include the Mediterranean Sea. Last autumn, SEA\LNG member The Maritime and Port Authority of (MPA) Singapore made a decision to ban vessels discharging scrubber-produced wash-water. Discharge of wash-water from open loop scrubbers is also facing specific restrictions in other regions such as Chinese inland and coastal waters.

IEA considered only new ship building for Container and Cruise Liners for their projections on LNG use as marine fuel. No. of cruise liner with LNG as fuel will increase from 9 to 13 by 2024. Strength of Containers carriers with LNG will double from current 10 by the same period. Retrofitting for LNG is expensive proposition when compared with scrubber installation as of now and not factored in the forecast. Estimated demand for LNG as bunker fuel by 2024 is 90 Kbpd.

	2018	2020	2022	2024
Demand of LNG as Bunker Fuel (Kbpd)	10	25	55	90

More than 80 % of 90 Kbpd will be used in Cruise and Container ships in NW Europe, Mediterranean and Central America which are moving relatively short and fixed routes only in already sensitive declared regions.

The contribution of LNG in bunker mix will be 2% by 2024 but within the segment, the rise in demand will be around ten fold. LNG may find higher thrust if the plans to add infrastructure on a global spectrum come through. World Oil Outlook 2018 (WOO 2018) by OPEC suggest that United Arab Emirates (UAE) is reportedly working on a plan to install LNG storage facility at Fujairah, the second largest bunker hub. In addition to investment plans of EU in LNG pipeline for marine fuels in Italy, WOO 2018 also report that international group formed in 2014 to cooperate on LNG Bunkering expanded its scope in2016 to include the port of Jacksonville (USA), The Norwegian Maritime Authority, Ministry of Land, Infrastructure, Transport and Tourism of Japan and Ulsan Port Authority (South Korea). Recent introduction to the group are ports from China, France and Canada.

IMO is also considering the strategy on greenhouse gas emissions. With 20-25% difference in emissions between LNG and Oil, the economics and environmental considerations combined together will be the top of all ship-owners consideration. Impact on LNG will be clearer after that in next five years.

The impracticalities and economics of retrofitting existing vessels with LNG tanks and the lack of ready access to LNG bunkers in some parts of the globe necessitate a portfolio approach to marine fuelling

solutions for ship-owners and managers, with different fuels best suited to different vessels and trading routes.

5.0 Conclusion

MARPOLE 2020 set the waves of different size and strength across the globe . It provides scope of large number of options to both Shippers as well Refiners. No single solution will resolve the issue and achieve the objectives of the protocol.

Any solution while has its own advantages , it also throws challenges and new issues to manage. Quality compliance while blending distillates with residues to produce a compliant fuel with low sulfur is surly a technical challenge. With different grades of fuels in use , new infrastructure needs to be developed for bunkering. Increased demand for gas oil and low sulfur residues will have its impact on internationalpricing of and trade pattern of sweet crude and distillates. Freights are expected to rise sharply as the compliance picks up. All this will impact the global economy with more impact on developing nations but also on developed economy as well.

Use of scrubbers will shift the problem from air to water if no adequate measures are taken. Many nations are trying to be stringent .This may complicate the whole process of compliance at least initially but equilibrium will arrive with time. IMO signatory nations have to step up vigilance and enforcement to ensure compliance and thus achieve the objectives. This calls for revamp of regulatory regime in many ways.

It also opens the venue for new industry with quick as well as long term benefits. Dry docking with installation of scrubbers, retrofit for low sulfur bunker or LNG , new tonnage with more efficient and new fuel engines.

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ENVIRONMENT

Sustainable Plastic Material Development - Polyolefin to Biodegradable Plastics

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Introduction

Today plastic is the integral part of human existence and it has a substantial role in many technical advancements. The different needs of 7 billion people in health, clean energy, safe food, construction and commodities cannot be fulfilled without plastics. No wonder that global plastics production has surpassed the 300 MMT per annum and expected to reach around 350 MMT per annum by 2020. The plastic has replaced the conventional materials like wood and metal in many applications and even outperformed conventional materials in a number of application attributed to its properties like light weight, transparent, chemical resistance, insulation, durable, moldable, low-cost etc.

Polyolefins (PO) have more than fifty percent share of total plastic production. The discovery of Ziegler-Natta (ZN) catalyst system and its constant improvements have resulted in significant impact in polyolefin production. The high productivity, better morphology control and stereoregularity of ZN catalyst system have made the polyolefin production one of the most important industrial processes. Polyolefins have a wide variety of applications ranging from commodity to engineering and today different grades of polyethylene and polypropylene are available. Advancement of ZN catalyst and introduction of metallocenes catalyst have an advantage to design new polyolefin grades through variation in molecular architecture. Moreover, molecular architecture and polymer properties are directly related to its applications.

Single-Use Plastic & Sustainability

The plastics used for packaging, grocery bags, straws, bottles, containers, cup & cutlery, carry & garbage bags etc. comes under single-use plastic. Single-use plastic or 'use & throw' (disposable) kind of plastics accounts for 30-40 % of total plastic production. About half of the plastic waste in the world compose of single-use plastic. The fate of single-use plastic after its service period could be recycled, incinerated, dumped in landfills or littered in the surroundings. In general less than 15-20% of plastic get incinerated or recycled and the rest major chunk lies in the landfill or in the environment.

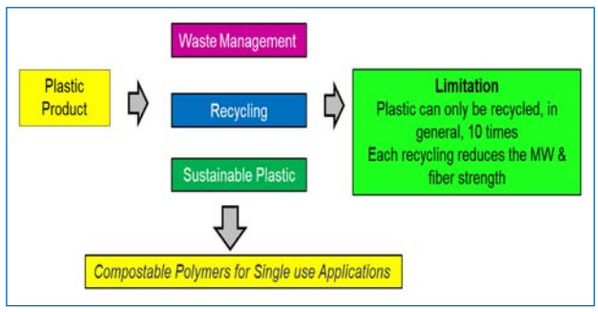

Chart 1. Waste Plastic Management

Countries around the globe are concern about increasingly plastic pollution and more than 60 countries have introduced regulations to curb single-use plastic waste.[1] Germany, Finland, Austria, Indonesia, Thailand and many African & Asian countries have taken private-public initiative to reduce the single-use plastics. These countries introduced a definitive planning to phase out single-use plastics through levies on plastic bags, awareness campaign, discount on shopping cloth-bags and these resulted into drop in consumption of plastic carrier bags per person per year.[1]

In India more than 20 states have been banned the use of single-use plastics. Plastics like polypropylene (PP), Non-woven PP, multi-layered co-extruded PP, polyethylene (PE), PVC, HDPE, LDPE, polystyrene (PS), thermocol, polyamides, Nylon, polyterephthalate (PT), and polymethyl methacrylate (PMM) are comes under government regulations.

Need of the Hour

Majority of conventional plastics lack the functional moieties on its polymer backbone that make it resistant to processes like hydrolysis and oxidation and this increases its durability. That is why after their service period when these plastics are discarded to natural environment, they stay there for a long time and creates serious environmental pollution, many time refers as 'white pollution'. Over the years it has polluted rivers, oceans, roadsides, landfills. In recent years the awareness towards global warming and sustainable environment have rose a grassroot level movement against the increasing plastic pollution and it has enforced governments to regulate the single-use plastics. This has opened the door for industries to innovate novel sustainable plastics materials for a better tomorrow. Due to plastic regulation it is expected that market value for biodegradable polymers will exceed to $1 billion by 2023. (IHS Markit, 26 July, 2018).

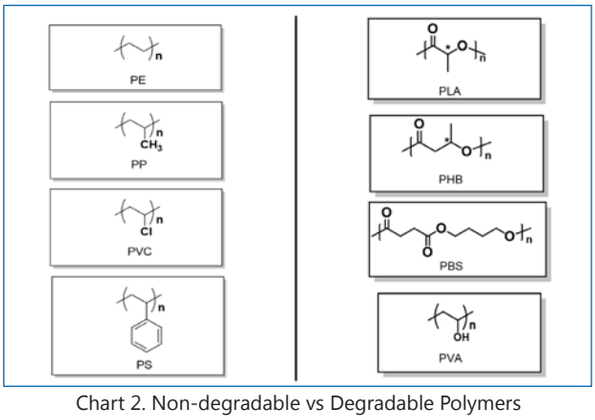

Chart 2. Non-degradable vs Degradable Polymers

Biodegradable Polymers – An alternative to conventional single-use plastic

Biodegradable polymers have the features of biodegradability and biocompatibility, hence they can provide a solution to managing packaging waste and also have potential in biomedical and pharmaceutical applications. For a biodegradable polymer it is very important that it must hold suitable mechanical properties for targeted applications like packaging, agriculture, disposable moulded articles etc. At the end cost-effectiveness is the determining parameter for its commercial success. Poly(lactide) (PLA) is the most talk about and promising biodegradable polymer today. It has become a commercial reality and is being produced at world-scale plants.

Aliphatic and aliphatic-aromatic polyesters are the class of material that is potentially biodegradable. Since esterification thermodynamically a reversible reaction and such polymers have potential to depolymerize in certain conditions like ambient temperature, moisture and microbes.[2] The other examples of biodegradable polymers are poly(glycolide) (PGA), poly (β-hydroxy butyrate) (PHB), poly(ε-capolactone) (PCL), poly(butylene succinate) (PBS), poly(butylene adipate) (PBA) etc. A generalised classification of biodegradable polymer is depicted in chart 3.

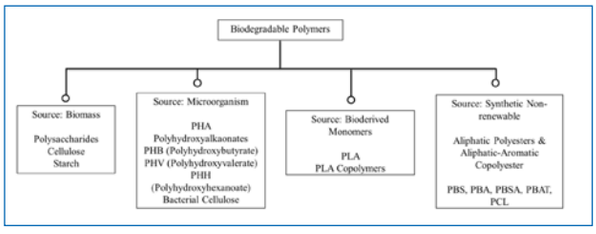

Chart 3. Types of Biodegradable Polymers

Biodegradation of Polymers

There are a number of factors that contribute to the polymer degradation, where physical properties as well chemical structure have a crucial role. Polymer molecular weight, crystallinity, molecular orientation, surface area and glass transition temperature have determining effect on degradation of polymer in a given set of degradation conditions.[2] Biodegradation is a process that eventually degrades the polymer in water, carbon dioxide and bio-mass in the presence of microorganisms. Various test methods such ASTM D6400, IS/ISO14851, EN13432, ISO/IS 17088 are standard methods to check the biodegradability of the polymers.

Sustainable Materials Development

Sustainable materials are those which can be used effectively and recycled after its service period without exerting detrimental effect of on the environment, additionally it follows use-recyle-use concept. In-terms of polymers, a wide variety of different classes are available and can fulfil the demand from commodity to engineering applications. It has made our life easier in many ways. However, we see plastic as a problem today, but we must not ignore its usefulness. Imagine, how much wood and metal would be required if we wish to replace plastic in construction and engineering applications. The plastic problem is more related to behavioural aspect of the consumers and awareness in this front is equally important for a sustainable solution.

For single polymer it is difficult to address all requisites for a certain application and blending is the solution for this. Polymer blending is known to be the most effective method for modification of polymer properties like mechanical strength, thermal resistance, barrier properties, degradation rate etc.

Polymer blending bring definite properties which are not shown by their individual components. However, polymer blending itself is a challenging methodology as majority of the polymers are immiscible in each other and creates issues like phase separation that eventuality deteriorates the mechanical properties. This can be overcome by the incorporation of suitable additives and modifiers. As compared to design a new polymer for a targeted application, polymer blending is an easy, low-cost and scalable way to enhance the properties of the pristine polymers to serve the purpose.[2]

A variety of polymers such as aliphatic polyesters, aliphatic-aromatic polyesters, bio-based polymers such as polysaccharides and certain classes of polyurethane, polyanhydride and polycarbonates are potential materials for biodegradable sustainable material development.

Polymer blending is a promising methodology for cost-effective and sustainable material development with desired mechanical and physical properties.

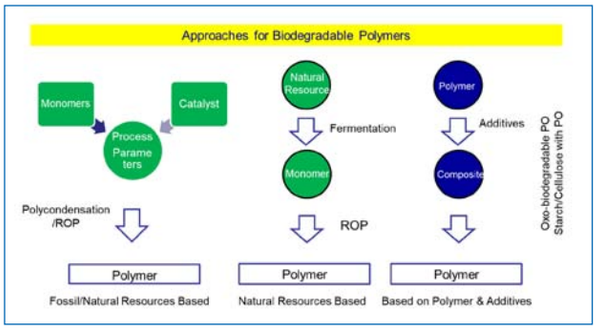

Chart 4. Approaches for Biodegradable Polymers

The products based on aliphatic and/or aliphatic–aromatic polyesters can be tailor made through blending & compounding using melt extrusion, blown & cast film and injection moulding methodologies. The application of these product cover flexible to rigid packaging, net-bags, mulch films, thermoformed products, 3D printing articles and coatings. In view of application development polymer can be blended with inorganic and organic fillers this facilitates better processing and product properties. Additionally, through blending process cost effectiveness and new applications can be achieved. Chart 5 depicts the process for new material development from polymers to products.

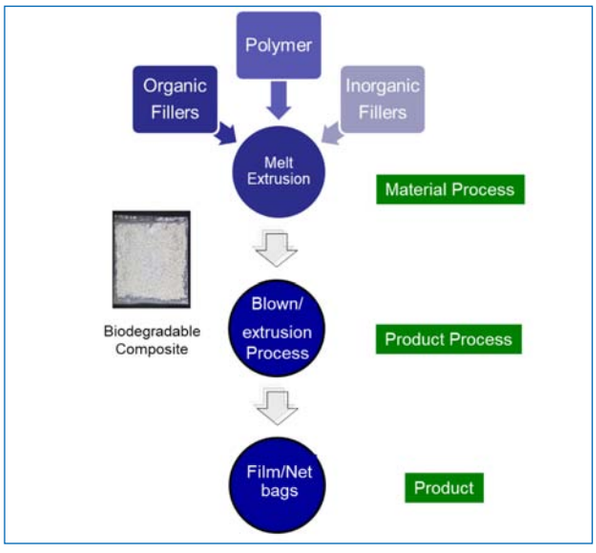

Chart 5. Process for Polymer to Products

Material Development: We have devised a blend of aliphatic and aliphatic-aromatic polymers and developed the application for packaging purpose. The material composed of different fillers & additives which are uniformly distributed in polymer matrix. The developed green plastic product has the ability to be processed at downstream processes such as melt extrusion, cast and blown film processes. The

material can be processed at existing/conventional machines and hardwares, thus have a drop-in solution for single-use plastics to develop various applications like shopping and garbage bags, agriculture films, rigid packaging, fiber net bags etc. Through blending process green material could be altered to film, fiber, injection moulding and thermoform grade products.

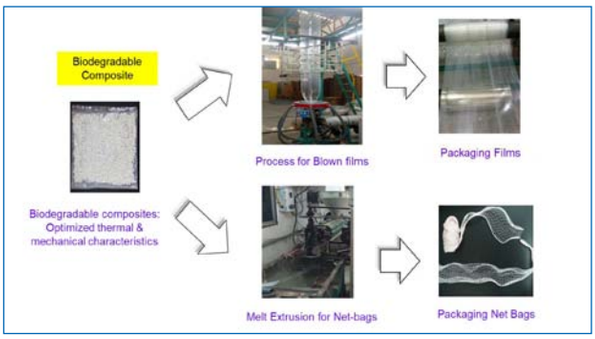

Fig 1. Blown and extrusion processes for films and bags developments

Material Properties: The mechanical properties (Tensile strength 12-20 MPa; Elongation at break >200%) of green products are suitable for single use packaging applications. The products are thermally stable up to 300 °C.

Potential Applications:

The developed green plastic product has the ability to be processed into different new application such as agriculture mulch films, injection molded products, biodegradable coatings, products, thermoforming and 3D printing.

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STRATEGY

Ensuring Profitability in an Uncertain Market: Monetize Heavy Feeds Using Flexible Technology platforms

Jacinthe Frecon

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With crude oil prices today around $62/bbl, a 20% increase in liquid yield can net a refiner more than a $180 million per year for a 40,000 BPD residue hydrocracker relative to a delayed coker of the same capacity. This has been the driving force behind the hydroprocessing of atmospheric and vacuum residues globally. Since the first oil shock in 1973, refiners had already begun shifting their focus away from conversion towards technologies like the H-Oil ebullated-bed hydrocracking platform to maximize liquid yield of transportation fuels.

Provided that oil prices remained low (i.e., less than $20/bbl), such as the stable 40-year period prior to the first oil shock, the onus was on achieving 100% conversion of vacuum residue to distillate and coke. This is when the U.S. became the largest market for delayed coking in the world, beginning with the commercial introduction of delayed coking in 1929 by Standard Oil of Indiana. Against this backdrop, tailoring a combination of innovative hydroprocessing configurations with existing conversion technology helps balance technical risks and minimize CAPEX towards 100% destruction of high sulfur residual fuel oil.

With the recent introduction of regulations concerning marine fuel oil by the International Maritime Organization, the demand for high sulfur residual fuel oil will continue to decline in the near future because of the difficulty in meeting the new low sulfur standard for residual fuel oil. Consequently, refiners will now have an incentive for complete residual oil destruction for heavy high sulfur crudes. The PIRA energy consulting firm forecast the net supply of high sulfur fuel oil could decline by 1.4 million barrels per day "BPD" from 2020 and low sulfur (0.5 wt % or less) fuel oil will grow by 900,000 BPD. Upgrading margins has not recovered in recent years but could do so in the future. However refiners must look at a wide range of alternatives to meet their target return on investment in light of this uncertain market.

One option available in today's market includes the integration with downstream petrochemicals to increase the margin over the entire upgrading chain from crude oil to finished products. Another option includes the development of tailor-made solutions that take advantage of existing assets at a specific refinery location along with local market opportunities for fuel outlets and environmental regulations.

Methodology

Axens has developed a standard technology screening methodology that helps refiners to define

the basis of a feasibility study. Key criteria to consider are existing assets at the refinery (i.e. delayed coker, residual fuel oil boiler, SDA unit, etc.), types of crudes to be processed in the future, source of hydrogen and its cost. During the feasibility study, in close collaboration with the petroleum refiner and technology provider, alternate schemes are defined and carefully evaluated. The most appropriate option is selected taking into account the price of crude oil, finished and intermediate products, local market outlets for the products, local and national environmental regulations, CAPEX, operating cost and plant operability.

Selective conversion of difficult feeds The H-Oil® Suite of technologies is based on the well proven H-Oil platform and provides a refiner with many options to increase overall liquid yield while meeting a good rate of return

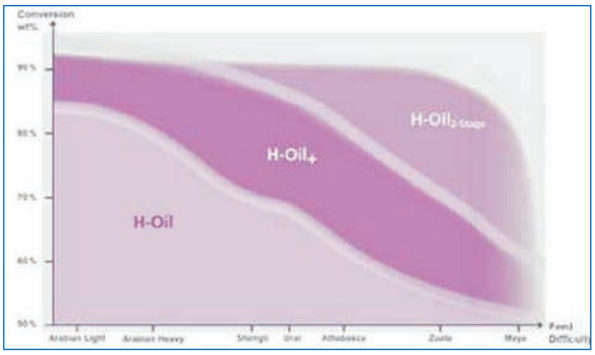


Exhibit 1 H-Oil Suite of Technologies

on its investment. Exhibit 1 illustrates the relative performance of the H-Oil® Process, the HOil ®+ and the H-Oil® 2-stage configuration that makes up the suite of hydroprocessing technologies available to a refiner. Each technology option offers unique advantages in terms of conversion and ability to process various types of feed difficulty. Conversion is defined as the cracking of vacuum residue into valuable transportation fuels while feed difficulty typically refers to heavy crude oil with high concentrations of asphaltenes and other heteroatoms which require special selection of operating conditions and catalyst.

H-Oil® Process

The H-Oil® Process is based on the ebullated-bed reactor system that was invented in the 1950's and the first patent was issued in 1961. A demonstration plant started up in 1963 at the Cities Service refinery in Louisiana and its successful operation led to the first large scale commercial plant which started up in 1968 at the KNPC Shuaiba refinery in Kuwait. The process has been described in many publications. Over 90% of the world's vacuum residues that are hydrocracked use the ebullated-bed reactor. The ebullated-bed reactor operates at a constant temperature and catalyst activity. The exotherm generated inside the reactor is quenched by the cold feed and the catalyst activity is controlled by varying the amount and type of catalyst that is added on a daily basis. The conversion of vacuum residue is normally set between 75 wt% and 80wt% when production of a stable residual fuel oil is desired from the unconverted residue. A typical configuration is shown in Exhibit 2.

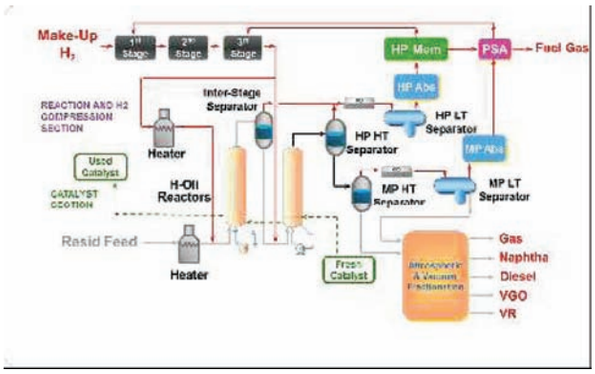


Exhibit 2: Typical H-Oil Configuration

The unconverted vacuum residue has other commercial applications, including fuel to an onsite boiler for steam and power production as done commercially at PKN Orlen refinery in Plock, Poland, gasification for hydrogen production as done commercially at Shell Convent, LA refinery or feed to a delayed coker for production of either fuel grade or anode grade coke as done at the Husky Energy Upgrader in Canada.

In many cases conversion can be increased to higher levels depending on the application and the types of crudes being processed. In the application of feeding unconverted vacuum residue to a gasification unit, the optimal conversion level is sometimes set at 86 % in order to produce enough unconverted oil to the gasification unit to put the complex in hydrogen balance. This operation was economically attractive when margins were high. When the margins shrank, the refinery took advantage of spreads between low sulfur and high sulfur opportunity crudes. During this time period, throughput was maximized and the unconverted oil was routed to the residual fuel oil pool.

Research has also demonstrated that unconverted bottoms from high conversion operation could be successfully blended to make road grade asphalt by Nova Husky Research center. The level of blending was determined by two main factors; (1) the conversion level, and (2) the grade of road asphalt that was desired by the end user.

It has been 50 years since the startup of the first large scale commercial plant. During this time period Axens has been working hard to enhance the operation and reliability of this technology through new innovative designs, the use of improved equipment and the development of breakthrough catalysts. Some of the technology improvements include:

- Improved Recycle Cup Design inside the reactor to reduce gas holdup and improve the efficiency of the ebullated-bed reactor
- ISS – Inter-Stage Separation for a design which includes two reactors in series. By off-loading the gas from the first reactor, the hydrogen partial pressure can be increased in downstream reactors or the hydrogen partial pressure can stay the same by lowering the overall system pressure. This allows for a decrease in overall CAPEX
- Catalyst Cascading whereby the spent catalyst from the lag reactor is cascaded to the front reactor thus reducing overall catalyst addition rate, which results directly in a reduction in operating costs. This is an effective tool for feedstocks with low to medium levels of metals in the crude oil.
- High Performance Catalyst has enabled refiners to raise conversion with minimal increase in sedimentation or decrease in stability of the unconverted oil. In addition, catalyst can now be tailored-made to specific crude oils for situations that are tied to specific crude oils for processing.
- Automated "WABT" weighted average bed temperature controlled by adjusting the feed oil temperature to the reactor in the control panel
- Automated Ebullated-bed Level control by detecting the bed level through nuclear detectors on the reactor and then adjusting the variable frequency drive that controls the rpm of the ebullating pump.

Exhibit 3: LUKOIL H-Oil Unit in Bulgaria

Majority of these new technology features were designed into the latest commercial plant at LUKOIL's Burgas refinery in Bulgaria that started operations in 2015. A picture of this plant is shown in Exhibit 3. In addition, a new advanced hydrogen management scheme using membranes and PSA to minimize hydrogen losses and reduce the number of compressors was incorporated into the design of this plant. This new H-Oil unit is designed to process 46,000 BPSD of vacuum residue from Ural crude. The plant started operations in 2015. The design allowed for a staged investment whereby a new VDU and VGO hydrocracking unit would be integrated and added to this existing unit at a later time. This unit in 2016 passed all performance objectives thereby validating the new innovative technology advances incorporated into the design. Achieving high conversion on this difficult crude was a major achievement while also attaining high onstream time with over 96% availability. Feedback from prior commercial units is incorporated in all new units which helps ensure a safe and reliable operation.

H-Oil®+ Suite of Technologies

The plus "+" stands for an additional technology features that works with the basic platform of the H-Oil® Process. Several options are available to meet the needs of a refiner that requires additional conversion at a modest increase in capital investment.

Some additional technology features used commercially inside the H-Oil® Process include the use of:

- Vacuum Bottom Recycle (VBR) to reduce reactor severity and conversion per pass thus reducing the formation of sediment downstream of the reactor
- A Low Space Velocity design that allows for deep hydrogenation and improved catalytic

conversion while reducing the sediment levels in the unconverted residue

- H-CAT is a new liquid catalyst precursor that reduces product sediment and allows refiners to operate at higher conversion levels

The innovative technology features described above are gaining wide acceptance in the industry. Many of these features have expanded the slate of heavy crudes that can be processed in an H-Oil® unit.

The VBR feature has been used at Shell's Convent, LA refinery in the USA since its startup in 1984. This unique application has allowed the refiner to run in several different modes including high conversion and maximum throughput depending on the market conditions.

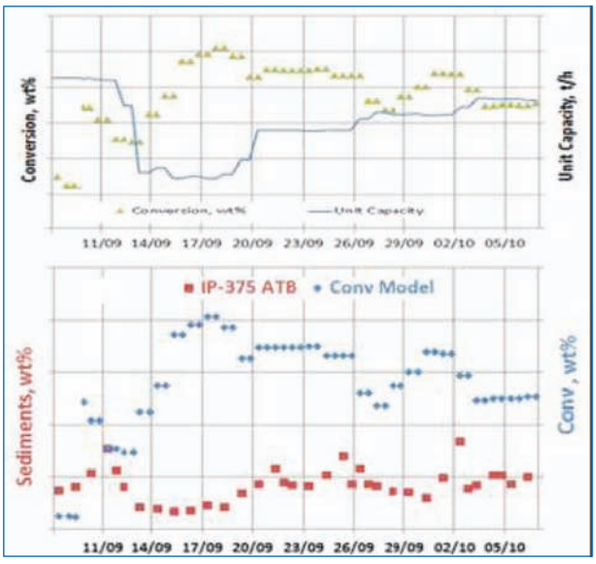


Exhibit 4: Low LHSV Demonstration

The Low Space Velocity design option is a powerful way to boost conversion and hydrogenation reactions. The effluent quality is improved and sedimentation/ fouling levels are reduced downstream of the reaction section. In a recent industrial demonstration, the feedrate was reduced which allowed for a significant increase in conversion while the sediment levels in the downstream fractionator bottoms decreased as shown in Exhibit 4. This demonstration validated earlier research work which indicated conversions up to 95 wt% could be achieved with production of a stable UCO on an ebullatedbed pilot unit. As expected, the conversion of asphaltenes, CCR and HDS were also increased during this demonstration test.

Increasing the catalytic activity is another way to improve performance in both conversion and heteroatom removal. The classic way to achieve this improvement in activity is by either increasing the residence time (i.e. larger reactors) or by increasing the catalyst addition rate.

The former increases capital investment while the later increases the refiner's operating cost through the use of more catalyst per day. An innovative alternative is adding a liquid catalyst precursor to the oil feed entering the reactor.

The HCAT catalyst complements the solid supported catalyst and allows the ebullated-bed reactor system to operate more efficiently by facilitating the transfer of hydrogen to the asphaltene molecule as shown in Exhibit 5. This liquid catalyst is finely dispersed in the feed oil to the ebullated-bed reactor by a specially designed mixing device. The hydrogenation of asphaltenes leads to higher asphaltene conversion at lower levels of sediment in the unconverted residue.

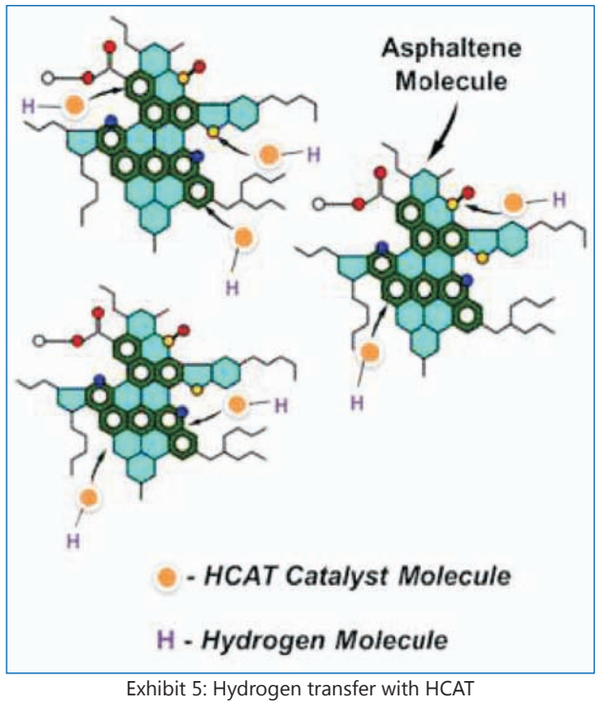


Exhibit 5: Hydrogen transfer with HCAT

The impact on sediment formation is shown in Exhibit 6.

During a pilot plant test in support of a commercial plant, the use of small concentrations of HCAT allowed for a 14 percentage points increase in conversion while maintaining the IP-375 sediment level at or below the standard level typically used in commercial operations. Sediment level measured downstream in the fractionator bottoms is used as an indication of fouling tendencies in the vacuum tower

as well as the stability of the unconverted vacuum residue from the unit. HCAT is ideally suited for upgrading projects using residues from heavier opportunity crudes but it is also powerful to achieve very high conversion with easier feed. This novel catalyst additive is now in use at several commercial hydrocracking ebullated-bed plants around the world, including non Axens licensees.

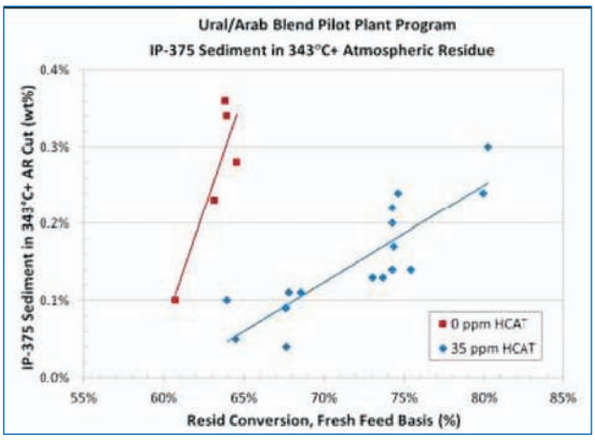


Exhibit 6: Impact of Sediment formation when using HCAT

Some features of the H-Oil®+ Process include the use of additional technologies downstream of the H-Oil unit. As an example, routing unconverted vacuum residue from the H-Oil® Unit to an existing delayed Coker, completely eliminates residual fuel oil production and achieves 100% conversion overall. An alternative is to route the unconverted oil to a new or existing solvent deasphalting unit to remove the asphaltenes and improve the quality of the distillates for further treatment. Both schemes are shown in Exhibit 7. The concept of H-Oil followed by a second conversion unit helps the refiner minimize technical risk, lower investments cost by utilizing existing assets and most importantly achieve high onstream time which is necessary to pay off the original investment and achieve good economic results.

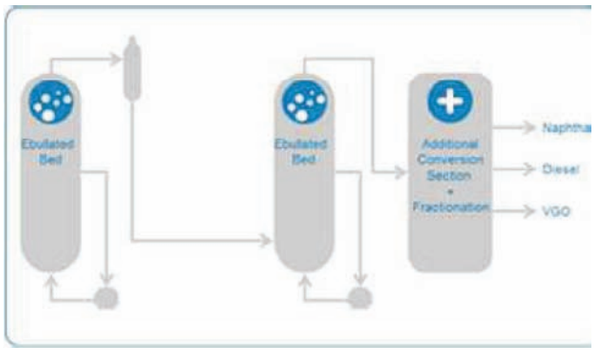
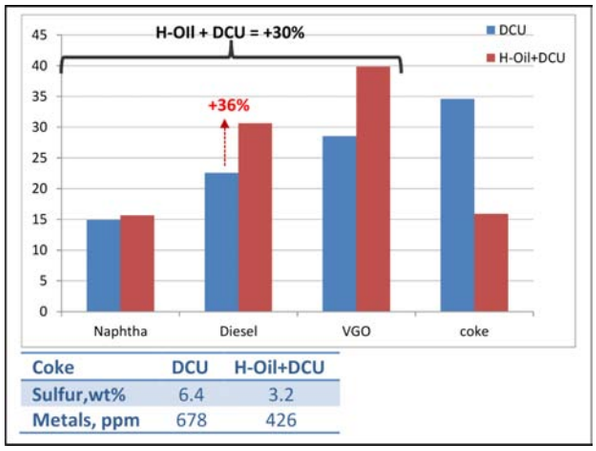


Exhibit 7: H-Oil + Process Scheme

The first use of this combination was achieved by Husky Energy in Canada. In a detailed study performed with Axens, an optimum conversion level was achieved in both conversion units that balanced technical risks and minimized CAPEX. Both units could operate separately to achieve higher plant reliability while making a high quality synthetic crude oil and a finished transportation fuel. In addition, Axens confirmed that fuel grade or anode grade coke could be made with this technology by optimizing the design and operating conditions of the plant.

The latest design of an H-Oil unit followed by a delayed coker is the scheme selected by ZRCC for its complex in China. By adding the residue hydrocracker upstream of their existing Delayed Coker, the amount of petroleum coke was reduced by 32% due to the conversion of concarbon residue in the H-Oil unit. The overall conversion is 92 wt.% with this configuration. In addition, the quality of the new coke produced was improved due to the removal of impurities in the upstream residual hydrocracker. Currently this unit is due to start-up at the end of 2018 and will be the latest ebullated-bed unit designed for high conversion.

The key driver to the H-Oil/Delayed Coker combination is the increase in overall liquid yield compared to just using the Delayed Coker by itself. In addition, the vacuum residue eedrate can be increased since a substantial amount of CCR conversion occurs in the residue hydrocracker. Exhibit 8 shows the overall increase in liquid yield by 30 % with a strong selectivity towards the production of diesel fuel. With the increase in liquid yield and high oil price, the payout for this type of plant can be very economically attractive.



Coke	DCU	H-Oil+DCU
Sulfur,wt%	6.4	3.2
Metals, ppm	678	426

Exhibit 8: Increase in Liquid Yield when adding H-Oil unit upstream

Another example includes the use of Sequential Deasphalting (H-Oil®+SDA) which paves the way for major increases in conversion through the removal of asphaltenes from the unconverted oil. The deasphalted oil "DAO" can either be hydrocracked for increased yield in diesel production or cracked in a FCC Unit for additional gasoline production depending on the local market conditions. The unconverted pitch from the SDA has many potential outlets ranging from blending into road grade asphalt to burning or gasifying to make power and hydrogen.

The Hengli project in China is a perfect example of the option that integrates the upgrading of heavy oil at the refinery with a petrochemical plant downstream as shown in Exhibit 9. This large complex was optimized by a team of engineers from Axens and Hengli that resulted in a configuration that includes the high conversion H-Oil® Suite of technologies;

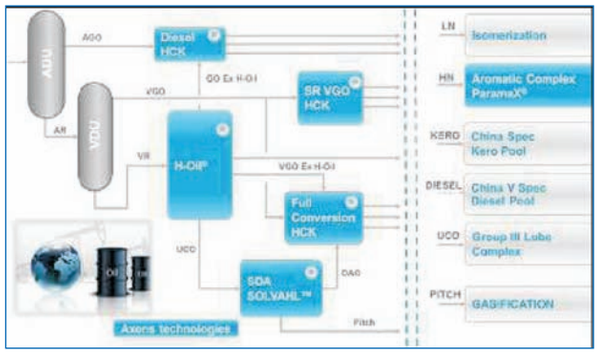


Exhibit 9: Hengli Complex in China

H-Oil® Process, SDA (Solvahl™), hydrocracking (HyK™) of the VGO and DAO, for the maximum yield of naphtha for processing in a downstream petrochemical plant. Hengli is able to maximize its overall margin by producing petrochemicals. This 110,000 BPSD plant uses 2 parallel trains with two ebullated-bed reactors in series for each train. The design feedstock is a blend of Arabian and Marlin crudes. The pitch from the SDA unit is routed to a gasification unit. Axens provided the major technologies for both the refining and petrochemical plants. This unit is scheduled to start-up the first Q of 2019. More than 92 wt.% conversion will be achieved with no production of fuel oil.

H-Oil® 2-Stage Configuration

The deep conversion of very refractory feeds faces many challenges, among which causes adverse effects on reactor stability. To overcome these issues, a first stage of moderate conversion is set in a two stage configuration. The heaviest fraction from the first stage is routed to an SDA unit to remove the unconverted asphaltenes while the clean effluent undergoes additional conversion in the second stage. The 2nd Stage consists of one H-Oil reactor as shown in Exhibit 10. High levels of performance are achieved with this configuration.

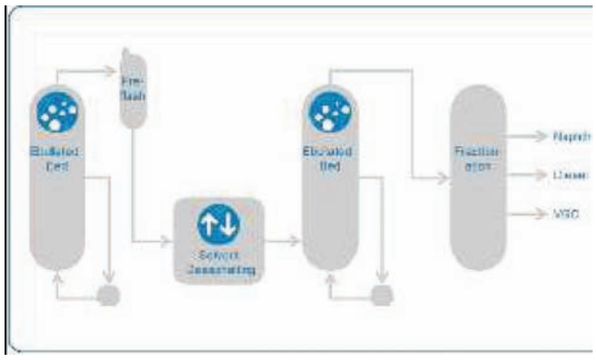


Exhibit 10 H-Oil 2-Stage Configuration

The Solvent Deasphalting section prevents the asphaltenes-rich and instability-promoting fraction of the effluent from being processed in the second stage. By segregating deasphalted oil from first stage effluent, stability is maximized in the whole complex. Conversion levels are in the range of 65 to 90 wt% with this scheme.

The highest investment is associated with the H-Oil 2-stage configuration. This application is most appropriate for processing high refractory feedstocks found in Venezuela for example.

Real results

To understand the potential economic benefit of each of the schemes described in the H-Oil® Suite, Axens undertook an in-house study based on the processing of a Ural vacuum residue feedstock with a capacity of 2,600 ktpa (46,000 BPSD). Three configurations were evaluated;

H-Oil Process; standard processing scheme, H-Oil®+ Process; featuring 2 ebullated-bed reactors in series followed by an SDA unit, and the H-Oil® 2-stage configuration; for maximum conversion. In all cases, the VGO was routed to a downstream hydrocracking unit.

A gross margin (i.e. the difference between the selling price of products and the cost of feedstocks: vacuum residue and hydrogen) was calculated for each scheme. The results of this analysis are shown in Exhibit 11.

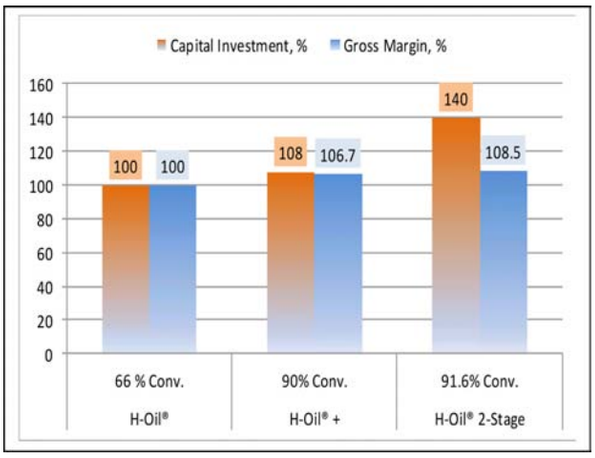


Exhibit 11 Economic Benefit of Various Options

As expected, each of the schemes shown in the exhibit showed an increasing benefit in gross margin as the conversion level was increased. High gains in economic benefit will pay substantial benefits to refiners as oil margins increase. The final economic benefit measured by internal rate of return will be a strong function of the final capital investment. In many cases the high incremental capital investment required for achieving higher conversion does not result in the best return on investment. Having a tailored solution based on existing local assets at the refinery and local conditions will determine which scheme maximizes the IRR for each refinery.

R&D stewardship leads to process breakthroughs

Technology innovation has been a cornerstone of the improvements to the H-Oil® Process. Improvements come from feedback from commercial operating units and IFPEN's R&D support. IFPEN is ranked in Reuters Top 100 global innovation organizations and over 100 000 hours of operating data and others have contributed to the following breakthroughs:

- Inter-stage Separation (ISS) – provides the ability to debottleneck limitations in gas velocity and increase feed-rate in a single train which reduces CAPEX.
- Implementation of Advance Process Control – greatly improved operation and reliability of the plant.
- Development of a new analytical tool that can measure extreme low levels of C7 asphaltenes – this tool led to a major breakthrough in producing a "clean DAO" in Solvent Deasphalting
- Developing Inter-stage Sampling techniques provides the ability to measure the composition of effluents across each reactor stage in order to precisely determine individual reactor exotherm and optimize the overall design of the Unit.
- The use of Spiral Heat Exchangers – greatly improved efficiency and reduction in CAPEX downstream fouling for the plant.
- Major Development in a new Predictive Model – enables refiners to predict performance and sedimentation in the unconverted bottoms based on crude properties.

  This helps the refiner maximize profitability by targeting the acquisition of distressed crudes on the open market.

IFPEN is continuing to pursue innovative developments at its research facilities R&D work are continuing in the areas of oil stability, high conversion, process fundamentals and process modeling. With IFPEN and HTI, Axens is the only technology provider in the world that can provide pilot testing to customers in a real ebullated-bed pilot unit. This pilot plant has the capability to produce results than can be used as a direct comparison to an industrial unit with regard to fouling (i.e. sedimentation in the fractionation bottoms).

High unit availability

Fifty years ago the first large scale H-Oil® Plant was inaugurated. The latest H-Oil® Unit was started in 2015 at LUKOIL's refinery in Bulgaria. Throughout the world, the operating HOil® Units have accumulated more than 230 years of experience, which is highest level of experience in any residue hydrocracking technology, and licensed units represent a total capacity of more than 1,020,000 barrels per stream day.

Of the 21 licensed H-Oil Units in the world today, most are located in North America followed by Europe and the Far East as shown in Exhibit 13. The boom in North America came as the result of refiners requesting technologies that could improve liquid yield once oil prices started to increase from $20/BBL in the 1970s to over $70/BBL today. As shown in Exhibit 12, most of the unconverted oil from these licensed units is directed towards residual fuel oil. There has been a substantial shift in recent years to eliminate residual fuel oil all together by routing the bottoms to delayed coking and SDA to increase overall liquid yield.

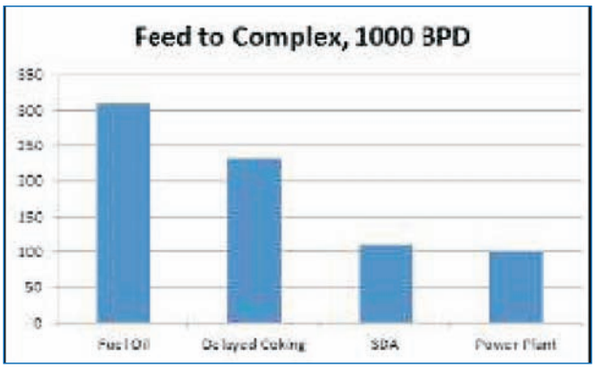


Exhibit 12: Routing of Unconverted Oil Exhibit

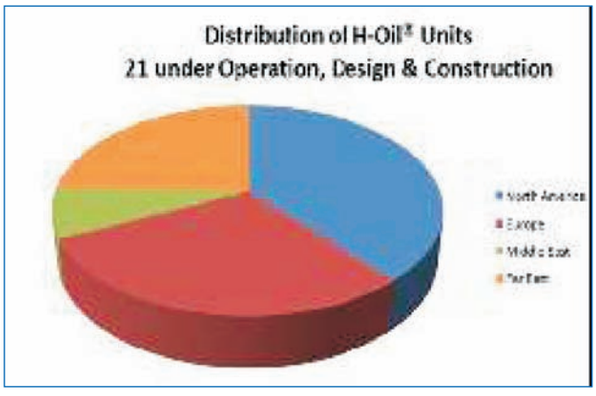


Exhibit 13: Geographic location of Plants

A key advantage of a mature technology is its ability to achieve high unit availability or sometimes referred to as on-stream time. A review of 9 commercial plants over many years has resulted in an average unit availability of 97%. Even the newest unit to startup in 2015 is operating at this level which includes all of the latest technology innovations. In a recent internal study, a reduction in on-stream time from 96% to 90% can cost a refiner $45 million U.S. dollars per unit in lost revenue. This fact explains why so many of our older plants are requesting updated operating simulators. The cost of training new operators can easily pay for itself when this plant operates one extra day a year.

Leveraging economies of scale One of the most pronounced trends over the past 20 years has been the reduction in capital investment in commercial H-Oil Units. With the advancement in Technology Innovation, the processing capacity per unit train has increased substantially.

This has provided significant cost advantages to the refinery industry. The train capacity has gone from 14,000 bpd of vacuum residue in the 1960s to over 60,000 bpd today. The most startling example is the commercial plants constructed at the Shell refinery in Convent, LA which started operations in 1984 with a design capacity of 35,000 bpd. The H-Oil® RC plant consisted of two parallel trains with two reactors in series for each train. Both trains had their own dedicated catalyst handling sections with a common fractionation section. About 10 years later, Axens was able to design a 34,000 bpd plant for PKN Orlen in Poland in one train with two reactors in series. With virtually the same feed capacity, the number of pieces of major equipment and associated capital costs were substantially reduced. As shown in Exhibit 14, Technology Innovation has led to substantial reductions in capital cost by taking advantage of economies of scale and reduction of major equipment. Today commercial plants are being designed to process up to 70,000 bpd in a single train plant.

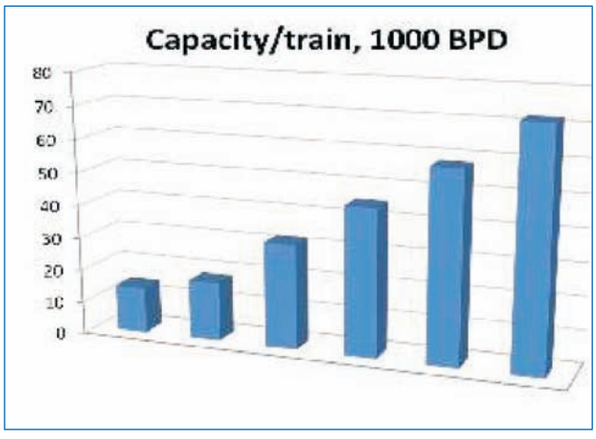


Exhibit 14: Achieving breakthroughs in processing capacity

Profitable routes to 0.5 wt% S limit in RMO

With the MARPOL regulations starting in 2020, the sulfur level in marine fuel oil will drop from the current 3.5 wt. % sulfur level to 0.5 wt. %. A recent internal study has discovered a couple of viable options using the H-Oil® + for making low sulfur Residual Marine fuel Oil "RMO". Some attractive options are shown below:

- Route VGO from the H-Oil unit to the Marine Gas Oil (MGO) pool, if its price MGO rises above the price of diesel fuel, then it is profitable.
- H-Oil followed by SDA. In this case the DAO from the SDA is blended with the vacuum gas oil from the H-Oil unit to meet the 0.5 wt. % sulfur specification.
- SDA followed by the upgrading of the DAO in the H-Oil® unit. The unconverted residual oil meets the sulfur specification and the pitch from the SDA unit is routed to a delayed coker,

bitumen pool or also used as a liquid or solid fuel.

- H-Oil unit processing low to medium sulfur feedstocks and using a low sulfur cutterstock like light cycle oil from a FCC unit can also meet the RMO specification.

The best scheme for an individual refiner requires a site specific screening study to identify the optimal solution. This study takes into account the existing assets, site-specific constraints, investment strategy and the local market outlook. Axens has joined forces with PROSERNAT, a leader in sulfur recovery; to perform the screening studies for both revamp and grassroots solutions.

Upgrading distillate from high yield hydrocracking Many of the older commercial plants upgrade the H-Oil distillate products in existing units at the refinery. In newer units under design or recently started, the H-Oil distillate products are being upgraded in units designed as part of the overall refinery expansion.

Naphtha production from an H-Oil unit typically represents less than 10% of the total naphtha processed at the refinery and therefore the simplest solution is to blend off this product into existing streams within the refinery for additional upgrading.

The diesel product is significant with a yield in the range of 25 to 30 vol % of the fresh feed to the unit. As one might expect, distillate products from a residue hydrocracker would be more refractive because the most reactive sulfur and nitrogen compounds have already been converted. In Exhibit 15 the results of characterizing a typical H-Oil diesel product is shown and compared to a straight run "SR" mid-distillate material. The SR diesel has more than 50% BT – Benzothiophene, which is easy to convert while the H-Oil diesel contains more than 50% DBT

GC-2D	SR Diesel	H-Oil® Diesel
Sulfide/Thiophene	27%	5%
BT	54%	24%
DBT	18%	58%
Ph-T, BNT	0%	12%
Total Sulfur, ppmwt	8892	1835

Basic Nitrogen	SR Diesel	H-Oil® Diesel
Aniline	0%	2%
Quinoline	27%	43%
Acridine	13%	11%
Total Basic	41%	56%
Total Nitrogen, ppmwt	114	1832

– Dibenzothiophene, which is a more refractory compound and consequently more difficult to convert. The same analysis was conducted on nitrogen compounds. Distillates which contain large quantities of basic nitrogen create difficulties for sulfur removal because they inhibit the hydrodesulphurization reactions. The removal of high levels of nitrogen compounds typically requires greater reactor severity in comparison to desulfurization reactions.

It is worthwhile to also compare H-Oil diesel reactivity to other cracked feedstocks coming from Delayed Coking (i.e. LCGO – light coker gas oil) and from an FCC unit (i.e. LCO – light cycle oil). In Exhibit 16 the results are shown from pilot tests that were conducted for the purpose of producing ultra-low sulfur diesel fuel with 10 wt. ppm sulfur. The key variable was LHSV which relates to the amount of catalyst volume required to achieve this result. A lower LHSV means substantially more volume of catalyst is required in the reactor to achieve the same result. In these tests, the HOil diesel was found to be the most reactive compared to LCGO and LCO.

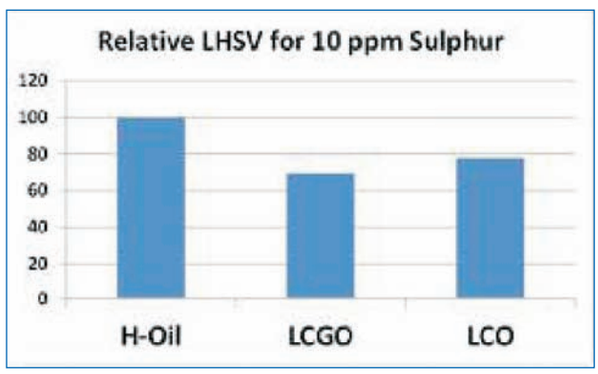


Exhibit 16: Reactivity of various cracked diesel cuts

Several refineries today process H-Oil diesel in existing low/moderate pressure units as well as dedicated units added to an existing unit. The later application is the H-Oil unit at PKN Orlen's refinery in Plock, Poland. A dedicated diesel unit was added

after the original H-Oil unit started operations in order to produce low sulfur diesel fuel. Several options were examined by both parties and an optimal design was made and implemented in 2007. The details of the design and successful operation were presented and later published. New units under design have considered integrated hydroprocessing units for both initial start-up or as part of a phased investment.

Vacuum Gas Oil "VGO" is another major distillate product that has been routed in the past directly to an FCC unit without any pre-treatment. In recent designs the VGO is routed to a hydrocracker to maximize the production of high quality diesel fuel. In some cases the VGO is pretreated with straight run VGO in a hydrotreater before routing to the FCC unit to increase the yield and conversion to gasoline. As a rule of thumb, a 0.1 wt % increase in hydrogen content of the VGO will result in an increase of 1 to 2 % in gasoline yield.

Detailed characterization (i.e. sulfur, nitrogen and aromatic compounds) is required to develop the optimal hydroprocessing conditions along with selecting the optimal catalyst to meet the desired performance objectives. In many cases the VGO is routed to stand alone hydroprocessing units but in recent years refiners have been looking at adding new integrated units with the residue hydrocracker. Several configurations have been examined including the use of an in-line hydrocracker taking the entire overhead from the H-Oil hot high-pressure separator, which is mainly naphtha and diesel, and then adding the recovered VGO from the downstream fractionation column. This high pressure unit suffers from lower hydrogen purity and high levels of hydrogen sulfide and ammonia compounds in the feed which inhibit catalyst activity. In addition overcracking of the diesel fraction leads to increases in production of light gases (i.e. C1 to C3) which in-turn increases hydrogen consumption.

A better scheme would use the optimal hydrogen partial pressure levels for each processing unit (i.e. residue and VGO) that could result in savings of capital and operating cost. Exhibit 17 shows the optimal scheme developed by Axens for integrating H-Oil with VGO hydrocracking. The two units use the same make-up hydrogen compressor and share the same high pressure amine absorber and hydrogen purification system. The high pressure purge from the

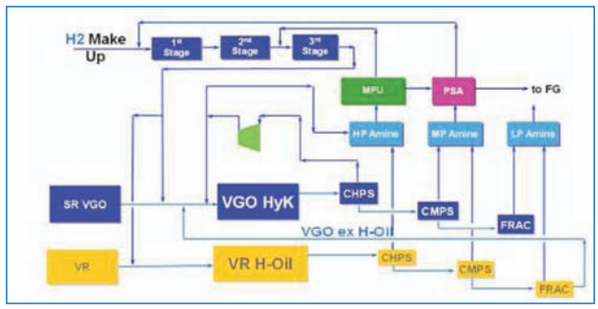


Exhibit 17: Optimal Integration of H-Oil with VGO Hydrocracking

VGO hydrocracker is routed to the common HP amine absorber thus resulting in a higher purity hydrogen and corresponding lower operating pressure for the hydrocracker.

There are several references utilizing this design today.

Flexible routes to ROI vs market risk

With the uncertainty in the market, companies will need tailored solutions for their refining site which can take advantage of utilizing existing units while meeting local and national environmental regulations, local market outlets for products and achieving high reliability.

The H-Oil® Suite of technologies provides a wide range of applications that can be utilized in today's uncertain market. These technologies have been accepted worldwide by the refining industry as providing low risk and high returns on investment.

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FINANCE

Budget 2020 – Direct Tax Expectations – Oil & Gas Sector

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A. Setting the backdrop

The oil and gas sector is among the eight core industries in India and plays a major role in influencing decision making for all other important sections of the economy. India had crude petroleum reserves of 594.49 million tonnes and 1,339.57 billion cubic metres of natural gas reserves as at 31 March 2018 . However, due to the size of the population of India, the demand for such fuel far exceeds current reserves, which result in substantial import of oil and gas in India. India depends on imports for about 83 per cent of its crude oil requirement and 47 per cent of natural gas requirements.

The reliance on imports would be reduced by accelerating the exploration and production ('E&P') activities in India, which could be boosted by various measures from the Government of India ('GOI'). Over the last year we have witnessed that the GOI has tried to boost the domestic production in India through the introduction of various reforms in existing policies and new framework to enhance domestic production and incentivize enhanced recovery methods. However, the sector has experienced several challenges from direct tax perspective due to factors such as removal of tax holidays, litigation on existing incentives, etc. To attract better traction and investments, it is important to tackle these issues to provide certainty and clarity.

B. Overview of the current tax regime

Indian incorporated companies

Currently, Indian companies having turnover of more than INR 400 crore are taxed at a maximum marginal tax rate of 34.94 per cent. All other companies are taxable at a maximum marginal tax rate of 29.12 per cent.However, such companies are entitled to claim various exemptions, incentives, etc. provided under the

[1]Oil and Gas statistics published by Make in India - http://www.makeinindia.com/sector/oil-and-gas

[2]Oil and Gas statistics published in March 2019 by Ministry of statistics and programme implementation - http://www.mospi.gov.in/sites/default/files/publication_reports/Energy%20Statistics%202019-finall.pdf

[3]Taxation Laws (Amendment) Ordinance 2019 dated 20 September 2019

provisions of the Income-tax Act, 1961 ('the Act').

Taking cues from the global economic turmoil, there was an increased need to boosteconomic business investments in India and generate employment. Accordingly, the GOI on 20 September 2019 has announced several direct tax measures to reduce the corporate tax burden on Indian incorporated companies.A summary of relevant announcements is as under:

- Option to apply reduced corporate tax rate of 22 per cent (25.17 per cent including surcharge and cess) for Indian companies not claiming any exemption, incentive benefits,on satisfaction of certain conditions;
- Option to apply concessional corporate tax rate of 15 per cent (17.16 per cent including surcharge and cess) for companies' setup and registered on or after 1 October 2019,which begins manufacturing on or before 31 March 2023, on satisfaction of certain conditions;
- Minimum Alternate Tax ('MAT') shall not apply to companies who opt for reduced rate of taxation of 22 per cent / 15 per cent.ReducingMAT rate to 15 per cent (excluding surcharge and cess) for all other companies.

Foreign companies

Foreign companies are taxed at a marginal maximum tax rate of 43.68 per cent (no changes in tax rate of foreign companies in recent direct tax measures announced by GOI). Under Double Taxation Avoidance Agreements ('DTAA') signed between India and another country, a foreign company is liable to pay tax in India from its business operations, in case the said entity constitutes a Permanent Establishment ('PE') in India. Entities engaged in the business of exploration, extraction or production of gas assets may constitute a PE in India depending on the terms of each DTAA, and only income attributable to the said PE would be taxable in India.

Further, under Section 44BB of the Act,an option to avail presumptive tax regime is provided tonon-resident service providers to oil and gas companies operating in India. Under these provisions, the tax payer shall be allowed to offer 10 per cent of their gross receipts as profits and compute tax thereon.

C. Key tax benefits/incentives expected

GOI is on the verge of revising, consolidating and simplifying the existing direct tax laws by amending the Actor by introducing a new Direct Taxes Code.In order to give impetus to businesses in India, it is expected that GOI could provide tax incentives by way of lower tax rates, additional deductions and relaxations of similar nature. In the ensuing paragraphs, we have discussed key tax benefits/ incentives expectedas a result of such changes, along withglobal developments, which may impact the sector.

i. Lower corporate tax rates for foreign companies

A current overview of the Indian tax regime has been depicted in the previous paragraphs. It is noteworthy that a domestic company is now taxed 25.17 per cent or 17.16 per cent, the corporate tax rates for foreign companies in India still stands at a steep 43.68 per cent.

Further, the Act also provides, under Section 115BA, an incentive to domestic manufacturing / production companies to offer their incomes to tax at a reduced rate of 25 per cent.

While the GOI has taken steps to attract domestic investors, it is pertinent to understand the significance of foreign investment in the growth of Indian economy. To make India an attractive jurisdiction for business investments, it is expected by the industry that the GOI brings down the high tax rates applicable to foreign companies to bring about parity with tax rates for domestic companies.The industry would expect that the reduced tax rate of 17.16 per cent applicable to domestic companies, be applicable to companies in the oil and gas sector to make the sector more attractive to investments.

ii. Removal of MAT for Oil and Gas Companies

MAT is an alternate mechanism to tax companies

[4]Petroleum and Natural Gas Regulatory Board (Authorizing Entities to Lay, Build, Operate or Expand Natural Gas Pipelines) Regulations, 2008

having tax payable, under normal provisions of the Act, lower than 15 per cent of book profits. However, keeping in mind the long gestation period and high uncertainty involved in the oil and gas business, and to provide an impetus to the sector in general, it would be an industry expectation that MAT not be applicable to oil and gas companies operating in India.

iii. Tax holiday for Oil and Gas Companies

Oil and gas companies in countries such as Thailand enjoy tax holidays for 8 years pursuant to signing of the Production Sharing Contract ('PSC'). In India also, tax holidays were provided to companies in E&P sector. To boost investment and provide a fillip to the oil and gas sector, the industry would hope that the GOI introduces a tax holiday framework for oil and gas companies in India.

iv. Relaxation on conditions to claim deduction under Section 42 of the Act

Under the current tax regime, the tax payer is allowed to claim 100 per cent deduction of capital expenditure incurred on E&P assets under Section 42 of the Act. To claim the said deduction, the Act requires the production sharing contract as well as revenue sharing contract entered intoby E & P Company with the GOI to be tabled before each house of the Parliament. It has been observed that such contracts are not tabled before the Parliament immediately upon signing of contracts and at times takes years before the same is tabled. Accordingly, such companies face serious challenges in tax proceedings while claiming allowance under Section 42 of the Act. The industry would expect that the GOI remove the tedious burden as thesecontracts are already signed by the President of India.

Further, under Section 42 of the Act, taxpayers may be allowed to claim expenses that were incurred towards infructuous or abortive exploration. However, for such claim of expenses, there currently exists a pre-requisite to surrender the exploration area of abortive or infructuous exploration. The timing difference between abandoning an exploration area and surrendering it to the GOI may lead to disallowance of such expenses in a year of abandonment and deferral of the allowance until the year in which the exploration area is surrendered. Industry would expect that the GOI brings about a clarification that expenditure towards infructuous or abortive exploration be allowed in the very year of abandonment of the exploration area and the requirement to surrender the abortive exploration area be waived off.

v. Necessary clarifications for specified businesses

The Act provides for deductions in respect of capital expenditure incurredfor the purposes of"laying and operating cross-country natural gas or crude or petroleum oil pipeline network for distribution, including storage facilities being an integral part of such network".

100 per cent deduction for capital expenditure is available for companies engaged in laying and operating cross-country natural gas or crude or petroleum oil pipeline network. However, there is lack of guidance on application of the aforesaid provision. Scope of the term 'cross-country' is unclear. Thus, it needs to be clarified whether this provision can be applied to pipeline used within the city gas distribution network spanning from one city to another or whether it can be applied for pipeline spanning from one state to another. Interestingly, the prescribed rules define natural gas pipeline to include spur lines but excludes pipelines in a city or local natural gas distribution network. Accordingly, there is uncertainty whether aforesaid deduction can be claimed by companies engaged in the business of operating a cross country pipeline under domestic tax laws of India. Therefore, inadvertently, the intended benefitto oil and gas pipelines is not actually available tocrude oil pipelines and the pipelines dedicated to the supplyof petroleum products to a specific consumer. It is expected by the industry that the GOI waives off the requirement to obtain PNGRB approval for crude oil pipelines to be eligible to claim the intended tax benefits under this provision.

vi. Widening the scope of presumptive taxation regime

Section 44DA of the Act provides for taxability of

royalty and fees for technical services received by a non-resident through its business presence in India.

As discussed in preceding paragraphs, Section 44BB of the Act provides a deeming fiction which allows the taxpayerto offer 10 per cent of its gross receipts as business profits and compute tax thereon. This section explicitly carves out incomes that a taxpayer may earn under Section 44DA of the Act. As a result, such taxpayers are not given the option to offer royalties or fees for technical services,arising on account of providing services to oil and gas companies, under the presumptive taxation mechanism under Section 44BB of the Act.

Applicability of presumptive tax regime (viz. Section 44BB of the Act) to certain foreign companies are challenged and, in many cases, benefit of presumptive taxation are denied on the grounds such as:

i. Services rendered by foreign companies do not have proximate nexus to field operations (for e.g. design and engineering done outside India);

ii. Foreign companies engaged by sub-contractors are not eligible for presumptive taxation; and

iii. If foreign company is rendering a bouquet of services, only income earned from certain services are eligible for presumptive basis of taxation.

This is a practical difficulty that taxpayers are facing, and the industry would hope that GOI widen the scope of Section 44BB to allow such service providers to offer income from aforesaid activities under Section 44BB since the activities are in connection with the prospecting and extraction of mineral oil.

D. Final thoughts

The Direct Tax Code Committee has submitted its report on the new Direct Tax Code to be implemented by the GOI. Various media reports suggest that GOI may only tweak the Act and not replace the Act with the Direct Tax Code. However, the industry would hope for several amendments to the Act in the upcoming Budget 2020 to reduce the complexities and provide a fillip to new and existing oil and gas businesses.

The information contained herein is of a general nature and is not intended to address the specific circumstances of any particular individual or entity. The views and opinions expressed herein are those of the author.

SAFETY

Essar Raniganj (East) Coal Bed Methane (CBM) Project- A Perspective from 'Safe Practices'in development

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Sukanta Ray
Sr. Manager – Environment

Essar Exploration and Production Ltd. (EOGEPL)

Essar pioneered development of Unconventional Hydrocarbons in India from our first CBM wells in early 90's to present portfolio of strategically located assets with 15TCF net resources. Flagship Raniganj asset remains highest recorded Indian CBM producer so far. We have also demonstrated here the efforts instituting Raniganj as an awardedsustainable initiative.

Abstract

The origin of CBM is traced back to making coal mining future-safe. Gas emissions from coal seams have been a big issue in terms of safety hazard during coal mining operations, particularly in India and China, where coal mining industry is still massive and is perceived to be there for the next few decades.

With the nation engaging in a conversion of the country to an essentially gas based economy, role of CBM development has become very crucial, since, after several years of nascence, the resource is finally on the resource map (with a few commercial blocks) and slated to increase its share in the domestic natural gas basket in the forthcoming years, particularly in the Eastern part of India, finally getting connected to the gas grid and surge of domestic gas demand expected.

Initially, development of CBM was tagged with a plethora of environment hazards including its scale of activities and the particular concern of produced water and its handling. Not being able to handle it will essentially defeat the purpose of a clean and green fuel by instead creating more ambient pollution. Therefore, an efficient and adept handling of this concern (& a sustainable development) was one of the main focus area or inherent motto of Essar, in the development of the Raniganj East CBM asset. In this article, we have given some overview of the accomplishments in our safe development of CBM journey.

Introduction

Coal Bed Methane (CBM) as the term refer is the methane gas produced from coal seams. Unlike conventional reservoirs, coal seams are the source, trap, and reservoir for Coalbed Methane (CBM). A comparison of the two reservoir types shows profound differences in reservoir properties, storage mechanisms, flow mechanisms, and production profiles. Understanding the reservoir differences is key to successful evaluation and operation of a CBM project.CBM extraction continues to undergo research and development. CBM reservoir behavior is comparatively complex and difficult to predict in the early stages of recovery. Hence prior to the development it also requires to go through the Oil & Gas E&P Phase wise approach of Exploration, Pilot Assessment, Development and finally to the Production Phase declaring commerciality.

The requirement of Safety Practices and its implementation is interestingly in a progressive and continuous sequence and spread across the entire field life, because unlike an Oil and Gas well, dewatering in a CBM project will continue as old wells are depleted and newer infill wells are drilled. In the words of many renowned upstream specialists, CBM is a project of water management and handling (both in sub-surface and surface perspectives).

Fig. 1 -CBM Project stages

A typical CBM well (exploratory and/or development) involves the standard steps of drilling to completion. However, interestingly, due to delicate nature of coal and its wide variation both vertically and laterally across the field, it requires specific skills and analysis at each step for optimum completion and healthy extraction. This is the most essential skill-set acquired over time by the operator and is attributed as the 'Learning Curve'.

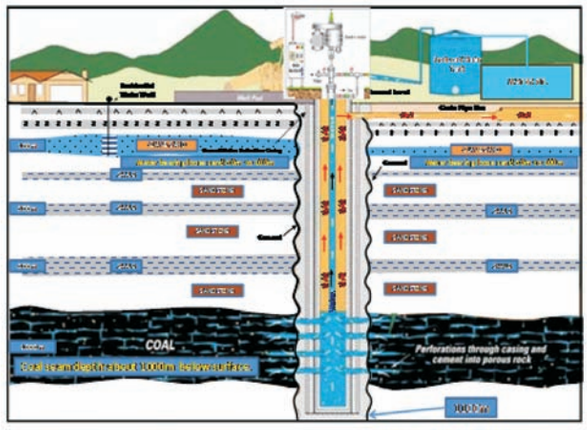


Fig. 2 -CBM Development schematic

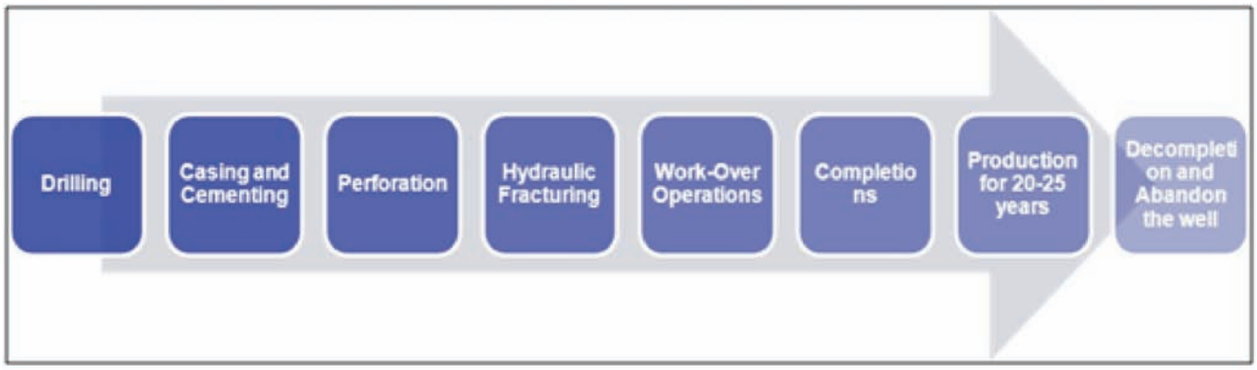


Fig. 3 -CBM well - Full life cycle

About the Raniganj CBM Project

The Raniganj CBM block is developed by Essar as a flagship of operational standards (since 2005). This is the first block to have crossed the threshold of 1.0 million cubic metres of gas production per day (mmscmd) on a sustained basis. Today the project is commissioned with around 350 wells drilled, about 3.0 mmscmd of gas compression and handling facility and an indigenously engineered and set-up of 300 km of in-field and customer delivery point connected pipeline.

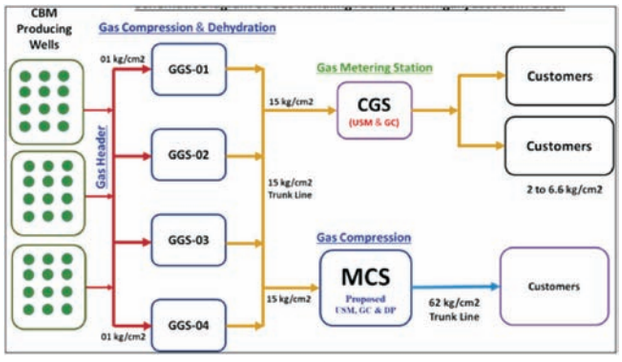


Fig 4 – Schematic of the CBM Project

Fig 5 – Pictorial representation – Raniganj East CBM Project

Health, Safety and Environment Practices

Foundation 1 - A standard HSE Policy

Foundation 2 - Stringent HSE management Element

Essar Oil & Gas's HSE policy, the guiding document of HSE Management system&which clearly reflects top management commitment towards HSE management system, was revised on 17thAug-2018.

There are eight Elements of CBM Raniganj HSE Management system in line with Group guidelines.

CBM Raniganj Online HSE Incident Reporting System also usedin Mobile application.

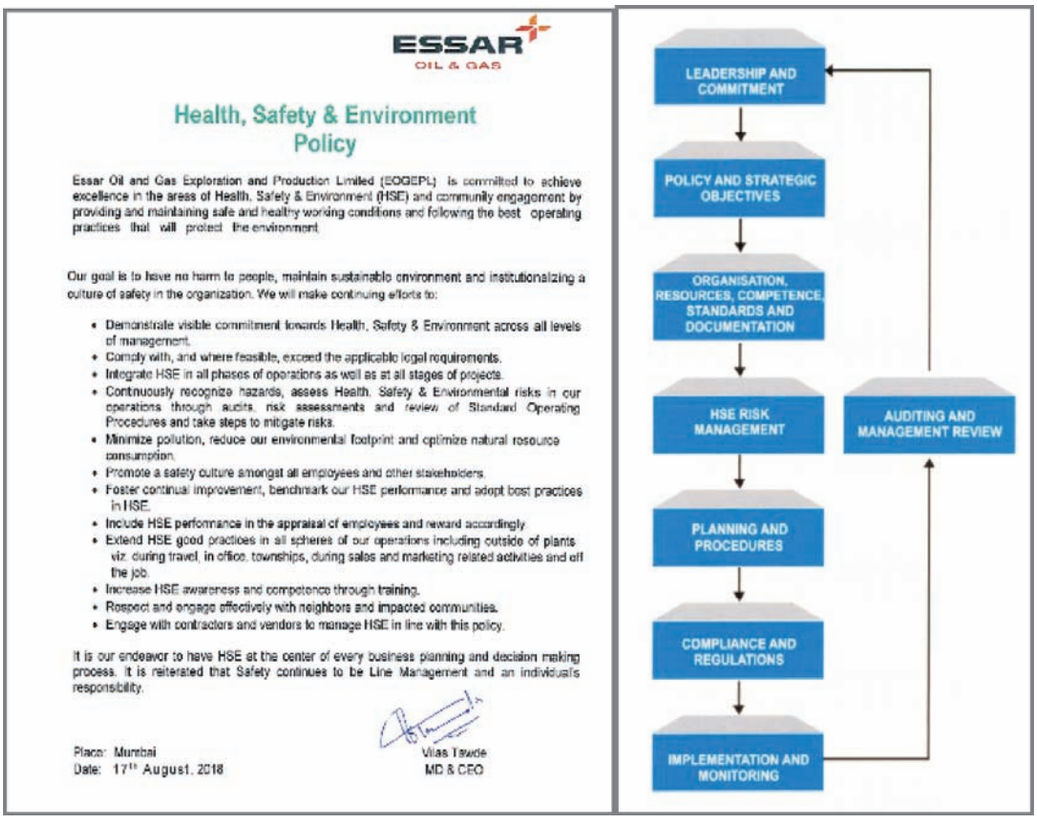


Fig 6 – HSE Policy and Elements

Discussion on Safety Management Elements

a.	Process Hazard Analysis Studies	Suitable method of hazard identification has been adopted at project to identify hazards and assess the risks associated with operations of existing facilities & green-field/brown-field projects. Various Process Hazard Analysis Studies are conducted for each installation right from design to operation stage to determine highest degree of safety of projects & operations.
b.	Management of Change	Modifications (capacity enhancements / revamping) to existing equipment/systems or operating procedures are managed through a Management of Change (MOC) system, an integral part of Process Safety Management.
c.	Work Control (Permit To Work System)	A permit to work system implemented for activities that involve exposure to high risk. Work permit system have been implemented as per Oil Mines Regulation-2017 requirement and classified to Hot work and Cold Work.
d.	HSE Training	HSE training imparted with aim at ensuring that the personnel are aware of hazards associated with their work, the control measures necessary to minimize the risk of personal harm or loss / damage to property or the environment.
e	Incident Reporting & Investigation	Incident investigation and analysis is an important part of the hazard identification and risk assessment process. An Online HSEF portal facilitate each employee to report any Incident including near miss and line manager to investigate tool to complete the investigation in a systematic manner.
f	HSE Inspection & Audit	Monitoring and measurement of all of EOGEPL's operational activities in relation to safety health and environmental aspects and impacts is an essential element of the EOGEPL HSE Management System (MS). EOGEPL maintains a systematic procedure to monitor and measure HSE performance, both qualitative and quantitative.
g	Contractor Safety Management	Contractor Safety Management is intrinsic part of EOGEPL HSE Management system. It starts from floating tender, in which HSE requirement given as a mandatory requirement. Bridging document develop for proper managing contractor and avoid ambiguity.
H	a. Emergency Preparedness	Emergency Response and Disaster Management Plan (ERDMP) has been prepared in line with regulatory requirement like PNGRB, OMR, Environment Protection Act, Oil Mines Regulation----etc.
i.	Safety Training Observation Program (STOP)	Safety Training Observation Program (STOP) implemented since May-2012. On an average, every year around 500 observation recorded through STOP observation program, In other word we can say that we avoid 500 incidents.
j.	Employee Participation/ Consultation	Safety Committees has been formed for a more holistic approach and benevolent employee/stakeholder opinion and process upgradation.
k.	HSE Promotional Activities	National Safety Day Celebration, World Environment Day Celebration, Road Safety Week Celebration, Van Mahotsav and Reward Program pertaining to promoting HSE at workplace

Environment Management

The environmental management of any industrial operation stands for

(i) Discharge and Emission Management and

(ii) Waste Management and Utilizations of Natural Resource.

A. Water Management

1. In CBM production operation, water is produced along with gas form CBM wellhead. This water has high salt content which is not suitable for disposal. The water is stored over ground tank at CBMwell site and directly sent to RO through interconnecting pipelines. The company has installed centralized Reverse Osmosis (RO) Plant at 5 (five) locations with a treatment capacity of around 10,000 KLD.
2. Also, water pump is used in each well head to withdraw water form subsurface. The power supply to these pumps are through Gas generator sets at each well site.

Fig 7: RO Plant

B. Noise and Air Pollution management

3. The major source of air & noise emission in this operation is around 100 nos. of DG sets each of 125 KVA capacity. Initially dieselwas used as fuel for operating the same. Immediately after Gas breakup DG sets of the well pads were converted to Gas generator sets. It also minimizes the emission load of the Project. On the other hand it minimized the utilization of natural resources (i.e. HSD).
4. Only Green DG/GG set (CPCB approved) with acoustic enclosure are used to minimize noise impact of the area. Regular Ambient Air Quality monitoring and Noise Monitoring is carried out to check in the surrounding habitat and major facilities of the project.

Fig 8 – Green DG/GG snaps from across the block

C. Control of flaring

CBM development belts (particularly Raniganj in this case), happened in predominantly coal belts, which are traditional and cheaper in terms of heat value equivalent. Also, there is and in fact yet to be available gas pipeline for 100% evacuation of the gas. However, the CBM development or production break is achieved only by continuous production to ascertain project deliverance in the long run. Apart from the environmental concerns of flaring, there is also the stigma of loss to national resources.

In the operational front the flaring related issues have been addressed by creating a dedicated network wherein all the well pads are connected through pipelines with Gas Gathering Station (GGS) which haveflare stacks for safety / emergency purposes. Since the global warming potential of CBM (predominantly methane) is around 28 times that of CO_2, cold venting is not in practiceand gas is flared only through flare stacks to minimize the emission burden on environment. A CNG station ia also in progress to supply the excession gas through casecade system to make Zero flaring.

D. Waste Management

As per available standards, in CBM Raniganj operation a three bin solid waste collection systems is present. The three different colour coded waste bins are placed in each well pad and major facilities for segregation of waste at

Fig 9– Waste Management

The green coloured bin is for biodegradable waste (i.e. food waste), blue coloured bins for recyclable waste and red coloured bins for hazardous waste.

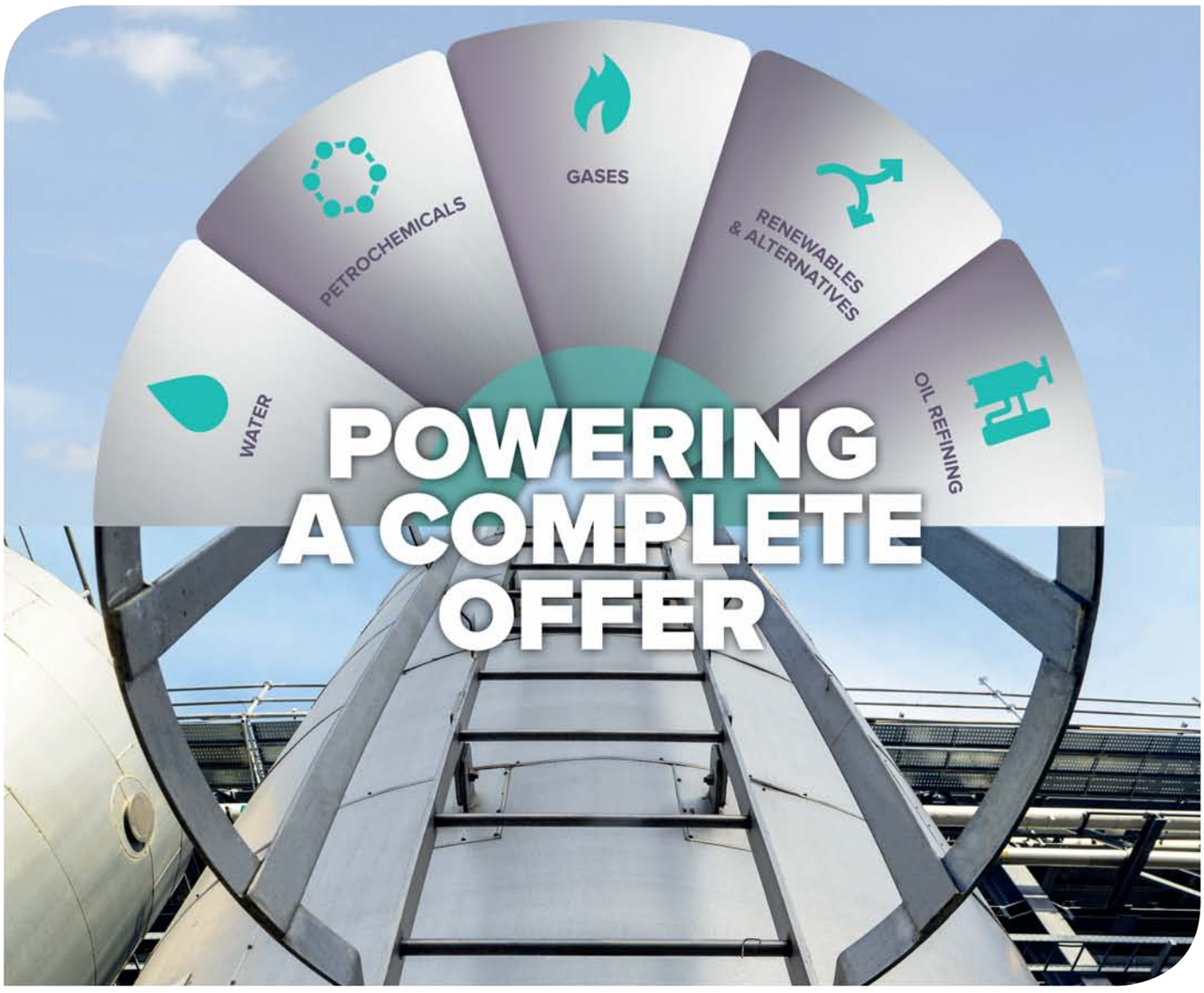
The hazardous waste generated from the maintenance of the gas compressors, generators and RO of the project which generates mainly oil contaminated material and waste filter is intermediately stored in a separate storage facility at warehouse and is finally disposed to hazardous waste TSDF at Haldia.

Conclusion

Essar has attempted to establish the Raniganj Project as a showcase of operational standards. The Raniganj Project is already certified for ISO 14001 (environmental Management System) and ISO 45000 (Occupational Health Management System by renowned DNV GL.

Safety, both to the human capitaland the environment is often back-seated. HSE practices needs to be stringently followed in the wake of the global need for a sustainable future both in terms of energy forms and it impact.

Our experienceshows that certain guidelines and controls, in accordance with the Oil Mines Regulations (2017), needs to be revisited in terms of CBM operations viz. the safe distance and flare stack statutes which might be relooked in terms of the more dynamic and adaptive API guidelines.



Axens continues its development and takes on a new identity

Building on the acquisition of Heurtey Petrochem and Prosernat, Axens expands its portfolio of solutions

Natural Gas Treatment:

- By combining Axens' catalysts & adsorbents products with Prosernat's portfolio of gas treatment technologies, Axens is now offering one of the most complete portfolio on the market of advanced technological solutions for all types of gas treatment applications.

Modular Units:

- Axens now offers modularization options, providing Axens' clients fully integrated solutions with associated guaranteed process-equipment packages.

Furnaces:

- Heurtey Petrochem's industrial legacy expands Axens offer in the field of process furnaces. Capacity to work on multiple licensor technologies and strong regional network, for project execution, will be maintained.

Axens becomes the global brand for all its activities represented by the following commercial brand names:

Axens SOLUTIONS

- Catalysts & Adsorbents and Process Licensing activities, including the modular units business.

Heurtey Petrochem SOLUTIONS

- Furnace business including waste heat recovery units.

Axens HORIZON

- Auditing, consulting and digital applications activities.

axens.net

Axens
Powering integrated solutions

UPSTREAM

Environment Friendly Waterless Fracturing for Unconventional Deposits

Diganta Sarma
Head of Application Technology & Market Development,
Linde Gas Asia Pte. Ltd, Singapore

In Asia-Pacific markets, rising energy consumption is fuelling fast growth in demand for gases. At the same time, the gap between supply and demand is widening. Reducing dependency on foreign sources of oil and natural gas is seen as a priority across the region. This makes the fracturing of unconventional reservoirs an imperative. Drilling horizontally through a layer of shale, and then fracturing along the length of that layer (Figure 1), increases the surface area contact within the producible reservoir and encourages previously trapped hydrocarbons to flow to the wellbore. Increasing the Expected Ultimate Recovery (EUR) of the well depends on using the best fracturing technique for the type of unconventional play at hand.

The choice of fluids other than water

The common fracturing fluids used today are water-based, predominantly slick water or gelled water. However, gases such as carbon dioxide (CO_2) and nitrogen (N_2) in liquid form have also been successfullyused for the hydraulic fracturing and stimulation of wells for some time now. CO_2 has enhanced properties that make it the ideal gas to provide energy for the removal of aqueous solutions and the lifting of liquid hydrocarbons. It offers high solubility in water for excellent recovery of hydraulic fluids and high miscibility for enhancing hydrocarbon flow. With a density similar to water, liquid CO_2 can bepumped into the well with pumping pressures similar to water. At reservoir conditions, CO_2 is almost always supercritical with a specific gravity of 1 or sometimes higher. As the CO_2 penetrates the fracturedzone, it displaces fluid in the reservoir rock and exits the reservoir as a gas. In addition, CO_2 has excellent miscibility in hydrocarbons and compatibility with formation fluids, allowing for enhanced mobility

and recovery. Where readily available, CO_2 provides superior benefits as the gold standard of hydraulic fracturing fluids. N_2, like CO_2, can be used in its pure state or mixed with other components, and is typically more readily available in unconventional reservoir plays. It can be injected into the well in pure form or as a gas. It works effectively alone without proppant in formations where the rock effectively props itself. For liquid-free stimulations, it

can be ideal for fracturing dry, shallow formations, such as CBM. Though less soluble than CO_2, N_2 can ensure presence in the invaded zone with additional measures, such as delaying flowback to allow the gas phase to penetrate. Because it is an energised treatment, N_2 improves reservoir flow, providing trapped hydrocarbons with a lift, and reduces leak-off while improving fracturing fluid recovery. When foamed, it reduces the amount of water used, also contributing to reduced total and liquid or fluid leak-off. Because it has a lower density than water,

N_2 requires more horsepower to achieve desired pumping pressure and is more practical in lower total depth wells than CO_2.

The ultimate goal of well stimulation is to achieve the maximum EUR, defined as maximum productivity over the life of the well, at the lowest unit cost while maximising the area under the decline curve. Achieving economically desirable fracture penetration and conductivity is particularly challenging in unconventional reservoirs. Fracturing drops considerably in the presence of water. The rock-to-fluid interactions soften the rock, further promoting proppant embedment as the rock closes on the proppant. Often in unconventional reservoirs fractured with water-based fracturing fluids, the majority of the water is never recovered. Energising the fracturing fluid with CO_2 or N_2 will:

(1) reduce the amount of water necessary to pump the job,

(2) lower the leak-off of the water phase, and

(3) improve flowback as the invadedwater saturation is lower.

In other words, energised fracturing fluids improve the total flowback volume and rate, as well as, when foamed, significantly lower the total and liquid leak-off coefficient, minimizing fluid retention.

Employing current stimulation practices, proppant can be improperly deposited. The absence of proppant, due to poor proppant placement, yields insignificant fracture conductivities. If the fracturing fluid consists of a gel-based solution, improper flushing of the proppant pack results in blocking or impeding flow due to gel residue. Gelled fracturing fluids must be retrieved from the formation to clean out as much residue as possible from the proppant pack. Foamed energised fracturing fluids of high quality provide superior proppant transport properties. Adding CO_2 or N_2 to the fracturing fluid reduces the need for gelled fluid and therefore the amount of residual gel left behind in the proppant pack.And, as issues continue to arise around water-based fracturing using a tremendous amount of water, adding or using CO_2 or N_2 can reduce or eliminate the water volume. According to Chesapeake Energy Corp., the second largest producer of natural gas and a top 15 producer of oil and natural gas liquids, fracturing one of its typical horizontal deep shale natural gas or oil wells requires, on average, 4.5 million gallons (1 gallon = 3.78 litres) of water. The US Environmental Protection Agency (EPA) estimates the use is 2.5 to 5 million gallons of water per well with some reporting numbers as high as 9 million gallons. Acquiring, transporting, storing, recovering and recycling, or disposing of that water presents an ever increasing challenge

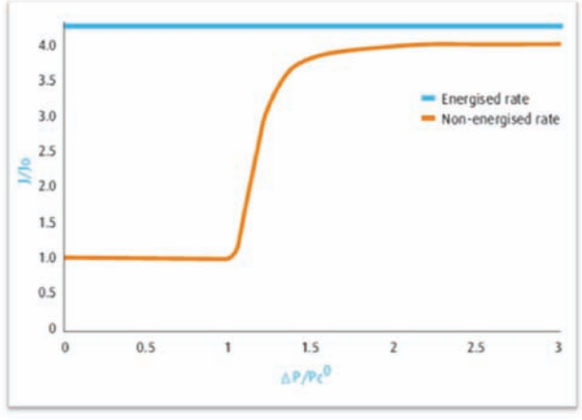


Figure 1: Comparison of the predictive productivity (unitless measure of J/J0) of energised solutions versus non-energised water fracture stimulations.

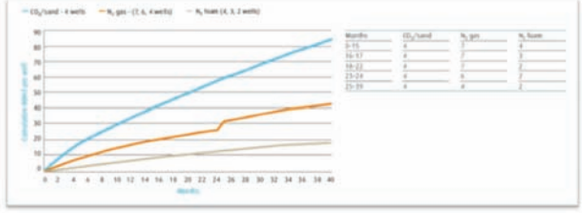


Figure 2: Cumulative gas production comparison utilisingenergised fluids for fracturing. Devonian Shale, Pike County, Kentucky.

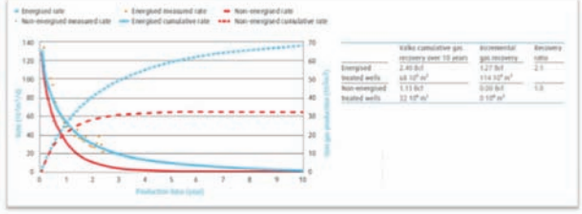


Figure 3: Averaged well 10-year Valko decline analysis from "Improved Productivity Performance of Energised Fracturing Fluid over Non-Energised: A Montney Study."

Productivity Improvements: Theory & Practice

Friehauf and Sharma1 compare the predictive productivity of energized versus water fracture stimulations (as shown in Figure 1, page 2). Their paper provides the theoretical framework supporting the improved productivity results utilisingenergised solutions for fracturing. Recent field studies evaluating energised solutions further validate this by showing that economic EUR can be optimised using this alternative treatment. From South Texas to Canada's Montney basin to the Marcellus shale (as shown in Figure 2, page 2), energized solutions have been proven effective. A 2011 study of the Montney basin showed that the use of energised fluids improved well performance by 1.6 to 2.1 times compared to non-energised solutions (as shown in Figure 3, page 2). Energised solutions were proven to

significantly increase well productivity more cost effectively, presenting opportunities to reduce fracturing resources such as water consumption and proppant required, and to reduce injection rates and injection pressures. They are ideally suited for use in tight, depleted or water-sensitive formations, or to enhance the mobility of more viscous hydrocarbons around and through the wellbore, especially in underpressured reservoirs.

With a very few exceptions, propped "fracs" are used to increase productivity from sandstone and shale reservoirs. Fracturing a formation creates a high permeability pathway from the formation into the wellbore. Fracture permeability will be many times the permeability of the formation. For example, some of the new shale gas developments have reservoir permeability measured in nanodarcys, whilst permeability in the fracturesis multi Darcy—many orders of magnitude more. To create a fracture, a fluid "pad" is pumped into the well at above the reservoir formation fracture pressure. This hydraulically fractures the formation. Fracture direction will be determined by the (in situ) stress in the formation, and the fracture will always open perpendicular to the minimum stress in the formation. Fracture size (height, width, and length) are a function of pump rate, pressure, formation permeability, and fluid pad viscosity. Once the fracture is open, proppant is blended into the fluid as it is pumped into the well. The proppant is carried into the fracture, packing it, and preventing it from closing when the pumping stops.

Proppant selection will depend on the size of the fracture and closure stresses in the formation. Where closure stress is low, natural sand will be used. Medium and high closure stresses will require ceramic and bauxite, respectively. Proppant concentration will be low at the beginning of the treatment but is gradually increased as the job progresses. As a result, a propped frac operation normally sees the highest fluid (slurry) density and the highest pressure at the end of the treatment, when "screen out" is reached. Fracture pressure and screen out pressure can be very high. It should be noted that offset wells could be at risk during a fracturing operation. In one incident in Canada, a fracturing operation resulted in overpressure of an adjacent rod pump well shearing the polished rod at the pump jack and destroying the stuffing box. 4 Similar problems have been reported at multiwell pads during the hydraulic fracturing of shales.

AsadiM et all reportedof use of CO_2 for waterless fracturing recently – here a liquid CO_2 is mixed with sand as sent down the hole under high pressure. The CO_2 is delivered and stored in the well pad, and blended at precise concentration with sand depending on the type of shale formation precisely, connected with necessary piping and the mixture is pumped at specified rate into the hole. In this particular case, the treated well was produced utilizing a size 114D beam pumping unit with an high volume insert bottom-hole pump. Immediately after the CO_2 fracturing treatment, the Mississippian Chat produced 17 BOPD and 310 BWPD. After one month, production increased to 21 BOPD and 370 BWPD. After seven months the Mississippian Chat production decreased to 31/2 BOPD and 275 BOPD. After 261 days the Mississippian Chat production had stabilized at 2 ½ BOPD and 250 BWPD before a mechanical problem shut down rod pumping operations.

Conclusion

A lot of interest is seen to improve productivity as well as save the precious water resources at the same time reducing carbon footprint of the industry. Use of nitrogen and carbon-di-oxide for fracking is seen to be contributing to this, with a mature technology of productionog these gases and downhole pumping already available.

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NEWS FROM MEMBERS

67th Annual General Meeting of HPCL

67th Annual General Meeting of Hindustan Petroleum Corporation Limited was held on 21st August 2019 at Y B Chavan Centre, Mumbai. During the meeting Chairman and Managing Director along with Functional Directors addressed the shareholders about the performance of the Corporation during FY 2018-19 and future plans.

Subsequently in the evening, they interacted with the press and responded to Media queries about the performance of the Corporation during FY 2018-19 and future plans.

HPCL plans to invest Rs. 74,000 crore in next 5 years in refining, petrochemical and petroleum marketing. In 2018-19, HPCL recorded highest ever refining thruput of 18.44 MMT and highest ever overall sales of 38.7 MMT.

HPCL shines at 9th PSE Excellence Awards

HPCL bagged 4 Awards at 9th PSE Excellence Awards under Maharatna & Navaratna Category held at New Delhi. The following awards were received

- Best in 'Human Resource Management Excellence'
- Best in 'Contribution of Women in PSEs'
- Runner-up in 'Corporate Social Responsibility (CSR) & Sustainability'
- Jury Award – 'Company of the Year'

The PSE Excellence Awards is an initiative of Indian Chamber of Commerce to acknowledge the game changers among public enterprises who have contributed immensely in shaping up the Indian economy. It is a platform to celebrate the performance of PSEs. The awards were judged by an independent and distinguished jury, based on quantifiable parameters applied on detailed analysis by Price water house Coopers (PwC).

Former Secretary, Ministry of Commerce & Industry, GoI, Dr. Ajay Dua under the august presence of Former Secretary (DPE), Jury Chair, ICC Dr Bhaskar Chatterjee and Vice President, ICC Shri Pradeep Sureka presented the awards to representatives from HPCL viz. ED – HR, Shri Abhishek Datta, CGM–Co-ordination, Shri Alok Kumar Gupta and CGM – CSR, Shri Saytanarayan Subbarao along with other Officials.

HPCL bags 'Best Navratna' under Manufacturing Category at Dun & Bradstreet PSU Awards 2019

HPCL bags 'Best Navratna' award in 'Manufacturing Category' at Dun & Bradstreet PSU Awards 2019 consecutively for second year in a row. The award ceremony was held on 22nd August, 2019 at New Delhi.The award winners were felicitated by Shri Arvind Ganpat Sawant, Hon'ble Minister of Heavy Industries & Public Enterprise; in the august presence of Shri Subhash Chandra Garg, Secretary, Ministry of Power, and Shri Manish Sinha, Managing Director-India, Dun & Bradstreet. CGM - Co-ordination, Shri Alok Kumar Gupta and CGM- PRCC, Shri Rajeev Goel received the award on behalf of HPCL.

Dun & Bradstreet PSU Awards have been instituted to recognize and felicitate the top performing PSUs in India for business excellence and acknowledge their contribution in socio-economic development of the country. The awards are given across various categories based on multiple performance parameters.

Award winners were selected based on a proprietary financial model developed by M/s Dun & Bradstreet India. The model takes into consideration of size, growth and profitability indicators to arrive at the award winners. This prestigious award is the testimony of HPCL's excellence across all facets of business.

UPCOMING EVENTS

One-Day Conference

on

Digital Transformation in Oil & Gas Sector

November 20, 2019

India Habitat Centre, New Delhi

3rd Program on

Realizing Hydrocarbon Vision 2030 for North East India – Way Ahead

December 20-21, 2019

Lemon Tree Hotel, Gangtok, Sikkim

FIPI EVENTS

Interactive Session with PNGRB

The Federation of Indian Petroleum Industry organized an interactive session with PNGRB on July 4, 2019 at India Habitat Centre, New Delhi. Shri D.K. Sarraf, Chairperson, PNGRB and Shri S.P. Garg, Member, PNGRB graced the occasion with their presence. The objective of this session was to address the issues related to upstream gas producers, midstream gas companies, LNG companies, downstream oil refining & marketing companies, CGD companies that fall under the purview of PNGRB.

Shri D.K. Sarraf in his opening remarks mentioned that PNGRB is working for the industry which has been extremely responsive on the issues being pursued by PNGRB. He emphasized that PNGRB is now more of a 'Facilitator' than a 'Regulator'.In his address, he also emphasized on the increased use of gas as a cleaner fuel and the key role being played by CGD players in gasification of Indian economy. Pointing out to the global survey on pollution which says 14 of the top polluted cities are in India, Mr. Sarraf said, increase in use of natural gas can help in battling the emission. Talking about NITI Aayog's sustainable development goals on energy, he said that NITI Aayog's data shows that 44% of Indian household use clean energy like LPG, piped gas etc. and 56% are still using the unclean energy, which needs to be changed.

Shri S.P. Garg, Member, PNGRB spoke about the efforts taken in addressing the issues prevailing in the gas, pipeline and CGD sectors. Speaking on the Gas trading hub, Mr. Garg said that a draft regulation has been prepared for the Cabinet's approval. He stressed on the need for inclusion of gas under GST to enable increased usage of gas.

The event witnessed a large number of participations from Oil & Gas sector which was well received by them.

Dr RK. Malhotra DG FIPI welcoming the august audience at the interactive session with Mr. DK Sarraf Chairperson, PNGRB

Mr. S P Garg, Member, PNGRB addressing the participants

Mr. D.K.Sarraf Chairperson, PNGRB addressing the participants

A section of the participants

Budget Analysis – Union Budget 2019-20

The Federation of Indian Petroleum Industry (FIPI) organised its flagship Budget Analysis Session, in association with EY as the knowledge partner, on Monday, 8 July, 2019 at India Habitat Centre, New Delhi. The objective of the session was the recently presented Union Budget 2019-20 and weigh the impacts of the Budget with respect to Indian oil and gas industry. The session was attended by Mr Sanjiv Singh, Chairman, FIPI and Chairman, IndianOil along with Mr P K Jain, Former DG, GST Council; Mr S P Garg, Member, PNGRB among other eminent personalities from across the oil and gas value chain.

Mr Raju Kumar, Partner, EY presented on Direct Tax Implications; MrAchal Chawla, Partner, EY and Ms Preeti Sharma, Director, EY made presentations on GST Implications and Personal Tax Implications respectively.

Mr. Rajiv Bahl, Director (Finance), FIPI delivering his welcome address

The main highlight of the session was the 'Panel Discussion on GST', focussing on the experiences of oil and gas companies on completion of two years of GST. The panel comprised of Mr P K Jain, Former DG, GST CBEC; Mr S P Garg, Member, PNGRB; Mr Subhash Kumar, Director (Finance) ONGC; Mr. Karikeya Dube, Director (Finance) & Vice President Tax, BP India Mr A K Tiwari, Director (Finance), GAIL and Mr Sandeep Kumar Gupta, Director (Finance) – Designate, IndianOil. The panel discussion was moderated by Mr. Harishanker Subramaniam, Partner, EY. During the course of the discussions, it was highlighted that the five key petroleum products have not been included under the GST due to looming uncertainties over

Dr. R. K. Malhotra, Director General, FIPI addressing the gathering

revenue implications of inclusion on States and the Central Government. As a next step, it was suggested that the Government should consider including natural gas and ATF under the GST regime as they have the least impact on the State Government revenues. However, some of the panellists pointed out inclusion of natural gas will only increase the stranded input credits for the refineries as they use natural gas both as a fuel and a feedstock. Hence, the Government should consider all five petroleum products together for inclusion under GST. Mr P K Jain highlighted that it is expected that the petroleum products may attract a combination of GST and excise & VAT so as to maintain the Government's share of revenue and also to ensure that the end prices for the consumer do not go up. He was of the opinion that inclusion of petroleum products under GST in a phased manner would be a better approach.

Delivering the closing remarks at the session,

Panel discussion on "GST learning and experience for oil and gas sector"

Mr. Sanjiv Singh mentioned the need for the oil and gas industry to take advantage of the small and big opportunities in the market, highlighting that the Government's focus on infrastructure will also benefit the oil and gas market. He further emphasised that the oil and companies must align their strategies with the vision of the Government for the larger benefit of the country.

Mr. Sanjiv Singh, Chairman, FIPI & IOCL delivering the concluding remarks

R&D Conclave 2019

The Federation of Indian Petroleum Industry (FIPI) organised the third edition of its flagship event R&D Conclave, 2019 at Coorg, Karnataka during 11 – 13 July, 2019. Dr. Anil Kakodkar, Chairman, Scientific Advisory Committee (SAC) on Hydrocarbons, Ministry of Petroleum and Natural Gas and INEA Satish Dhawan Chair of Engineering Eminence, BARC graced the occasion as the chief guest at the conclave. The conclave was attended by Mr. B Ashok, Chairman, Ratnagiri Refinery and Petrochemicals Ltd; Mr A K Dwivedi, Director (Exploration), ONGC; Mr P K Sharma, Director (Ops), OIL; Mr Biswajit Roy, Director (HR), Dr SSV Ramakumar; Director (R&D), IndianOil; and Mr V S Shenoy, Director (Refineries), HPCL among other eminent personalities and sectorial experts.

Lighting of the lamp

The welcome address was delivered by Dr R K Malhotra, Director General, FIPI. Dr Malhotra mentioned that in order to achieve the Government's ambitious objective of doubling the size of the Indian economy from the current USD 2.61 trillion to USD 5 trillion by 2024-25, energy will play a significant role. He mentioned that the demand for crude oil and natural gas in the country is poised to increase till

Dr. R K Malhotra, DG FIPI welcoming the august audience

2040. To fuel the fast-paced growth of the economy, the oil and gas sector needs to focus on increasing domestic production and improving efficiencies. In this regard, R&D will play a key role in the future. He underlined that as BS-VI fuel standards are implemented, Indian refineries will continue to maintain a broad basket and there will be a need for improving the octane numbers of the product.

While inaugurating Dr. Kakodkar, in his inaugural address, mentioned that the demand for fuels will not fall due to advent of EVs. Due to the absence of supportive infrastructure for EVs in the country, the demand for transport fuels in the country is only going to increase in the foreseeable future. He opined that the country should target for petrochemical exports to support the refinery business. He suggested that India should move towards energy self-sufficiency and reducing carbon footprints. In this regard, more attention needs to be paid to renewable, bio sources and nuclear technology.

At the session 'Dialogues Over Dinner', Mr. B Ashok

Dr. Anil Kakodkar, speaking at the inaugural session

pointed out that the challenge for the energy companies is to strike the delicate balance between the rising energy demand of the population and the emission generated in producing the same. He further emphasised on the need for interlinking different types of technologies to generate greater value for the end consumer.

The first Session on R&D in Refining and Polymers (1) was chaired by Mr V S Shenoy. The objective of the session was to deliberate on the changing trends in the global downstream industry and provide the speakers with a unique opportunity to present their work in front of the R&D fraternity. The speakers at the session comprised of senior researchers from RIL, IndianOil R&D, HPCL, BPCL and EIL.

Mr B Ashok, CEO, RRPCL speaking at the special leadership session

The session on R&D Upstream (1) was chaired by Mr. T.K.Sengupta Director (E&P) FIPI who emphasized the importance of exploration scientists for their R&D efforts to find hydrocarbon reserves and discovery of new exploitation mechanisms. There were five presentations from different research centres of ONGC, OIL and also from ONGC Energy Center.

The Session II - R&D in Refining and Polymers (2) was chaired by MrGandham Sriganesh, Executive Director (R&D), HPCL. The panel at this occasion comprised of researchers from RIL, BPCL, W R Grace and IndianOil.

Session II: R&D in Upstream (2) was chaired by Mr P K Sharma, Director (Ops), OIL. The session focussed on indigenous technology development for upstream operations and witnessed participation of senior scientists from ONGC, OIL, Cairn and Essar.

Dr. Anjan Ray, Director, CSIR-IIP chaired the next session on 'Carbon Capture and Utilization'. The session deliberated on the latest developments in the field of carbon capture and discussed various technologies developed by companies across the globe. The session was attended by speakers from HPCL, IndianOil, RIL, Lanzatech and Carbon Clean Solutions.

A Section of the participants

The next session Biotechnology' was chaired by Dr Sean Simpson, Chief Scientific Officer, Lanzatech, USA. The objective of the session was to deliberate on the latest developments in the field of biotechnology and its benefits for the energy industry The speakers at the session included researchers from CSIR-IIP, HPCL, Axens, IndianOil and RIL.

A 'Session on HR and Finance Issues in R&D', Mr Biswajit Roy, Director (HR), OIL pointed out that to attract the best talent to oil and gas R&D, the private sector needs to play an integral role through investing in infrastructure and developing strong industry-academia associations. Speaking at the session, Mr Rajiv Bahl, Director (Finance), FIPI underlined that the contribution of private sector in financing R&D projects in India has been less than 40 per cent against an average of 60 per cent contribution in developed countries and there is an urgent need for private sector to come forward in this regard.

Mr Arnab Ghosh, Regional Director, IHS Markit emphasized on the role of innovation in the oil and gas sector. He underlined the fact that innovative business leaders generate seven times more revenue than their counterparts who do not harness R&D.

Session VI on Crude to Chemicals was Chaired by Mr N K Bansal, Director (Oil Refining and Marketing), FIPI. Speaking at the session, Mr Bansal stated that with the introduction of wide variety of fuels for transport sector, the growth rate of conventional hydrocarbon fuels is expected to decline in the near future. Petrochemical sector, however, has enough gap to grow especially in growing economies. The session witnessed speakers from HPCL, RIL, Lummus Technologies and HMEL.

Over the three days, R&D Conclave 2019 witnessed dedicated technical sessions on various aspects of upstream and downstream alongside discussion on managerial issues of R&D and upcoming technologies, which will revolutionize the industry in the short to medium term. The Conclave provided researchers from Indian oil and gas companies with a unique platform to showcase their work and deliberate on the common challenges faced by these organization. R&D Conclave 2019 proved to be a huge success and witnessed overwhelming participation of over hundred researchers from across the oil and gas value chain.

Corrosion Awareness Meet

Federation of Indian Petroleum Industry (FIPI) in partnership with NACE International organized a 'Corrosion Awareness Meet' during the pre-launch of CORCON 2019. The event was held on 24th July 2019 at India Habitat Centre, New Delhi in which a select gathering of industry professionals participated.The event saw presence of executives from a diverse range of organizations from oil and gas sector, fertilizer, power, technology & service cos and DRDO alongwith senior executives from NACE and FIPI.

Mr. Tushar Jhaveri, NACE delivering the welcome address

The welcome address was given by Mr. Tushar Jhaveri, from NACE, who gave an overview of NACE and the purpose of organising this meet. Mr. N.K. Bansal, Director (Oil Refining & Marketing), FIPI in his address gave an overview of FIPI and highlighted the importance of awareness of corrosion and its management in all the activities of life including industrial processes to ensure trouble free, reliable and efficient system management.

Dr. U. Kamachi Mudali, distinguished Scientist and Chairman, Heavy Water Board, Government of India made a brief presentation on the basic aspects of corrosion. He mentioned that corrosion is a natural

Dr. R. K. Malhotra, Director General, FIPI moderating the discussion

phenomenon, which cannot be eliminated but by adapting proper measurers, its acceleration can be reduced which will increases the productive life of a system.

The presentation was followed by a round table discussion. Dr. R.K. Malhotra, Director General, FIPI initiated the proceedings of round table and requested the participants to share their views and issues on this critical subject.

The vote of thanks was given by Mr. T.K. Sengupta Director (E&P) FIPI who thanked the participants for bringing up several critical issues relating to industrial corrosion and NACE for partnering with FIPI in holding this precursor event to CONCOR 2019 being organised by them in association with FIPI in Sept 2019.

Dr. U. Kamachi Mudali, Distinguished Scientist and Chairman, Heavy Water Board, Govt. of India making a brief presentation on the basic aspects of corrosion

Interactive session with PNGRB - City Gas Distribution Sector

PNGRB intends to play the role of a facilitator in supporting the growth of CGD network in India: Mr D K Sarraf, Chairman, PNGRB

The Federation of Indian Petroleum Industry (FIPI) organized an interactive session with Petroleum and Natural Gas Regulatory Board (PNGRB) on August 6, 2019 at PHD House, New Delhi. Shri D.K. Sarraf, Chairperson, PNGRB Shri S.P. Garg, Member, PNGRB and Shri S. Rath, Member, PNGRB graced the occasion with their presence. The objective of this session was to address the issues related to City Gas Distribution (CGD) companies.

Shri T.K. Sengupta, Director (Exploration &Production), FIPI set the background of the interactive session by mentioning that, it is the 2nd interactive session with PNGRB on gas related issues. As suggested by Shri D.K. Sarraf, Chairperson, PNGRB during the 1st interactive session with natural gas companies, this special interactive session was arranged with CGD companies.

The welcome address was delivered by Dr. R.K. Malhotra, Director General, FIPI. In his address, Dr. Malhotra spoke about the efforts taken by PNGRB to increase activities in Piped Natural Gas (PNG) and Compressed Natural Gas (CNG) sectors. Dr. Malhotra apprised the participants about the ongoing Gas4India campaign and the key role played by FIPI in promoting Natural Gas and in spreading awareness about the cleaner fuel.

Shri D.K. Sarraf in his opening remarks spoke about the common goals of PNGRB and CGD companies in increasing gas consumption, doing more business and transforming India in to a gas-based economy. He said that PNGRB is there to support the CGD industry while protecting the customer interests. He emphasized that PNGRB is now more of a 'Facilitator' than a 'Regulator' and PNGRB will actively interact to address the CGD industry issues. On issued faced by CGD companies pertaining to state Governments, municipal bodies, other states agencies and authorities, he opined on the need for a 'Whitepaper' to collectively address the issues faced by the CGD companies.

Following Shri Sarraf's address, the floor was opened for interaction. Officials from different CGD companies interacted with the Shri Sarraf, Shri Garg and Shri Rath on a host of issues falling under the ambit of PNGRB. These included, Municipality charges, Pipeline RoU, clearance, authorization, Technical requirements of HPD, especially inside cities and towns, Gas swapping – RLNG to CNG from one GA to another GA, GST under recovery etc.

Shri Sarraf, appreciating the interactive session suggested that FIPI must provide a regular forum to CGD players for addressing their issues.

PNGRB's vision is to develop gas infrastructure in the country and make gas available in all parts of the country at affordable prices - Mr S Rath, Member, PNGRB

Shri Rajiv Bahl, Director (Finance, Tax and Legal), FIPI appraised the house on GST and the key role played by FIPI in taking up this issue with the Government at various levels.

Shri N.K. Bansal, Director (Refining & Marketing), FIPI proposed the vote of thanks and expressed gratitude to Shri D.K. Sarraf, Shri S.P. Garg and Shri S. Rath for interacting with the CGD sector fraternity and addressing their issues.

The event witnessed large participation from CGD sector and was largely successful in addressing their concerns.

Interactive session on 'How to Access Finance for Oil and Gas Projects jointly organised with British High Commission (BHC)'

The Federation of Indian Petroleum Industry (FIPI) joined hands with the British High Commission to organise 'How to Access Finance for Oil and Gas Projects' at Shangri La's Eros Hotel, New Delhi. The objective of the event was to apprise the key decision makers from the Indian oil and gas industry with the easy financing options being made available by UK Export Finance (UKEF). The session was attended by Ms Rhiannon Harries, Deputy Trade Commissioner - South Asia, British High Commission (BHC); Mr Rahul Tabhane, India Head, UK Export Finance (UKEF); Mr Mohan Bhuyan, Business Development Adviser – Primary Markets - India at London Stock Exchange (LSE); and Ms Jennifer Fagan, First Secretary, Trade and Investment and Head of Energy Team, Department for International, Trade (DIT), BHC.

The Welcome address at the session was delivered by Mr Rajiv Bahl, Director - Finance Taxation & Legal, FIPI. Mr Bahl mentioned that over the last few years the Government policies and interventions have changed the face of the Indian petroleum industry. He underlined that to achieve the Hon'ble Prime Minister's vision of a USD 5 trillion economy and to shift towards a gas based economy, the Indian oil and gas sector will require large scale investments. He pointed out that the petroleum sector in the country is already poised to invest in the upwards of INR 15 lakh Crores in the next five to ten years and for such large scale investments India will require low cost loans from foreign lending agencies. He further informed the audience that Indian oil and gas industry has been working closely with UKEF for a long time and looks forward to further this association.

Delivering the opening remark at the session, Ms Rhiannon Harries mentioned the close cultural ties that India and the UK share and she hoped that furthering the business association between the two countries will only further strengthen the relationship.

Mr Rahul Tabhane apprised the participants that UKEF is world's oldest export credit agency and has over hundred years of experience in helping overseas buyers. He informed the participants with the various ways UKEF could help Indian businesses ensure that capital goods or services from the UK come with competitive terms of financing. Mr Mohan Bhuyan informed the participants of ways, in which the various financing instruments available with London Stock Exchange (LSE) can help Indian oil and gas companies raise easy funding for their projects.

Ms Jennifer Fagan delivered the concluding remarks and vote of thanks for this session. The session witnessed overwhelming participation from across the Indian Oil and Gas value chain. Many of the participants found the funding schemes offered by UKEF lucrative and seemed inquisitive to find out more about the scheme. The session concluded with a networking dinner for the participants.

Mr. Rajiv Bahl, Director (F), FIPI speaking at the workshop jointly organised with British High Commission in India

A section of the invitees

CEO/CFO Round Table on GST

The Federation of Indian Petroleum Industry (FIPI) organised a CEO/CFO Round table on GST on Monday, 26 August, 2019 at Hyatt Regency, New Delhi. The objective of the Roundtable was to bring all oil and gas industry CFOs under one roof and seek their inputs on the FIPI's ongoing study on impact of GST on the oil and gas sector.

The Goods and Services Tax (GST) was introduced by the Government of India in July 2017. The new tax regime is the single largest tax reform in the history of independent India and proved to be transformative for individual businesses and increased the country's tax base manifolds. However, five key petroleum products crude oil, natural gas, ATF, MS and HSD have not been included under the GST regime. The non-inclusion of five petroleum products has resulted in huge stranded input tax credit for the oil and gas companies, which is proving detrimental to their operation and future investment capabilities. In this regard, FIPI has been at the forefront advocating for the earliest inclusion of the sector under the GST regime at various levels in the Ministry of Petroleum and Natural Gas (MoPNG), Ministry of Finance (MoF), GST Council and State revenue and finance ministries. In this direction on the request of MoPNG, FIPI commissioned a study on the impact of non-inclusion of the sector under GST with Deloitte to substantiate and share the financial impact with the policy makers. The findings of the report will be further advocated with the Government with the view to include the core petroleum products under GST at the earliest.

Mr. Hemal Zobalia, India Tax Leader, Deloitte India giving background on the study on GST being carried jointly with FIPI

Delivering the welcome address at the Round Table, Mr Rajiv Bahl, Director – Finance, Taxation and Legal,

Ms Bela Mao, Partner, Deloitte giving the presentation

FIPI recounted that non-inclusion of oil and gas sector under GST has been difficult for the entire industry and that all major companies in the sector have huge amounts stranded taxes in the form of input tax credit. He mentioned that due to the relentless efforts of FIPI and the industry, many of the recommendations have already been accepted by the Government. He sounded extremely positive that the findings of the report will further the industry's advocacy efforts and will present a stronger case for earliest inclusion under GST to the policy makers.

The findings of the ongoing study were presented to the participants by Ms Bela Mao, Partner, Deloitte. In her presentation, she elaborated the data collection methodology and the key findings of the report to the participants. She presented the methodology for arriving at the Revenue Neutral Rate (RNR) for each product and how each state and centre would be affected if these were to be brought under GST at these rates.

During open discussion, the participants offered their advices and recommendations to be included in the report to make it more targeted. The participants were of the opinion that after the completion of the report, a clear roadmap should be drawn to engage with the policy makers so as to ensure maximum impact.

In his concluding remarks, Dr R K Malhotra, Director General, FIPI expressed satisfaction with the outcomes of the report and informed the participants that the final findings and recommendations of this report, after the incorporating the views of industry members, will first be shared with MoPNG and will

Dr. R. K. Malhotra, DG, FIPI delivering the concluding remarks

consequently be advocated with other Ministries and State Governments.

The Round Table discussions turned out to be extremely successful in collecting industry inputs for the report. The Roundtable witnessed overwhelming participation from CEOs, CFOs and other key decision makers from oil and gas companies, operating across the value chain.

9th Annual Convention of FIPI Student Chapters

Participants of Annual Convention of FIPI Student Chapters

The 9th Annual Convention of FIPI Student Chapters was held at SPT, Pandit Deendayal Petroleum University, Gandhi Nagar on 4th September 2019 on the theme "How Digitalization Can Help in Improving Efficiency, Safety & Environment Protection in the Oil & Gas Sector". The FIPI Student Chapters were instituted to provide a platform for all academicians, students, technologists and management experts of the university/college for regular exchange of ideas in the field of energy with special reference to Oil & Gas and Petroleum Technology.

Faculty members and students from ten Chapters, viz Amrita Vishwa Vidyapeetham; IIT Guwahati; IIT (ISM) Dhanbad; IIT-Madras; JNTU Kakinada; MIT Pune; Osmania University; PDPU Gandhi Nagar; RGIPT Rai-Bareilly & UPES Dehradun participated in the Convention.

Dr. R.K. Vij, Director , (I/c), Petroleum Engineering, School of Petroleum Technology, PDPU, welcomed the august gathering. Dr. R.K. Malhotra, Director General, FIPI, inaugurated the convention as a chief guest. Dr. Malhotra gave an overview of linkage between academia and industry and also touched upon the important topics like: Digitalization, Internet of things etc. Dr C Gopalkrishnan, Director General, PDPU expressed his thanks and gratitude for agreeing to their request to host the convention. Mr. O N Gyani, Head IRS, ONGC; Mr D.Basu, Executive Director & Ahmedabad Assets Manager, ONGC requested the academician to inculcate Digitalization in the course curriculum. Prof. Subhash Shah, mentor for PDPU also emphasized on linkage between academia and industry so that the students are prepared as per the demand of oil & gas industry.

On the basis of presentation given by various chapters on the activities performed during the previous year, Dr. R.K. Malhotra, Director General, FIPI & Mr N.K. Basal, Director (Oil Refining & Marketing), FIPI evaluated the performance of each chapter and declared PDPU as the best chapter for the year 2019.

All the chapters made 10 minutes presentations on the theme "How Digitalization Can Help in Improving Efficiency, Safety & Environment Protection in the Oil & Gas Sector". Dr. R.K. Malhotra, Director General, FIPI & Mr N.K. Basal, Director (Oil Refining & Marketing), FIPI evaluated the presentations and Mr Bansal gave his observation on the theme presentations & declared the award winner. Mementoes were distributed to faculty coordinators from various universities/ institutes and certificates were handed over to faculty coordinators for further submission to students.

Five days Training Programme on 'Business Analytics'

FIPI, with faculty assistance from Great Lakes Institute of Management, Gurugram organized 5 days programme on 'Business Analytics' from September 23-27, 2019 at India Habitat Centre, Lodhi Road New Delhi. This program was the 3rd in the series of analytics workshops with Great Lakes Institutes of Management and exclusively designed for Marketing Executives in Oil & Gas Industry.

Thirty-one middle management executives of various disciplines from member organisations joined the course. Following topics were covered during the programme:

Business Analytics :Need, Models, and Decisions and Applications in different Business Settings; Marketing Aspects of Oil Industry Analysis; Appreciation of Analytics in Supply and Distribution of Petroleum Products; Visualisation of Supply and Distribution Data; Analytical approach towards marketing data; Customer Feedback through Analytical problem solving; Application of R towards marketing information data; Long term Demand Forecasting; Inventory management with continuous response models; Vendor management analytics; Demand forecasting; Python for Analysing performance of Energy Companies; Identifying demand drivers; Retail network analytics; Web and Social Media

NEW APPOINTMENTS

Sushil Chandra Mishra takes over as Chairman & Managing Director of OIL

Sushil Chandra Mishra

Mr. Sushil Chandra Mishra took over the charge of Chairman & Managing Director (CMD) of Oil India Limited (OIL), India's second largest National Exploration & Production Company on 1st October 2019.

Prior to taking over as Chairman & Managing Director, Mr. Mishra was heading OIL's Rajasthan Project as Executive Director (Rajasthan Project), where he oversaw highly successful implementation of India's first and deepest Cyclic Steam Stimulation (CSS) process - a technology to produce heavy crude oil, holding the promise of manifold increase in production of heavy-oil from Rajasthan fields.

Mr. Mishra with over 35 Years of rich and varied experience in Upstream Sector, has deep expertise in commercial matters and played a key role in framing and implementing procurement policies & procedures for inventory management, vendor development, framework agreement and its related strategies. He was also responsible for key functions like ERP, Strategic Planning, E&P Projects, Corporate affairs, managing renewable energy portfolio & business development etc. Known for his people skills & quick decision making abilities, Mr. Mishra has deep understanding of OIL's culture with proven ability to work creatively and analytically in a problem-solving environment.

Rajesh Kumar Srivastava takes charge as ONGC Director (Exploration)

Mr. Rajesh Kumar Srivastava took charge as the Director (Exploration) of Oil and Natural Gas Corporation (ONGC) Limited on 2 August 2019. A post graduate from Lucknow University, with a Masters Degree in Engineering Geology from Indian Institute of Technology, Kanpur, Mr. Srivastava joined ONGC as Geologist in 1984 at Krishna Godavari Basin, Rajahmundry. With over 35 years of experience, Mr. Srivastava is an expert in up-stream hydrocarbon exploration from well site operations (on-land & offshore), development geology, seismic data interpretation to monitoring and planning of exploration.

During his tenure at E&D Directorate, he was closely associated with the exploration and development activities of Assam & Assam-Arakan Basin, MBA Basin and Krishna-Godavari & Cauvery basins. He was one of the important members during formulation of 'Hydrocarbon vision-2030 for North East India' prepared by MoPNG. He has also evaluated several exploration & development blocks of Egypt & Sudan. With his commendable work, Mr. Srivastava was honored with the National Mineral Award in 2009.

Rajesh Kumar Srivastava

M Vinayakumar takes charge as Director Refinery – MRPL

M Vinayakumar

Mr. M. Vinayakumar has taken over as Director Refinery, MRPL on 11th July 2019. Mr. Vinayakumar graduated as a Mechanical Engineer from Cochin University of Science and Technology in the year 1982 and subsequently he completed Diploma in Management. He began his career in Hindustan Petroleum Corporation Limited (HPCL) in 1982. Later he joined MRPL as Manager Project in 1993. He handled various responsibilities in different departments over the years and became GGM I/c Refinery

Harish Madhav takes over as Director (Finance) Oil India Limited

Harish Madhav

Mr. Harish Madhav has taken over as Director Finance Oil India Limited on 2nd August 2019. Earlier, Mr. Madhav was Executive Director (Finance) at Oil India's Corporate office and was also functioning as the Chief Financial Officer handling a diverse gamut of financial and accounting functions covering International Fund raising, Treasury Management, Corporate Strategy, Risk Management, Corporate Accounts & Audit, and Budgeting. Before joining OIL, he had also worked with Hindustan Petroleum Corporation Ltd.

A Chartered Accountant by qualification, Madhav has over 30 years of rich and varied experience in Oil & Gas in both Upstream and Downstream sectors. Madhav's tenure in various capacities during the last decade witnessed major events at OIL and included successful raising of foreign currency borrowing of over $4.5 Billion in the form of syndicated loans and bonds. He was also instrumental in first ever listing of foreign currency bonds by an Indian oil sector company on the International securities market of London Stock Exchange (LSE).

R. Kesavan takes over as Director Finance, HPCL

Mr. R. Kesavan has taken over as Director – Finance of HPCL effective September 5, 2019. He is also the Chief Financial Officer (CFO) of the Corporation. Prior to his appointment as Director - Finance, Mr. Kesavan was Executive Director – Corporate Finance of HPCL for over 4 years. He is a fellow member of the Institute of Chartered Accountants of India (ICAI).

Mr. Kesavan brings rich experience of over 3 decades in handling various areas on Finance covering Corporate Accounts, Audit, Treasury Management, Risk Management, Budgeting, Pricing, Corporate Strategy & Margin Management, Heads of Commercial in various Marketing SBUs etc.

He had various academic distinctions to his credit and is a key technical speaker in In-house Capability Building seminars & workshops. He has contributed articles of Corporate interest in various publications.

R. Kesavan

Sandeep Kumar Gupta takes over as Director (Finance) at IndianOil

Sandeep Kumar Gupta

Mr. Sandeep Kumar Gupta has taken over as Director (Finance) on the Board of Indian Oil Corporation (IndianOil) on August 3, 2019. Earlier, he was Executive Director (Corporate Finance) at IndianOil's Corporate Office and was also functioning as the Chief Financial Officer and Chief Risk Officer in-charge of Corporate Accounts, Treasury, Investment Appraisal and Risk Management.

A Commerce Graduate and Chartered Accountant by qualification, Mr. Gupta has over 31 years of work experience in IndianOil. Besides handling a diverse gamut of financial and accounting functions at IndianOil's refinery units in north, west and north-east India for over two decades, his significant experience at IndianOil's Refineries Headquarters and Corporate Office includes hydrocarbon contracting, corporate accounts, planning & analysis, treasury functions, financial concurrence, risk management, etc.

Mr. Gupta also brings with him rich experience of being on the Boards of IndianOil's wholly-owned overseas subsidiary, IOC Middle East FZE, and domestic joint venture company, IndianOil Petronas Pvt. Ltd.

STATISTICS

INDIA: OIL & GAS

DOMESTIC OIL PRODUCTION (MILLION MT)

		2013-14	2014-15	2015-16	2016-17	2017-18 (P)	2018-19 (P)	April - June 2019 (P)	
									% of Total
On Shore	ONGC	6.7	6.1	5.8	5.9	6.0	6.1	1.5	36.5
	OIL	3.5	3.4	3.2	3.3	3.4	3.3	0.8	19.3
	Pvt./ JV (PSC)	9.4	9.1	8.8	8.4	8.2	8.0	1.9	44.3
	Sub Total	**19.6**	**18.5**	**17.8**	**17.6**	**17.5**	**17.3**	**4.2**	100
Off Shore	ONGC	15.5	16.2	16.5	16.3	16.2	15.0	3.6	89.8
	OIL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Pvt./ JV (PSC)	2.7	2.7	2.5	2.1	1.9	1.9	0.4	10.2
	Sub Total	**18.2**	**18.9**	**19.1**	**18.4**	**18.1**	**16.9**	**4.0**	100
Total Domestic Production		37.8	37.5	36.9	36.0	35.7	34.2	8.2	100.0
	ONGC	22.3	22.3	22.4	22.2	22.2	21.0	5.1	62.6
	OIL	3.5	3.4	3.2	3.3	3.4	3.3	0.8	9.8
	Pvt./ JV (PSC)	12.1	11.8	11.3	10.5	10.1	9.9	2.3	27.6
Total Domestic Production		**37.8**	**37.5**	**36.9**	**36.0**	**35.7**	**34.2**	**8.2**	100

Source : PIB/PPAC

REFINING

Refining Capacity (Million MT on 1st July 2019)

Indian Oil Corporation Ltd.	
Digboi	0.65
Guwahati	1.00
Koyali	13.70
Barauni	6.00
Haldia	7.50
Mathura	8.00
Panipat	15.00
Bongaigoan	2.35
Paradip	15.00
Total	**69.20**

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	0.10
Total PSU Refineries Capacity	**142.10**

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 249.4 (4.99 million barrels per day)
Nayara Energy Limited (formerly Essar Oil Limited)
Source : PPAC

CRUDE PROCESSING (MILLION MT)

PSU Refineries	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	April-June 2019 (P)
IOCL	53.13	53.59	58.01	65.19	69.00	71.81	17.28
HPCL	22.97	23.20	24.10	25.30	28.20	30.82	7.44
BPCL	15.51	16.20	17.20	17.80	18.20	18.44	3.92
CPCL	10.70	10.70	9.60	10.30	10.80	10.69	2.62
MRPL	14.60	14.60	15.53	15.97	16.13	16.23	2.56
ONGC (Tatipaka)	0.10	0.05	0.07	0.09	0.08	0.07	0.02
NRL	2.60	2.78	2.52	2.68	2.81	2.90	0.68
SUB TOTAL	**119.61**	**121.12**	**127.03**	**137.33**	**145.22**	**150.96**	**34.52**

JV Refineries	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	April-June 2019 (P)
HMEL	9.27	7.34	10.71	10.52	8.83	12.47	3.19
BORL	5.40	6.21	6.40	6.36	6.71	5.71	2.05
SUB TOTAL	**14.67**	**13.55**	**17.11**	**16.88**	**15.54**	**18.18**	**5.24**

Pvt. Refineries	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	April-June 2019 (P)
NEL	20.20	20.49	19.11	20.92	20.69	18.89	5.19
RIL	68.03	68.10	69.50	70.20	70.50	69.14	17.63
SUB TOTAL	**88.23**	**88.59**	**88.61**	**91.12**	**91.19**	**88.03**	**22.82**

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	April-June 2019 (P)
All India Crude Processing	**222.4**	**223.3**	**232.9**	**245.4**	**251.9**	**257.2**	**62.58**

Source : PIB Release/PPAC

CRUDE CAPACITY VS. PROCESSING

	Capacity On 01/07/2019 Million MT	% Share	Crude Processing Million MT April - June 2019 (P)	% Share
PSU Ref	142.1	57.0	34.5	55.2
JV. Ref	19.1	7.7	5.2	8.4
Pvt. Ref	88.2	35.4	22.8	36.5
Total	**249.4**	**100**	**62.6**	**100**

Source: PIB/PPAC

POL PRODUCTION (Million MT)

	2013-14	2014-15	2015-16	2016-17	2017-18 (P)	2018-19 (P)	April-June 2019 (P)
From Refineries	216.4	217.1	227.9	239.2	249.8	257.4	62.6
From Fractionators	3.9	3.7	3.4	3.5	4.6	4.9	1.2
Total	**220.3**	**220.7**	**231.2**	**242.7**	**254.4**	**262.4**	**63.8**

DISTILLATE PRODUCTION (Million MT)

	2013-14	2014-15	2015-16	2016-17	2017-18 (P)	2018-19 (P)	April-June 2019 (P)
Light Distillates, MMT	62.7	63.2	67.1	71.0	74.7	70.4	16.9
Middle Distillates , MMT	112.8	113.4	118.3	122.5	127.5	130.8	32.0
Total Distillates, MMT	175.5	176.6	185.4	193.5	202.2	201.2	48.9
% Distillates Production on Crude Processing	**78.9**	**79.1**	**79.6**	**78.9**	**80.3**	**78.2**	**78.2**

Source: PIB/PPAC

PETROLEUM PRICING

OIL IMPORT - VOLUME AND VALUE

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	April-June 2019 (P)
Quantity, Million Mt	189.2	189.4	202.9	213.9	220.4	226.6	55.4
Value, INR ₹000 cr.	864.9	687.4	416.6	470.6	566.0	783.4	189.1
Value, USD Billion	143.0	112.7	64.0	70.2	87.8	112.0	27.3
Average conversion Rate, INR per USD (Calculated)	60.5	61.0	65.1	67.0	64.5	70.0	69.3

OIL IMPORT - PRICE USD / BARREL

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	April-June (P)
Brent (Low Sulphur - LS-marker) (a)	107.5	85.4	47.5	48.7	57.5	70.0	68.7
Dubai (b)	104.6	83.8	45.6	47.0	55.8	69.3	67.4
Low sulphur-High sulphur differential (a-b)	2.9	1.7	1.8	1.7	1.6	0.7	1.3
Indian Crude Basket (ICB)	105.52	84.16	46.17	47.56	56.43	69.88	62.39
ICB High Sulphur share %	69.90	72.04	72.28	71.03	72.38	74.77	74.77
ICB Low Sulphur share %	30.10	27.96	27.72	28.97	27.62	25.23	25.23

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

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	April-June 2019 (P)
Gasoline	114.3	95.5	61.7	58.1	67.8	75.3	74.2
Naphtha	100.2	82.2	48.5	47.1	56.3	65.4	58.5
Kero / Jet	121.2	66.6	58.2	58.4	69.2	83.9	74.2
Gas Oil (0.05% S)	122.0	99.4	57.6	58.9	69.8	84.1	80.1
Dubai crude	104.6	83.8	45.6	47.0	55.8	69.3	67.4
Indian crude basket	105.5	84.2	46.2	47.6	56.4	69.9	62.4

CRACKS SPREADS ($/ BBL.)

	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19 (P)	April-June 2019 (P)
Gasoline crack							
Dubai crude based	9.7	11.7	16.1	11.1	12.0	5.9	6.8
Indian crude basket	8.8	11.3	15.6	10.6	11.4	5.4	11.8
Diesel crack							
Dubai crude based	17.4	15.7	12.0	12.0	13.9	14.8	12.7
Indian crude basket	16.5	15.3	11.5	11.4	13.4	14.2	17.7

DOMESTIC GAS PRICE ($/MMBTU)

Period	Domestic Gas Price (GCV Basis)	Price Cap for Deepwater, High temp Hingh Pressure Areas
November 14 - March 15	5.05	-
April 15 - September 15	4.66	-
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

Source: PIB/PPAC/OPEC

GAS PRODUCTION

Qty in MMSCM

	2015-16	2016-17	2017-18 (P)	2018-19 (P)	April-June 2019 (P)
ONGC	21177	22088	23429	24675	6128
Oil India	2838	2937	2882	2722	680
Private/ Joint Ventures	8235	6872	6338	5477	1223
Total	**32250**	**31897**	**32649**	**32873**	**8031**

		2015-16	2016-17	2017-18 (P)	2018-19 (P)	April-June 2019 (P)
Onshore	Natural Gas	8845	9294	9904	10046	2479
	CBM	393	565	735	710	164
	Sub Total	**9237**	**9858**	**10639**	**10756**	**2643**
Offshore		23012	22038	22011	22117	5388
	Sub Total	**23012**	**22038**	**22011**	**22117**	**5388**

Total	**32249**	**31897**	**32649**	**32873**	**8031**
(-) Flare loss	1120	1049	918	817	232
Net Production	31129	30848	31731	32056	7799

	2015-16	2016-17	2017-18 (P)	2018-19 (P)	April-June 2019 (P)
Net Production	31129	30848	31731	32056	7799
Own Consumption	5822	5857	5806	6017	1557
Availabilty	25307	24991	25925	26039	6242

AVAILABILTY FOR SALE

	2015-16	2016-17	2017-18 (P)	2018-19 (P)	April-June 2019 (P)
ONGC	16076	17059	18553	19597	4774
Oil India	2314	2412	2365	2207	547
Private/ Joint Ventures	6917	5520	5007	4235	921
Total	**25307**	**24991**	**25925**	**26039**	**6242**

CONSUMPTION (EXCLUDING OWN CONSUMPTION)

	2015-16	2016-17	2017-18 (P)	2018-19 (P)	April-June 2019 (P)
Total Consumption	46695	49677	52253	53054	14166
Availabilty for sale	25307	24991	25925	26039	6242
LNG Import	21388	24686	26328	27015	7924

GAS - IMPORT DEPENDENCY

	2015-16	2016-17	2017-18 (P)	2018-19 (P)	April-June 2019 (P)
Net Gas Production	31129	30848	31731	32056	7799
LNG Imports	21388	24686	26328	27015	7924
Import Dependency (%)	40.7	44.5	45.3	45.7	50.4
Total Gas Consumption*	**52517**	**55534**	**58059**	**59071**	**15723**

* Includes Own Consumption

Source:PIB/PPAC

SECTOR WISE DEMAND AND COMSUMPTION OF NATURAL GAS

Qty in MMSCM

		2016-17 (P)	2017-18 (P)	2018-19 (P)	2019-20 (P)			
					April	May	June	Total
Fertilizer	**R-LNG**	**7592**	**7781**	**8472**	611	716	687	**2014**
	Domestic Gas	**7802**	**6862**	**6574**	541	525	641	**1707**
Power	**R-LNG**	**2410**	**2645**	**3058**	265	336	769	**1370**
	Domestic Gas	**9131**	**9375**	**8878**	711	700	499	**1910**
City Gas	**R-LNG**	**3030**	**3881**	**3981**	290	322	328	**940**
	Domestic Gas	**4276**	**4659**	**5240**	471	472	463	**1406**
Refinery Petrochemi-cal Others	**R-LNG**	**12440**	**12439**	**12650**	1021	1056	1030	**3107**
	Domestic Gas	**3978**	**4872**	**5125**	432	438	448	**1318**

Source:PPAC

Member Organizations

S No	Organization	Name	Designation
1	Axens India (P) Ltd.	Mr. Philippe Bergault	Managing Director
2	Baker Hughes, A GE Company	Mr. Ashish Bhandari	CEO (Oil & Gas) South Asia
3	Bharat Oman Refineries Ltd.	Mr. Mahendra Pimpale	Managing Director
4	Bharat Petroleum Corporation Ltd.	Mr. D. Rajkumar	Chairman & Managing Director
5	BP Group	Mr. Sashi Mukundan	Regional President and Head of Country, India
6	Cairn Oil & Gas, Vedanta Limited	Mr. Ajay Kumar Dixit	Chief Executive Officer
7	Chandigarh University	Mr. Satnam Singh Sandhu	Chancellor
8	Chennai Petroleum Corp. Ltd.	Mr. S.N. Pandey	Managing Director
09	CSIR-Indian Institute of Petroleum, Dehradun	Dr. Anjan Ray	Director
10	Deepwater Drilling & Industries Ltd	Mr. Naresh Kumar	Chairman & Managing Director
11	Delonex Energy Advisors India Private Ltd.	Mr. Rahul Dhir	Managing Director
12	Dynamic Drilling & Services Pvt. Ltd.	Mr. S. M. Malhotra	President
13	Engineers India Ltd.	Mr. J.C. Nakra	Chairman & Managing Director
14	Ernst & Young LLP	Mr. Rajiv Memani	Country Manager & Partner
15	ExxonMobil Gas (India) Pvt. Ltd.	Mr. Bill Davis	CEO
16	GAIL (India) Ltd.	Dr. Ashutosh Karnatak	CMD & Director (Projects)
17	GSPC LNG Ltd.	Mr. Anil K. Joshi	President
18	Haldor Topsoe India Pvt. Ltd.	Mr. Alok Verma	Managing Director
19	Hindustan Petroleum Corporation Ltd.	Mr. M.K. Surana	Chairman & Managing Director
20	HPCL Mittal Energy Ltd.	Mr. Prabh Das	MD & CEO
21	IHS Markit	Mr. James Burkhard	Managing Director
22	IIT (ISM) Dhanbad	Prof. Rajiv Shekhar	Director
23	IMC Ltd.	Mr. A. Mallesh Rao	Managing Director
24	Indian Oil Corporation Ltd.	Mr. Sanjiv Singh	Chairman
25	Indian Strategic Petroleum Reserves Ltd	Mr. H.P.S. Ahuja	CEO & Managing Director
26	Indraprastha Gas Ltd.	Mr. E.S. Ranganathan	Managing Director
27	Indian Oiltanking Ltd.	Mr. Vivek Venkatachalam	Managing Director

S No	Organization	Name	Designation
28	IPIECA	Mr. Brian Sullivan	Executive Director
29	Jindal Drilling & Industries Pvt. Ltd.	Mr. Raghav Jindal	Managing Director
30	LanzaTech	Dr. Jennifer Holmgren	Chief Executive Officer
31	Larsen & Toubro Ltd	Mr. S.N. Subrahmanyan	CEO & Managing Director
32	Maharashtra Institute of Technology (MIT), Pune	Dr. L.K. Kshirsagar	Principal
33	Mangalore Refinery & Petrochemicals Ltd.	Mr. M. Venkatesh	Managing Director
34	Mitsui Chemicals India Pvt. Ltd.	Mr. Suraj Arya	President
35	Nayara Energy Ltd.	Mr. B. Anand	CEO
36	Numaligarh Refinery Ltd.	Mr. S.K. Barua	Managing Director
37	Oil and Natural Gas Corporation Ltd.	Mr. Shashi Shanker	Chairman & Managing Director
38	Oil India Ltd.	Mr. Sushil Chandra Mishra	Chairman & Managing Director
39	Petronet LNG Ltd.	Mr. Prabhat Singh	Managing Director & CEO
40	Pipeline Infrastructure Limited	Mr. Akhil Mehrotra	Chief Executive Officer
41	Rajiv Gandhi Institute of Petroleum Technology	Prof. A.S.K Sinha	Director
42	Reliance Industries Ltd.,	Mr. Mukesh Ambani	Chairman & Managing Director
43	SAS Institute (India) Pvt Ltd.	Mr. Noshin Kagalwalla	CEO & Managing Director-India
44	Shell Companies in India	Mr. Nitin Prasad	Country Chair
45	South Asia Gas Enterprise Pvt. Ltd.	Mr. Subodh Kumar Jain	Director
46	Total Oil India Pvt. Ltd.	Mr. Dilip Vaswani	Chairman & Managing Director
47	University of Petroleum & Energy Studies	Dr. S.J. Chopra	Chancellor
48	UOP India Pvt. Ltd.	Mr. Mike Banach	Managing Director
49	VCS Quality Services Private Ltd.	Mr. Shaker Vayuvegula	Director
50	World LPG Association	Mr. James Rockall	CEO and Managing Director

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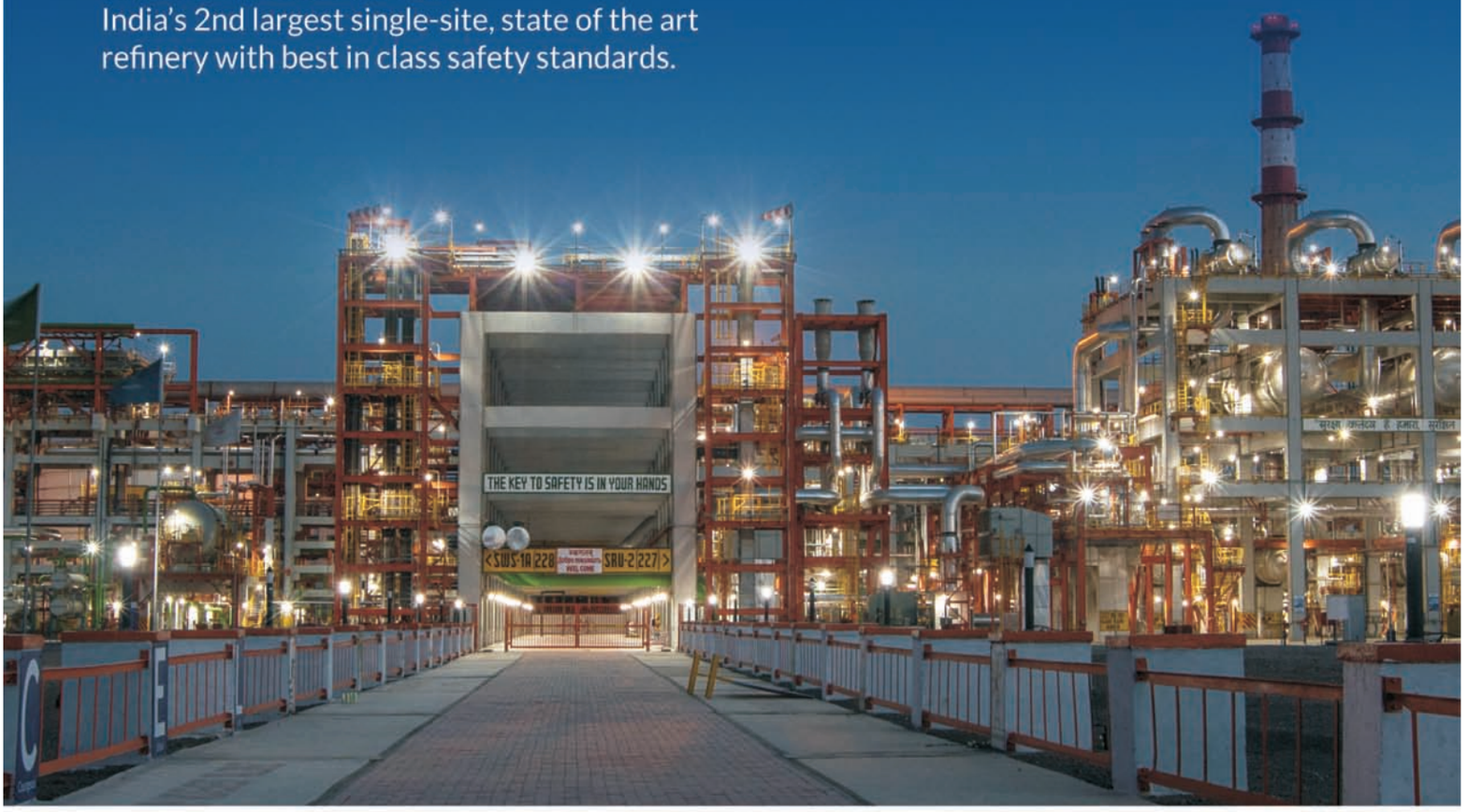

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