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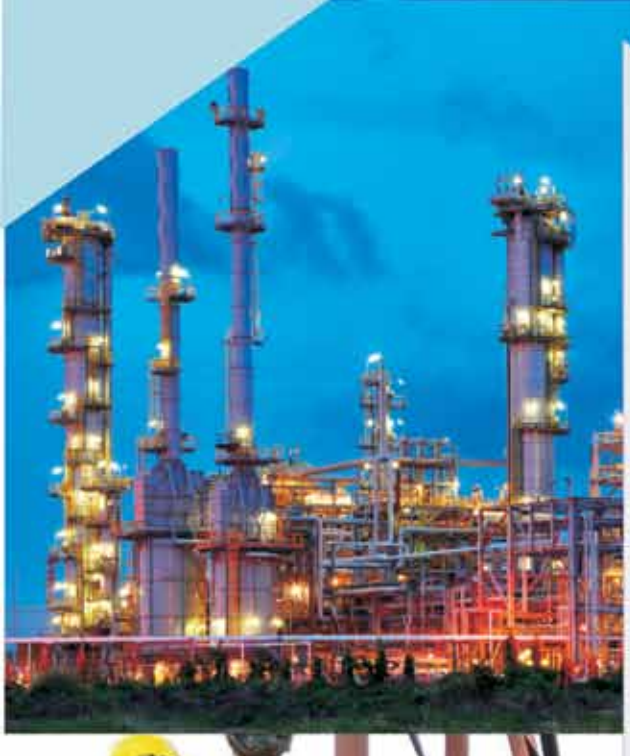
The Journal of Federation of Indian Petroleum Industry



Voice of Indian Oil & Gas Industry

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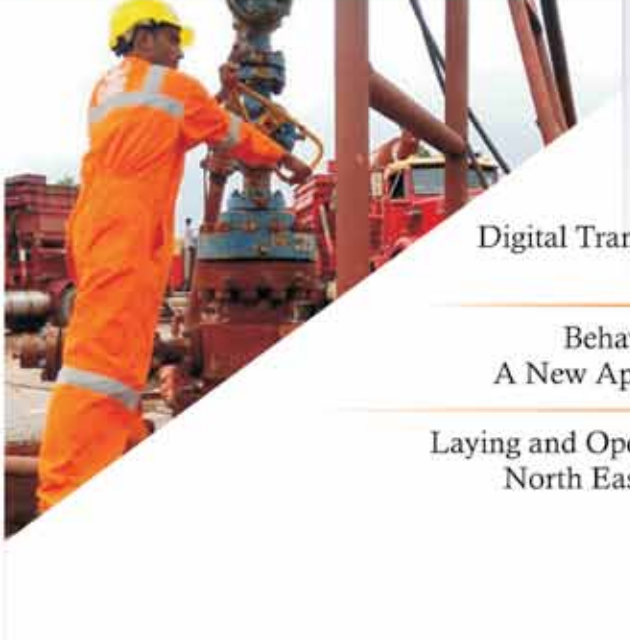

Digital Transformation for Oil and Gas Industry – A Practical Perspective

Behaviour Based Organisation Safety
A New Approach to Achieve Excellence in BBS

Laying and Operations of Petroleum Product Pipelines in North East – Challenges unique to North-East

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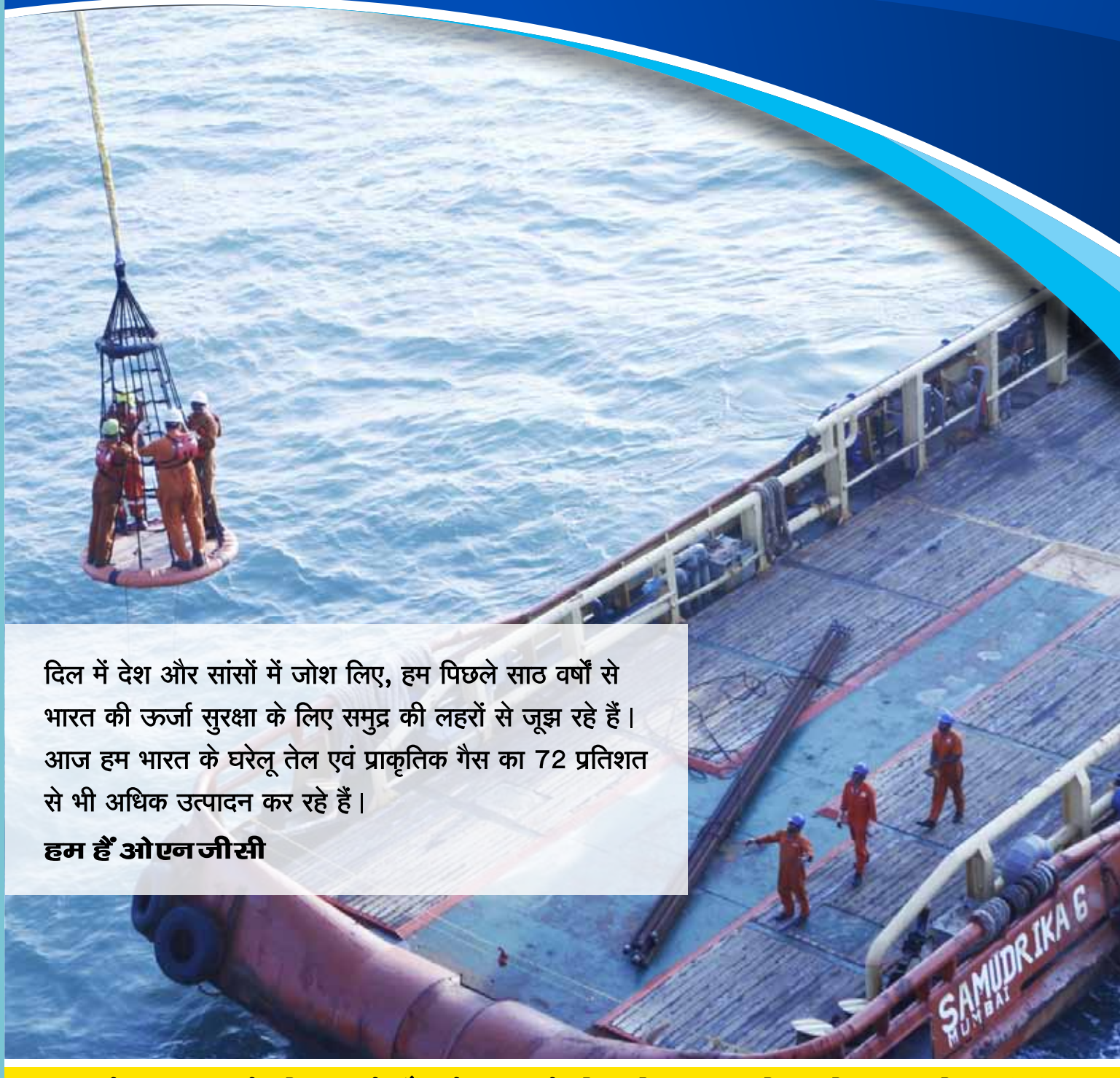

दिल में देश और सांसों में जोश लिए, हम पिछले साठ वर्षों से भारत की ऊर्जा सुरक्षा के लिए समुद्र की लहरों से जूझ रहे हैं। आज हम भारत के घरेलू तेल एवं प्राकृतिक गैस का 72 प्रतिशत से भी अधिक उत्पादन कर रहे हैं।

हम हैं ओएनजीसी

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From the Desk of the

Director General

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

The Indian economy has been writing a fascinating growth story over the last decade. Even when the world went into a slowdown, India endured. It has been due to the robustness of India's institutions, the resilience of its policy frameworks, the reforms initiated by the government and the responsiveness of industry bodies, stated by the Vice President of India during a recently held Summit in Mumbai. India has achieved the dual distinction of being a stable democracy and one of the fastest growing economies in the world. Due to various reforms undertaken by the Government, India has become a favourite investment destination, with a ranking of 11 in the Global FDI confidence Index 2018. This is the right time for foreign investors to tap into the huge potential offered by India in various sectors.

India's import dependence on crude oil and natural gas has been a source of big concern. While the Govt. has taken a large number of measures to moderate the increasing demand of oil through usage of bio-fuel and alternate technologies, policy measures have been taken to increase the hydrocarbon production to reduce imports.

To attract new investment in Exploration and Production (E&P) Sector, intensification of exploration activities in hitherto unexplored areas and liberalizing the policy in producing basins, The Union Cabinet has approved the Policy framework on reforms in exploration and licensing sector for enhancing domestic exploration and production of oil and gas. Considering stagnant/ declining domestic production of oil and gas, rise in import dependence and decline in investment in E&P activities, the need to bring further policy reforms was felt, which focus on four major areas. Firstly, increasing exploration activities in unexplored areas. In basins where no commercial production is there, exploration blocks would be bid out exclusively on the basis of exploration work programme without any revenue or production share to Government. Royalty and statutory levies, however, will be paid by Contractor. For unallocated/ unexplored areas of producing basins, the bidding will continue to be based on revenue sharing basis but more weightage to work programme. Secondly, to incentivize enhanced gas production, marketing and pricing freedom has been granted for those new gas discoveries whose Field Development Plan (FDP) is yet to be approved. Fiscal incentive is also provided on additional gas production from domestic fields over and above normal production. Thirdly, to enhance production from existing nomination fields of ONGC and OIL, enhanced production profile will be prepared by both PSUs. For production enhancement, bringing new technology, and capital, NOCs will be allowed to induct private sector partners. Fourthly measures will be initiated for promoting ease of doing business through setting up of a coordination mechanism, simplification of approval by DGH and alternate dispute resolution mechanism etc.

We hope that the above reforms as well as those ushered in during last few years will help in increasing the domestic oil & gas production.

In order to reduce import dependence and to push the agriculture and rural sector, the Govt. of India has also been focusing on Bio-fuels and has targeted to achieve 10% blending percentage of Ethanol in petrol by 2022. Despite efforts of the Government such as higher ethanol prices and simplification of ethanol purchase system, the highest ever ethanol procurement stands around 150 crore litre during Ethanol supply year 2017-18 which is sufficient for around 4.22% blending on Pan India basis. Therefore, an alternate route viz. Second Generation (2G) Ethanol from biomass and other wastes is being explored by MoP&NG to bridge the supply gap for EBP programme.

In addition to the ethanol blending programme, Govt. has initiated the Compressed Bio-Gas (CBG) programme under the SATAT scheme. The Hon'ble Minister for Petroleum and Natural Gas & Skill development and Entrepreneurship, Shri Dharmendra Pradhan recently handed over the 100th Letter of Intent (LOI) to the Compressed Bio-Gas (CBG) Entrepreneur (producer) under the scheme, which is an initiative aimed at providing a Sustainable Alternative Towards Affordable Transportation as a developmental effort that would benefit both vehicle-users as well as farmers and entrepreneurs. Speaking on the occasion, Shri Pradhan hailed the occasion as a breakthrough in realizing the vision of a clean and green India as envisaged by the Government of India. He also reiterated that spreading the gas grid fed by CBG from thousands of such plants across the country would significantly reduce India's import burden and provide an economical and environment-friendly alternative to conventional petroleum fuels.

The past couple of months have seen FIPI busy in a variety of events for the oil & gas industry. We rang in the New Year with the Youth Forum 2019, which was organized under umbrella of Petrotech 2019, India's

flagship energy conference. The Youth Forum was uniquely designed to bring under one roof, students from across the country and industry leaders to interact and explore the prospects of a rewarding career in the oil and gas industry. The event witnessed participation of over 200 students from various colleges and universities across the country. Many eminent personalities such as Shri Sanjiv Singh, Chairman, IndianOil; Dr. Mahesh Gupta, Chairman & Managing Director, Kent RO Systems Ltd; Brig (Dr) Sunil Kumar Moudgil and Shri Anish De, Partner & Head, Energy and Natural Resources, KPMG India interacted with the students over the course of this event.

Another pre-cursor event to Petrotech 2019 was the one-day conference on "Digital Transformation in Oil & Gas Sector." This program was uniquely designed to bring various technology leaders under one roof to explore the opportunities for the Indian oil and gas industry in Digital Transformation. The event witnessed participation of over 120 executives from various oil companies across the country. With M/S Deloitte being the knowledge partner, this event saw the presence of industry leaders from 14 companies namely ONGC, HPCL, Cairn India, Reliance Industries Limited, Deloitte, Schlumberger, Baker Hughes, A GE Company, Siemens, Honeywell, Larsen & Toubro, SAP, Kongsberg Digital and Hexagon Capability Center India so as to understand the current status of digitalization in O&G sector and the experiences that can be derived from prominent organizations in this regard. Among the key topics discussed were, Industrial Internet of Things, Digital Oilfield 4.0, Industry 4.0, Augmented and Virtual Reality, Machine Learning and Big Data Analytics. The conference was carefully designed with a perfect blend of information and experience on the latest technology trends in the O&G industry from both technology provider/manufacturer and end-user side.

Petrotech 2019 which was organized by ONGC and FIPI under the aegis of Ministry of Petroleum and Natural Gas had a pavilion by FIPI at the exhibition hall - 'FIPI Innovation Center', which accorded an opportunity to the young entrepreneurs to be a part of the most prestigious event of the Indian oil and gas industry.

The report of the study on 'Impact of Oil & Gas on Indian Economy' conducted by FIPI in association with KPMG was also released by the Hon'ble Minister for Petroleum and Natural Gas & Skill Development and Entrepreneurship, Shri Dharmendra Pradhan during the Petrotech-2019.

Among firsts, the Federation of Indian Petroleum Industry joined hands with the World Petroleum Council (WPC) to organize the second edition of WPC leadership conference from 18-20 February, 2019 in Mumbai, India. The WPC Leadership Conference is a global event on industry leadership in responsible operations, international cooperation and sustainable solutions for the petroleum sector. This latest edition of the conference was deemed to be especially important since India is one of the major demand centers for energy and has a large growing population with increasing appetite for energy, while at the same time is faced with serious concerns regarding air quality and climate change. With key themes of the conference being Engaging Energy Poverty, Energy Transitions and Industry Responses to Climate Change, the conference was attended by major stakeholders from the Indian and International Oil and Gas industry, including industry leaders, experts and academia. During the course of the discussions, it was realized that for a sustainable future, affordable energy access for all will remain the central focus while the key levers in this transition will be energy efficiency, digitalization and acceptance towards disruptive technologies. It was realized that for a smooth transition towards a cleaner future, natural gas and renewables will play a key role in the India's energy mix.

FIPI in association with BP India presented the BP Energy Outlook 2019 in New Delhi and Mumbai. Mr. Spencer Dale, Group Chief Economist, BP p.l.c. in his presentation of BP Energy Outlook 2019 spoke on the energy transition under different scenarios. He explained as to how the outlook presents and analyses future energy trends and how the growing demand will be met over the coming decades through a diverse range of supplies including oil, gas, coal and renewables. The global energy demand is set to rise by around one-third by 2040, driven by increasing population and improving living standards in Asia, particularly in India and China, Mr. Dale believed that renewables will be the largest source of global power generation by then.

FIPI is all geared up for a very energetic 2019-2020 year ahead. A number of events and training programs have been lined up to cater to the needs of the industry. While May 2019 will see for the first time the FIPI-IHRDC program and Study Tour on "Challenges and Opportunities facing Today's Senior Petroleum Leaders", the R&D Conclave 2019 is slated to be held in July. Keeping in mind the rising interest in specialized programs, an Expert Workshop on 'Innovative Energy Storage System' is planned in association with the World Petroleum Council (WPC) to be held in September.

FIPI is committed to the cause of our stakeholders and is engaged in a variety of projects keeping in view the changing times for the oil and gas companies. This past year, we have successfully completed two relevant studies, namely the study on "LNG for Transportation" and "Impact of Oil & Gas Industry in Indian Economy". The third study on "Impact of Electric Mobility on India's Oil and Gas sector" is on the verge of completion and will provide the necessary framework for the companies to operate in an EV disruptive scenario. We will soon be launching the second phase of the study on "Impact of Oil & Gas Industry in Indian Economy" which will focus on the pathway for the oil & gas industry. With India's focus on moving towards a gas-based economy, FIPI has planned various events for assessing the supply, demand & policy scenario on natural gas in the country. With such industry-relevant studies and workshops, we shall continue to strive to better ourselves and work towards adding more value to our industry.

Dr. R. K. Malhotra

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TECHNOLOGY

Digital Transformation for Oil and Gas Industry – A Practical Perspective

Nubeel Ansari
Industries and Digital Leadership
SAP India Pvt. Ltd.

Introduction

India is the 3rd largest consumer of energy and yet its per capita consumption is only 1/10th of that of USA. As per Niti Aayog's estimate, the per capita consumption will increase more than twice by 2040. Focus on natural gas and renewables along with growing concerns on carbon emissions are leading the energy transition from fossil fuels to more cleaner sources of energy.

Technology is a backbone of any industry today and has the potential to transform. Commercialization of digital technologies, like artificial intelligence (AI), internet of things (IoT), machine learning (ML), advanced analytics and blockchain is acting as a catalyst to this transformation. In line with MoPNG's focus on making the sector efficient and competitive, digital technologies will play a significant role towards this end objective. We believe that a systematic approach would go a long way in ensuring that organizations are able to deliver long term value through digital transformation.

Drivers for Transformation of O&G Sector in India

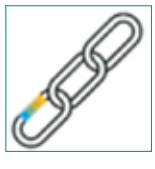
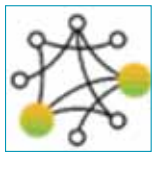
Oil and Gas is one of the key sectors for the overall growth of the Indian economy in the future. Right now, it is in a state of perceptible transformation and shift – getting impacted by global trends and domestic policy initiatives. Local policy level reforms have paved the way for increased competitiveness. However, Govt.'s intent to move towards a gas-based economy and planned investments in electrical vehicles as part of National Electric Mobility Mission Plan, will have long term impacts on the sector.




Volatility in crude oil prices	Natural gas & renewables as cleaner alternatives	Global concern on sustainability	Indian policy level initiatives
• Brent crude oil prices averaged at $71.1/ barrel in 2018, one of the highest since 2012, more than $15/barrel from 2017 average value • It reached almost $85/ barrel in Oct-18 but has dropped to $ 51/ barrel in January-19	• Compared to a growth of 1.7% in global oil consumption, natural gas consumption grew by almost double at 3% in 2017 • Renewables have been registering a growth of 8-9% for many years now, with India again witnessing the lowest tariff of Rs. 2.44/KWh in the recent biddings	• India is aiming to reduce 33% in the carbon intensity of GDP from 2005 level by 2030 • Requires better monitoring of HSE and bringing visibility in GHGs emissions across the organization.	• Daily dynamic pricing of fuel has had a positive impact on the industry, especially for the refiners and marketers • Govt.'s move to allow home delivery of fuel will usher in a new era of consumer service and collaboration with other e-tailers

How Oil and Gas Companies Can Respond to the Challenges

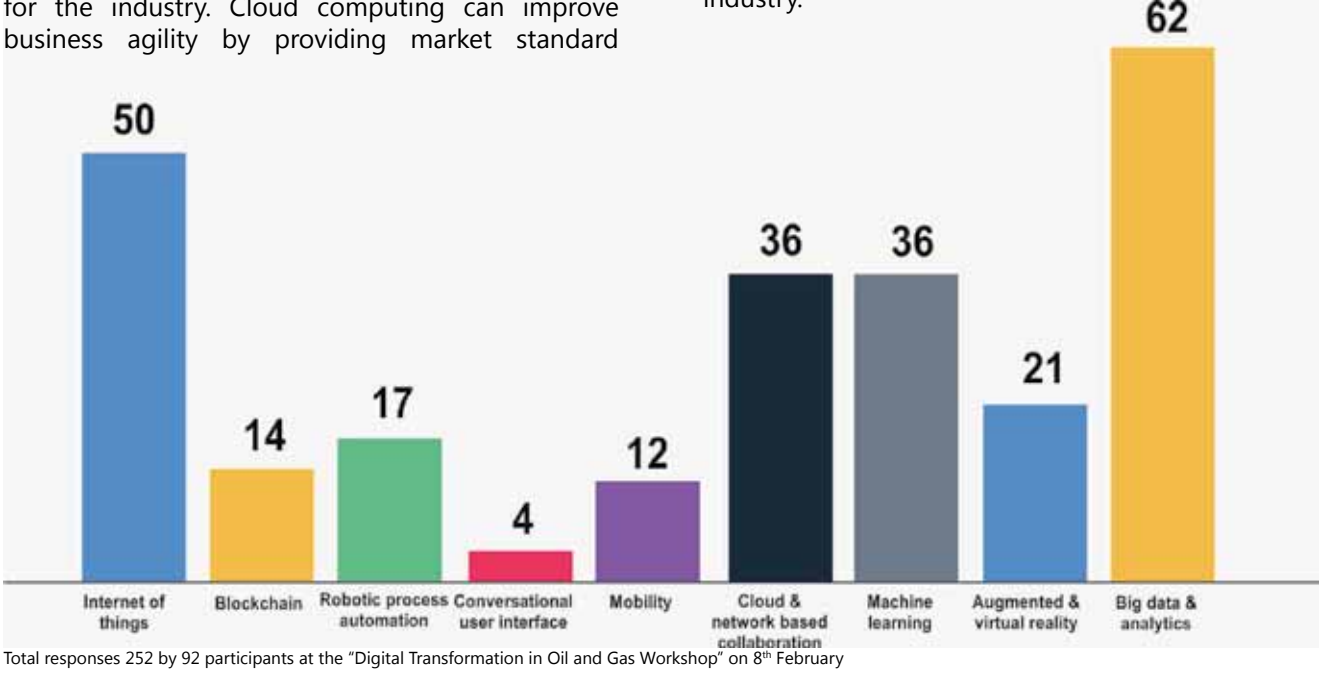
Oil and gas companies are facing unique challenges and to thrive, they need to respond with leaner, agile and innovative ways, which leverage digital as the key enabler


Lean – Survive with fluctuating commodity prices	Agile – Scale without sacrificing efficiencies	Innovate – New business models	Digital – Advanced technologies as strategy enablers
• Build cost competitiveness across enabling functions, like logistics, procurement and support functions, like finance, IT and HR • As per SAP digital oil and gas assessment survey, only 21% organizations have real-time visibility across hydrocarbon supply chain from raw material acquisition to finished product inventories, while almost 86%feel that it is important to do so	• Leverage comprehensive, real-time planning, forecasting, modeling across enterprise • Create scalable processes and systems through automation, AI/ML, and connected eco-system	• Focus on value creation for ultimate customer (e.g., new outcome-based offerings) • As per WEF, 'beyond the barrel' initiatives, like digital customer services in the form of hyperlocal mobile fuel options and omnichannel retail, experiential services and targeted marketing could add potential value of around $75B between 2016-2025 in the industry & and the ecosystem	• Technology platform must enable flexible scale, and innovation • As per SAP enterprise digital readiness assessment, organizations that are best in class in driving business process innovation and business model adoption tend to have respectively a 1.5X and 1.6X digital maturity score as compared to those that are below peers

Overview of Digital Technologies for O&G Industry

In comparison with other industries, O&G industry's approach to digital transformation is expected to be evolutionary, since the automation level of the industry has always been on the higher side. Recent commercialization and developments in technologies such as the cloud, IoT, analytics and big data are driving trends that have immense potential for the industry. Cloud computing can improve business agility by providing market standard processes. IoT provides the capability to leverage real time and streaming data and merge with transactional data. Big data and analytics can help with innovation by supporting in analyses of large quantities of structured and unstructured data from disparate sources. In a recent workshop on digital transformation for Oil and Gas industry organized by FIPI, participants were surveyed on top 3 emerging technologies, which they believe can transform the industry.

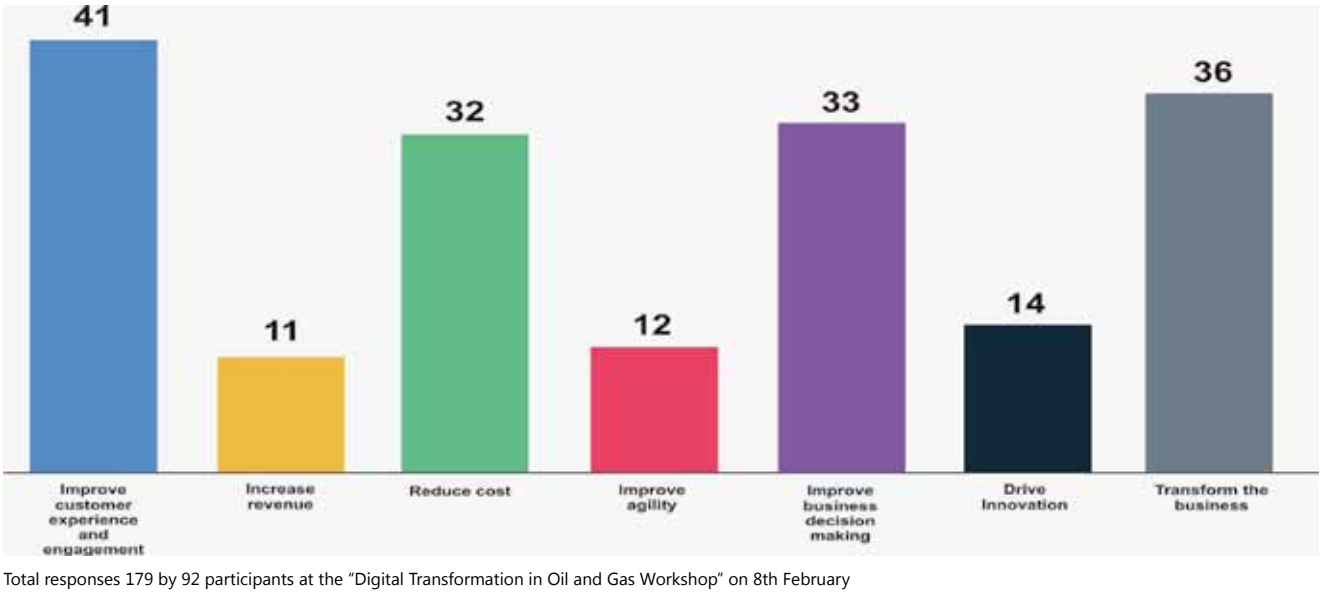


Total responses 252 by 92 participants at the "Digital Transformation in Oil and Gas Workshop" on 8th February

Almost half of the responses (~45%) selected two emerging technologies – 1) big data and analytics and 2) internet of things (IoT)

Key Objectives of Digital Transformation

Digital technologies have tremendous potential to move O&G companies beyond sluggish growth and deliver exceptional shareholder, customer and environmental value. In a survey conducted with representatives of oil and gas companies of India during a digital transformation workshop by FIPI, following emerged as the top priorities from digital transformation (participants were asked to select top 2)



Total responses 179 by 92 participants at the "Digital Transformation in Oil and Gas Workshop" on 8th February

60% of the responses were around 3 priorities – 1) improving customer experience, 2) business decision making and 3) reducing cost of operations

Possible Areas of Innovation for O&G Sector in India

Overall digital technologies can impact the O&G industry across many functional areas within a company. However, it is important to identify the key functions, where the impact could be significant across levers like, cost, revenue, safety and customer satisfaction. As per our assessment, digital technologies can bring in game changing impacts through the following key themes across major functional areas of an O&G company.

A. Intelligent Asset Management and Safe Operations

B. Collaborative and Ecosystem Based Approach

C. Energy Outcomes for Customers

D. Step Change in Productivity

E. Operational Transformation

Significant value can be added by deploying use cases across the above five key themes, which can be enabled through digital technologies. The table below lists down some of the use cases that have been piloted and experimented by companies:

Theme	Potential Use Cases	Digital Technologies
A. Intelligent Asset Management and Safe Operations	1. Asset Collaboration and Remote Monitoring using Digital Twin	Cloud and IoT
	2. Predictive Asset Health Monitoring	IoT
	3. Real Time Energy Monitoring	IoT
	4. Intelligent Workplace and Safety Compliance	Machine Learning
	5. Connected Aviation Refueling	IoT
B. Collaborative and Ecosystem Based Approach	1. Real Time Fleet Monitoring	IoT & Advanced Analytics
	2. Crude Quality Provenance	Blockchain
	3. Joint Venture Management	Blockchain
	4. Bank Guarantee Management	Blockchain
C. Step Change in Productivity	1. Invoice and Payment Matching	Machine Learning
	2. Employee Queries	AI & Chatbot
D. Energy Outcomes for Customers	1. Customer Support and Service	ML, AI & Chatbot
	2. Connected Cylinder	IoT
E. Operational Transformation	1. Subsurface Data Analysis	Advanced Analytics
	2. Rig Schedule Optimization	Advanced Analytics
	3. Well, Reservoir and Facility Management	Big Data Analytics
	4. Predicting Loss in Production	Machine Learning

Organizations may differ in their digital maturity level and hence the start point of digital adoption. However, a practical a practical approach could be the analysis of these possible initiatives on 2 key parameters – value that can be delivered and the feasibility of deployment considering the maturity of the underlying digital technology and the organizational readiness. This resultant view can help companies to plan their approach better.

Clearly, IoT related use cases fall under the high feasibility zone considering the maturation of the technology and the widespread awareness on it. Same holds true for advanced analytics as well.

An important point to note is the reasonable feasibility of some of the use cases pertaining to ML and AI. While both these technologies are relatively less commercialized, the entry barrier here is low. Unlike IoT, where sensors, communication and data transfer are key elements, for ML and AI no such efforts are required. They can thrive on the latent data that most of the organizations already have – transactional information, call data records of interaction with customer and suppliers, unstructured social data etc. A case in point could be the matching of payments received from B2B customers against their open invoices. In general, this has been a rule driven exercise, however, with machine learning it can be made more accurate and self-improving based on the historical data and constant learning

Case Studies

1. Case Study - Worker Health through IoT

Challenge - One of the world's largest oil extraction, exploration, production, and refinery company was looking to improve worker safety at one of its facilities, including the health and medical testing of workers prior to shift activity. Due to the number of workers (80-120) for each shift, they needed a solution to automate as much of the process as possible and minimize testing time.

How They Did It - The solution leveraged a cloud platform, self-serve medical test stations, and IoT sensors. Before each shift, workers initiate a self-test at the medical station, using an ID card to verify their identity. The medical station gathers blood pressure, pulse, and body temperature, followed by a breath test (for alcohol) and a visual stimuli system to track user pupil response (for tiredness, depression, and drug use). After each worker's self-test, the data is sent to a doctor's workstation to track worker health, as well as to identify health issues that need to be addressed.

Business Impact - The entire self-test process now takes around 90 seconds. This was a dramatic improvement over the prior system, which required four trained paramedics and took up to 5 minutes per worker. It has also resulted in a more proactive health plan for treatment on health issues for workers supported by corporate

HR by delivering ongoing monitoring that could identify and track ongoing issues more efficiently.

2. Case Study - Digital Refinery

Challenges - A multi-national oil and gas company based in the Middle East had a vision to undertake a digital transformation initiative to improve flexibility, agility, and responsiveness for quickly implementing product changes based on changing global market demand for their products.

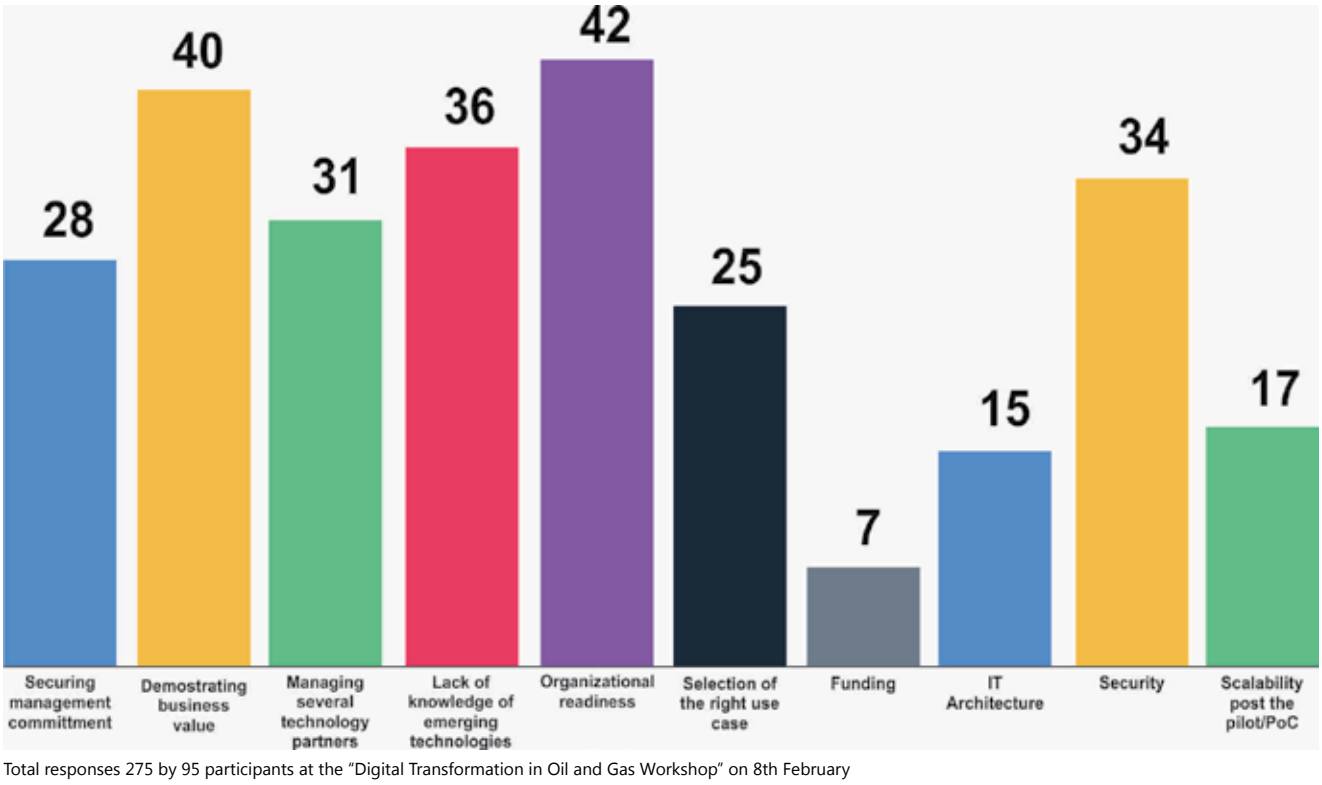
How They Did It - In collaboration with its technology partner, the company developed a model of an entire digital refinery operation that provided comprehensive visibility into operations.

The ultimate solution was based on a cloud platform, supporting "unit-wise product costing", which helped reduced the number of operational systems by 50 percent. Core business apps, supporting Big Data and analytics, human capital management, finance, cash management, and business intelligence were implemented, along with an automated disaster recovery solution.

Benefits - The completed project delivered solid results, improving overall agility to make quick changes to planned product development, aligning with global market demands for the refinery. In addition to improving operational visibility and efficiency, the company estimates it saves approximately US$4 million annually due to this new solution. The company has also realized improvements to its real-time inventory and lifting schedule, which improved overall satisfaction.

Recommendations and Way Forward

Digital transformation is not a technology led initiative, rather it needs to be addressed as a business transformation project, where technologies will just play an enabling role. In that sense, it becomes important for organizations to approach it holistically covering multiple areas. As part of the survey done with the participants of the workshop on digital transformation for oil and gas industry by FIPI, it was felt that there are many challenges which organizations should watch out for. **Organization readiness, demonstrating business value** and l**ack of knowledge of emerging technologies** appeared to be the top 3 ones as shown in the graphics



Total responses 275 by 95 participants at the "Digital Transformation in Oil and Gas Workshop" on 8th February

Some of the key points, which will help oil and gas companies in managing digital transformation projects effectively are:

- Support from the senior management for transformation
- Systematic way of undertaking digital/innovation projects. Creation of a team and identification of a set of people, usually from functional IT background to be the torch bearers of digital projects
- A dedicated fund to support digital led innovations, which is different than IT budgets.
- Skillset of the people need to be augmented. There should be a training and education support on new technologies for the existing team members from IT teams on new technologies. Capacity building as part of the transformation approach
- Large-scale enablement for all the employees to make them aware of the possibilities with the new technologies.
- Crowd sourcing from the business teams through a portal to get the list of ideas/use cases from the business teams. Change management and empathy led discoveries
- Cloud is a reality and needs to be explored. There should be a team focused on assessment of cloud as an accelerator and cost-effective way for deploying digital innovations without compromising sensitive information.
- Cybersecurity should be added as a focus area within the IT team
- Economics of the solution – ROI/business case needs to be very clear and should be created for each of the digital interventions

Summary

Oil and Gas sector is at the cusp of transformation in India. Growing domestic energy demand, entry of global super majors and commercialization of digital technologies presents enormous opportunities to get the industry transformed. Intelligent asset management and safe operations, collaborative ecosystem-based approach and outcomes for customer are some of the areas where digital technologies can make a game changing impact. However, this transformation can't be achieved with internal organizational efforts alone, favorable policy framework and support from the regulatory bodies are a must to make it happen. To start with, use cases based on IoT and machine learning appear low hanging initiatives, which can deliver business value. Organizations can chart out their roadmaps to cover a set of initiatives based on the guidance provided in the article by looking at key areas, capturing the value that could be delivered and assessing the feasibility of deployment

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GAS

Making Gas a Viable Option in Power Generation

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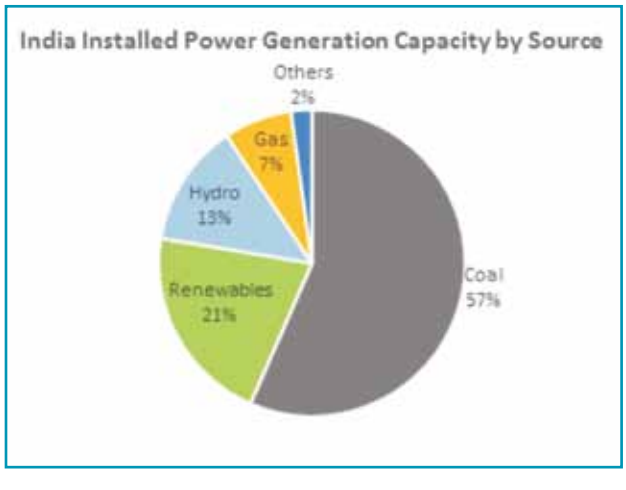
India is today one of the fastest growing energy markets in the world. Driven by its thriving economy, rapid industrialization and pressing needs to deliver electricity and clean cooking fuel to large section of its population, BP Energy Outlook 2019 predicts, India will emerge as the World's largest energy growth market, surpassing China by the mid-2020s. The alarming air quality levels across all major cities in the country and an ambitious Intended Nationally Determined Commitments (INDC) has brought an unprecedented push to renewable sources and natural gas. To achieve the Prime Minister's vision of shifting towards a gas based economy, a flurry of forward looking policy interventions have benefitted the upstream and downstream segment of natural gas.

The idea of creating a gas based economy implies that the gas consumption in each consuming sector must grow. In India there are two major anchor consuming sectors of natural gas – fertilizers and power. Both these sectors are extremely price sensitive in nature. While gas consumption from the fertilizer sector has witnessed a robust growth, the gas based power generators in the country are struggling to compete with coal and renewables. The BP Energy Outlook 2019 suggests that power sector has the potential to provide an unparalleled boost to natural gas consumption in India. However, due to extreme price sensitivity of the power sector, Government is forced to explore incremental gas demand from other segments viz a viz transport, Piped Natural Gas (PNG) etc. As a result, the underutilization of gas based power plants have turned them into stressed assets only to worsen the ongoing Non Performing Asset (NPA) crisis.

Introduction to Indian Power Sector

India has a net installed power generation capacity of over 349 GWs. The fuel mix for power generation in the country is dominated by coal (56.5%) followed by renewables (21.2%) and hydro (13%). India also has 24.9 GWs of natural gas based capacity, which constitutes roughly 7.2% of the total power generation capacity.



The present power generation mix of the country is heavily skewed towards coal because of the low generation cost of coal based power. Coal based power is produced at a levelized cost of Rs 2.5 – 3 per unit along with an additional carbon tax of Rs 0.14 per unit. Cost of Gas based power produced from imported LNG amounts to Rs 4.5 – 5 per unit. About 85 per cent of the coal based power plants in the country are based on sub-critical boiler technology and have a low efficiency of 35 per cent. This has led to a low carbon efficiency of coal based plants, producing 1100 g of CO2 per unit of power produced in India against a 600 g produced from gas based power plants. The above cost of coal based power does not take into account the externalities due to emissions, climate change, deaths and health issues amongst miners. International environmental studies indicate that the cost of externalities of coal based power plants in India is ~ Rs 5.4 per unit. This cost of externalities when added to the cost of power production from coal gives an overall cost of Rs 8 – 8.5, much higher than an overall cost of Rs 5 – 6 per unit for gas. For India to keep up with its emission reduction targets, it is imperative that natural gas plays a more significant role in the country's power mix.

Under-Utilization of Gas Based Power, Leading to NPAs

More than half of India's gas based power generation capacity is presently not being used and is on the verge of becoming a non-performing assets. According to a 2018 report of the Standing Committee on Energy, the country has over 14 GWs of natural gas based power generation capacity that is stranded due to non-availability of domestic gas and high cost of imported LNG. India has 25 GW of gas based power generation capacity with an estimated gas demand of 42 Bcm/Yr (at 85% PLF). In 2017 – 18, gas based plants received 12 Bcm of natural gas .i.e. less than 30 per cent of its requirements. Due to unavailability of natural gas, the Plant Load Factor (PLF) of gas based power plants in the country have shrunk from ~43 per cent in 2010 – 11 to a mere 22 per cent in 2017 – 18. To alleviate this situation, the Government had launched the E-RLNG scheme in March 2015 but was forced to discontinue the scheme in 2017, after just two rounds, due to aggressive bidding by companies.

The low utilization of gas based power plants have placed the investment of over USD 15 billion in these plants at risk. The sub-optimal returns from these plants have presented a concerning Non-Performing Asset (NPA) situation for the country. Further, less gas flow to these gas based power plants have led to low utilization of gas pipelines, which in turn have affected the financial returns of cross country pipeline projects. The low return on investment is adding to the financial risks of the LNG importer and posing a major challenge to all upcoming pipeline projects in the country, delaying the completion of a National Gas Grid. Doing away with the impending NPA situation and making gas based power plants an integral part of the India's power mix will require innovative application supported by targeted policy interventions by the Government. In this regard, the following could be considered:

1. **Integrating Gas Based Power with Renewables**

   India presently has over 74 GWs of renewable based power generation capacity. The variability and uncertainty of renewable based capacity presents the opportunity for gas based power to address peak demand situations and grid balancing. The presently under-utilized gas based power plants have ample capacity available to be utilized for grid balancing purposes.

   The power supply - demand gap arising from peak demand during the evening hours and a shortfall of renewable power could be addressed by running existing gas based power plants at a high PLF for a period of four to six hours in the evening. While during rest of the day these plants could run at moderate PLFs. Most of the gas based power generation capacity in the country is combined cycle based, which could be ramped up to 85 per cent PLF within a period of 30 minutes unlike its coal based counterpart, which takes a longer time in ramping up and has serious environmental implications.

2. **Replace Diesel Generators with Gas Based Power in Industries**

   To ensure reliable and continuous power supply, most industrial units have diesel generators to provide back power supply. The cost of generation

of these diesel generators is in the range of Rs 14 – 16 per unit and the generation process includes heavy emissions. The Government should look into introducing a policy for industries to replace diesel generators with comparatively cheaper grid connected gas based power.

3. Using NCEEF to Support Gas Based Generation

Over the period 2010 – 11 to 2017 – 18, Rs 86,440 Crores was collected as carbon tax. Out of this the National Clean Energy & Environment Fund (NCEEF) received Rs 29,645 Crores. This fund needs to be used to support the ailing gas based power plants in the country. In this direction, a parliamentary panel has also recommended for use of NCEEF to provide financial support to stressed gas power plants. Also, the Supreme Court of India has directed that the clean energy cess collected till July 1, 2017, must be used only for environmental purposes.

4. Revival of E-RLNG Scheme

The Government of India is considering a gas allocation mechanism by pooling ONGC deep sea gas with LNG and subsidizing the tariff to revive the over 14 GWs of presently stressed gas based assets. At a regasified LNG price of USD 9/MMBTU, power from pooled gas can be generated at ~ Rs 5.9 per unit. With a Government subsidy on tariff of Rs 1.5 – 2 per unit, the gas based power could be made affordable.

EXPLORATION & PRODUCTION

Flow Assurance Challenges vis-a vis Organic Deposition in E&P Industry

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ABSTRACT

Flow Assurance, by definition, refers to ensuring successful and economical flow of hydrocarbon stream from reservoir to the point of sale. In the upstream sector, Flow Assurance is the application of multiple disciplines to ensure economic rates of flow from the hydrocarbon reservoir to a production facility over the life of a field and in any environment.

Flow Assurance involves effectively handling the solid deposits which create hindrances to the smooth flow of hydrocarbons and in severe depositions may even cease their flow. Paraffins (or wax) and asphaltenes are constituents of most crude oils. Deposits of paraffin or asphaltenes in surface equipment and downhole are a major problem in production operations. Severity of deposition varies widely, depending on crude oil composition, well depth, formation temperature, pressure drop, and producing procedures. The conditions that impede flow are so diverse that the same flow assurance solution may not be applicable under all conditions. Sometimes, the solution may a chemical treatment whereas at other times there may be a mechanical solution to the problem. Sometimes a combination of these remedies may also be used. The modern approach to Flow Assurance is a more proactive one, where data monitoring is used to feed into dynamic production models that enable prediction of flow problems in sufficient time to take mitigating action.

Therefore it may be construed that Flow Assurance is a multi-disciplinary activity involving a number of engineering disciplines including mechanical, chemical, instrumentation and software engineering. With declining conventional oil reserves, unconventional oil fields in deeper horizons are being developed with complex fluid properties. The financial loss from production interruption or asset damage due to a flow assurance mishap can be astronomical in these cases.

This article discusses the various flow assurance problems caused by organic deposition in the E&P industry and the possible ways of mitigating the same. This article is based on the invited talk on "Flow Assurance Challenges" delivered in the "FIPI R&D Conclave 2018" held on August 22-24, 2018 at Goa.

INTRODUCTION

In the E&P (Exploration and Production) Industry, the term 'Flow Assurance' means ensuring uninterrupted flow of hydrocarbons from the reservoir to the refinery. Flow Assurance involves the application of multiple disciplines to maintain optimum and economic rates of flow throughout the life of a reservoir.

One of the major objectives of Flow Assurance is dealing with the risks and problems arising from

the properties and behaviour of the produced hydrocarbons, associated fluids and solids. Therefore, it involves effectively handling many solid deposits, such as Paraffins, Asphaltenes, Scales, Gas hydrates etc. which precipitate during hydrocarbon production in the down-hole and surface equipment like tubing, flow-lines, separators, pipeline etc. These deposits impede the flow of hydrocarbons causing decline in production. In case of severe deposition, the tubing or pipeline may get plugged causing loss in production. In such a scenario, the entire pipeline or a portion of it may have to be replaced or a well intervention job may be required to be carried out to revive the flow. Thus, the E&P companies end up incurring huge losses due to loss of production and subsequent remedial operations caused by Flow Assurance problems in the field. This also adversely effects lifting cost of crude oil and thereby economics of the company.

Deposition of Paraffins and Asphaltenes is one of the major causes of flow assurance problems being encountered in the oil industry. These are the high molecular weight components of petroleum fluids which may get deposited in surface facilities, pipelines, tubing and in the reservoir. These deposits also contain resins, crude oil, fines, scale and water. A lot of effort is put in to keep the tubing and flow-lines free from Paraffin and Asphaltene deposits. A huge amount of revenue is lost annually due to well downtime, fishing jobs, manpower and equipment deployed etc. as a result of deposition problems.

DEPOSITION MECHANISM

The heavy organic deposits commonly associated with the production of crude oil are mostly a mixture of Paraffins and Asphaltenes. Paraffins and Asphaltenes are the constituents of most crude oils. Paraffins are usually the major component of these deposits, which are alkanes of relatively high molecular weight. Asphaltenes on the other hand are the black components present in the crude oil having also relatively high molecular weight. They consist of polycyclic, condensed, aromatic ring compounds and may have oxygen, sulphur, nitrogen and various metals in their molecular structure. They are usually polar compounds soluble in organic solvents but insoluble in petroleum distillates like diesel and kerosene. Resin is another component of crude oil which has a bearing on the tendency of Asphaltene deposition. Resins are structurally similar to Asphaltenes, but are less polar, less aromatic and have lower molecular weight as compared to Asphaltenes. Several studies have suggested that a high resin content stabilizes the asphaltenes in the crude oil, thus inhibiting its deposition tendency.

The most common cause of Paraffin deposition is the lowering of crude temperature below the WAT (Wax Appearance Temperature or Cloud Point) of the crude oil. Below the WAT the wax crystals precipitate in the crude oil and get deposited inside the tubing, flow-lines and other equipment. During the course of its production from the bottom of the well to the surface, the crude oil gets cooled by losing heat to the surrounding formations as it travels upwards through the tubing. There may also be additional temperature drop due to the cooling produced as a result of the associated gas expanding, cooling produced by the dissolved gas being liberated, change in temperature caused by intrusion of water, loss in volume and change in temperature due to vaporization of the lighter components in the crude. The crude oil may further encounter cooling in the flow-lines and pipelines due to cold ambient conditions. All these conditions contribute to paraffin deposition. Asphaltene deposition on the other hand takes place primarily due to reduction in the system pressure. Asphaltene deposition is less widespread as compared to paraffin deposition. However, it can cause severe flow assurance problems in crude oils with high asphaltene content. Even in lower concentrations, asphaltenes that precipitate from the crude oil act as a nucleating agent for paraffin crystals to agglomerate. These agglomerates may then separate from the crude oil and get deposited in a well's producing system.

The severity of paraffin or asphaltene deposition vary widely due to difference in crude oil composition, well depth, reservoir and down-hole pressures and temperatures, production strategy, ambient conditions and many other factors. Moreover, the measures adopted for removal or prevention of organic deposition that are effective in one well may not be applicable in a well from a different reservoir or even in a different well from the same reservoir.

FLOW ASSURANCE CHALLANGES

The first challenge in dealing with a flow assurance problem is having a comprehensive understanding of the composition of the produced fluid in terms of API gravity, gas/oil ratio, composition etc. Representative samples of the reservoir as well as produced fluids are taken for carrying out laboratory tests to determine the PVT (pressure – volume - temperature) properties, compositional analysis, physical fluid properties (API gravity and pour point), wax and asphaltene content etc. However, reservoirs are not generally homogeneous. Many of the

reservoirs usually have varying compositions with lighter fluids at the top and heavier fluids at greater depths. The produced fluid is usually a mixture of the light and heavy ends with their proportions varying throughout the producing life of a well. As a result, a well which do not have any flow assurance problems may encounter problems during the later stage in in its life.

Another challenge is to ensure that the system pressure and temperature are maintained such that the conditions are not favourable for precipitation and deposition of any organic matter. However, over a period of time, as the production from a reservoir depletes, there will be a change in the reservoir pressure, fluid characteristics, flow rate, flowing pressures and temperature etc. Therefore, the measures taken for ensuring flow assurance based on initial flow characteristics may have to be reconsidered under such dynamic conditions. Some of the measures adopted for removal of organic deposits are time consuming and labour intensive. Under such changing conditions, the deployment of manpower and resources in an optimum manner pose a major challenge to the field personnel.

TECHNOLOGIES USED FOR FLOW ASSURANCE IN THE E&P INDUSTRY

There are various methods which are adopted for removal of wax or asphaltene deposits from the downhole and surface equipment. The most common methods include application of mechanical means, heat, chemicals and microbial treatment. These methods are briefly discussed below.

1. Mechanical

The mechanical methods include mechanical scrapping, pigging etc. Scrappers and cutters are most commonly used to remove deposits from the tubing. These tools are usually run into the well manually through a wireline unit when the well is in flowing condition. The cuttings are thus removed by the crude coming out from the wellhead. This is a relatively economical technique and is hence, widely used. However, it is a labour intensive technique and needs to be repeated at regular intervals (daily, alternate day, weekly etc.) depending upon the severity of deposition. In this method there is risk of the scrapping tool getting stuck inside the tubing causing undesirable fishing in the well, which may lead to cost intensive fish recovery operation and hampering the production of the well.

Pigging technology is another very popular mechanical method of removing deposits from pipelines and flow-lines. The lines are scrapped by forcing pigs through them. The pigs are soluble or insoluble plugs which remove the deposit build up in the lines as they travel through them. The soluble plugs are made of microcrystalline wax or naphthalene, which dissolve over a period of time. The insoluble pigs are usually hard rubber or sharp edged plastic spheres. There are also Smart / Intelligent Pigs which act as Pipeline Inspection Gauges. These are fitted with sensors which can gather data which helps to determine the health and integrity of pipelines. However, severe deposition in the pipeline may cause the pig to get stuck inside the pipeline. Retrieving a stuck pig from the pipeline is again a very time consuming and labour intensive job.

Organic deposits seen in the cross-section of a cut-out portion of a pipeline

2. Thermal

Among the thermal methods, hot oiling using LWC (Low Wax Crude) with or without solvents is a popular method of removing deposits from the wells and flow-lines. Hot oil is circulated in the well either through the annulus and up through the tubing in case of open completions or by using a Coil Tubing Unit (CTU) which carry the hot oil down-hole and then it rises up through the annulus between the tubing and coil tubing in case of wells with packer completions. Paraffin

is melted and dissolved in the hot oil making this an effective method for removal of wax deposition. Steam injection is another thermal method carried out to melt the deposits in the tubing and flow-lines. For both these methods, down-hole applications have to be carried out carefully because the melted paraffin may be forced into the formation resulting in plugging the perforations.

Coil Tubing Unit used for hot oil circulation in the tubing

The use of Electrical Bottom hole heaters to raise crude temperature is another thermal method of preventing paraffin deposition in the tubing. This method allows the paraffin crystals in the crude to melt and dissolve into the crude and thus prevent them from depositing in the walls of the tubing. Another alternate method at development stage is use of heating cables in the tubing. The heating cables are lowered inside the production tubing string to maintain the temperature of the crude above the crystallization temperature of paraffins and asphaltenes. The heat is generated from electrical power supplied from an overhead power line or generated by a gen set at the surface. Power supply may be a daunting task in case the wells are located in far-flung areas.

Temperature drop of the crude from the reservoir to the well head is the most important contributing factor for paraffin deposition in the tubing. To minimize this heat loss, use of Thermally Insulated Tubing is a method to minimize the heat loss due to conduction. Another method is using Thermally Insulating Packer Fluids in the annulus to minimize the heat loss due to radiation. These are usually high gel strength fluids that are placed in the annulus using a hot oil circulation unit. This method is applicable for self-flowing packer-less wells or in wells completed with packer and sliding sleeve.

For flow assurance in flow-lines and pipelines indirect heaters are used to prevent deposition of paraffin in the horizontal flow regime of crude oil. The crude is heated indirectly through a bath (filled with water or glycol) as opposed to being directly heated by a flame or furnace. The use of Indirect Heaters helps to maintain the crude temperature above the WAT and prevent paraffin deposition in the flow-lines and pipeline where they are used.

Indirect Heaters used to maintain elevated line temperatures

3. Chemical

The chemicals used in mitigating deposition problems include solvents, dispersants, Flow Improvers, Pour Point Depressants (PPD), inhibitors etc. A combination of two or more chemicals is also used. Solvents are commonly used to clean well bore deposits. Paraffins get easily dissolved in most condensates, kerosene or diesel and as such they are used in wells with low asphaltene content in the deposits. For asphaltene deposits, aromatic solvents like xylene, toluene or condensates containing aromatic components are used. One of the methods of application of solvents is to circulate the solvent down the annulus and back through the tubing or circulating it inside the

tubing using a coil tubing unit. Another method is soaking the deposits with the solvent for a period of time. This procedure is usually preferred if the formation is plugged with deposits. Solvents are also used to remove deposits from flow-lines and pipelines. The recipe for the treatment is mostly designed in the laboratory based on the characteristics of the deposits and its solubility in various solvent combinations.

Apart from the solvents, the other chemical additives like dispersants, flow improver, PPD, paraffin / asphaltene inhibitors etc. are injected into the crude in small doses. Ideally, chemical injection in the well is carried out with the help of a chemical injection mandrel installed in the tubing at a desired depth.

A chemical injection set-up

4. Microbial

PDB (Paraffin Degrading Bacteria) are used for microbial degradation of paraffin deposition in the tubing. The bacteria used for this purpose is capable of surviving the high temperature in the oil wells and degrade the paraffins under low oxygen (anaerobic) and nutrient conditions. The PDB are ideally isolated from the bacteria in the reservoir or its surrounding environment as they are already known to be compatible in the harsh well conditions. Mass cultivation of the bacterial consortium comprising of the bacteria required for the mitigation of the paraffin deposition problems is carried out. The tubing of the well is filled up with the PDB and nutrients and well is shut-in for a considerable period (usually a couple of weeks or more). This allows sufficient time for the bacteria to degrade the paraffin deposits in the tubing and the crude flows freely when the well is put back on production.

Paraffin degradation observed after microbial treatment in the laboratory

MODELLING FOR PREDICTION OF ORGANIC DEPOSITION

Multiphase fluid flow modelling with the help of software has emerged as an important tool for simulating actual field conditions to find flow assurance solutions. The entire network of wells and pipelines can be modelled with software. These models help in identifying bottlenecks in the network, which can lead to rise in well head pressure adversely affecting the production. Transient simulation of the system is also possible which can predict time-varying changes in flow rates, fluid compositions, temperature, solids deposition etc. These studies can help in taking preventive measures in cases where organic deposition is predicted. Softwares like Pipesim, Olga and Pipe-line Studio etc. are used in the Industry for modelling purposes.

CONCLUSION

Flow Assurance is a major challenge ailing the Oil and Gas industry. It has a direct bearing on the economics of oil companies. Experts from various disciplines are involved in finding solutions to the Flow Assurance problems that are being encountered in the field. Worldwide, the conventional oil reserves are on the decline and easy oil is dwindling. As deeper reserves are being explored the oil finds are more paraffinic and asphaltic. The oil fields that are now being developed using the latest technologies available are throwing up more challenges in terms of Flow Assurance. Heavy and high pour point oil and oil with high asphaltene deposition tendency are being produced. Thus, it may be concluded that flow assurance will continue to play a major role in crude oil production in the foreseeable future.

SAFETY

Behaviour Based Organisation Safety
A New Approach to Achieve Excellence in BBS

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Abstract

Most of the post accident investigations in the root cause analysis revels that for past few decades finds inappropriate work place behavior at the top most cause for incidents. Industry has worked hard and has evolved various methods to improve behavior based safety of employees at work place. However in terms of Excellence in Safety, Industry has still not been able to get into Zero incidents and Zero Accidents stage. In this article internet based information on the various theories in vogue have been discussed along with their limitations and a new theory of Behaviour Based Organisation Safety (BBOS) has been propounded.

Keywords: Behaviour based Safety (BBS)

Introduction

Behaviour can be defined as an action by an individual that is observable by others. Human Behavioural psychology, is based on the Learning Model theory as per this all Behaviours are acquired through conditioning. Conditioning occurs through interaction with the environment. Behavioural scientists believe that our responses to situational stimuli shape our ultimate Behaviour.

It's estimated that that 70- 80 per cent of accidents at work place is attributed to unsafe Behaviour of workers at work place. There are many reasons why workers engage in risky Behaviour at work. Post incident Root cause analysis revels this as the most common factor. Some may subscribe to inappropriate unsafe Behaviour due to ergonomic factors, work monotony, fatigue, lack of motivation, lack of team spirit, lack of trust in team members, pre-conceived notions, lack of appreciation of risk for self and others, lack of training, lack of skills, multitasking beyond capacity, etc

We all are aware of the safety triangle approach to correlate frequency with severity of injuries using accident triangles. The traditional safety triangle shows that as severity decreases, frequency increases. It's simple to extend the triangle to include near misses and unsafe Behaviours.

There are more major injuries than fatalities, more first aid cases than over-three-day injuries, and more near misses and at-risk Behaviours than incidents of all kinds.

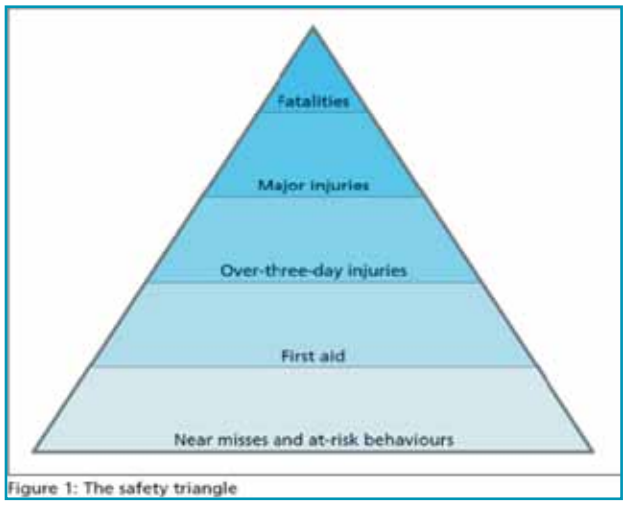


Figure 1: The safety triangle

At-risk Behaviour is an early warning system for accidents. The key to reinforcing safe Behaviours (good habits) and removing or reducing unsafe ones (bad habits) lies in identifying those Behaviours which are critical to safety and then in carrying out regular observations to monitor them. It's therefore a proactive safety management tool, with the information being obtained without anyone being hurt.

Theories of Behaviour interventions

The Behaviour interventions theories have evolved from 1950 onwards. The important theories which influence modern Safety Behaviour interventions are as given below:

1. Health Belief Model
2. Social Cognitive theory
3. Diffusion of Innovation Theory
4. Transtheoretical Model
5. Theory of Planned Behaviour
6. Social norms theory
7. Behaviour Change Wheel theory
8. Classical model for BBS

1. Health Belief Model (HBM)

This theory was developed in the early 1950s by social scientists at the U.S. Public Health Service in order to understand the failure of people to adopt disease prevention strategies or screening tests for the early detection of disease. An individual's course of action often depends on the person's perceptions of the benefits and barriers related to health Behaviour.

Limitations of Health Belief Model

a) It does not account for a person's attitudes, beliefs, or other individual determinants

b) Behaviours that are habitual and thus may inform the decision-making process to accept a recommended action (e.g., smoking).

c) Does not account for Behaviours that are performed for non-health related reasons such as social acceptability.

d) It does not account for environmental or economic factors

e) It assumes that everyone has access to equal amounts of information

f) It assumes that cues to action are widely prevalent in encouraging people

2. Social Cognitive theory

Social Cognitive Theory (SCT) started as the Social Learning Theory (SLT) in the 1960s by Albert Bandura. It developed into the SCT in 1986 and posits that learning occurs in a social context with a dynamic and reciprocal interaction of the person, environment, and Behaviour. The unique feature of SCT is the emphasis on social influence and its emphasis on external and internal social reinforcement. The past experiences influences reinforcements, expectations, and expectancies, all of which shape whether a person will engage in a specific Behaviour and the reasons why a person engages in that Behaviour.

Limitation of Social Cognitive Theory

a) Assumes that changes in the environment will automatically lead to changes in the person.

b) Loosely organized, based solely on the dynamic interplay between person, Behaviour, and environment.

c) Depends on processes of learning and in doing so disregards biological and hormonal predispositions

d) Focus on emotion or motivation, other than through reference to past experience.

e) Is broad-reaching, so can be difficult to operationalize in entirety.

3. Diffusion of Innovation Theory

This theory is also used to understand consumer behaviour. Diffusion of Innovation (DOI) Theory, developed by E.M. Rogers in 1962, is one of the oldest social science theories. It originated in communication to explain how, over time, an idea or product gains momentum and diffuses (or spreads) through a specific population or social system. The end result of this diffusion is that people, as part of a social system, adopt a new idea, Behaviour, or product. Adoption means that a person does something differently than what they had previously (i.e., purchase or use a new product, acquire and perform a new Behaviour, etc.). The key to adoption is that the person must perceive the idea, Behaviour, or product as new or innovative. It is through this that diffusion is possible.

When promoting an innovation, there are different strategies used to appeal to the different adopter categories.

a) Innovators - These are people who want to be the first to try the innovation

b) Early Adopters - These are people who represent opinion leaders.

c) Early Majority - These people are rarely leaders, but they do adopt new ideas before the average person.

d) Late Majority - These people are skeptical of change, and will only adopt an innovation after it has been tried by the majority.

e) Laggards - These people are bound by tradition and very conservative.

The stages by which a person adopts an innovation, and whereby diffusion is accomplished, include awareness of the need for an innovation, decision to adopt (or reject) the innovation, initial use of the innovation to test it, and continued use of the innovation.

Limitations of Diffusion of Innovation Theory

a) Including the adopter categories, did not originate in for Behaviours change or health innovations.

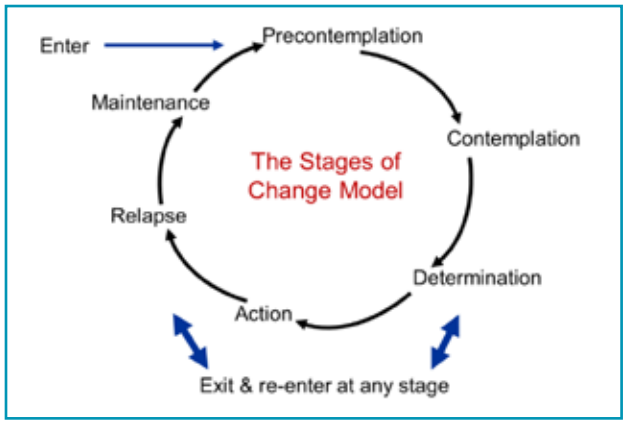
b) It does not foster a participatory approach

c) It works better with adoption of Behaviours rather than cessation or prevention of Behaviours.

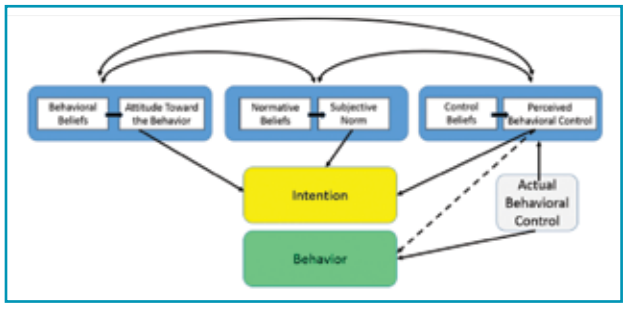
d) It doesn't take into account an individual's resources or social support to adopt the new Behaviour (or innovation).

4. Transtheoretical Model

The Transtheoretical Model (also called the Stages of Change Model), developed by Prochaska and DiClemente in the late 1970s, evolved through studies examining the experiences of smokers who quit on their own with those requiring further treatment to understand why some people were capable of quitting on their own. It was determined that people quit smoking if they were ready to do so. Thus, the Transtheoretical Model (TTM) focuses on the decision-making of the individual and is a model of intentional change. The TTM operates on the assumption that people do not change Behaviours quickly and decisively. Rather, change in Behaviour, especially habitual Behaviour, occurs continuously through a cyclical process with different stages.



Limitations of the Transtheoretical Model a) It ignores the social context in which change occurs. b) The stages can be arbitrary with no set criteria of how to determine a person's stage of change. c) There is no clear sense for how much time is needed for each stage, or how long a person can remain in a stage. d) The model assumes that individuals make coherent and logical plans in their decision-making process when this is not always true. 5. Theory of Planned Behaviour The Theory of Planned Behaviour (TPB) started as the Theory of Reasoned Action in 1980 to predict an individual's intention to engage in a Behaviour at a specific time and place. The theory was intended to explain all Behaviours over which people have the ability to exert self-control. The key component to this model is Behavioural intent; Behavioural intentions are influenced by the attitude about the likelihood that the Behaviour will have the expected outcome and the subjective evaluation of the risks and benefits of that outcome.



Limitations of the Theory of Planned Behaviour

a) Assumes the person has acquired the opportunities and resources to be successful in performing the desired Behaviour, regardless of the intention.

b) It does not account for other variables that factor into Behavioural intention and motivation.

c) Does not take into account environmental or economic factors that may influence a person's intention to perform a Behaviour.

d) It assumes that Behaviour is the result of a linear decision-making process, and does not consider that it can change over time.

e) It doesn't say anything about actual control over Behaviour.

f) The time frame between "intent" and "Behavioural action" is not addressed by the theory.

6. Social Norms Theory

The Social Norms Theory was first used by Perkins and Berkowitz in 1986 to address student alcohol use patterns. As a result, the theory, and subsequently the social norms approach, is best known for its effectiveness in reducing alcohol consumption and alcohol-related injury in college students. The approach has also been used to address a wide range of public health topics including tobacco use, driving under the influence prevention, seat belt use, and more recently sexual assault prevention.

- This theory aims to understand the environment and interpersonal influences (such as peers) in order to change Behaviour, which can be more effective than a focus on the individual to change Behaviour. Peer influence, and the role it plays in individual decision-making around Behaviours, is the primary focus of Social Norms Theory. Peer influences and normative beliefs are especially important when addressing Behaviours in youth. Peer influences are affected more by perceived norms (what we view as typical or standard in a group) rather than on the actual norm (the real beliefs and actions of the group). The gap between perceived and actual is a misperception, and this forms the foundation for the social norms approach.
- The Social Norms Theory believes that our Behaviour is influenced by misperceptions of how our peers think and act. Overestimations of problem Behaviour in our peers will cause us to increase our own problem Behaviours; underestimations of problem Behaviour in our peers will discourage us from engaging in the problematic Behaviour. Accordingly, the theory states that correcting misperceptions of perceived norms will most likely result in a decrease in the problem Behaviour or an increase in the desired Behaviour.
- Social norms interventions aim to present correct information about peer group norms in an effort to correct misperceptions of norms. In particular, many social norms interventions are social norms media campaigns where misperceptions are addressed through community-wide electronic and print media that promote accurate and healthy norms about the health Behaviour.

Limitations of the theory include the following:

a) Participants of an intervention focused on social norms are likely to question the initial message being presented to them due to misperceptions they hold. Information must be presented in a reliable way to correct those misperceptions.

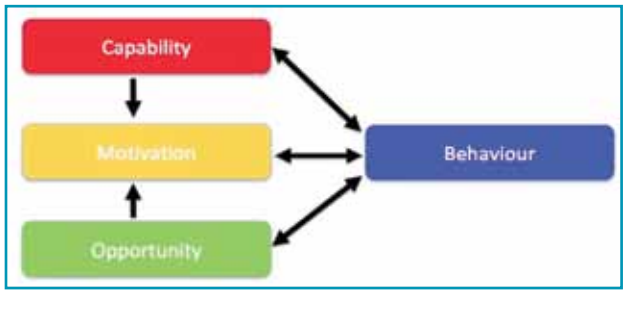
b) Poor data collection in the initial stages can lead to unreliable data and poor choice of normative message. This can undermine the campaign and reinforce misperceptions.

c) Unreliable sources, or sources that are not credible to the target population, can result in an unappealing message that undermines the campaign, even if the message is correctly chosen.

d) The dose, or amount, of the message received by the target population must be enough to make an impact, but not too much that it becomes commonplace.

7. Behaviour Change Wheel (BCW) theory

Dr Claire Williams, consultant, Human Applications and a Visiting Fellow in Human Factors and Behaviour Change at the University of Derby. She was the Principal Investigator on the IOSH funded project 'Measuring the impact of Behaviour change techniques on break taking Behaviour at work'. Co-authored an article with Margaret Hanson in SHP magazine about Behaviour change in a health and safety context (Just one more thing, SHP, July 2013). In the article, one model in particular – the COM-B (1) – which was liked by the author for its elegance and simplicity and which she valued for the research base from which it is drawn. The model is the central core of the Behaviour Change Wheel (BCW) discussed below.



As Figure below shows that the COM-B points that three things are required for a Behaviour to take place: the capability (physical and/or psychological); the motivation (both reflective and automatic); and the opportunity (which might be physical and/or

social). Behavioural safety has wrongly been billed as the panacea for all behavioural issues, the critics observations are:

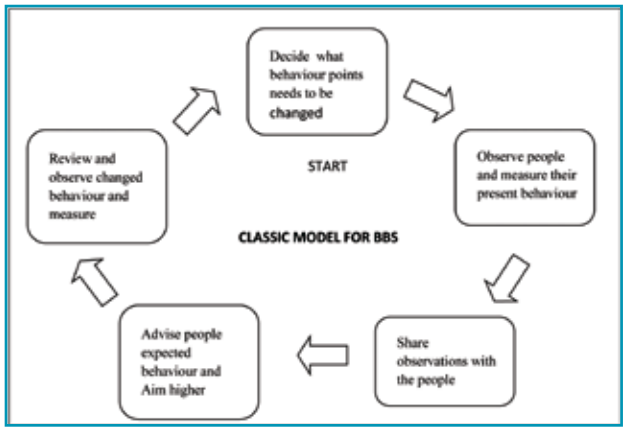
- Treat people like commodities or like animals. In some Behavioural programmes Organisations try to manipulate workers into behaving in certain ways and then blame them for getting it wrong; neglecting to consider the system or Organisational failures that supported those Behaviours.
- Be un-targeted – not clearly defining what the goals are for the intervention, based on a sound assessment of the specific issues.
- Ignore evidence – failing to draw on decades of psychology research in the health arena to support initiatives.
- Fail to give feedback – so that, rather than take a step-by-step approach, with learning for all, en route, the BBS initiative is a one off, often 'tick-box' exercises.

These issues along with others concern 'safe Behaviour programmes' have been discussed at length over the last decade. It's tempting to avoid the whole field of Behavioural safety altogether, so as not to fall into the considerable number of traps we find there. However, understanding what drives workplace Behaviours, and how this relates to safe performance, should be a pivotal part of health and safety practice across the globe. Getting the right focus on Behaviour Attending to the basics in the workplace should be the basis that precedes any attention to Behaviours. This means there should be well maintained and 'fit for practical purpose' workplace and equipment, with systems and work procedures that aid the people who deploy them. The worker participation that helps build the constant Organisational improvement of the workplace, equipment and systems also feeds into both opportunity and motivational drivers of Behaviour. All of these as aspects are important for propagating safety climate – the reference frame through which people understand expectations and are supported and rewarded in an Organisation. In simple words, just 'doing the groundwork right ' drives safety performance.

8. Classical model for BBS intervention

The contemporary model, Behaviour based safety (BBS) emphasizes that employees need to take an ownership of their safe as well as unsafe Behaviours. If they behave unsafe, they are not punished, instead they are repeatedly told to correct; and when they behave safe, they are encouraged. Both unsafe and safe Behaviours are counted and displayed. BBS also discusses the unsafe conditions that influence unsafe Behaviours.

The key stages of this approach are depicted below:



BBS is a data driven decision-making process. BBS believes that what gets measured gets done and each employee can make a difference in Organisational safety. Employees are the basic source of expertise of Behavioural change (observe and correct). BBS begins by briefing sessions for all work areas and depts. BBS is a teamwork; it is companywide and people driven. BBS purpose is not to enforce safety rules, force change, gossip about others, reporting to boss. Its purpose is to identify safe and at-risk Behaviours, identify possibility for injury, communicating the risk and helping to identify safer solutions. An implementation team or BBS steering committee monitors its progress. Essentially BBS is not a management driven tool for safety. It's an employee driven approach with management support.

Full engagement of the workforce in the programme is an essential part of Behavioural safety. The programme focuses on the small percentage of unsafe Behaviours that are responsible for a large percentage of an organisation's accidents or incidents. These can be identified by systematically examining the organisation's accident and incident records. - Observational data collection. Trained observers regularly monitor their colleagues' safety Behaviour against agreed measures, frequent observations increase the probability that the level of safe Behaviour will improve, as people tend to alter their Behaviour if they know someone's watching.

The data from the observation process allows measurement of safety performance. Then volunteer groups are brought together, such as a steering committee and observers, who then receive training in observation and feedback techniques. The project team oversees the development of the process in the Organisation, from the initial analysis of accident and incident data through to monitoring performance, setting goals and reviewing progress.

Choice of best theory for implementation

As per the article in EHS today, https://www.ehstoday.com/news/ehs_imp_33991

Many social, cultural, and economic factors contribute to the development, maintenance, and change of health Behaviour patterns. It is now generally recognized that public health and health promotion interventions are most likely to be effective if they embrace an ecological perspective and include upstream approaches, as discussed in McKinlay's chapter on Appropriate Research Methods. That is, interventions should not only be targeted at individuals but should also affect interpersonal, Organisational, and environmental factors influencing health Behaviour.

Challenges Moving Forward

Challenges Moving Forward Successful Behaviour change strategies take many forms. Theory and research suggest that the most effective Behaviour change interventions are those that use multiple strategies and aim to achieve multiple goals of awareness, information transmission, skill development, and supportive environments and policies. Goal-setting and monitoring are important elements of many successful interventions. The emergence of information technology tools such as the internet, wireless technology, and personal digital assistants have expanded the range of theory-based strategies available for effective Behaviour change in health care and community settings. Behavioural interventions should be sensitive to audience and contextual factors, and recognize that most Behaviour change is incremental and that maintenance of change usually requires continued and focused efforts.

Behavioural changes intervention fail ?

EHS Today Staff Article | Dec 31, 2000 is discussed below.

https://www.ehstoday.com/news/ehs_imp_33991

The Six Biggest Mistakes in Implementing a Behaviour-Based Safety ProcessJerry Pounds is senior vice president of Aubrey Daniels International headquartered in Atlanta, USA. He has been in the field of Behavioural analysis for more than 30 years.

A Behaviour analyst uncovers the six biggest mistakes companies make when attempting to implement the Behaviour-based safety process and explains how misunderstanding the process can inherently destroy it.

The six biggest risks organisations might take in implementing Behaviour-based safety are:

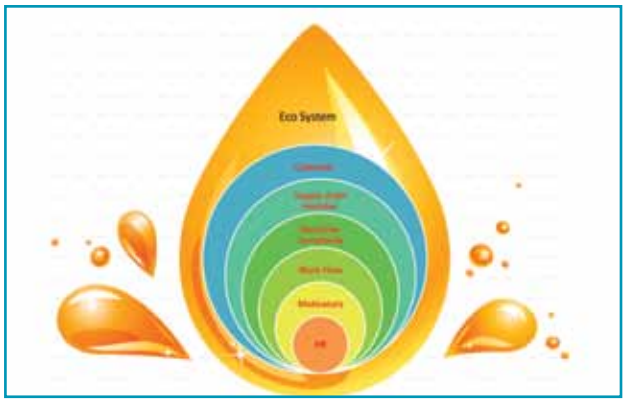
- Thinking that observation and participation are the core of Behaviour-based safety
- Failing to apply positive reinforcement systematically and effectively
- Changing only the contract employees
- Making Behaviour-based safety the primary responsibility of the employees
- Not training managers, supervisors and contract employees in Behaviour change technology
- Trying to fit an activities-based "program" to your Organisation

All of the above are reflections of the activities-based approach to Behaviour based safety. In contrast, the principles and concepts approach provides you with an understanding for the rationales behind the activities and allows you to use your knowledge of Behavioural technology to tailor and design a process that fits your requirements. Many of the programs now implemented do not use the practices listed above. The traditional activities approach is, therefore, much more demanding in terms of resources. Those who become more familiar with Behaviour technology will soon find that the shorter list is not only more desirable but also obtains the fastest and best results. In conclusion, the six risks in implementing a Behaviour-based process surround a core of misunderstanding what a Behaviour-based safety process really is. The correct approach begins with an in-depth knowledge of how to change human Behaviour. The laws and principles of Behavioural technology can be engineered to the exact requirements of your company and extended to all the Behaviours your Organisation's strategic performance objectives demand.

Behaviour Based Organisation Safety (BBOS) Theory

Industry has gained sufficient experience in implementation of various BBS programs. There is a need to re-think and develop the appropriate theory for design and achieve Excellence in BBS programs. The narrative so far in this paper identifies the need for Customized Behaviours change model for Organisations as all the existing models have limitations. In Oil & Gas Industry, over a period of time, BBS implementation has brought in considerable improvement in safety. In order to achieve Excellence in BBS, there is a need to introspect and examine the past failure as this would be the basis for enhancing the existing classical model of BBS. New design basis is proposed for developing a model for Behaviour Based Organisation Safety (BBOS) which needs

customization of the programs according to the needs of the organisation before implementation. As explained above, the success rate of BBS is low due to the complexities in the Organisation's eco-systems. The classical models of BBS assumes that all the facets / components of the various interactive forces for improvement of BBS will constantly improve and evolve over a period of time. This could be true to limited extent only. Hence, the improvements achieved in terms of reduction in no. of incidence are limited and may not be sustainable in a long run.



Model for Behaviour Based Organisation Safety (BBOS)

Another important point to ponder upon is that why the classical model is successful in some of the Industries and there is failure in the rest. A critical analysis in the Oil & Gas Industry at Installations across the country reveals the similar pattern. Some Installations within the same organisation are fairly successful where as some are struggling to implement BBS.

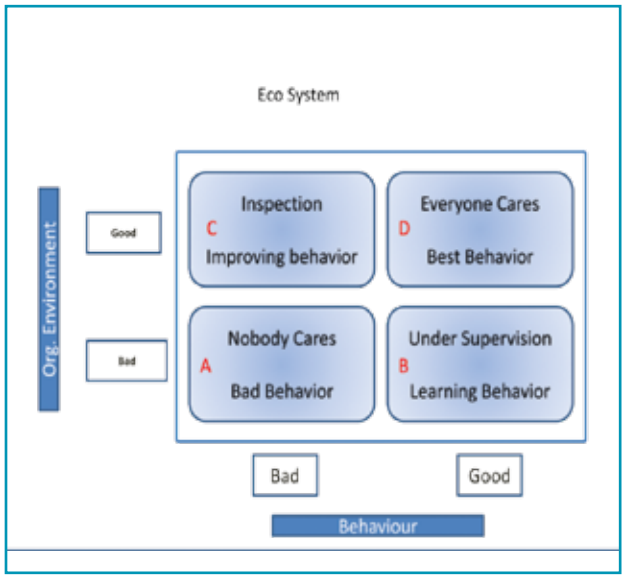
The critical analysis of the success and failure in the implementation of BBS has revealed that the following factors and the combination thereof lead to the success of the BBS programme.

1) Eco system
2) Human Resources
3) Motivation
4) Work Flow
5) Machine configuration
6) Supply chain members
7) Customers

The Fig. above clearly indicates that each success factor is a subset of other and they are interdependent for any given Orgnisation.

Let us discuss on each of the above in detail :

1. Organisation Eco System



The matrix above for Eco System provides the basis to understand the environment of the Installation where BBS needs to be implemented.

(A) If the organization Eco System is poor, where nobody cares for Safety, the bad Behaviour will prevail and reflect unsafe acts while at work.

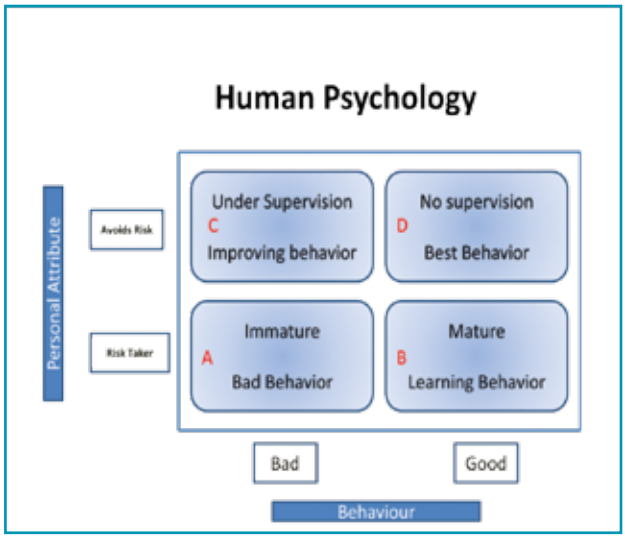
(B) If the Organisation Eco System has developed a some supervision system, the Behaviour maintained to be good but limited to the period they are being supervised; else they may return to their original Behaviour.

(C) If the org. Eco System is improving and during surprise inspections of the work places, there are tendencies of improvement in Behaviour at least under supervision, it reflects that the initiatives taken are improving the Behaviour based safety

(D) For achieving Excellence in BBS implementation, every Organisation must reach the top right quadrant of our eco system in which every one cares for safety of each other ; hence they are at their best Behaviour.

2. Human Resources

After having the mapping done for the Eco System, the Human Resources and their Behavioural attributes towards safety needs to be examined. The matrix above for Human psychology provides the basis to understand the personal attributes of employees at the work place where BBS needs to be implemented.



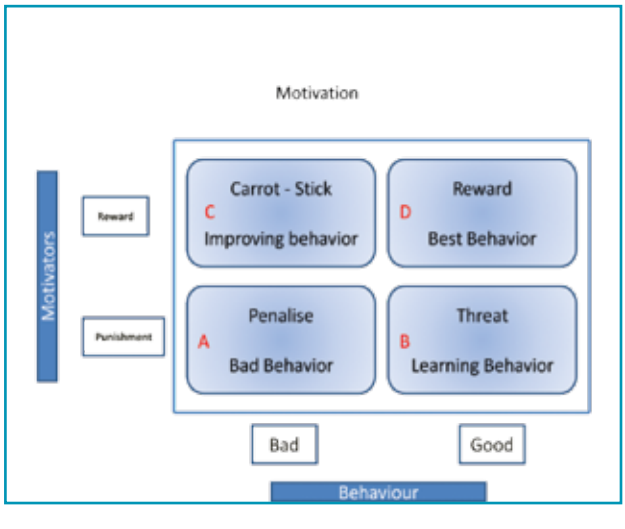
(A) If the personal employees attributes reflects risk taking where employees are immature, lacks skills the bad Behaviour will result in unsafe acts while at work. The Human Resources are not prepared for BBS initative.

(B) If personal attributes reflects risk taking but have mature employees, the Behaviour maintained will be good but limited to the period they are being supervised. The Human Resources must be considered for BBS initative.

(C) If the personal attributes reflects calculated risk taking behaviour even under adequate supervision and they are good tendencies of improving the Behaviour based safety. The Human Resources are engaged for BBS process.

(D) If the personal attributes reflects risk avoidance for safety even without supervision, the human recourses have reached the state of best Behaviour based safety and situation is good to achieve Excellence in BBS.

3. Motivation



After having the mapping done for the Eco System and Human Resources, the next step is to examine the motivators for good Behaviour to achieve the best Behaviour based safety. The matrix above for motivation provides the basis to understand the personal attributes of the Installation where BBS needs to be implemented.

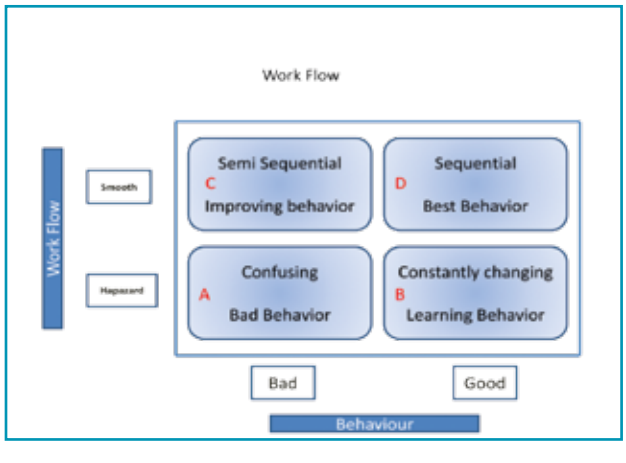
(A) If the personal attributes reflects risk taking where employees are immature, lacks skills and have eco system where nobody cares for Safety, the bad Behaviour will result in unsafe acts while at work. In such situations, there is a need to introduce high level of penalties.

(B) If the Eco System has developed a limited supervision system and have mature employees, the Behaviour maintained will be good but limited to the period they are being supervised. They may reflect a learning Behaviour for such situations. The employees performance evaluation threat levels if increased will be a good motivation to enhance BBS.

(C) If the Org. Eco System is good and during surprise inspection of the work places, there are tendencies of improvement in Behaviour, it reflects that the initiatives taken are improving the Behaviour based safety. To further improve the Behaviour patterns, the appropriate motivational tool is to have carrot and stick policy so that the employees willing to improve Behaviour will have an incentive which will act as a good motivator.

(D) For achieving excellence in BBS implementation, every Organisation must reach the top right quadrant where the eco system is good and every one cares for safety without supervision, the human recourses have reached the state of best Behaviour based safety. However, to ensure sustainability of the good Behaviour, the employees needs to be motivated appropriately rewarded and provided recognition for having highest level of Behaviour based safety.

4. Organisational Work Flow



After having the mapping done for the Eco System, Human Resources and the Motivational levels assessment, the next step is to examine the work flow for good Behaviour to achieve the best Behaviour based safety.

The matrix above for motivation provides the basis to understand the work flow attributes of the Installation where BBS needs to be implemented.

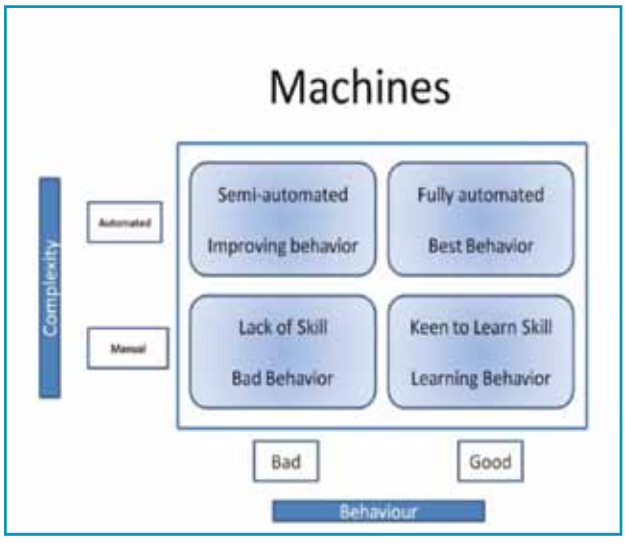
(A) If work flow reflects Hapazard work flow which is confusing to the employees the behaviour of the employees may be bad, which needs to be improved by the Management.

(B) If work flow reflects Hapazard work flow but management has cared for the workers suggestions and work flow is constantly changing the employees are less confused and may show learning behaviour which can improve the good behaviour which will help in introduction of BBS.

(C) If work flow is smooth after series of work flow improvement by management and work flow has been semi sequential there is no confusion and employees appreciate the ease of work there will be remarkable improvement in behaviour, but some bad behaviour may prevail as some employees whose work remains non sequential will remain disturbed.

(D) If work flow is smooth after series of work flow improvement by management and work flow has been totally sequential there is no confusion and employees appreciate the ease of work employees will feel the pride of working in a modern factory and their BBS will be at their best levels.

5. Machines Configuration



After having the mapping done for the Eco System, Human Resources, Motivational levels, and work flow evaluation the next step is to examine the Machines configuration to achieve the best Behaviour based safety.

The matrix above for motivation provides the basis to understand the machine configuration attributes of the Installation where BBS needs to be implemented.

(A) If work flow is on manually operated machines and workers are not skilled, the repetitive work may lead to fatigue and result in bad Behaviour, in such situation management must provide high level skill training to the employees before implementing BBS.

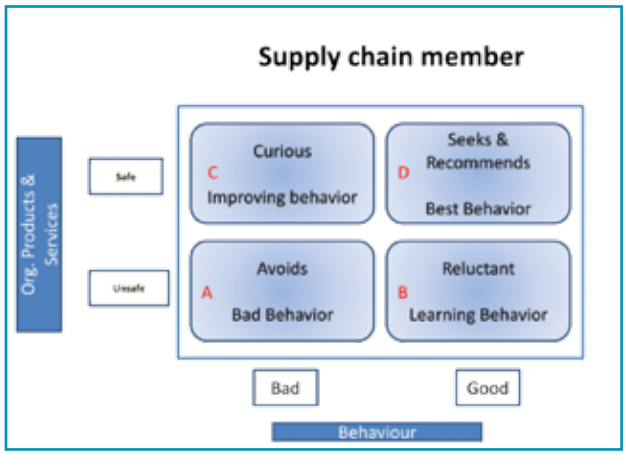
(B) If work flow is on manually operated machines and workers have been provided high skilled training, few employees who have been able to learn will reflect improved behavior.

(C) If work flow is semi automated and workers have learnt the skills the employees show remarkable improvement in behaviour and may adopt BBS implementation easily.

(D) If work flow is fully automated and workers have learnt the new skills to control such machines there is considerable pride in the employees and their behaviour may be good for implementation of BBS.

6. Supply chain Members

Having a good sophisticated plant, with zero incidents and employees also adhering to all SOPs without deviation is not adequate. All Organisations are in business for supply of Products and services. If the product is dangerous or requires special tools or training to handle the products, the errors inadvertently committed at the supply chain member's premises can trigger series of incidents. Such incidents can also lead to business losses. So when it comes to Stake holders the Organisation's Behaviour during the business of transacting products and services also matters. The matrix given below defines the Behaviour of Supply chain members.



(A) If Organisation which does not train the dealers, distributors, stockiest, warehousing agents etc on product safety and safe handling methods are liable to cause accidents/ injuries to the employees of the supply chain members. The Org Behaviour may be considered bad. Such supply chain members will avoid the Org Products and services.

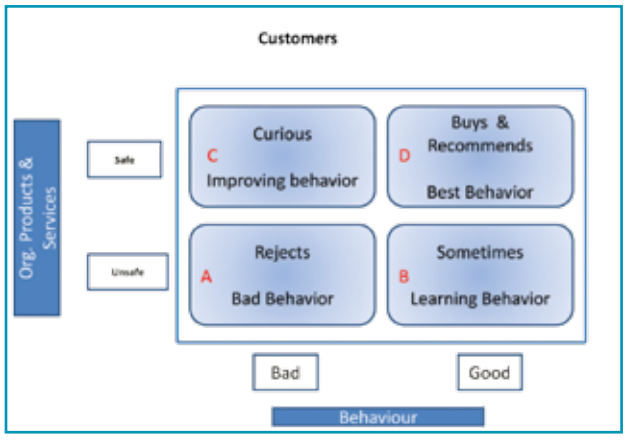
(B) If Organisation partially trains the dealers, distributors, stockiest, warehousing agents etc on product safety and safe handling methods the Supply chain member may reluctantly procure the product and services then the Org Behaviour may be considered Good with scope for improvement.

(C) If Organisation gets a safety certification for the product the Supply chain member may be curious to procure the product and services then the Org Behaviour may be considered as bad, however, it will be considered Good in terms of safety of the product.

(D) If Organisation gets a safety certification and ensures that training on all aspects for the product and services are imparted to the Supply chain members then the Organisation's Behaviour is considered to be the best and the supply chain member will seek the product and also recommend others and involuntarily promote the product and services.

7. Customers

The Customers are the sole purpose for which the Organisation, its employees, contract workers, its plant and machinery exists. It is the endeavor of the healthy Organisation to up rise the customers expectations to provide inbuilt safety in the product supplied. Organisations therefore work extensively to obtain certifications from various authorities to prove the products worth. An Organisation may have zero incidences, its supply chain members may have zero incidences but if the product is a risk, the customer would attribute the wrong design, manufacturing process, packaging and supply chain handling to the Organisation Behaviour. Thus, having excellent Behaviour based safety, within the Organisation, does not matter to the customers. Take the recent example of leading Multi National Company manufacturing cell phones, which caused explosion and fire due to wrong manufacturing / design / testing. Had the Organisation not made a recall of the phones from customers, the Organisation Behaviour could have in termed as Bad. The matrix given below represents the inter action between the customers and the Organisation products and services Behaviour.



(A) The product which is unsafe will be avoided by the customers as the Organisation Behaviour is bad. If the customer is not well informed about some preventive measures or precautions, he may consider the product unsafe and reject it as he considers, the Organisation behaviour as Behaviour as bad.

(B) The product sometime found unsafe probably if internal quality control is not good, the customers may consider Organisation Behaviour as bad but may sometimes buy the product under some compulsion

(C) If the customer observes in media that the defective product has been withdrawn reflecting Organaisation improved behaviour or new design / model product is certified for safety, he may be curious to buy the product, however the perceptual map in the mid of the customer may still consider the Organisation Behaviour bad due to the earlier experience.

(D) If the customers observes that the product is certified and rigorous testing has been undertaken through 3rd Party Agencies, with extended warranty / guarantee, the customer may consider the Organisation to be at their best Behaviour providing complete assurance of Safety of the product, he will buy the product and also recommend to others.

Thus, this matrix explains that the customer's safety should be the top most priority for the Organisations which would like to project themselves as best in class.

Conclusion

From the above, it is now obvious that, Organisations adopting the classical model of BBS may not always be successful. The BBS classical model has worked well for the Industry, however to achieve excellence in BBS, this new approach of Behaviour Based Organisation Safety (BBOS) is recommended.

The need therefore is to first map the Organisation through experts on the parameters mentioned above and first prepare the ground for implementation. During the preparation of the ground, employees' engagement is necessary so that they appreciate the leadership commitment in preparing the Organisation for the actual Behaviour based intervention. The engagement with the employees should be honest, sincere, level headed and providing a sense of Organisational improvement which will ultimately instill the pride of being a proud employee / supply chain member / customer of a progressive Organisation. The rest of the implementation could be undertaken as per the classical models for changed management for change in Organisational Behaviour.

The primary reason for adopting the above mentioned matrix flows from the arguments that any achievement in an Organisation is possible only when there is an alignment after change interventions for employees, Organisation and stake holders. Even if any one component fails, the incidence would still occur in the Organisational supply chain. Hence, when Organisation talks about sustainability on global basis, it has to benefit not only within the Organisation but also to the stake holders of the Companies products and services.

We should rechristen the word BBS which in normal parlance is always directed towards improvement in Behaviour towards safety by the employees. The rechristened BBS should therefore be called Behaviour based Organisational Safety (BBOS), which encompasses all including employees, contract workers, stake holders in supply chain and finally customers for overall improvement of Behavioural safety.

BBOS Implementations process

The BBOS expert must study the existing systems in the organization for each of the matrix mentioned above and provide the action points and plan for implementation. The sample template is given below:

Eco system				
Sr No.	**Quadrant**	**Action Objective**	**Action Plan**	**Action by**
1.	A	Kill these issues		
2.	A			
..	A			
5.	B	Pursue these issues		
6.	B			
..	B			
9.	C	Enhance these issues		
10.	C			
..	C			
14.	D	Sustain these attributes		
15.	D			
..	D			

Likewise all the matrices mention above needs evaluation and action plan drawn.

Performance Monitoring

The BBOs program implementation should be periodically monitored ever there months to see the action objectives mentioned above are fully achieved.

The performance monitoring of BBOS program can be done as per suggested format given below:

Responsi-bility	Action Points	Work in Progress	Completed	Progress
Group 1	16	12	3	19 %
Group 2	32	22	8	25 %
...	18	12	2	11%
Total	66	46	13	20%

Metrics for Measurement of BBOS program Success:

Sample template given below:

Parameters	Violations Baseline (Nos)	Actuals Now (Now)	Progress
Eco system	12	6	50%
Human Resources	18	4	77%
Motivation	15	6	60%
Work flow	18	4	77%
Machines config	23	9	61%
Supply chain	23	5	78%
Customers	15	6	60%
TOTAL	124	40	67%

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GAS

Accounting Hydrocarbons

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Introduction:

In the field of Oil & Gas, the commonality is a "hydrocarbon molecule". How effectively and efficiently one monetizes this molecule, is the one who profits more. This paper is to explain, the importance of its accounting called – "Hydrocarbon Accounting-HCA". This accounting is at times not properly understood or given less importance, which leads to losses, which are difficult to trace. A structured planning and deciding on the methodology of Hydrocarbon Accounting, helps industry to avoid such leakages during operations.

Understanding Hydrocarbon Accounting (HCA):

I would take the illustration of a regasification terminal, however, HCA plays a key role in determining revenues in entire oil & gas sector. HCA, now-a-days, is taken up by both Finance and Commercial departments, independently and considered as one of the key contributors to the business revenue and profits.

HCA is defined as "the system by which ownership of oil, gas, gas liquids and produced water is determined and tracked from the point of production to a point of sale or discharge". The terms allocation and production reporting are also commonly used to refer to this function.

The scope of this article is limited to a regasification terminal, receiving LNG from various suppliers under various contractual terms, storing in the cryogenic tanks, regasification and supplying natural gas (Regasified liquefied natural gas- RLNG) to end consumers through common carrier pipelines. The typical schematic is shown in Figure1.

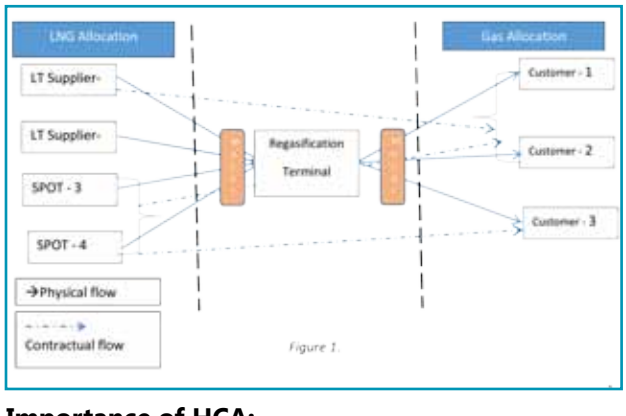

Figure 1.

Importance of HCA:

- Used for reporting to various governmental authorities
- It helps to determine the ownership of the comingled product in the case of multiple users/ titles of the hydrocarbons in one area.
- Provides important information to top management, finance and commercial team to ascertain whether value monetisation is done for that molecule.

Methodology:

Generally, HCA is done on energy units for ease of computation and understanding. Reason being in LNG/ gas industry, hydrocarbon molecules are bought and sold on energy terms (US$/mmbtu), though measurements primarily are done either on weight or volume. HCA has two essential elements to

focus on –

a) Accurate and timely measurement of LNG/ NG

b) Allocation of molecules

It has two essential elements: firstly, gathering and validating flow measurement data in order to establish the definitive record of hydrocarbon molecules purchased, unloaded, stored, regasified and transport to end consumers. In this entire chain, there is a need to measure the quantity of LNG procured, unloaded, stored, all in liquid phase. After processing to deliver to customers, need to be measured in gaseous phase. Another focus area is related to the molecules remained unaccounted, due to measurement uncertainties, flaring, process losses, aging of the product in tank or vessel, used in process, etc. Some organisations do focus on all these unaccounted losses and ensure to accurately measure them for HCA purpose.

...Secondly, it involves carrying out allocation of molecules on the flow measurements to derive quantities with price of purchase. Allocation procedures vary in complexity from the trivial to the highly complicated. In some cases, organisation do simple allocation wrt to the measured energy of unloaded LNG to the LNG owner, on whom the title is transferred. While at the other end of the complexity scale is the requirement to allocate based on the molecules sold to the end consumers.

Financial accounting of hydrocarbons purchased and sold can be either based on FIFO or LIFO based inventories in tanks. However, HCA enables organisation to predict the future deliveries and gives flexibility to allocate such molecules which are yet to arrive in inventories. This method is actually allowing to pool price, optimise the deals and continue to reap benefits of rolling margins, though a need remains is to reconcile the price with the financial accounting at the end of the year.

What is required to manage HCA successfully?

An effective HCA system must include:

- A well defined allocation procedure, in which the input data and calculations are specified in detail, and which is approved by all stake holders.
- A robust software which can collect, store, run algorithm and perform calculations and generate the required results. Such system needs a high degree of controls over the access of data and calculations in multi-user environments. As the systems need adequate controls, excel spread sheets should be avoided.
- Needs clear identification of roles and responsibilities avoiding conflicts and ensuring audit trails.

What can go wrong in absence of inadequate HCA systems?

HCA can be a complicated business, so much that the accurate and reliable collection, calculation and presentation of data often present a challenge. When it comes to errors, the following recur and becomes difficult to justify:

- Failure to establish one view in the organisation. There must be a single database that is accepted as the definitive source of production and accessible to everyone in the organisation who needs it. This is essentially to avoid duplication of work and wastage of time to avoid reconciling efforts between different numbers.
- An important function of HCA system is to allow corrections to measured data. Insufficient control over numbers and its corrections, becomes difficult to resolve.
- Consistency overruns accuracy at times. The user of HCA shall always double check its numbers before sharing it with wider audience, else can lead to serious errors going undetected for long periods, due to errors or outdated data or equations.
- Confidence in HCA results depends on a well understood and accepted set of calculations being carried out reliably. Nothing erodes confidence more quickly than unexplained errors appearing in the calculations.

FINANCE

Angel Tax Issues

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The oil & gas sector is among the core industries in India and plays a major role in influencing decision making for all the other important sections of the economy. The Government has taken many steps over the years to augment fresh investment in the oil & gas sector and reduce dependency on imports, the latest focusing on developing start-ups.

In line with this, many oil and gas public sector undertakings have launched start-up schemes to promote promising start-ups and nurture an eco-system conducive to innovation in the domestic hydrocarbons sector. While these are laudable initiatives, in the recent past, start-ups in general, have faced certain challenges on the income-tax front.

Challenges faced

Start-up companies often command high securities premium while issuing shares, which are backed up by their innovative ideas. Start-ups are generally valued on the basis of their ideas and business potential and not on the basis of net assets in their balance sheets.

However, this practice has attracted the attention of tax authorities, who have sought to tax such high premiums charged by start-ups under section 56(2)(viib) of the Income-tax Act, 1961 (the Act).

Section 56(2)(viib) of the Act provides that where a closely held company issues shares to a resident, for an amount received in excess of the fair market value of the shares, it will be deemed to be the income of the company under the head "Income from other sources."

For the purpose of this section, fair market value is considered to be the higher of

- The value arrived at on the basis of the method prescribed; or
- The value as substantiated by the company to the satisfaction of the tax authorities, based on the date of issue of shares.

Section 56(2)(viib) of the Act was introduced to tax the undisclosed money being used to acquire shares at inflated value. However, the aforesaid section did not distinguish between this practice and the shares genuinely issued at a premium based on idea and business potential. This resulted in tax authorities issuing notices to start-up companies by invoking section 56(2)(viib) of the Act, to recover tax on the basis that shares were issued at inflated valuation. Further, in some of the cases where tax authorities also invoked provisions of section 68 of the Act wherein tax authorities, when not satisfied with the nature and source of investments received, have taxed such investments as unexplained income!

The start-up community, in general, raised a concern about this and requested the Government to issue a clarification so that genuine start-ups could be spared the tax issues.

Relief from Government

The Government had issued a notification on 11 April, 2018, wherein an exemption was provided from levy of income-tax if start-up companies fulfil certain conditions. Furthermore, on 16 January, 2019, the Government issued another notification to ease some conditions laid down earlier for claiming exemption, such as increasing the limit of average returned income of INR 25 lakh or more for preceding three financial years to INR 50 lakh for the financial year preceding the year of investment.

However, concerns remained regarding the applicability of these provisions (including misuse of provisions by tax authorities); therefore, various representations were made before the Government. Consequently, the Government issued a fresh notification on 19 February, 2019, in supersession of the previous notifications and expanding the definition of "start-up" by providing the following relaxations:

- The conditions for eligible start-ups have been relaxed by extending the time period of recognition from seven to ten years from the date of incorporation.
- The ceiling limit of maximum turnover in any financial year is also increased from INR 25 crores to INR 100 crores.
- The notification also aims to extend relief from section 56(2)(viib) of the Act by excluding investments received from non-residents, venture capital entities and certain listed companies from the prescribed threshold limit of INR 25 crores in respect of share capital and share premium.
- The earlier condition to submit the valuation report and obtain approval from the Central Board of Direct Taxes (CBDT) has been removed; instead, a declaration in a specified form shall be sufficient.

In brief, the new notification aims to facilitate the Government's objective of ease of doing business in India and simplify the tax environment to catalyse the growth of start-ups in the country. The notification shall apply irrespective of the dates on which shares are issued by start-ups from the date of its incorporation, except for the shares issued for which an addition under section 56(2)(viib) of the Act has been made in an assessment order under the Act, before the date of issue of notifications.

CBDT on 05 March, 2019, issued a notification supressing the previous notifications dated 24 May, 2018, applicable from 19 February 2019. This notification clarified that the provisions of section 56(2)(viib) of the Act shall not apply to consideration received by a company for issue of shares that exceed the face value of such shares, if the said consideration has been received from a person, being a resident, by a company that fulfils the conditions specified in the notification dated 19 February, 2019.

Concluding remarks

The government may have addressed the concerns of stakeholders in the aforesaid notification. However, there may still be an element of uncertainty on account of the following:

- The notification provides for exemption only from section 56(2)(viib) of the Act and does not specifically deal with section 68 of the Act.
- The notification does not provide the immunity for the cases where the addition has already been made or where the case is pending before appellate authorities, even if a start-up satisfies the conditions. This may not provide respite to existing cases and one hopes that appropriate directions are given by CBDT to extend this to eligible ongoing cases.

While above concerns remain, the proactive approach adopted by the Government to resolve the tax issues of start-ups is very heartening. The move from an approval regime to a declaration regime for start-up registration also makes the process much easier and reflects a trust-based approach.

Views expressed in this article are personal.

http://indianoilstartupfund.in/, http://startup.hpcl.co.in/HPCLStartup/, https://ebiz.bpc.co.in/BPCLStartup/

LOGISTICS

Laying and Operations of Petroleum Product Pipelines in North East – Challenges Unique to North-East

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Introduction

North-East region of India comprises eight states with total population of about 4.56 crore that accounts for 3.4% of the India's population. However, each state of North-East has unique demography, different terrain and population density. Assam has largest population among N-E states. Excluding the state of Assam, population of rest of the North-Eastern states is only 1.43 crore, which is just about 1% of the overall India's population. The geographical spread of North-East region is relatively large and accounts for 8% of geographical area of the country. The overall density of population in North-East region is, thus, 159 persons per sq.km. However, the distribution pattern of population is not homogeneous. For instance, the state of Assam, the principal state of the region, has a population density of 397 persons per sq.km, whereas, the state of Arunachal Pradesh has an average density of 17 persons per sq.km.

From the above, it can be reasonably concluded that the consumer base for petroleum products in the North-East region is low and consumption centers (expect the state of Assam) are spread over a large geographical area. It creates hurdle in investment of infrastructure by private entities on commercial or economic considerations. Larger inter-distances between consumption centers combined with lower demand is the main hurdle in development of cross country petroleum products pipelines in the North-East region. Petroleum pipeline projects are capital intensive and revenues of the pipelines depend on the volumes being moved through pipelines.

Moreover, there are unique technical challenges also in laying and operating petroleum pipelines in North-East region. The topography of North-East region is highly undulating with high hills and deep gorges. Cross country pipelines in highly undulating terrains poses challenges during the construction and operating phases of the pipelines. Consequently, petroleum products (especially liquid products) pipelines in the North-East region through pipeline mode may not be a financially viable option, except on a few routes.

This article discusses the major challenges for developing and operating petroleum pipelines in North-East so that Industry can deliberate and come up with techno-economics solutions so that availability of petroleum products in North-East can be ensured reliably, without increasing financial burden.

Existing Infrastructure in the downstream Petroleum sector in North-East

There are 4 refineries in North-East region, all located in Assam with a combined capacity of 7 MMTPA. Out of 4 refineries, 3 are of IOCL at Guwahati, Bongaiagon and Digboi and 1 is of Numaligarh Refinery Limited (NRL).

Out of total 13 Petroleum, Oil & Lubricants (POL) Depots in North-East region, IOCL currently operates

11 depots (10 in N-E and 1 in Sikkim), HPCL and BPCL operates one each at Betkuchi and Rangpo (Sikkim) respectively. There are two petroleum products pipelines with the combined product pipeline capacity of 3.1 MMTPA. Thus, Assam state of the North-East region is relatively better served by products pipeline network. Existing Infrastructure in the downstream Petroleum Pipelines in North-East is depicted in Fig.1.

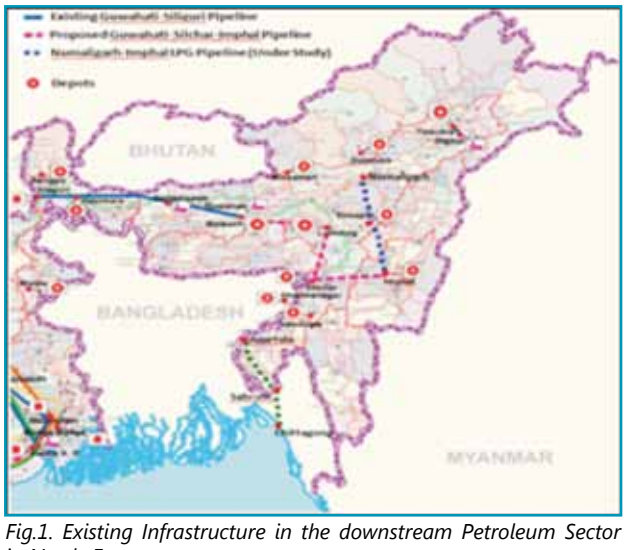

Fig.1. Existing Infrastructure in the downstream Petroleum Sector in North-East

Logistics pattern for POL products in North-East

Current modal mix of transportation of petroleum products in the North-East is depicted in Table.1. From the table, it is evident that out of 11 terminals (other than refinery locations), 2 terminals are connected to pipelines for receiving products from refinery locations, 4 terminals are receiving products through rail mode, and 5 terminals are receiving products through road mode. Further, it can be inferred that alternate modes of transportation such as Rail and Road are well established in the region.

State	Depots	Mode
Assam	Betkuchi	Pipeline
	Digboi	Pipeline
	Lumding	Rail
	Silchar	Rail
	Missamari	Road
Meghalaya	Nil	Nil
Tripura	Dharamnagar	Rail
Arunachal Pradesh	Doimkuh	Road
Manipur	Malom	Road
Mizoram	Vairengte	Road
Nagaland	Dimapur	Rail
Sikkim	Rangpo	Road

Table.1. Modal mix of transportation of petroleum products in North-East

Existing LPG infrastructure in North-East

There are 13 LPG bottling plants in North-East region with a combined capacity of 532 TMTPA. Out of 13, 12 bottling plants are of IOCL with total capacity of 508 TMTPA. NRL has one bottling plant with a capacity of 24 TMTPA. There are 6 bottling plants in the state of Assam with a combined capacity of 413 TMT (78% of total bottling plant capacity in North-East). Other than Assam, all other states have very small LPG bottling plants with capacity of 11 to 23 TMTPA. There is no LPG bottling plant in the state of Meghalaya and its demand is met from Assam through Tankers.

Almost half of the LPG bottling capacity is at plants co-located with refineries i.e. Guwahati Refinery (120 TMT), Digboi Refinery (120 TMT), Bongaigaon Refinery (30 TMT), and NRL (24 TMT), which doesn't require any transportation infrastructure. Unless augmented, these refineries do not have any significant surplus to supply LPG to other bottling plants. Till now, there are no LPG pipelines in North-East and movement of LPG from sources (refineries) to consumption centers (bottling plants) is by Road mode only.

Major challenges for developing and operating petroleum pipelines in North-East

While natural gas pipelines are natural monopoly as mode of transportation for long distance and, thus, owners may be in a position to transfer cost of pipeline transportation to customer, same is not case of liquid hydrocarbons like MS, HSD or even LPG as liquid pipelines needs to be cost competitive w.r.t. Road and Rail, which are also used for transportation of petroleum products including LPG. Initially, liquid hydrocarbons used to be transported through Road and Rail only. Pipelines gained importance after 1950s primarily due to cost competitiveness w.r.t. other modes. Pipelines also offered more reliability, energy efficiency, all weather operation etc., which encouraged industry to shift to pipelines; however, primarily it was cost competitiveness w.r.t. Road and Rail, which propelled growth of liquid hydrocarbon pipelines.

Obviously, there has to be a minimum threshold of throughput for pipeline system to remain competitive w.r.t. Road and Rail. If requirement of petroleum products at any location is below a certain level, transportation through Road or Rail would be cheaper as pipelines are capital intensive projects.

In last 5-6 years, the average cost of cross country pipelines have increased manifold. There are substantial increase in the cost of acquisition of Land and RoW due to the Impact of LARR Act, 2013.

Economics of LPG Pipelines are more constrained as compared to pipelines for other liquid hydrocarbons

like MS, HSD, ATF etc. as delivery/ throughput for LPG is limited by capacity of linked bottling plants. Thus, any LPG pipeline in North-East, is practically not viable, as explained in next para.

Economics of Pipeline construction and operation in North-East

For understanding economics of a LPG pipeline in North-East, let us consider a 200 km LPG pipeline connecting a bottling plant of 24 TMT annual capacity. Directional capital cost of a 200 km LPG pipeline would be minimum Rs.1000 crore. Operating cost of any independent pipeline system is about 4 to 5% of Capex. Thus, if we consider 10% as cost of capital and 4% of CAPEX as annual OPEX, the cost of transportation per MT of LPG by pipeline mode would be about Rs. 58000/MT i.e. about Rs. 290/ MT/Km.

Even if we assume that Government funds the entire capital cost, still, operating cost of pipeline alone would be Rs.83/MT/Km, whereas, prevailing cost of road transportation is about Rs.6-10/MT/km.

Obviously, pipelines mode of LPG transportation would provide many other advantages, but, such advantages can't justify such higher cost of transportation.

Cross country pipelines in Undulating terrains - Issues

Cross country pipelines in highly undulating terrains such as the case discussed above poses challenges during the construction and operating phases of the pipelines. Laying of cross country pipelines across the hills is very difficult and other feasible option is to lay pipelines along the highways in the midst of hills. However, existing roads are narrow and circuitous with very sharp bends at frequent intervals. Moreover, existing roads are already congested with heavy traffic of trucks/tankers. Laying the pipeline along the existing highways may aggravate the traffic congestion and National Highway Authorities may not permit the pipeline laying works in these areas. Further, there would be difficulty in positioning construction equipment and machinery to the site, difficulty in transporting mainline pipeline, and difficulty in excavating rocky terrain.

Cross country pipelines in North-East – Routes with high undulations

The topography of North-East region is highly undulating with high hills and deep gorges and it poses challenges both during construction as well as operation phase. Construction is a time bound activity and one can still manage with additional cost, however, operational issues for liquid hydrocarbon pipelines are much more complex to deal with.

Let us understand by taking a hypothetical case i.e. options to link state capital of Manipur i.e. Imphal with products or LPG pipeline. It can be linked either from IOCL's Guwahati refinery or NRL's Numaligarh refinery; which are two nearest refineries from Imphal.

The following figures (Fig.2 & Fig.3) indicates elevation profile along the route options available for extending the pipeline connectivity to Imphal either from Guwahati refinery via Silchar or from Numaligarh refinery via Dimapur.

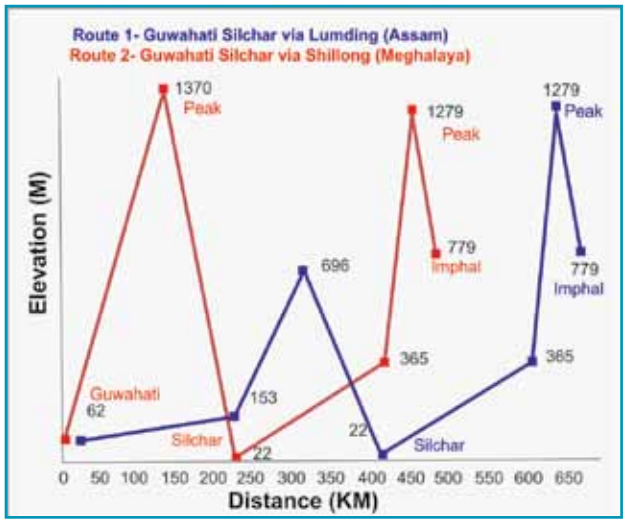

Fig.2. Route options for pipeline connectivity to Imphal from Guwahati Refinery

Fig.2 depicts two possible routes for extending pipeline connectivity from Guwahati refinery to Imphal. Route-1 is from Guwahati to Silchar via Lumding and then to Imphal and Route-2 is from Guwahati to Silchar via Shillong (Meghalaya) and then to Imphal. Further it is evident that Route-2 is the shortest among the possible options, however, this route experiences significant peaks (as high as 1370 m from mean sea level) in the Guwahati-Silchar section. In both the route options, there are significant peaks as high as 1279 m in the Silchar-Imphal section.

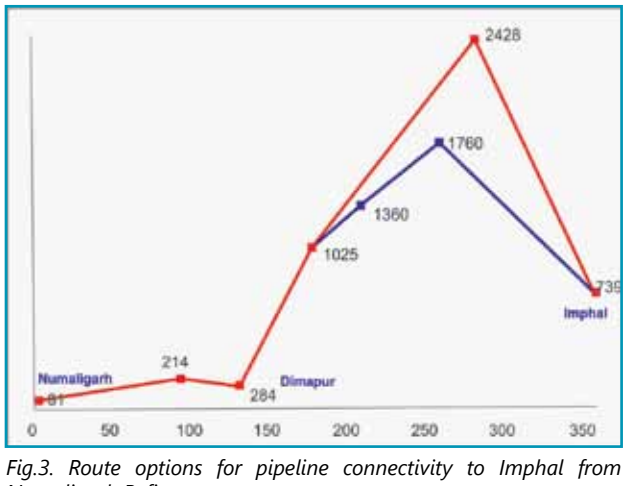

Fig.3. Route options for pipeline connectivity to Imphal from Numaligarh Refinery

Fig.3 depicts two possible routes for extending pipeline connectivity from Numaligarh refinery to Imphal. Both the routes have highly undulated terrain with significant peaks (2428 m in one option and 1760 m in another) in the Dimapur Imphal section.

From the above figures (Fig.2 & Fig.3), it can be inferred that extending pipeline connectivity to Imphal either from Numaligarh via Dimapur or from Guwahati via Silchar is difficult due to highly undulating terrain with significant peaks on the way to Imphal.

Issues during the operating phase

Issues of steep elevation profile can be taken care by providing additional intermediate pumping stations and sectionalizing valves. However, such requirements would enhance operating cost of the pipelines much more compared to pipelines laid in plain terrains and consequently, make such pipelines costly proposition w.r.t. Rail or Road mode.

Further, handling of interface would be a major challenge during the operating phase. Transportation of liquid hydrocarbon(s) through pipelines is more challenging as many products of varying density are pumped in batches in the pipeline. Intermixing of products occurs at the interface of different product batches leading to generation of product interface requiring disposal. This interface is mixed with neat product in certain proportions without affecting product quality. The interface quantity increases in long distance pipelines laid in a terrain having peaks in between. Thus, every pipeline requires minimum batch length requirements for different products with matching storage tankages at delivery locations.

Further, product pipelines require tankages of adequate capacity for absorption of interface at delivery locations and adequate batch length of product. Due to low POL demand in North-East, slow depletion of stocks would occur and pipeline operation would be linked to availability of ullage in tanks. In such a scenario, prolonged and frequent shutdowns would be necessitated in the pipeline operation. Such operating scenario is undesirable as it impacts interface quantity and also product quality in pipeline.

Therefore, absorption of interface becomes a major technical challenge and thus multi-product pipeline transportation for low product volumes over a long distance with varying altitude is not preferred. For transporting liquid petroleum products, alternate modes of transportation such as Rail and Road are well established. An integrated transportation model mix comprising Pipeline, Rail and Road would be best suited, if demand in small quantities is scattered at multiple locations such as the case with North-East region.

Other Technical issues – Line fill vs Monthly demand

The average monthly sales of various states in the North-East for the FY 2017-18 are depicted in Fig.4.

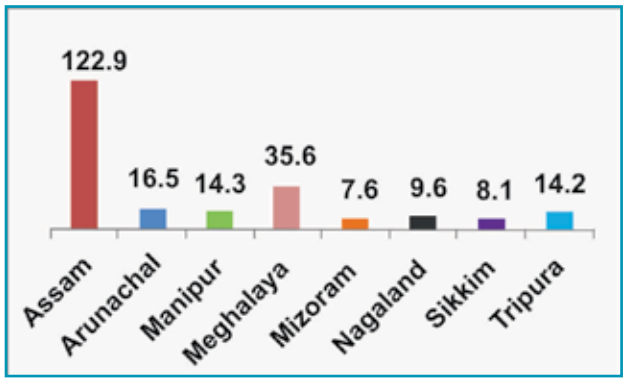

Fig.4. Monthly sales (in TMT) of HSD/MS/SKO in North-Eastern states

From Fig.4, it can be inferred that except the state of Assam, all other states in North-East have very low monthly sales. With this scenario, it may be possible that line fill quantity even for smallest size 8" dia. for cross country pipelines exceed monthly demand of some of the states. To corroborate the above proposition, a case has been presented in Table.2, which indicates line fill quantity of a 8" dia. pipeline to various terminals in these states from nearest refineries.

Terminal	Distance (along the Gas grid) from Nearest Refinery	Line fill for smallest size PL of 8" Dia (HSD in TMT)
Itanagar (Arunachal Pradesh)	192 km from NRL	4.7
Imphal (Manipur)	600 km from GR/ 270 km from NRL	14.5/6.5
Aizwal (Mizoram)	552 km from GR	13.3
Dimapur (Nagaland)	85 km from GR	2.0
Agartala (Tripura)	627 km from GR	15.2

Table.2. Line fill of various probable pipelines along gas grid in the North-East

From **Table.2,** it is clear that the Line fill quantity even for smallest size 8" dia pipeline is exceeding monthly demand of Tripura, Mizoram and Manipur. Pipeline connectivity to these terminals may not be a practical option till monthly demand at these terminals exceeds at least twice of line fill. Moreover, the prolonged storage of product in a pipeline affects the quality of products such as MS.

Conclusion

Pipelines transportation have proved to be the most convenient and economical mode for transportation of high volumes of Petroleum products including LPG. The advantage of the pipeline system is its relatively easier and routine nature of operation, inexpensive maintenance and continuous movement of products. There are no associated problems with returning empty containers / vehicles to loading points as in the case of other modes of transportation, resulting in saving in energy and cost. Transit loss, which is sizable in other modes of transport, is also considerably reduced. However, pipelines cannot always be cost competitive and role of road transportation for small requirements/ last point connectivity can't be undermined.

A proper and judicious integrated system comprising Rail, Road and Pipeline systems would help in meeting customer's requirement in most cost effective way.

BIOFUELS

2G Bio-Ethanol: A Green Initiative to Realise India's Ethanol Blending Program

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Introduction

Bio-fuels are renewable energy options with huge opportunity to help decarbonize transportation and other systems across the globe. For developing country like India, bio-fuels consequently relate to numerous sustainable development goals, diversification of energy basket and national commitments to limit climate change and mitigate GHGs. With ambitious target of present policies of MoPNG for reduction in crude oil consumption by 10% in 2022, bio-fuels hold a paramount domain in future energy needs of the nation. India, world's fourth largest carbon emitter with population of 1.3 billion, ratified Paris agreement "COP-21 (Conference of the Parties-21) - Global Climate Agreement" on climate change in 2016, an agreement within the United Nations Framework Convention on climate Change (UNFCCC). Thereby, India is committed for R&D in biofuels and implementation of developed technologies for greater interests of environmental protection and climate change.

Bio-Ethanol is ethanol produced from biomass such as sugar containing materials like sugar cane, sugar beet, sweet sorghum etc.; starch containing materials such as corn, cassava, rotten potatoes, algae etc.; and ligno- cellulosic materials such as bagasse, rice straw, corn cob, wood waste, forestry residues. First Generation (1G) bio-fuels are derived from food

crops (wheat, sugarcane, soybean, sugar beet, edible oil etc.) and echoes Food vs. Fuel debate, especially for a nation like India with gigantic population and limited land resource. First Generation (1G) ethanol is presently being produced directly from sugarcane juice or B-heavy molasses in India. Second Generation (2G) bio-fuels being carbon neutral are derived from ligno-cellulosic non-food crops residues like wood, agriculture residues, organic wastes etc. and are better choice and bio-ethanol produced from these sources lies in 2G bio-fuels domain and is increasingly being given impetus in policy implementation due to limited availability of 1G ethanol.

National Bio-fuel Policy (NBP-2018) was released in 2018 as a second version with prior version released in 2009 and it clearly emphasises that India's energy security would remain vulnerable until alternative fuels to substitute/supplement petro-based fuels are developed based on indigenously produced renewable feed-stocks. As per the policy bio-fuels are defined as fuels produced from renewable resources and used in place of or in blend with, diesel, petrol or other fossil fuels for transport, stationary, portable and other applications with renewable resources defined as the biodegradable fraction of products, wastes and residues from agriculture, forestry, tree based oil other non-edible oils and related industries as well as the biodegradable fraction of industrial wastes.

Ethanol Blending Programme (EBP) is a flagship initiative of Government of India originally launched in 2003 on pilot basis which has been subsequently extended to the notified 21 States and 4 Union-Territories to promote the use of alternative fuels and to reduce import dependency for energy requirements in transport sector. The blending of ethanol was initially targeted at 5% and as limited ethanol was sourced from First Generation (1G) ethanol plants. An indicative target of 20% blending of ethanol in gasoline is proposed by 2030. With this backdrop, all the OMCs (M/s IOCL, BPCL, HPCL) and M/s MRPL are mandated to set up 12 2G bio-ethanol plants across 11 states of India with a capacity of 100KLPD each and 60KLPD for M/s MRPL. The feedstock for these plants will be dependent on locally available biomass residues near the plant geographical location. For instance, for Bargarh plant of M/s BPCL, Rice straw is considered as design feedstock for 2G ethanol plant as Bargarh is primarily rice bowl of Orissa state and therefore ample quantity of rice straw is available near the plant. EIL as a premier consultancy organisation had prepared Detailed Feasibility Reports (DFRs) for most of these plants. Figure 1 shows that estimates of ethanol required for blending in gasoline will be around 440 Cr litre for year 2021-22 with gasoline projected demand of 4400 Cr litre and meeting 10% blending requirement.

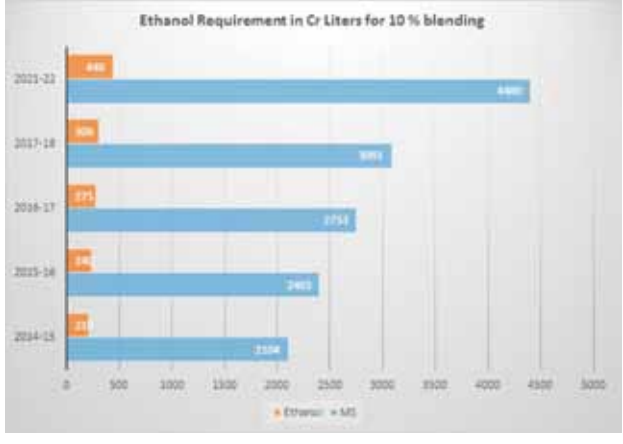


Fig. 1: Ethanol Requirement (Cr litre) for 10% Blending in Gasoline (Source www.ppac.gov.in)

The National biofuel policy not only promotes bio-fuels but also proposes to give fiscal benefits such as differential pricing, tax credits, advance depreciation and viability gap funding through Pradhan Mantri Ji-VAN (Jan Indhan - Vatavaran Anukool Fasal Awashesh Nivaran Yojna). The objective of the scheme is to create an ecosystem for setting up commercial projects and boost to Research and Development in 2G Ethanol domain. Under the scheme, 2000 Cr are allocated for supporting 12 Commercial and 10 Demonstration 2G ethanol Plants for VGF (Viability Gap Funding). As per the scheme, ethanol produced by the beneficiaries 2G plants must be mandatorily supplied to OMCs for blending. The benefits of the scheme includes promoting Second Generation (2G) bio-fuels technologies, creating employment opportunities in 2G Ethanol projects and Biomass supply chain, contributing towards Swacch Bharat Mission by utilizing agro residues that are otherwise burnt in fields and thereby also addressing environmental concerns of stubble burning in addition to other benefits like reducing carbon foot print, boost agriculture sector, creating rural employment and empowerment. Considering its promising appeal, Government of India with special impetus for developing the complete ecosystem for producing fuel grade 2G ethanol pan India had already initiated construction of plants at Bathinda in Punjab, Bargarh in Orissa based on rice straw as feedstock and Numaligarh in Assam with bamboo as feedstock.

Fig. 2: Proposed 2G Ethanol plants in India

Feedstock Availability in India

Agriculture being main primary sector of our country and India hosts six major climate subtypes ranging from desert in west, tundra and glaciers in north, tropical rainforests in west and island territories in south. Depending upon topography, varied crop, plantation and agricultural biomass residues are available like Rice husk, Wheat straw, Maize stalks, Mustard husks, Groundnut stalks, Bajra stalks, Soyabean stalks, Jowar stalks & pods, Cotton boll shell, husk & stalks, Banana residue, Coconut fronds, shell, Coffee pruning wastes, Sugarcane bagasse, Cassava solid waste, Millets stalks, Corn Cob, Napier grass and Bamboo etc. India produces nearly 670 MMT (million metric Tonne) of biomass annually. Figure 3 shows crop wise biomass residue generation with their cultivation area across India.

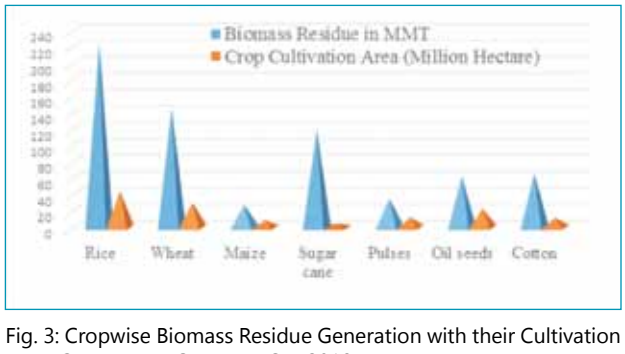


Fig. 3: Cropwise Biomass Residue Generation with their Cultivation Area (Source: TIFAC Report, Oct 2018)

Keeping in view, various agri-needs, fodder requirements for large cattle population, surplus biomass stands at around 140-160 MMT per annum and the potential for producing 2G ethanol is around 3000 -3500 crore litre annually. Nearly, 20% blending target can be met by around 25% utilisation of available surplus biomass. Further, expansion of scope of raw material for ethanol production to allow use of sugarcane juice, sugar containing materials like sweet sorghum, sugar beet, starch containing materials like corn, cassava, damaged food grains like broken rice, wheat, rotten potatoes, unfit for human consumption is announced by the government to bolster the supply chain.

Technological Routes for 2G Ethanol Production

2G ethanol can be produced through biochemical and thermochemical routes. Second generation ethanol produced essentially from ligno-cellulosic biomass, is produced by enzymatically converting the cellulosic and hemicellulose content of biomass in to C6/C5 sugars and fermenting them using yeast or bacteria. Biochemical route employs enzymes which act as bio-catalysts to hydrolyse the hemicellulose and cellulose in biomass after harsh pre-treatment step that breaks lignin and exposes hemicellulose and cellulose to enzymes. In thermochemical route, biomass is gasified into syngas, syngas is cleaned and sent in to fermentation reactor and gas phase fermentation technique is used for producing ethanol. Other thermochemical routes includes super critical routes etc.

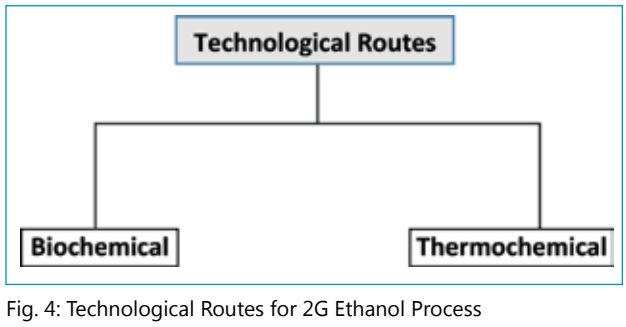


Fig. 4: Technological Routes for 2G Ethanol Process

In biochemical process severity and efficiency of pre-treatment step enhances and governs ethanol yield as it improves and enables accessibility of enzymes hydrolysis to hemicellulose and cellulose. This step alters the physical and chemical properties of biomass and improves the enzyme access and effectiveness which may also lead to a change in crystallinity and degree of polymerization of cellulose. The pore volume of pre-treated biomass are increased which facilitates accessibility of enzymes and thereby

enhancing rate of yield of monomeric sugars. Post pre-treatment, biomass undergoes enzymatic hydrolysis for conversion of polysaccharides into monomer sugars, such as glucose and xylose. Subsequently, sugars are fermented to ethanol by the use of yeast and ethanol is recovered and purified by distillation molecular sieves.

Key Advantages of biochemical process:

- Lower Capex.
- Low temperature, low pressure process.
- By-products such as furfural, acetic acid can be recovered.
- Lignin can be used as a fuel or speciality value added chemical by valorisation.

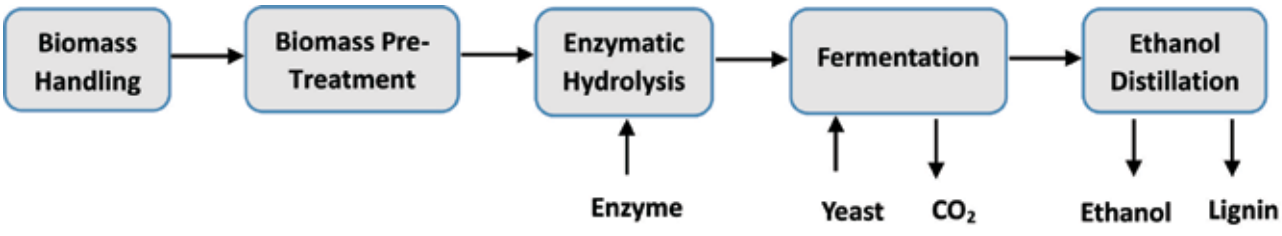


Fig. 5a: Schematic for Bio-chemical 2G Ethanol Process

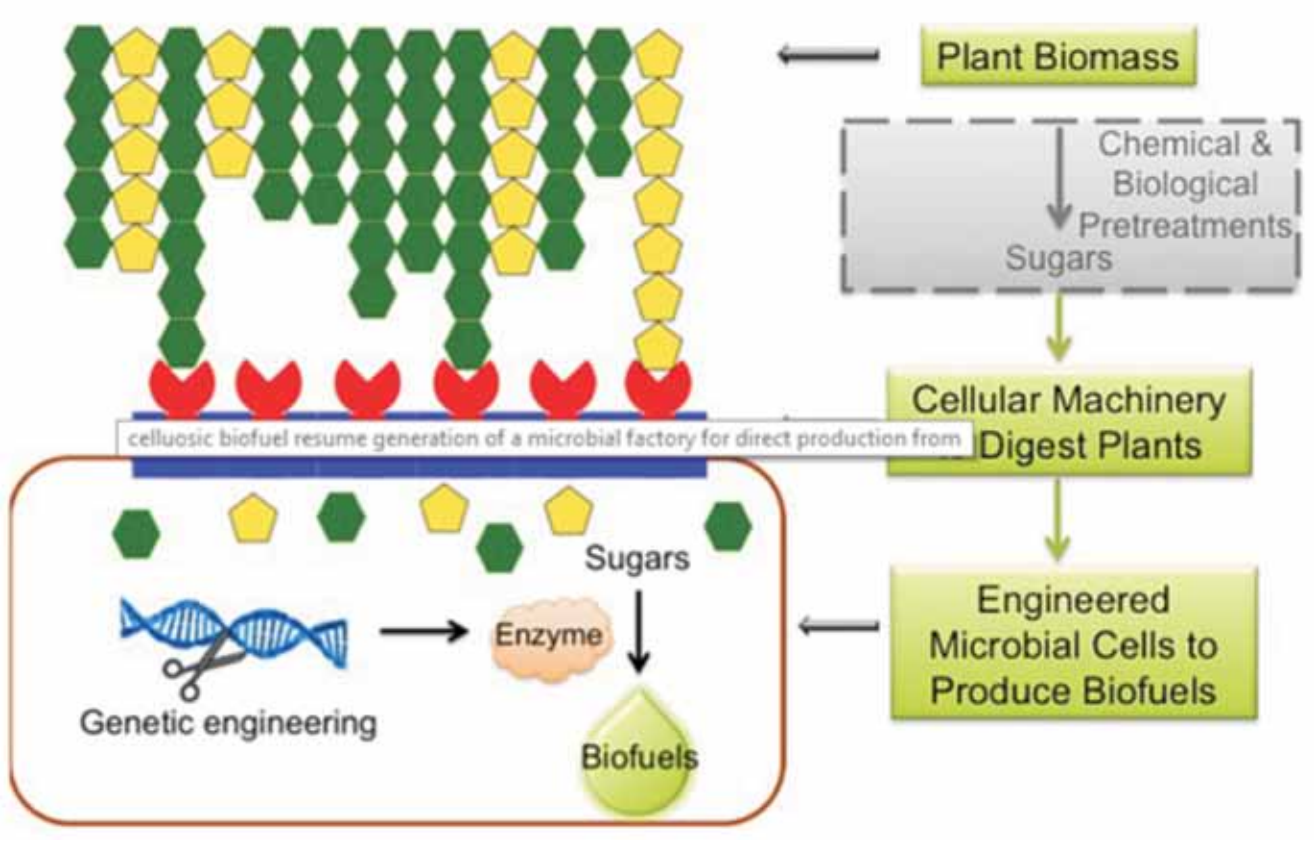


Fig. 5b: Bio-chemical 2G Ethanol Process (Technical)

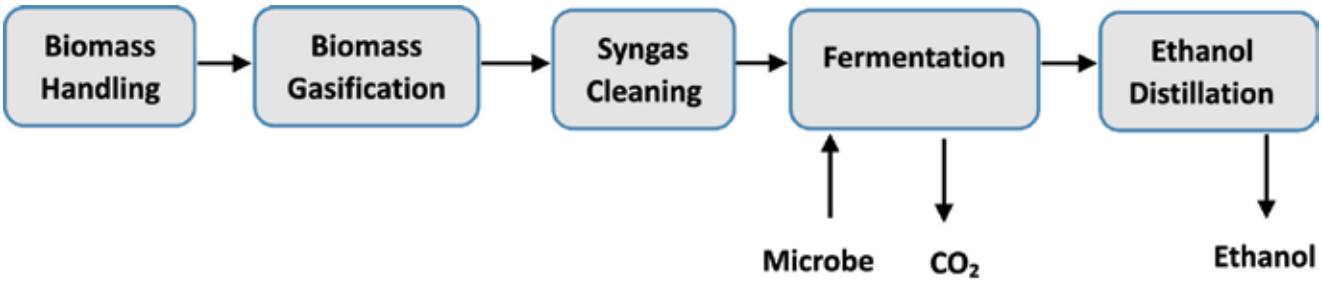


Fig. 5C: Schematic for thermo-chemical 2G Ethanol Process

Key Advantages of thermochemical process:

- Ability to use wide varieties of feedstock including MSW.
- Less prone to microbial contamination.
- Lignin independent.
- Also suitable for off gases in steel mills, petroleum refinery.

Major Challenges Ahead and Conclusion:

Feedstock supply mechanism:

Though surplus ligno-cellulosic feedstock is available in India, necessary ecosystem is still premature except in few states like Punjab, Gujarat. Subsidised biomass collection machinery and equipment, strategies and involvement of local farmers and self-help groups is required to be established. Decentralised strategic biomass storages at minimum economical distance from proposed 2G ethanol plant are to be established. Special incentives for village level entrepreneurs would also be the key to feedstock availability. Challenges for 2G Ethanol plants with enzymatic routes are encompasses below, since, present ongoing 2G Ethanol plants in India under implementation are based on enzymatic routes.

Technology maturity:

- Second generation ethanol production plants at commercial scale are not existent in India. There are references of about 10 TPD demonstration plants in Pune, Maharashtra and Kashipur, Uttarakhand based on different indigenous technologies and matured transition of these technologies to commercials scale is key to success of 2G Ethanol plants.
- Lignin based boiler operation is another key area of maturity for commercial scale plant. Boiler handling three phases, namely lignin, stillage and gases with commercially proven boiler vendor availability should be addressed.
- Understanding of pre-treatment and enzymatic hydrolysis process should be more elaborately understood. Reactor scale-up handling (enzymatic reactors) with scope for optimization of chemical and enzyme consumption shall be completely explored to bring down the cost.
- Commercially proven biomass feed pre-treatment digester should be properly implemented.
- Hydrolysed Slurry handling with vendor development and sourcing of equipment's should also be addressed.

Conclusion:

Ethanol Blending Program is the flagship initiative of Government of India to increase national energy security, reduce carbon foot print and generate rural employment. With a substantial potential of surplus biomass to produce 2G ethanol, India is poised to lead globally in this arena with multiple benefits of forex savings, GHG emission controls, abating stubble burning and enhancing energy basket. Government of India is taking major strides in advancing the setting up of 2G ethanol plants as part of its green initiative. The need for addressing the issues for successful implementation of ethanol blending in petrol is imperative.

OIL & GAS IN MEDIA

MoU for Setting up Centre of Excellence in Oil, Gas and Energy Signed between IIT Bombay and PSU Oil Companies.

To provide a competitive advantage to India's Oil and Gas industry, Oil & Gas PSUs and IIT Bombay have come together to set up a "Centre of Excellence in Oil, Gas and Energy". The Centre of Excellence is aimed at collaborative Research & Capability Building in the areas of Oil, Gas & Energy. It will work towards developing sustainable solutions and explore new frontiers in technology for future energy needs. The Centre of Excellence will leverage the expertise available with IIT Bombay and the Oil and Gas industry. It will also provide an institutionalised platform for Industry - Academia interactions. The Centre of Excellence is expected to help in fostering innovations and help in developing a future ready energy industry in the Country.

A Memorandum of Understanding (MoU) for setting up Centre of Excellence in Oil, Gas and Energy was signed between Director, IIT Bombay and CMDs of PSU Oil Companies and EIL on 2nd January. Union Minister of Petroleum & Natural Gas and Skill Development & Entrepreneurship Shri Dharmendra Pradhan and Secretary, Ministry of Petroleum and Natural Gas Dr M.M. Kutty graced the occasion.

Speaking on the occasion, Shri Dharmendra Pradhan said the MoU will meet the need of the Mission Green, as it will encourage Research and development in the sector and also do the capacity building. He said that energy is the prime requirement for all activities in the modern world. Indian appetite for energy is increasing day by day, and we have to provide for clean, affordable and accessible energy sources. He said that there is need for mass production through domestic sources, and distribution through decentralization. Shri Pradhan said that the technological and industrial changes are happening very fast, and the coming together of the Academic and Industrial organizations gives best results. He said that there is need to put academic research in the entrepreneurial mode, so that results are effective. The Minister said that MoU should be outcome based and must have roadmap for deliverables, and it should set examples for others. He said that India is a large energy market, and effort should be made to develop our own petroleum standards. We should strive to be leaders in Biomass conversion and Hydrogen based energy. IIT Bombay, being the premier institute, should provide the missing link and help in evolving new strategies in the sector.

Bid round –III under Open Acreages Licensing Policy (OALP) launched by Shri Dharmendra Pradhan

Union Petroleum and Natural Gas & Skill Development and Entrepreneurship Minister Shri Dharmendra Pradhan launched the bid round –III under Open Acreages Licensing Policy (OALP) on 10th February 2019 at Greater Noida, the venue of PETROTECH-2019. Under this Bid round, 23 blocks, covering over 31,000 sq km od area will be available for exploration. Following the contract signing of 55 Blocks under OALP Bid Round-I, the Government launched OALP Bid Round-II on 07th January 2019 offering 14 Blocks under Petroleum Operation Contract for International Competitive Bidding. With the launch of the third bidding round, more than 1,20,000sq km of area has now been made available for exploration in last one year. The OALP adopts all features of HELP - reduced royalty rates, no Oil Cess, uniform licensing system, marketing and pricing freedom, Revenue Sharing Model, Exploration rights on all retained area for full contract life etc.

Speaking on the occasion, Shri Pradhan said we recently awarded 55 blocks spread across 10 sedimentary basins under maiden Bid Round after a gap of 6 years and 30 contract areas under the Discovered Small Field Policy Bid Round-I. The 2nd Bid Rounds for both Discovered Small Field Policy and Open Acreages Licensing Policy are now underway and have also seen encouraging response from investors. The overwhelming participation from investors is a testimony to their faith and confidence in India's upstream sector potential. He invited the investors to participate in the bidding round and be a part of the Indian growth story.

The Union Minister for Petroleum & Natural Gas and Skill Development & Entrepreneurship, Shri Dharmendra Pradhan launching the bid round –III under Open Acreages Licensing Policy (OALP), on the sidelines of the PETROTECH – 2019, at Greater Noida, Uttar Pradesh on February 10, 2019. The Secretary Ministry of Petroleum & Natural Gas, Dr. M.M. Kutty and other dignitaries are also seen.

Source : PIB

PETROTECH 2019

The Prime Minister, Shri Narendra Modi delivering the inaugural address at the PETROTECH-2019, the 13th International Oil & Gas Conference & Exhibition

Petrotech-2019 was organized by ONGC and FIPI under the aegis of Ministry of Petroleum and Natural Gas (MoP&NG), Government of India from 10 – 12 February, 2019 at Greater Noida. Petrotech 2019, the grand show of Indian oil and gas industry was inaugurated by the Hon'ble Prime Minister of India Shri Narendra Modi in the presence of Shri Dharmendra Pradhan, Minister, Petroleum and Natural Gas and Skill Development and Entrepreneurship, Government of India.

Petrotech 2019, the 13th edition of the biennial conference and exhibition, provided experts from national and international oil and gas industry with a platform to share knowledge and expertise and display the technological developments across the oil and gas value chain. The theme of Petrotech 2019 was aptly set as 'Shaping the New Energy World through Innovation and Collaboration'. While the conference at this occasion witnessed sectorial experts sharing their views on issues touching upon various aspects of the petroleum industry, the exhibition presented an opportunity for both national and international companies, working in the oil and gas space, to exhibit the latest technologies in the industry and explore business opportunities globally.

At Petrotech 2019, FIPI had set up a pavilion at Hall 14 in the exhibition area. The FIPI pavilion at the event was rightly called the 'FIPI Innovation Centre', as it extended an opportunity to the young entrepreneurs to be a part of the most prestigious event of the Indian oil and gas industry. The FIPI Innovation Centre was inaugurated by Shri Dharmendra Pradhan, Minister, Petroleum and Natural Gas and Skill Development and Entrepreneurship. He also launched the FIPI, KPMG study on 'Impact of Oil & Gas on Indian Economy' at this occasion. The inauguration of the FIPI Innovation Centre was also attended by Dr. M M Kutty, Secretary, MoP&NG and Mr. Shashi

Shanker, Chairman, FIPI & Chairman and Managing Director (CMD), ONGC among other dignitaries. The Innovation Centre set up by FIPI at Petrotech 2019, presented a unique opportunity for the young start-ups to display their products and explore possible business opportunities with stakeholders from global oil and gas industry.

The display of innovative technologies by young start-ups at the FIPI Innovation Centre attracted much attention from the visitors at Petrotech 2019. These young entrepreneurs were supported by seven state PSUs viz. ONGC, IndianOil, Oil India Ltd, GAIL, EIL, HPCL and BPCL under the Government's Rs 320 Crore start up fund for young entrepreneurs in the oil and gas sector. The overwhelming interest shown by the visitors and key industry participants did not just provide these young entrepreneurs with an unparalleled marketing opportunity but also proved a constant source of encouragement to them.

At the pavilion, FIPI apprised global stakeholders with the crucial role it has played as an industry interface with Government and regulatory authorities towards creating an enabling policy ecosystem for the oil and gas sector in the country. It also highlighted the leadership role FIPI has taken up over the years in advocating for key industry issues. FIPI also promoted its upcoming WPC leadership conference in Mumbai at the pavilion, which attracted much attention from key industry participants.

Several members of FIPI's leadership team represented the organization at various knowledge sharing sessions at Petrotech 2019. Dr R K Malhotra, Director General, FIPI shared his insights on the role of R&D in the continued growth of the country's petroleum sector at the plenary session 'Building Energy Ecosystem Through R&D and Innovation'. Dr. Malhotra also chaired a technical session on 'Emerging Alternative Energy Options'. Mr. T K Sengupta, Director (E&P), FIPI and Mr. N K Bansal, Director (Oil Refining and Marketing), FIPI chaired technical sessions 'HP – HT and Tight Field Development & Technology' and 'Health, Safety and Environment', respectively where useful insights were given by experts in these areas.

The thirteenth edition of Petrotech 2019 which portrayed 'Shaping of the New Energy World through Innovation and Collaboration' was a grand success

The Prime Minister, Shri Narendra Modi at the inauguration of the PETROTECH-2019. The Minister of State of UAE & CEO Abu Dhabi National Oil Company (ADNOC) Group, Dr. Sultan Ahmed Al Jaber, the Union Minister for Petroleum & Natural Gas and Skill Development & Entrepreneurship, Shri Dharmendra Pradhan, the Chief Minister of Uttar Pradesh, Yogi Adityanath and other dignitaries are also seen

The Union Minister for Petroleum & Natural Gas and Skill Development & Entrepreneurship, Shri Dharmendra Pradhan at the PETROTECH – 2019, at Greater Noida, Uttar Pradesh on February 10, 2019. The Secretary Ministry of Petroleum & Natural Gas, Dr. M.M. Kutty and other dignitaries are also seen

Dr. R. K. Malhotra, DG, FIPI speaking in the plenary session on 'Building Energy Ecosystem through R&D and Innovation'

Hon'ble Minister Shri Dharmendra Pradhan, MoP&NG inaugurating FIPI Innovation Center

The Governor of Uttar Pradesh, Shri Ram Naik and the Union Minister for Petroleum & Natural Gas and Skill Development & Entrepreneurship, Shri Dharmendra Pradhan at the concluding ceremony of the PETROTECH – 2019

Hon'ble Minister Dharmendra Pradhan releasing FIPI's study on 'Impact of Oil and Gas on Indian Economy' at Petrotech 2019 Exhibition during his visit to FIPI Innovation Center

FIPI EVENTS

BP Energy Outlook 2019

Federation of Petroleum Industry (FIPI) and BP India jointly presented the BP Energy Outlook-2019. Two events were organized, one in Delhi and the other at Mumbai in the month of March 2019.

BP Energy Outlook, the pristine position it holds as a beacon of guidance for the energy sector, both the events saw attendance of top executives from the oil and gas companies in India.

Mr. Spencer Dale, Group Chief Economist BP in his presentation of BP Energy Outlook – 2019 spoke on the energy transition under different scenarios. He explained as to how the outlook presents and analyses future energy trends and the growing demand will be met over the coming decades through a diverse range of supplies including oil, gas, coal and renewables.

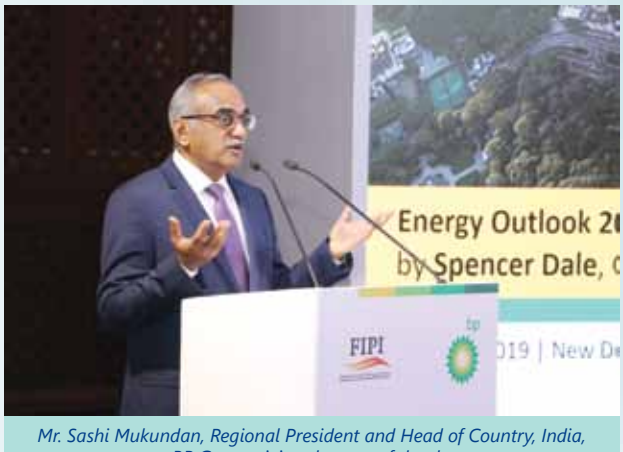
The presentation was followed by an engaging question and answer round, post which Mr. Sashi Mukundan Regional President and Head of Country, India, BP Group presented the vote of thanks and expressed his gratitude to Mr. Dale for the invigorating session as well as FIPI for having contributed towards making this event a success.

Mr. T. K. Sengupta, Director (E&P), FIPI welcoming the participants at Mumbai

Dr. R. K. Malhotra, Director General, FIPI welcoming the participants at Delhi

Mr. Spencer Dale, Group Chief Economist, BP delivering the presentation on 'BP Energy Outlook 2019

Mr. Spencer Dale, Group Chief Economist, BP flanked by dignitaries on the dais



Mr. Sashi Mukundan, Regional President and Head of Country, India, BP Group giving the vote of thanks

2nd WPC Leadership Conference

Federation of Indian Petroleum Industry (FIPI) joined hands with the World Petroleum Council (WPC) to organize the second edition of WPC leadership conference from 18 – 20 February, 2019 in Mumbai, India. The WPC Leadership Conference is a global conference on industry leadership in responsible operations, international cooperation and sustainable solutions for the petroleum sector. Recent edition of the conference was even more important in the Indian context because India, one of the major demand centers for energy, has a large growing population with increasing appetite for energy and is faced with serious concerns regarding air quality and climate change. The key themes of the conference were Engaging Energy Poverty, Energy Transitions and Industry Responses to Climate Change. The conference was attended by major stakeholders from the Indian and International Oil and Gas industry, including industry leaders, experts and academia.

The two-day conference commenced with the welcome remark and setting of context by Mr. Tor Fjæran, President, World Petroleum Council and Dr. R. K. Malhotra, Director General, Federation of Indian Petroleum Industry (FIPI). Mr Fjæran underlined the rising concerns due to air quality and climate change and emphasized that the efforts of the industry will be fruitful only through collaboration, dialogue and sharing of best practices. Dr Malhotra pointed out that as the world approaches energy transition, access to energy sources at an affordable price will be of paramount importance. The first session of the conference 'Energy Transitions – The Changing Role of the Oil & Gas Industry' was chaired by Dr Sun Xiansheng, Secretary General, International Energy Forum (IEF). During the discussion, it was well established that the energy transition has already been put in motion by ground breaking developments in the industry like Electric Vehicles (EVs), emergence of renewables and digitalization. In the future, the energy transition will be driven by three major factors – efficiency, innovation and digitalization. Going forward, bringing clean energy access to even the most under privileged will be the main focus for the entire energy industry. In this direction, the success of Government of India's Pradhan Mantri Ujjwala Yojana (PMUY) scheme, that made clean cooking fuel in the form of LPG cylinders available to more than 60 million under privileged households, drew wide spread appreciation. The panelists agreed that faced with the energy transition, the Oil & Gas industry will have to shoulder a responsibility more important than ever before to ensure a smooth transition to a sustainable future.

In this edition of the Conference, learned speakers deliberated about the upcoming energy transition and the industry's preparedness towards it. This transition, unlike all previous energy transitions, is driven more by the very fundamental concerns over air quality and climate change. During the course of the discussions, it was realized that for a sustainable future, affordable energy access for all will remain the central focus while the key levers in this transition will be energy efficiency, digitalization and acceptance towards disruptive technologies. It was realized that for a smooth transition towards a cleaner future, natural gas and renewables will have play a key role in the India's energy mix. For a sustainable future, the Oil & Gas sector will have to shoulder a responsibility much beyond generating returns and will have to engage with the local communities for an over-all socio-economic development. The petroleum companies, to ensure their place on the right side of the history, will not just have to be a stakeholder in the upcoming energy transition but will also have to be a vanguard in this major paradigm shift.

Dr. R. K. Malhotra, Director General, (FIPI) delivering the welcome address

Mr. N. K. Bansal, Director (Oil Refining and Marketing), FIPI speaking at the session 'Cleaner fuels - Innovative Technologies for safe and clean downstream operations'

Dr. S S V Ramakumar, Director (R&D), IndianOil speaking at the plenary session 'Energy Transitions'

Dr. Sun Xiansheng, Secretary General, IEF moderating the special keynote session 'Energy transitional challenges in the wake of growing energy demand in India'

Mr. Rajiv Bahl, Director (Finance), FIPI moderating the highly absorbing session on "Managing Stakeholder Expectations"

A section of the participants

Dr Pierce Riemer, Director General, World Petroleum Council moderating the Expert Panel on "Best Practices in engaging energy poverty and local communities"

Mr. T. K. Sengupta, Director(E&P), FIPI speaking at the Session Increasing safety, environmental protection and energy efficiency: Impact of Digitalization

Mr. Tor Fjaeran giving the closing remarks at WPC Leadership Conference

Youth Forum 2019

The Federation of Indian Petroleum Industry (FIPI) organized the Youth Forum 2019 during 9 – 10 January, 2019 in New Delhi. The Youth Forum 2019 organized under the umbrella of Petrotech 2019, India's flagship energy conference, was uniquely designed to bring under one roof, students from across the country and industry leaders to interact and explore the prospects of a rewarding career in the oil and gas industry. The event witnessed participation of over 200 students from various colleges and universities across the country. Many eminent personalities such as Mr. Sanjiv Singh, Chairman, IndianOil; Dr. Mahesh Gupta, Chairman & Managing Director, Kent RO Systems Ltd; Brig (Dr) Sunil Kumar Moudgil and Mr. Anish De, Partner & Head, Energy and Natural Resources, KPMG India interacted with the students over the course of this event.

The event opened with a warm welcome address by Mr. Rajiv Bahl, Director (Finance and Taxation), FIPI. Mr. Bahl underlined that the objective of Youth Forum 2019 is to provide students with an opportunity to interact with the leaders of Indian oil and gas industry and to provide an ideal platform to explore the opportunities available in the sector. He mentioned that as the country continues to grow at a brisk pace, the demand for energy is poised to grow significantly in the years to come. He also emphasized that the growing energy sector will present a vast range of opportunities to the youth in the country.

The highlight of the event remained the interactive session with Mr. Sanjiv Singh, Chairman, IndianOil along with Dr. R.K. Malhotra Director General FIPI. Mr. Singh in a very eloquent manner introduced the students to the Indian oil and gas industry and informed them about the potential growth areas and the exciting career opportunities in the oil and gas space. He suggested that the newest technological advancements in the sector will have a long lasting impact on the dynamics of the global energy industry. With new technologies like Electric Vehicles (EVs) and LNG driven vehicles on the horizon, he urged the students to view these fuel technologies in combination as they will coexist in the near future. At the occasion, Dr R K Malhotra, Director General, FIPI encouraged students to stay abreast with the latest developments in the sector and explore newer possibilities to contribute to the growth of the sector.

Mr. Rajiv Bahl, Director (Finance), FIPI welcoming the participants

Students at Youth Forum 2019

Students at Youth Forum 2019

Brig. Sunil Kumar Moudgil energized atmosphere at Youth Forum with his inspiring address. He motivated the young participants on importance of unwavering determination & commitment towards their dreams, for achieving success in any & all walks of life

Mr. Mahesh Gupta, Founder-Chairman, Kent RO Systems Ltd shared some really inspiring stories with the students

Mr. Anish De, Partner and Head, Energy and Natural Resources, KPMG in India shared a very informative presentation with the young participants on 'Role played by Technology & Innovation in Oil & Gas Sector

Mr. Sanjiv Singh, Chairman, IOCL interacting with the students

Mr. Sanjiv Singh, Chairman, IOCL along with Dr. R. K. Malhotra, Director General, FIPI discussed about the rewarding career opportunities for students in the Oil and Gas Sector of India

Mr. Siddharth Banerji, Senior Assistant Director (Policy & Planning), FIPI anchoring the programme

Mr. Anand Vaidyanathan, Senior Assistant Director (E&P), FIPI anchoring the programme

One Day Conference on "Digital Transformation in Oil & Gas Sector"

The Federation of Indian Petroleum Industry (FIPI) organized a one-day conference on "Digital Transformation in Oil & Gas Sector" on February 8, 2019 in New Delhi, as a precursor to Petrotech 2019. This program was uniquely designed to bring various technology leaders under one roof to explore the opportunities for the Indian oil and gas industry in Digital Transformation. The event witnessed participation of over 120 executives from various oil companies across the country.

Many industry leaders from 14 companies namely ONGC, HPCL, Cairn India, Reliance Industries Limited, Deloitte, Schlumberger, Baker Hughes, A GE Company, Siemens, Honeywell, Larsen & Toubro, SAP, Kongsberg Digital and Hexagon Capability Center India made their presence to showcase the opportunity to know the current status of digitalization in O&G sector and the experience of the prominent organizations in this direction. M/S Deloitte provided the knowledge partnership for the conference.

The event opened with a warm welcome address from Mr. NK Bansal, Director (Oil Refining & Marketing) Mr. Bansal underlined that the objective of the conference to focus on the current status, opportunities, issues, challenges and future pathways to accelerate the pace of digital transformation in O&G sector. Inaugural address was given by Mr. Subash Kumar, Director (Finance), ONGC.

Many interactive sessions on various themes such as digital opportunities, sector insights with global and Indian examples and digital initiatives in the Indian O&G sector; latest technologies in digital transformation in the oil and gas sector; application of digital technologies and experience in the O&G sector; opportunities, challenges and readiness for the digitalization in the Indian O&G sector; digital culture and agility on the grounds of O&G industry were also held during the one day conference.

The one-day conference ended on a high note with executives carrying the crux of knowledge in digitalization in O&G sector. Mr. N.K. Bansal, Director (Oil Refining & Marketing) proposed the vote of thanks and encouraged the industry leaders to stay abreast with the latest developments in the sector and explore newer possibilities to contribute to the growth of the sector.

Mr. N.K. Bansal, Director (Oil Refining & Marketing) delivering the Welcome Address

Mr. Subhash Kumar Director (Finance), ONGC delivering the Inaugural Address

Mr. Debasish Misra, Deloitte, India, Mr. Kalyan Sundaram, Deloitte USI & Mr. Nubeel Ansari, SAP addressed the keynote session of conference on Digital Transformation & shared their valuable thoughts on Digitalisation & its future in energy sector

The panel including Mr. Nirav Shah RIL, Mr. Sriram Ayyar L&T, Mr. Piyush Gupta, Cairn; Dr. Debnath Basu SIS brainstormed on the Digital Application in energy Sector. This enlightening session was moderated by Mr. Shree Parthasarathy

Conference got more interesting,with session on Latest Technologies in Digital Transformation,delivered by Mr. Dhaval Trivedi KDI; Mr. Pramod Agrawal BH; Mr. Purav Bhatt, Siemens India; Mr. Akshay Gupta Honeywell, UOP & moderated by Mr. Kalyana Sundaram

Mr. Manomay Das IBM, Mr. Rajnish Mehta, HPCL & Mr. Dharam Raj, ONGC carried out a very insightful discussion on building Digital DNA within Oil & Gas sector moderated by Ms. Kalpana Jain, Deloitte India

Mr Shekhar Konidena HCCI, Mr. Gurumurthy Santhanakrishnan GE, Dr. Debnath Basu SIS, Mr Vijay Phatarphekar gave their insights on Opportunities & Challanges of Digital Implementation in oil and gas sector in a discussion moderated by Mr. Shatanik Goswami, Deloitte India

NEW APPOINTMENTS

B.N. Reddy takes over as OSD (International Cooperation) (Joint Secretary Level) in the Ministry of Petroleum & Natural Gas, Govt. of India.

B.N. Reddy

Mr. B.N. Reddy takes over as Officer on Special Duty (International Cooperation) (Joint Secretary Level) in the Ministry of Petroleum & Natural Gas, Govt. of India w.e.f 27th February 2019.

Mr. B.N. Reddy joined the Indian Foreign Service (IFS) in 1993, and had served in Indian Missions in Indonesia (1995-98), Lao PDR (1998-2001), New York (Permanent Mission of India) (2005-2008), Malaysia (2008-2011) and Geneva (as the DPR in Permanent Mission of India) (2013-16). Mr. Reddy served as the High Commissioner of India to Nigeria from June 2016 to December, 2018. He has served in the Ministry of External Affairs in the Administration Division and subsequently as the Director/Joint Secretary to the External Affairs Minister of India. Mr. Reddy has learnt Bahasa Indonesia at the University of Indonesia (UI) during his posting in Indonesia in 1995.

Mr. Reddy has a Master's Degree in Thermal Engineering from IIT, Bombay, and Bachelor's Degree in Mechanical Engineering from Birla Institute of Technology and Science (BITS), Pilani. Prior to joining the Ministry of External Affairs, Mr. Reddy also served with TELCO (now Tata Motors) and also in the Indian Engineering Service (IES).

S.K. Handa assumes charge as Director (Projects), EIL

Mr. S.K. Handa has assumed charge as Director (Projects) of Engineers India Ltd. (EIL) w.e.f. March 11, 2019.

Having joined EIL as Management Trainee in 1983, he has been associated with many green field & brown field projects implemented by EIL. He has also been involved in development of in-house technology & its commercialisation in the hydrocarbon field.

His areas of responsibility spanning 35 years career in EIL include process design, technology development & its commercialisation, engineering services & business development across entire hydrocarbon value chain in midstream & downstream sectors. He was nominated to the board of Certification Engineers India Ltd. (CEIL), subsidiary of EIL, as Part-Time Director in 2015.

Mr. Handa is a B. Tech (Hons.) in Chemical Engineering from Department of Chemical Engineering & Technology, Panjab University, Chandigarh (1983 batch).

Prior to assuming charge of Director (Projects), he led the position of Executive Director (Technical) in EIL.

S.K. Handa

STATISTICS

INDIA: OIL & GAS

DOMESTIC OIL PRODUCTION (MILLION MT)

		2013-14	2014-15	2015-16	2016-17	2017-18 (P)	April-December 2018 (P)	
								% of Total
On Shore	ONGC	6.7	6.1	5.8	5.9	6.0	4.6	34.7
	OIL	3.5	3.4	3.2	3.3	3.4	2.5	19.1
	Pvt./ JV (PSC)	9.4	9.1	8.8	8.4	8.2	6.1	46.2
	Sub Total	**19.6**	**18.5**	**17.8**	**17.6**	**17.5**	**13.1**	100
Off Shore	ONGC	15.5	16.2	16.5	16.3	16.2	11.3	88.8
	OIL	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	1.4	11.2
	Sub Total	**18.2**	**18.9**	**19.1**	**18.4**	**18.1**	**12.8**	100
Total Domestic Production		37.8	37.5	36.9	36.0	35.7	25.9	100.0
	ONGC	22.3	22.3	22.4	22.2	22.2	15.9	61.4
	OIL	3.5	3.4	3.2	3.3	3.4	2.5	9.7
	Pvt./ JV (PSC)	12.1	11.8	11.3	10.5	10.1	7.5	28.9
Total Domestic Production		**37.8**	**37.5**	**36.9**	**36.0**	**35.7**	**25.9**	100

Source : PIB/PPAC

REFINING

Refining Capacity (Million MT on 1st January 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	April-Dec. 2018 (P)
IOCL	53.1	53.6	58.0	65.2	69.0	54.5
HPCL	15.5	16.2	17.2	17.8	18.2	13.8
BPCL	23.0	23.2	24.1	25.3	28.2	22.8
CPCL	10.7	10.7	9.6	10.3	10.8	7.8
MRPL	14.6	14.6	15.5	16.0	16.1	12.0
ONGC (Tatipaka)	0.1	0.05	0.07	0.09	0.08	0.04
NRL	2.6	2.8	2.5	2.7	2.8	2.2
SUB TOTAL	**119.6**	**121.1**	**127.0**	**137.3**	**145.2**	**113.1**

JV Refineries	2013-14	2014-15	2015-16	2016-17	2017-18	April-Dec. 2018 (P)
HMEL	9.3	7.3	10.7	10.5	8.8	9.4
BORL	5.4	6.2	6.4	6.4	6.7	3.7
SUB TOTAL	**14.7**	**13.6**	**17.1**	**16.9**	**15.5**	**13.1**

Pvt. Refineries	2013-14	2014-15	2015-16	2016-17	2017-18	April-Dec. 2018 (P)
NEL	20.2	20.5	19.1	20.9	20.7	13.8
RIL	68.0	68.1	69.5	70.2	70.5	52.6
SUB TOTAL	**88.2**	**88.6**	**88.6**	**91.1**	**91.2**	**66.4**

	2013-14	2014-15	2015-16	2016-17	2017-18	April-Dec. 2018 (P)
All India Crude Processing	**222.4**	**223.3**	**232.9**	**245.4**	**251.9**	**192.6**

Source : PIB Release/PPAC

CRUDE CAPACITY VS. PROCESSING

	Capacity 0n 01/01/2019 Million MT	% Share	Crude Processing Million MT April-Dec 2018 (P)	% Share
PSU Ref	142.1	57.0	113.1	58.7
JV. Ref	19.1	7.7	13.1	6.8
Pvt. Ref	88.2	35.4	66.4	34.5
Total	**249.4**	**100**	**192.6**	**100**

Source: PIB/PPAC

POL PRODUCTION (Million MT)

	2013-14	2014-15	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
From Refineries	216.4	217.1	227.9	239.2	249.8	193.0
From Fractionators	3.9	3.7	3.4	3.5	4.6	3.7
Total	**220.3**	**220.7**	**231.2**	**242.7**	**254.4**	**196.7**

DISTILLATE PRODUCTION (Million MT)

	2013-14	2014-15	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
Light Distillates, MMT	62.7	63.2	67.1	71.0	74.7	52.9
Middle Distillates , MMT	112.8	113.4	118.3	122.5	127.5	97.9
Total Distillates, MMT	175.5	176.6	185.4	193.5	202.2	150.8
% Distillates Production on Crude Processing	78.9	79.1	79.6	78.9	80.3	78.3

Source: PIB/PPAC

PETROLEUM PRICING

OIL IMPORT - VOLUME AND VALUE

	2013-14	2014-15	2015-16	2016-17 (P)	2017-18 (P)	April-Dec. 2018 (P)
Quantity, Million Mt	189.2	189.4	202.9	213.9	220.4	170.5
Value, INR ₹000 cr.	864.9	687.4	416.6	470.6	566.0	607.5
Value, USD Billion	143.0	112.7	64.0	70.2	87.8	86.9
Average conversion Rate, INR per USD (Calculated)	60.5	61.0	65.1	67.0	64.5	69.9

OIL IMPORT - PRICE USD / BARREL

	2013-14	2014-15	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
Brent (Low Sulphur - LS-marker) (a)	107.5	85.4	47.5	48.7	57.5	72.3
Dubai (b)	104.6	83.8	45.6	47.0	55.8	71.3
Low sulphur-High sulphur differential (a-b)	2.9	1.7	1.8	1.7	1.6	1.1
Indian Crude Basket (ICB)	105.52	84.16	46.17	47.56	56.43	72.05
ICB High Sulphur share %	69.90	72.04	72.28	71.03	72.38	74.77
ICB Low Sulphur share %	30.10	27.96	27.72	28.97	27.62	25.23

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

	2013-14	2014-15	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
Gasoline	114.3	95.5	61.7	58.1	67.8	78.5
Naphtha	100.2	82.2	48.5	47.1	56.3	68.5
Kero / Jet	121.2	66.6	58.2	58.4	69.2	86.4
Gas Oil (0.05% S)	122.0	99.4	57.6	58.9	69.8	86.5
Dubai crude	104.6	83.8	45.6	47.0	55.8	71.3
Indian crude basket	105.5	84.2	46.2	47.6	56.4	72.1

CRACKS SPREADS ($/ BBL.)

	2013-14	2014-15	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
Gasoline crack						
Dubai crude based	9.7	11.7	16.1	11.1	12.0	7.3
Indian crude basket	8.8	11.3	15.6	10.6	11.4	6.5
Diesel crack						
Dubai crude based	17.4	15.7	12.0	12.0	13.9	15.2
Indian crude basket	16.5	15.3	11.5	11.4	13.4	14.4

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

Source: PIB/PPAC/OPEC

GAS PRODUCTION

Qty in MMSCM

	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
ONGC	21177	22088	23429	18416
Oil India	2838	2937	2882	2061
Private/ Joint Ventures	8235	6872	6338	4173
Total	**32250**	**31897**	**32649**	**24650**

		2015-16	2016-17	2017-18 (P)	April-Dec 2018 (P)
Onshore	Natural Gas	8845	9294	9904	7543
	CBM	393	565	735	534
	Sub Total	**9237**	**9858**	**10639**	8077
Offshore		23012	22038	22011	16573
	Sub Total	**23012**	**22038**	**22011**	16573

	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
Total	**32249**	**31897**	**32649**	**24650**
(-) Flare loss	1120	1049	918	602
Net Production	31129	30848	31731	24048

	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
Net Production	31129	30848	31731	24048
Own Consumption	5822	5857	5806	4510
Availabilty	25307	24991	25925	19538

AVAILABILTY FOR SALE

	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
ONGC	16076	17059	18553	14634
Oil India	2314	2412	2365	1675
Private/ Joint Ventures	6917	5520	5007	3229
Total	**25307**	**24991**	**25925**	**19538**

CONSUMPTION (EXCLUDING OWN CONSUMPTION)

	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
Total Consumption	46695	49677	52253	40255
Availabilty for sale	25307	24991	25925	19538
LNG Import	21388	24686	26328	20717

GAS - IMPORT DEPENDENCY

	2015-16	2016-17	2017-18 (P)	April-Dec. 2018 (P)
Net Gas Production	31129	30848	31731	24048
LNG Imports	21388	24686	26328	20717
Import Dependency (%)	40.7	44.5	45.3	46.3
Total Gas Consumption*	**52517**	**55534**	**58059**	**44765**

* 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)									
				April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Fertilizer	**R-LNG**	**7592**	**7781**	660	745	697	729	714	696	404	683	786	**6114**
	Domestic Gas	**7802**	**6862**	516	503	570	527	551	520	830	470	514	**5001**
Power	**R-LNG**	**2410**	**2645**	235	286	316	236	186	245	643	155	203	**2505**
	Domestic Gas	**9131**	**9375**	814	780	693	763	760	758	514	825	795	**6702**
City Gas	**R-LNG**	**3030**	**3881**	329	349	331	356	338	317	333	323	350	**3026**
	Domestic Gas	**4276**	**4659**	405	415	404	429	439	427	445	423	468	**3855**
Refinery Petro-chemical Others	**R-LNG**	**12440**	**12439**	1035	1128	1117	1148	1170	1142	1106	959	969	**9774**
	Domestic Gas	**3978**	**4872**	417	394	393	399	427	411	477	405	474	**3797**

Source:PPAC

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पहल

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