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OffshoreWorld

INSIGHT INTO UPSTREAM & DOWNSTREAM HYDROCARBON INDUSTRY

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'Digitalization is about making sense of data'

'The future belongs to those organizations who will be able to close the loop between data extraction and value creation in real time', says **Sajiv Nath, Managing Director, Yokogawa India Ltd.** In an exclusive interaction with **Rakesh Roy** of **Offshore World,** he shares insights about how Digital Transformation can embrace the full automation of the entire Oil & Gas Industry and Yokogawa Digital Transformation journey in detail.

> *A more real-time data-enabled decision-making process, integrated with market and process realities, can support sustainable and safe productivity growth.*

According to you, how digitalisation can leverage the full automation of the entire hydrocarbon industry? How has Yokogawa planned to adopt the changing business environment?

Digitalisation is not industry specific. Digitalization is touching our everyday life and every industry. Digitalization is about making sense of data – data, in most of the cases, are already available in the industry. Hydrocarbon industry is relatively more automated and generates TBs of data every day. Merely 5 per cent of those data are meaningfully used. Off course, in some cases, smart sensors need to be added to get fuller information on the process and its safety and productivity. However, the key point is the usage of data and make sense of those data. Corelating different types of data, using combinational analytics will help users to achieve newer outcomes. Yokogawa believes that the future belongs to those organizations who will be able to close the loop between data extraction and value creation in real time.

As always, Yokogawa embraces the new technology, converts it to useful form for our customers and delivers effective solutions to customers' pain points. With enormous potential that digitalization can deliver, Yokogawa announced Synaptic Business concept in 2017 for the Industrial Automation segment which essentially converges Operational Technology for Operations Management and Control and Information Technology for business system – both together creates sustainable value for our customers and our solutions support improved productivity across the plant life cycle, from the management level to the operations level.

How do you evaluate the Indian Oil & Gas Automation market in the Digital era?

Indian Oil & Gas is one of the best in the world - in terms Process, Level of Automation, Productivity and safety standard. A few Indian companies generate high GRM in the world. They can handle heavy/ low quality crude through complex refining process. Not only refining process, our refiners are advanced in business process also, like dynamic product mix strategy and effective crude sourcing strategy to align with changing market need.

Many of them are at higher level of digital maturity. However, we have a lot more to achieve. A more real-time data-enabled decision-making process, integrated with market and process realities, can support sustainable and safe productivity growth.

Easy oil is gone and the industry is now going to deepwater and offshore of harsh environment to find oil. In this scenario, how does Automation play a key role to optimise production and improved operational safety and efficiency?

Safety, Reliability, Scalability and Remote Access are the key value drivers in the harsh and difficult-to-access deep-water exploration.

With years of pioneering offshore experience, Yokogawa has kept pace with the industry's increasing requirements for technology and safety. Yokogawa's subsea control system, proven to be robust and extremely reliable, ideally suited for the world's deepest subsea facility. Along with this, Yokogawa's Intelligent Sensing devices with flexibility, Scalability and connectivity create a formidable and right automation choice for subsea harsh environment.

With power of Digitalisation now available with industry, Yokogawa's Advance Analytics of data from such intelligent devices continuously captures the site situation, improve data quality and support agile decision making which is of utmost importance in a very dynamic deep-water environment.

"Safety, Reliability, Scalability and Remote Access are the key value drivers in the harsh and difficult-to-access deep-water exploration."

How do you view the Indian Govt's plan to raise share of clean energy in the energy mix? What are the sustainable approaches of yours towards clean energy?

We are in a phase of contradicting requirement - in India and Globally. With rising standards of living across the globe, the consumption of energy is bound to go up. We also have a serious issue to deal with and that is Climate change. Renewable energy can partly solve the issue but demand for energy will be much higher than what renewable natural sources of energy can cater to. Hence productivity has to be enhanced, usage has to be optimized and loss in transmission and distribution to be avoided. However the goal set by the Government is ambitious and the success of it will largely depend on implementation efficiency and speed.

Yokogawa is committed to Sustainable Development Goals (SDG) and have taken many initiatives. Our SDG goals by 2050 are 3 – Net-zero emissions, Quality life for all and Circular Economy. Both as a route to achieve our SDG goals as well as DNA of Yokogawa's vision, we have high quality, innovative solutions to optimize the process ,safety and energy consumption. Through our Digital Transformation journey, we make our intelligent sensors to sense-making to our customers.

Yokogawa's unique Advanced Data Analytics goes much deeper and analyses Physical properties of manufactured products, physical phenomena, equipment restrictions, weather and environmental conditions apart from Process Characteristics. With strong base layer control, intelligent sensors, KBC's (a Yokogawa company) advanced technology applications and industry know-how provides the basis for ensuring successful and sustainable outcomes and value for our global customers.

Refiners are now using mix crudes to keep higher margins and producing fuels comply with certain environmental norms. According to you how does Automation help to optimise the crude processing in refiners in this scenario?

Yes, crude processing is getting complex day-by-day to keep pace with ever increasing global competitiveness and volatile environment around crude oil. This is thereby necessitating to refine lower quality crude. Refiners are increasingly using more complex refining process to handle low quality crudes, so refiners are constantly trying to unlock values by increasing reliability, availability efficiency and safety. Concerns for climate change, SDG and change in environmental regulations are added dimensions to the refiners.

As a comprehensive solution to such complex process and environmental requirement, Yokogawa has adopted a concept of Synaptic Business Automation where we Co-innovate with customer to drive agile and adaptive management, Synaptically synthesize everything – people, systems, data, services and supply chain, create optimum answers through our business and domain knowledge and OT/IT solutions and services and finally create sustainable value for the customers.

Yokogawa has always Smart and Intelligent sensors in the portfolio but we have changed the role of sensors from sensing to sense-making, using the power of Advanced Data Analytics which uses the enormous data thrown out by the intelligent sensors and analyses multi-dimensional factors as Process Characteristics, Physical properties of manufactured products, Physical phenomena, Equipment restrictions, weather and environmental conditions. With this comprehensive and customer-centric Digital Transformation journey of Yokogawa, we are enabling our customers to address their over-all business needs along with SDG goals. ●

Indian EPC Oil & Gas: Current Market Trends, Future Growth Drivers, Opportunities & Key Challenges

The EPC market in Oil & Gas in India is expected to grow in pace with economic growth, coupled with the growing energy needs of its vast population and industrialization. Looking at the Indian Government's thrust on reforms and policies towards increasing domestic exploration and production to minimize import dependence, increase the natural gas share in the energy mix, and self-sufficient in refining, the article shares a holistic view of the current market trends and future growth drivers of Indian EPC Oil & Gas industry, along with the key challenges and opportunities in the sector.

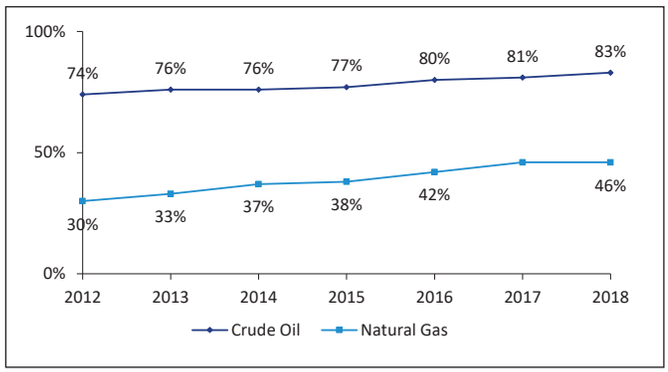
India with its GDP currently just over USD 2.6 trillion is on a rapid economic growth trajectory and aims to enter to the club of USD 5 trillion economies soon. Since 1991 when India's economy was opened up, the growth has been phenomenal largely driven by the rapid growing population, urbanization and industrialization. Despite being the third largest energy consumer in the world, India's per capita energy consumption stands at 0.6 tons of oil equivalent as compared to World's average. Energy would continue to play a pivotal role in supporting economic growth and improving the quality of life of people. It is this reason that energy security, access, efficiency and sustainability continue to remain a key challenge for the government and policy makers. As per BP World Energy Outlook 2018 estimates in the Evolving Transitions Scenario, India's oil consumption is expected to grow from current 5 million barrels per day to 9 million barrels per day by 2040. The gas consumption is likely to grow from current 54 BCM to 185 BCM in 2040.

The Asia-pacific region is emerging the new growth center for the EPC services for various reasons – including the rising oil and gas discovery, expansion of natural gas pipeline, increasing trade of LNG, and growing demand for refined products and petrochemicals, especially in China, India, Australia, Indonesia and Vietnam. This is inevitable since in the coming two decades almost all energy demand growth is anticipated to come from emerging Asia. The EPC market in oil & gas in India is expected to grow in pace with economic growth. Given the large import dependence on crude and gas there is a policy thrust towards domestic Exploration and Production (E&P). The volatility in crude oil prices has negatively impacted the demand for EPC services as many E&P companies slowed their investments into exploration and field developments especially the deep-water/ ultra-deepwater projects.

Unleashing the Opportunities in Indian Upstream Sector

In 2019, Oil and Gas accounted for about 36 per cent of the total energy consumption in the country and registered a CAGR of nearly approx. 6 per cent for oil and gas consumption during 2014-2019. Presently, about 83 per cent of oil and 46 per cent of natural gas requirement is imported. India's dependence on imports has increased since 2015 despite the goal set out by Prime Minister Modi of reducing imports by 10 per cent.

Import Dependence (% of Consumption)

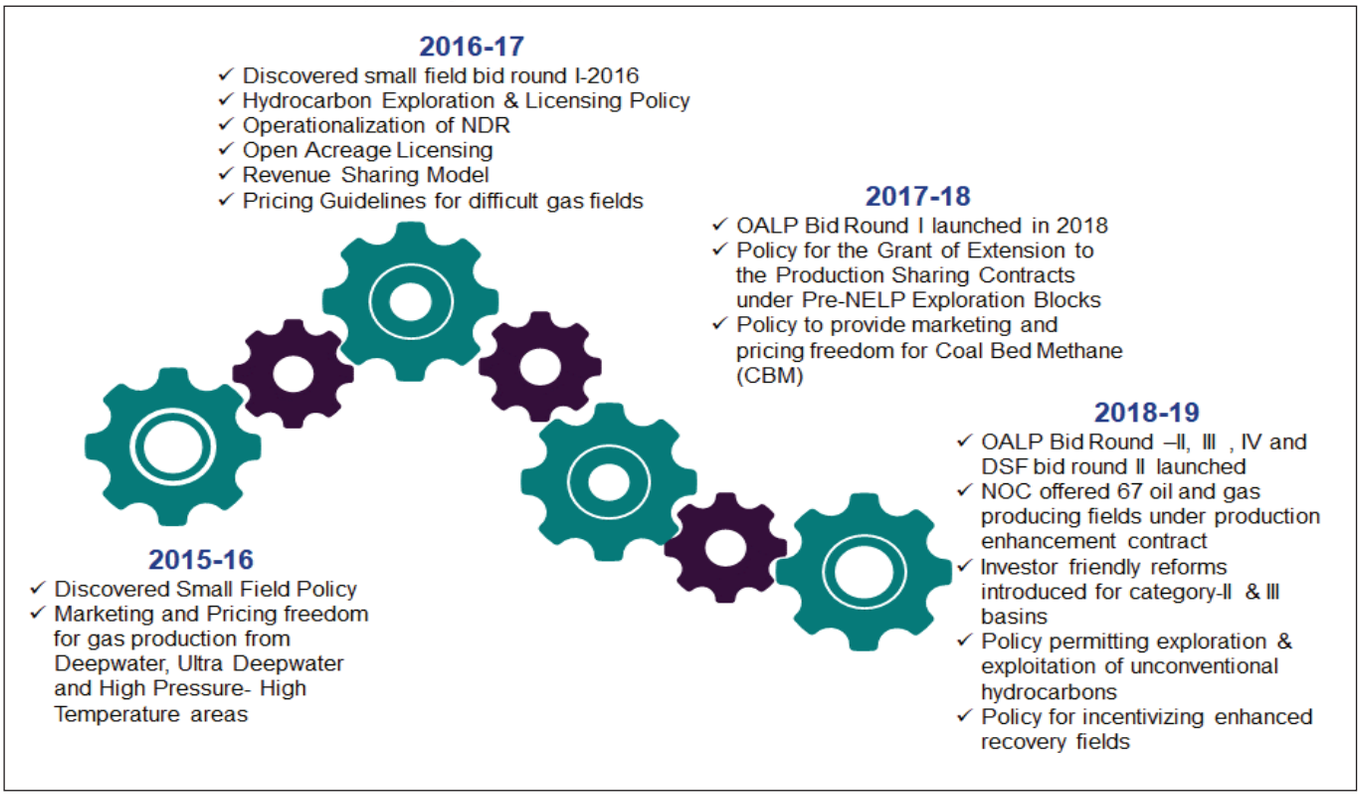


Source: KPMG in India Analysis, PPAC

In order to drive India's domestic oil and gas production, the Ministry of Petroleum and Natural Gas initiated a series of policy measures – including introducing the new Hydrocarbon Exploration Licensing Policy, or HELP, steps to allow contractual flexibilities in the Production Sharing Contracts (PSCs), setting up National Data Repository (NDR), allowing marketing and pricing freedom for sale of natural gas and recently exempting operators from sharing revenues with government in unexplored area namely category II and III basins.

> *"India is clearly one of the most attractive markets for Oil and Gas EPC business with around 120 to 150 billion dollars of investment planned in next 5-7 years and around 300 billion dollars planned in next two decade."*

Policy and Regulatory Reforms in Indian Exploration and Production Sector



The above policy measures have led to significant improvement in the business environment for the exploration and production industry. So far, under three rounds of OALP and two rounds of DSF, India has awarded over 0.12 million square of acreage which is three times the area awarded under various rounds of the earlier NELP regime. About 30-35 billion dollars of investment is expected in next 5-7 years in the upstream sector with significant part of it planned in the development phase and in offshore projects.

Regime	Area (Sq. Km)	Blocks Awarded	Estimated Investment in next 5-7 years (in Billion USD)
Nomination	37185**	12**	4 -5
PSC[1] (NELP/ Pre-NELP)	39000**	39**	25- 27
DSF[2]	3777	53	0.8 – 1
OALP[3]*	118280	87	1.8 – 2

*Data excludes OALP round-IV details-Launched on 26th August 2019. Blocks are offered not yet awarded

**Area & no. of blocks awarded are under PEL area (Petroleum exploration license)

[1]Production Sharing Contract (PSC), New Exploration Licensing Policy (NELP)
[2]Discovered Small Field Bid Rounds
[3] Open Acreage Licensing Policy

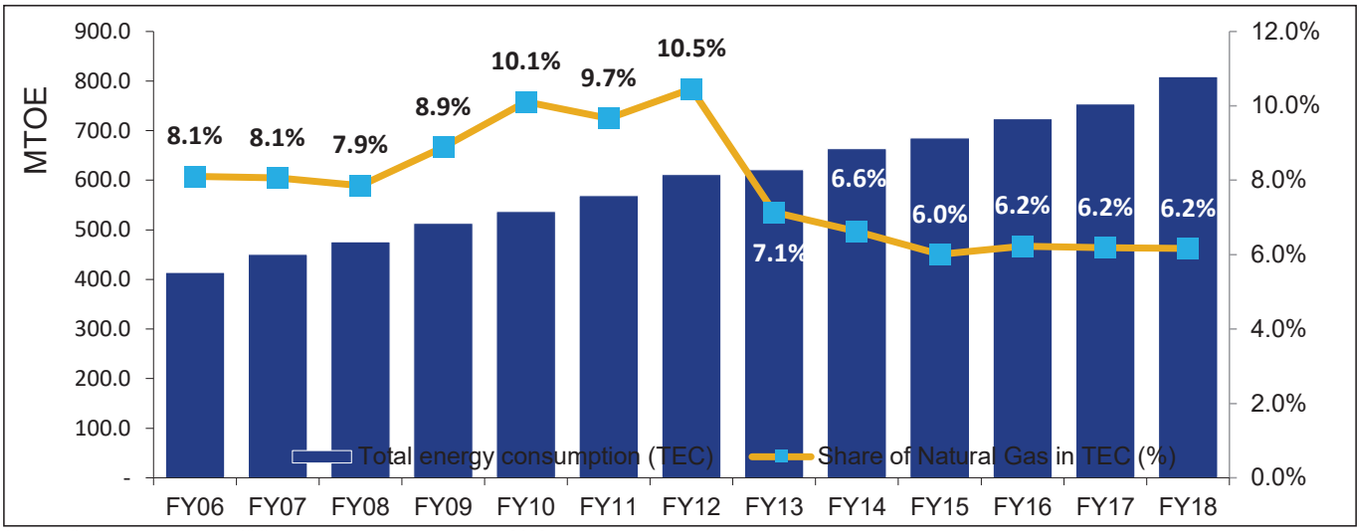
India's Ambition to Move towards a Gas-based Economy

Over the years, Indian policy makers have emphasized on growth of share of natural gas in the energy basket. The government intends to move towards a gas-based economy and has set a target of 15 per cent share for natural gas by 2030. The share of natural gas in the energy mix has been fallen significantly since 2012 largely due to stagnated domestic production and increasing demand.

The key barrier to the growth of natural gas market are stagnated domestic production, pricing and allocation issues, lack of infrastructure and imperfect access regime. India currently has about 16,789 Kms of gas pipeline networks transporting gas largely towards western and northern markets. There is no connectivity of these trunk pipelines to central India, north-eastern and part of east coast and with various gas sources in other

"Low commodity price discourages recovery of investments and has implications for the EPC business, but the opportunity remains large. EPC players have to evolve lean operating practices, innovation and digitalization to secure a brighter future for the EPC business in oil and gas in the coming decade."

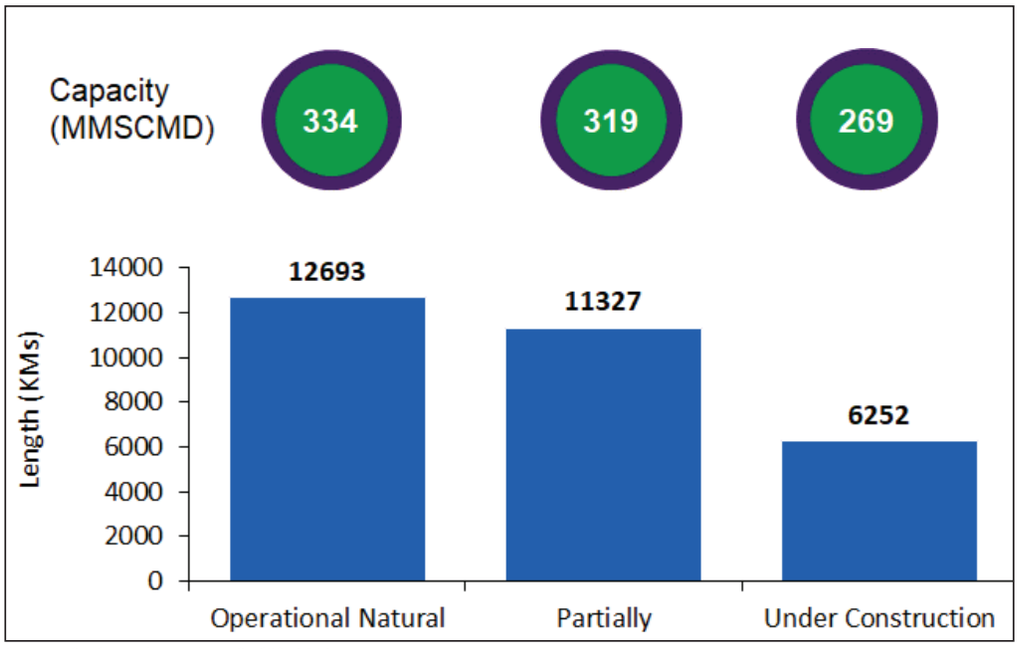
Share of Natural Gas in Total Energy Consumption



Source: KPMG in India Analysis, BP Statistical Review of World Energy 2019

parts of India. There are also few isolated networks in the southern and north eastern region. As per plans, there are about 12000-13000 kms of gas pipelines being planned and built which will increase the overall capacity of the national gas grid from existing 370 MMSCMD to about 900 MMSCMD. Despite huge expansion plans, most of the pipeline projects have failed to progress on ground due to lack of demand and unfavorable viability. The government realizing the issues provided about 40% capital budgetary support to GAIL's Urja Ganga Gas Pipeline Project, a 2665 kms pipeline bringing connectivity to eastern regions of the country. However, the pipeline development continues to face significant economic viability and on ground implementation challenges which needs to be addressed for India to achieve 15 per cent share.

Gas Pipeline Infrastructure in India



Source: KPMG in India Analysis, PNGRB, 2019

As per industry estimates, about USD 7-9 billion of investment is required in developing the planned pipeline projects. Of this, around 20-25 per cent of investments are already committed. These pipeline projects are critical for providing access to various consumers who do not have the access to natural gas today.

The LNG re-gasification capacity has grown significantly since the first LNG terminal was commissioned in Dahej in the year 2004. The current capacity is around 39.5 MMTPA, spread between six terminals namely Dahej, Ennore, Hazira, Kochi, Dhabhol and Mundra. There are several greenfield and brownfield expansions planned. If most of these planned projects are implemented, then there would be adequate LNG capacity to assist India reach the end of the decade without requiring any further capacity addition. If the India would add around 30 MMTPA of LNG capacity in next 5-6 years, a total of USD 3-4 billion of investment would be required.

Creating as gas-based economy would mean that the demand in major gas consuming sector needs to grow significantly. This brings along a complex set of challenges in power sector where gas faces price pressures due to cheap coal and growing renewable. Further, the other top consuming sector fertilizer is not

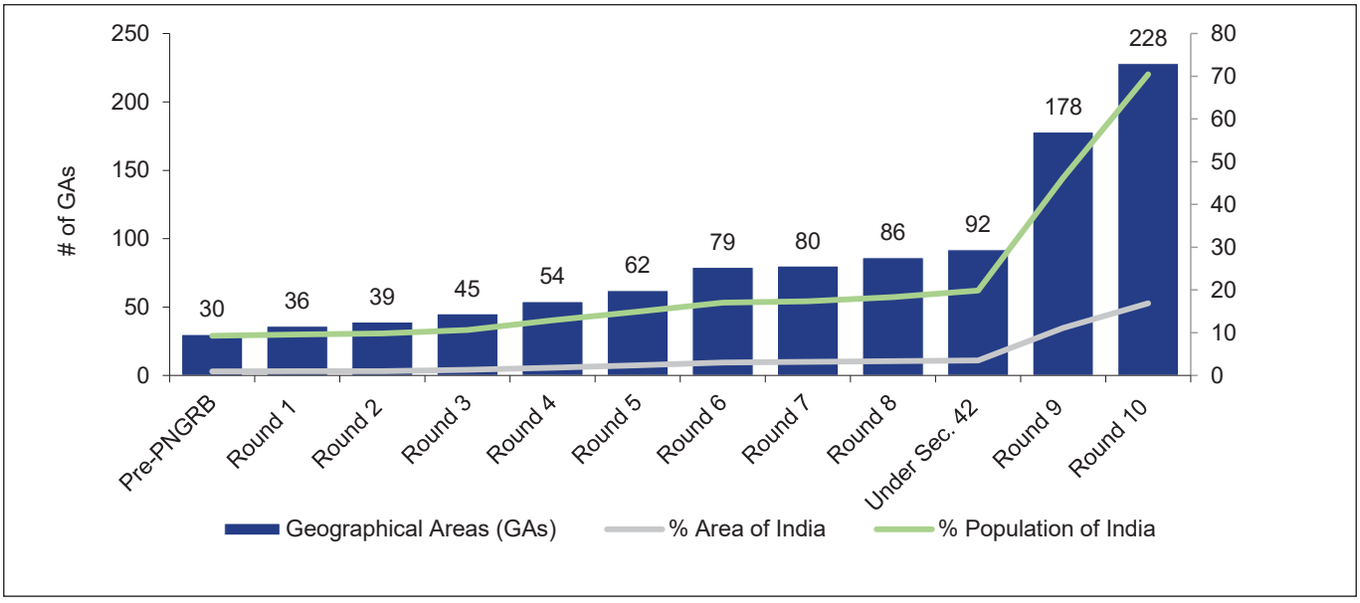
LNG Terminals – Existing and Planned

LNG Terminal	Entity/Promoters	Status	Capacity (MMTPA)
Dahej	Petronet LNG Limited	Operational	17.5
Hazira	Hazira LNG Private Limited/Shell	Operational	5.0
Dabhol Ratnagiri*	Konkan LNG Private Limited	Operational	2.0
Kochi	Petronet LNG Limited	Operational	5.0
Ennore	Indian Oil Corporation Limited	Operational	5.0
Mundra	GSPC LNG Limited	Ready for commissioning	5.0
		Total Existing Capacity	39.5
Jaigarh FSRU	Western Concessions Private Limited	Under Construction	4.0
Dhamra	Adani Group & Total Group	Under Construction	5.0
Chhara	HPCL Shapoorji Energy Private Limited	Under Construction	5.0
Jafrabad FSRU	Swan Energy	Proposed	5.0
Andaman and Nicobar	Petronet LNG Limited	Proposed	0.2
Gangavaram	Petronet LNG Limited	Proposed	5.0
Haldia	Venerable LNG Private Limited	Proposed	3.0
Karaikal FSRU	AGP Karaikal LNG Private Limited	Proposed	1.0
Krishnapatnam FSRU	Krishnapatnam Port/BPCL	Proposed	5.0
		Proposed/Upcoming Capacity	33.2
*5 MMTPA with breakwater			

Source: PNGRB, 2019

expected to grow significantly in future. It is with this context; the government is betting big on expansion of city gas distribution networks to catapult the gas demand. As a step towards this, the government has assured domestic gas supply to the residential Piped Natural Gas (PNG) customers and Compressed Natural Gas (CNG) users in CGDs. Further, the Petroleum and Natural Gas Regulatory Board (PNGRB) recently concluded the ninth and the tenth round of CGD auctions offering 136 Geographical Areas (GAs) covering 298 Districts, 70 per cent of India's population and 53 per cent of areas under CGD.

Coverage of CGD Network



Source: PNGRB, 2019

The successful bidders have collectively committed to provide 42 million of domestic PNG connections, lay 0.17 million Inch-kms of steal pipeline and set up 8181 CNG fueling stations. As per estimates, about USD 17-19 billion of investment is expected in development of City Gas Distributions in around 300 Districts by 2030 in phased manner.

India – Eyeing at Mega Greenfield Expansion to Remain Self-sufficient in Refining

The country's refining capacity has increased from a modest 62 MMTPA in 1998 to 250 MMTPA in 2019. India is the Asian refining hub and is the fourth largest refiner in the world after US, China and Russia. There are total 23 refineries in the country well spread geographically and connected with cross country pipeline. India is self-sufficient and also exports significant quantity of petroleum products. As per estimates[4] , the refining capacity is projected to increase from, current 250 MMTPA to about 440 MMTPA by 2030. While so far India has maintained to remain self-sufficient in meetings its demand for petroleum fuels, it needs to augment its refining capacity to meet the projected demand. In addition, it also plans to continuously upgrade the existing capacity to meet the BS-VI (EURO VI equivalent) emission norms planned to be implemented country wide by 2020. The world's largest single location refinery of capacity 60 million tonnes per annum (MMTPA) is proposed to be set up in the state of Maharashtra with the joint venture of three national oil marketing companies and two foreign partners namely Saudi Aramco and Abu Dhabi National Oil Company (ADNOC) with an investment of approximately USD 44 billion. It is estimated that refining sector in India would attract investments worth USD 55 billion by 2030 including all planned greenfield and brownfield projects.

India – A Bright Spot Emerging for EPC Business in Global Oil and Gas Landscape

India is clearly one of the most attractive markets for Oil and Gas EPC business with around 120 to 150 billion dollars of investment planned in next 5-7 years and around 300 billion dollars planned in next two decade. There are several challenges viz. time & cost overruns due to regulatory delays, availability of limited funding, limited equipment market and vendor base, logistical and supply chain challenges. However, these challenges can be addressed with adoption of innovative business model and technologies. While the oil and gas sector show sign of recovery particularly in growth countries viz. China and India, there is need for traditional EPC business to evolve. As disruption is the new normal for the oil and gas industry, there are voices demanding capex efficiency without comprising on the performance, quality and safety of assets. EPC players need to re-think on their approach and business models that enable industry achieve its goals of remaining competent in such disruptive scenarios.

The performance challenges of EPC companies have been many, but in part can attributed to following reasons:

- Lack of innovation and delayed adoption of new technologies
- Insufficient knowledge transfer and cross-learnings from project to project
- Siloed approach to project development
- Poor Cross-functional coordination
- Ineffective collaboration with suppliers
- Lack of skilled manpower

The EPC companies needs to focus on following areas to transform their organization and methodologies:

- Adopt a collaborative business model with developer as against the traditional LSTK approach. Developers today are looking for a risk-reward type of contracts
- Integrating supply chain from project to operational phase – alliances with strategic suppliers
- Flexible organization to adopt to business cycles and respond to market needs
- Embracing digitalization to unlock value for clients

With quantum leap in digital technology a holistic approach needs to be adopted to reshape the existing business and operating models to ensure a far-reaching transformational impact. Embracing digital technologies will bring in immense value in following ways:

- Enhance productivity through the oil and gas value chain
- Enablement of employees with powerful decision support technologies viz. Digital twins and mixed reality
- Enhanced health and safety with active security compliance and monitoring using AI, cognitive and spatial analytics
- Gain operational insights though connectivity using digital asset management solutions
- Effectively manage complex supply chain using AI, ML, IoT, Big Data and Analytics
- Improved project monitoring, collaboration and real-time visibility performance, cost and risk of capital projects

With several reforms already implemented and many others planned, the business environment is better than ever for global players including investors and EPC companies. The economic crisis in 2008 and oil price slump in 2014 severely hit the investments in oil and gas and allied sectors and provided some valuable lessons for the industry. Low commodity prices discourages recovery of investments in the sector and has implications for the EPC business, but the opportunity remains large and EPC players have to evolve lean operating practices, innovation and digitalization to secure a brighter future for the EPC business in oil and gas in the coming decade. ●

(The views expressed by the author are personal.)

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KPMG India
Email: anishde@kpmg.com

[4] *Report of the Working group on enhancing refining capacity by 2040*

'Minimal equipment requirements and compact footprint make PRICO ideal for offshore liquefaction projects'

Black & Veatch (B&V) has been involved in a lot of LNG facilities across the world and its PRICO Technology is mostly used all of these projects. **Hoe Wai Cheong, President - Oil & Gas, Black & Veatch,** shares the development of B&V's on-going and past involvement in LNG facilities across globe and details about why PRICO technology is a preferred choice for FLNG applications, **with Rakesh Roy** of **Offshore World.**

How many LNG plants has Black & Veatch been involved with? What was one of your most challenging projects to date?

Black & Veatch was involved in many of the world's first LNG facilities in Algeria and in the United States in the early 1960s.

We have developed more than 30 operating LNG production facilities globally, two of which are offshore, most of which use our PRICO single-mixed refrigerant process. The facilities handle a broad range of gas streams from pipelines, produced gas, coal gasification, coal seam production and coke oven gas. Our plants have produced more than 176 mm tons of LNG.

In addition to liquefaction plants, Black & Veatch has strong LNG import terminal capabilities. Among the most significant of these, historically, is the Costa Azul LNG terminal in Mexico. Currently we are supporting the development of India's LNG import infrastructure with the regasification terminal at Ennore for Indian Oil Corporation; and a floating storage and regasification unit (FSRU) terminal for Swan LNG at Jafrabad. The Ennore terminal, with a send-out capacity of five million tonnes, entered operation earlier this year.

Some of our most complex projects have been the unique, first-of-a-kind work, in the FLNG sector. Our FLNG firsts include the projects below. First of a kind projects, by definition present new challenges.

- The world's first barge-based floating liquefaction unit, currently operating Argentina
- First-of-a-kind conversion of an LNG carrier to a floating on-board natural gas liquefaction and storage vessel, which unit has been commercially deployed, currently operating in Cameroon

Can you please detail about the success of bagging the second contract from Golar LNG for an FLNG conversion?

We have secured a second FLNG conversion project for Golar. The first was the Hilli Episeyo in 2014. The success of that project led to the award of the Gimi conversion in 2018. Both projects are for conversion of Golar LNG carriers into floating liquefaction vessels (FLNGV).

Our scope of work is broadly the same across both projects: detailed engineering and process design, specify and procure topside equipment, and provide commissioning support for the topsides and liquefaction process.

PRICO, which is used on both vessels, has been central to us winning the work. The system is proven; its minimal equipment requirements and compact process footprint make it ideal for offshore liquefaction projects. Confidence in the technology's suitability for offshore applications was rewarded in 2016 when PRICO became the world's first liquefaction technology to achieve production on a floating facility. In 2018 the technology successfully completed its Guaranteed Performance Test aboard Hilli Episeyo.

The Hilli Episeyo was the world's first FLNG vessel developed as a conversion project from an LNG carrier. The vessel is moored, and in operation, off the coast of Cameroon. First of a kind projects have unique challenges. The lessons we learnt from the Hilli increased efficiencies on the subsequent project.

Tell us about B&V's work on the Tango FLNG?

Exmar's Tango FLNG is the world's first barge-based floating liquefaction unit, designed by B&V to produce 0.5 MTPA LNG. Earlier this year the barge's PRICO plant completed its Guaranteed Performance Test and commenced commercial operations to load Argentina's first cargo for exporting LNG.

Unlike the conversion projects, Tango was a purpose built new barge vessel designed for jetty mooring, rather than open water. The barge has a smaller footprint and was possible only with use of our space efficient PRICO technology. The size constraints provided their own challenges but proved to be a very successful configuration in that scale.

Tell us about Black & Veatch's PRICO technology? What makes it so well-suited for FLNG applications?

Minimal equipment requirements and compact footprint make PRICO ideal for offshore liquefaction projects. The single-mixed refrigerant process' entire liquefaction train (0.5 -2.0 MTPA) can be built in a single module with gas coming in and LNG going out. This minimizes module interconnection which is undesirable on FLNG. PRICO offers the lowest capital cost of all competing technologies and a simplified control system. Our patented process allows for rapid start-up and shutdown and is proven in reliable operations, with reduced personnel requirements. PRICO configurations have been fully vetted for offshore application on FLNG with marinization.

FLNG operations with multiple smaller trains also benefit from providing manageable offtake capacity to serve single or multiple sales contracts. Installing the process in the controlled environment of a shipyard anywhere in the world helps ensure consistent high quality

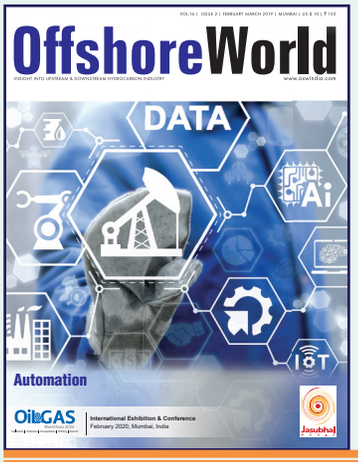
In addition to FLNG applications, PRICO is used for onshore base-load LNG supply, peak shaving, vehicle fuel supply and gas distribution systems. The current industry demand and trend is to utilize midscale multiple trains configuration for both offshore and onshore applications. PRICO configurations fit this well with our single train-single module designs up to 2.0 MMTPA per train. ●

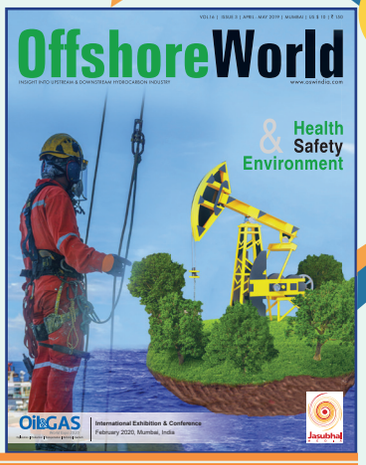
OffshoreWorld

INSIGHT INTO UPSTREAM & DOWNSTREAM HYDROCARBON INDUSTRY

Offshore World is an all-encompassing magazine for the hydrocarbon and allied industries. A bi-monthly magazine, launched in December 2003, Offshore World disseminates authentic, critical and well-researched information on global hydrocarbon industry innovations. The magazine offers latest and strategic information on the upstream and downstream hydrocarbon industry. The endeavour of Offshore World is to become a vehicle in making "Hydrocarbon Vision 2025" a reality in terms of technologies, markets and new directions, and to stand as a medium of reaection of the achievements and aspirations of Indian hydrocarbon industry.

Circulation: 28,000



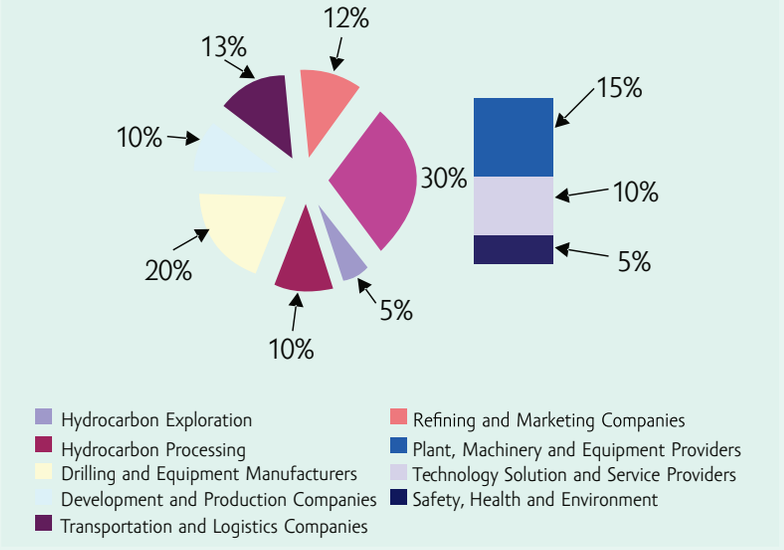


OSW Region-wise Presence

- 53% Western Region [including Mumbai,Gujarat, Pune, etc]
- 23% Northern Region [including Delhi, UP, etc]
- 10% Southern Region [including Bangalore, Hyderabad, Chennai, Coimbatore, etc]
- 9% Eastern Region [including Kolkata, Assam, etc]
- 5% International [includes USA, MiddleEast, Russia, Brazil, Iran, China, Germany, Italy, France, etc]

OSW Reader's Profile

- CEOs & Senior Management of Oil Companies
- Petroleum Engineers & Refineries Contractors
- Project Managers
- Refining & Pipeline Engineers
- Corrosion Control Engineers
- Operations Managers
- Technical Managers
- Safety Managers & Engineers
- Purchase Managers
- Marketing Executives
- Pollution Control Specialists
- R&D Personnel
- Industry Consultants
- Engineering & EPC Consultants
- Indian & Overseas Industry
- Associations
- Training Institutes



OSW Target Segments

- 5% Hydrocarbon Exploration
- 10% Hydrocarbon Processing
- 20% Drilling and Equipment Manufacturers
- 10% Development and Production Companies
- 13% Transportation and Logistics Companies
- 12% Refining and Marketing Companies
- 15% Plant, Machinery and Equipment Providers
- 10% Technology Solution and Service Providers
- 5% Safety , Health and EnvironmentZA

Centrifugal Separation Technology for Water Treatment in Oil & Gas Industry

Treatment of produced water poses challenges for oil and gas producers. There are many technologies are available, and it is not easy to know which technology is best suited to the task at hand. The volumes and composition of produced water vary significantly, depending on numerous factors. Often several technologies are used in combination, along with the addition of process chemicals, to treat produced water due to changing properties in terms of a broad range of contaminants and their varying concentrations. The white paper aims to familiarize engineers working on oil and gas rigs and floating production storage and offloading (FPSO) vessels with centrifugal separation technology as a compact, effective and often chemical-free alternative to conventional technologies.

Produced water is an integral part of, and often the largest volume waste stream associated with, oil and gas production operations. Due to increasingly stringent regulations, produced water requires extensive treatment before discharge into the environment. The varying volumes and composition of produced water, with frequent re-routing of reject streams and high chemical dosing, make treatment complex. Many oil and gas producers are often looking for solutions that simplify produced water treatment.

When faced with complex produced water compositions, many oil and gas producers find that they have difficulty treating produced water effectively with conventional technology. To achieve performance that complies with environmental regulations, global players and local oil and gas producers have approached Alfa Laval to gain a better understanding of centrifugal separation technology, its capabilities and performance track record in treating produced water both offshore and onshore.

Centrifugal separation technology is proven, robust technology widely used in the marine industry to treat hard-to-handle oily waste streams. It effectively separates these streams into oil, water and solids that comply with environmental regulations for safe discharge and/or disposal.

However, it is a technology that is not well-known or widely used within the oil and gas industry. That said, oil and gas producers familiar with the use of high- speed separators for onshore processes have used the technology offshore to treat produced water with success for the past 30 years.

Despite the reservations of oil and gas producers to use technology with moving parts, the Alfa Laval centrifugal separators have proven robust, reliable, effective and easy to maintain when used for produced water treatment. It is important to note that, when using high-speed separators to treat produced water, there is generally no need for pretreatment such as heating or chemical dosing.

There are also no reject streams to route back to the treatment system. Plus the compact size and weight of centrifugal separators make them ideal for use on new offshore installations or as retrofits on existing installations.

The aim of this Alfa Laval white paper is to address the most frequently asked questions raised oil and gas producers. Oil and gas producers are struggling with conventional technologies and are considering the use of centrifugal separation technology to treat produced water on offshore installations. By sharing insights into why centrifugal separation is a sound choice for treating produced water, we hope that oil and gas producers who struggle to comply with increasingly stringent environmental regulations may consider centrifugal separation as an alternative to conventional produced water treatment methods.

Centrifugal Separators in Oil and Gas Field Applications

Does centrifugal separation technology perform differently when used in oil field applications versus in gas field applications?

Generally speaking, there is no discernible difference in performance when using high-speed separators in oil field applications or in gas field applications. Gas field applications, however, are somewhat more challenging because the size of the droplets in the oil fraction tend to be smaller and more stable than those found in oil field applications. Below is an overview of the performance of Alfa Laval centrifugal separators when in various oil field applications and gas field applications.

Polishing/tertiary treatment

The performance of Alfa Laval centrifugal separators is essentially the same whether used in applications in oil fields or gas fields. It is important to note, how- ever, that produced water generated in gas fields tend to contain droplets of dispersed oil that are smaller in size compared to droplets generated in oil fields. This is primarily due to greater pressure drops and different well chemistry found in gas fields. Condensate is more easily dispersed in produced water by shearing due to low interfacial tension. In addition, the low interfacial tension reduces the coalescence of the dispersed droplets, resulting in the formation of more stable emulsions.

While these smaller droplets pose a greater challenge to conventional produced water treatment equipment, they are well within the operating range of centrifugal separators, which can easily remove small droplets in the range of 1–10 microns in size. To handle difficult cases with significantly smaller droplets, centrifugal separators require minor adjustments to enable the effective removal of oil droplets; this includes a reduction in flow rate and a slightly longer residence time – typically from one to two seconds or from two to three seconds.

Conversely, if conditions improve, the higher separation efficiency due to the larger droplets can instead be used to shorten the residency time and achieve higher capacities. This was the case at the Woodside North Rankin A (WNRA) gas field in Australia. WRNA has long operated at a pressure drop from the well of approximately 100 bar. At this pressure drop, shear forces generated small droplets that an Alfa Laval high-speed separator removed at a flow rate of approximately 29 m^3/h. Due to recent process changes, the pressure drop was reduced to 50 bar. As a result, the positive effect of less shear generates larger droplets, enabling an 28% increase in separator capacity, from 29 m^3/h to 40 m3/h while maintaining separation efficiency or the same low levels of oil-in-water after treatment. In addition, residence time was reduced by 25%, from 2 seconds to 1.5 seconds.

Centrifugal separators are used in primary treatment/ polishing of reject streams. Tertiary treatment, in this context, is understood as salt removal, which is not common for centrifugal separators in produced water treatment because salt normally does not precipitate from the streams. It is important to note, however, that any precipitated salt will be removed in a high-speed separator. Separators, for instance, are used offshore to remove small salt precipitates that are less or much less than 10 microns in size from monoethylene glycol (MEG) streams. An Alfa Laval centrifugal separator tested on a floating liquefied natural gas (FLNG) vessel to remove precipitated salt from MEG streams resulted in effective removal of salt particles down to 0.8 micron in size.

Dispersed and dissolved oil removal

A mechanical piece of equipment, a centrifugal separator only removes dispersed oil while simultaneously removing suspended solids. It does not remove dissolved oil. While the focus of produced water treatment tends to be on dispersed oil removal, it is important not to overlook the positive effects of the simultaneous removal of solids. Increasingly, oil and gas producers are focusing on solids management in many installations because fine solids stabilize small oil droplets. These fine solids pose challenges when re-routing reject streams back into conventional produced water treatment processes; the presence of solids in the reject streams make the overall performance of the system worse. This is not an issue in produced water treatment systems using centrifugal separators; solids are either intermittently or continuously discharged from separator for disposal and therefore do not negatively impact the system's performance (Figure 1).

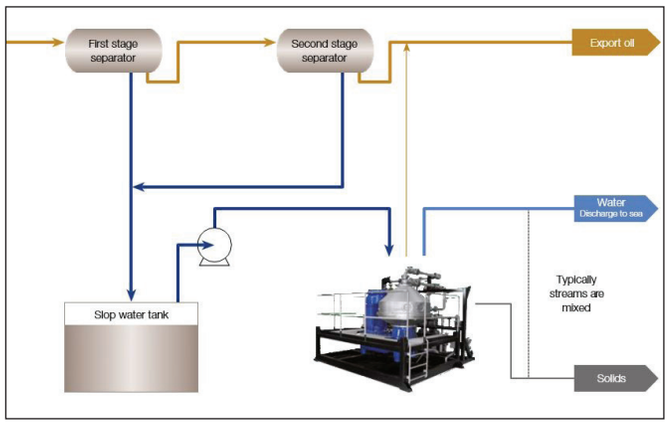


Fig 1

Produced water

Not only are centrifugal separators used to treat produced water, but they are also used to treat other oily water streams in various processes during oil and gas production. Sometimes produced water is called slop water, which is the term typically used on floating production storage and offloading (FPSO) vessels where the volumes of produced water are not significant. FPSOs may, in some installations, accumulate all produced water in a tank and then feed the water into a centrifugal separator. FPSOs may also have a conventional produced water treatment system in place, but also may collect streams from other areas, such as a tank that is subject to upset conditions, and then process these streams as slop water in a separator. Around the globe, Alfa Laval centrifugal separators treat slop water from processes on board FPSOs as well as bilge water on board marine vessels.

When using centrifugal separators, there is essentially no difference in performance between the treatment of slop water and the treatment conventional produced water; in most cases, the use of centrifugal separators results in treated water that contain between 2 to 15 ppm of oil-in-water, which can be discharged overboard in compliance with environmental regulations.

It is notable to draw an analogy between treating slop water on board FPSOs and treating oily water on board ships, where more than a 1,000 Alfa Laval PureBilge centrifugal separation systems are in operation worldwide. Certified by the International Maritime Organization (IMO), the Alfa Laval PureBilge system can effectively reduce the oilin- water content of bilge water with varying feed conditions to less than 5 parts per million (ppm).

Centrifugal separators are also used to treat oily water from various drains. The toughest application is drill deck drains, where separators alone are not suitable due to very high solids loads and the emulsifying additives used for mud. For successful treatment of tough applications such as these, treatment systems typically comprise decanters for solids removal, flocculation for chemical removal and band screen filtration, and separators for final polishing.

Typical configurations

There are various configurations for treatment systems using centrifugal separators. Separators may be selected as the sole piece of mechanical treatment equipment for a conventional degassing train, together with between one and three 3-phase static separators. More commonly, separators are used as a part of a produced water treatment system, together with hydrocyclones, a degasser or induced gas flotation (IGF) unit, and compact flotation unit (CFU) or similar. The process solutions, where centrifugal separators are an integral part of a system, have the advantage of processing higher volumes of water at higher flow rates, while at the same time minimizing capital expenditures (CAPEX) as well as the number of separators required (Figure 2).

Above all, centrifugal separators make it possible to avoid re-routing reject streams into the produced water treatment tank or crude dehydration process. Many system designers of these conventional processes often, and in fact almost always, re-route reject stream in the hopes that the flow rates are so small that the separation issue will somehow resolve itself. The use of a centrifugal separator effectively does away with the need to re-route reject streams.

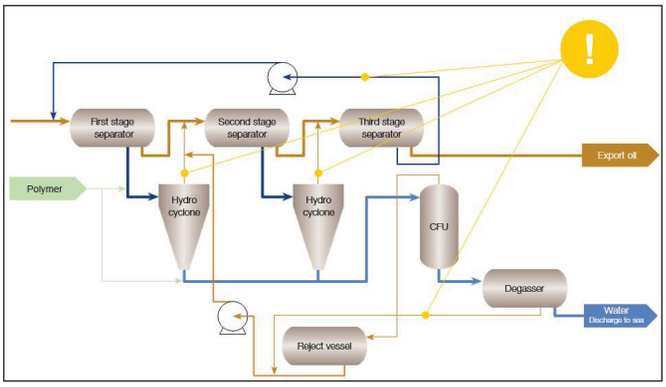


Fig 2: Conventional produced water treatment system: Troublesome reject streams are typically re-routed back into the process, thereby creating process issues.

Rerouting reject streams tends to cause process disturbances elsewhere by introducing small, often stabilized, oil droplets back into the process. These droplets have often been stabilized by small particles, waxes, corrosion-inhibitor chemicals and other means. Over time, the droplets collect in emulsion layers that build up inside the static separators. This not only results in poor separation performance, but also makes level detection and process control very difficult.

The most common system configurations for avoiding poor reject stream treatment are illustrated on Fig 3, 4, 5, and 6.

Many operators spend a lot of time trying to resolve separation issues that turn out to be related to the effects of re-routing. Rerouting only makes the separation task much more difficult. Numerous offshore installations struggle to treat their produced water properly. Hydrocyclone reject is often denominated as "oil" being returned into the process, but the reject stream can easily contain up to 95% water. Another issue is very low efficiency in installations using hydrocyclones at low pressure separation. Sometimes a pump is installed to increase pressure upstream of the cyclones, but this pump normally also contributes to the formation of smaller droplets and poor separation efficiency.

Finally, there are always solids in the crude oil stream from a well. This is not taken into consideration in the typical configurations shown here. Fine particles from the formation precipitate out of the stream and collect at various stages in the process. Eventually, sedimentation must be physically removed from, or dug out of, various locations, like the static separation tanks. The particles range in size down to microns; some of these small particles adhere to the surface of the oil droplets, stabilizing them and preventing coalescence of small droplets into larger droplets, which is necessary in order to remove the oil from conventional process streams.

Centrifugal separators, on the other hand, deliver high separation efficiency and operate 'once through'; no rerouting of reject streams is required. When a process operates at higher pressures, a degasser is generally required. Some centrifugal separator models are able to handle pressure of 4–6 bar. However, most models operate at atmospheric conditions.

Centrifuges used in different ways

The most common system configurations for avoiding poor reject stream treatment are illustrated below.

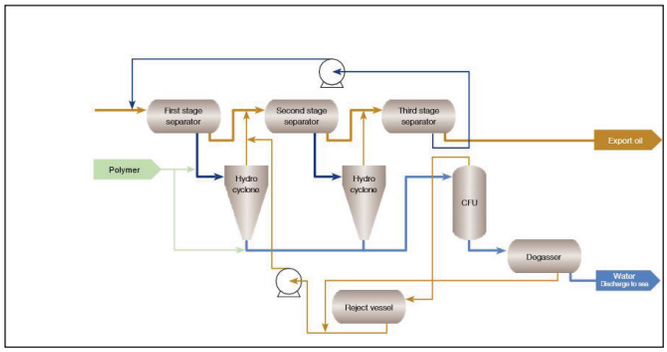


Fig 3: A traditional HC/CFU process.

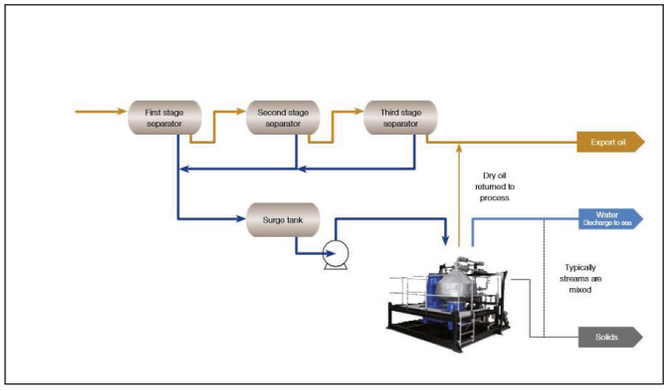


Fig 4: Installation used on Tyra platforms, where the water flow from the separator train is taken into a surge tank and fed into a centrifugal separator for treatment to obtain discharge specifications.

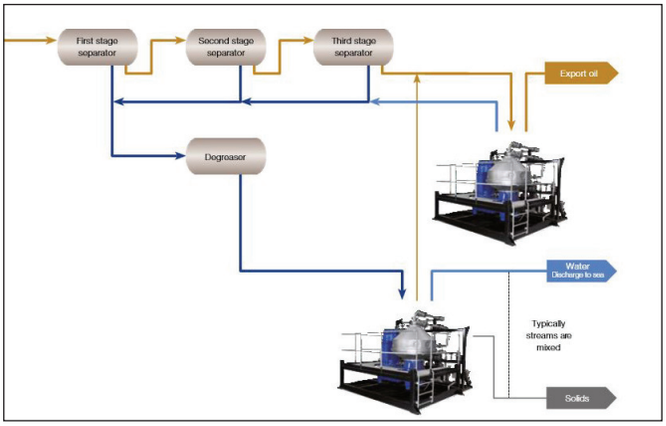


Fig 5: Proposal for oil platform: Full-flow treatment of produced water with centrifugal separators. In installations built on separators for both oil treatment and water treatment, the separators can be converted from oil to water treatment as the water cut increases over the lifetime of the field.

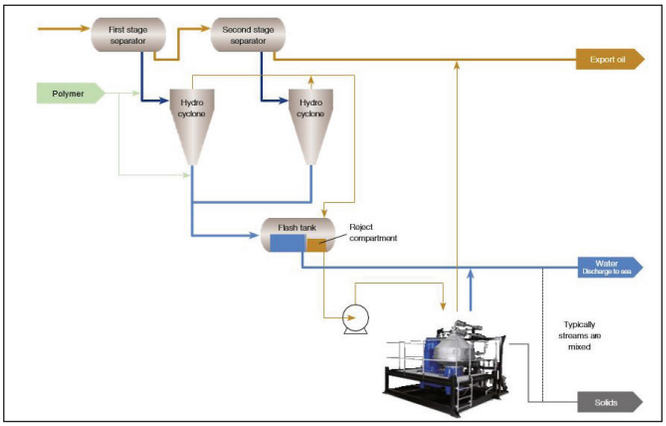
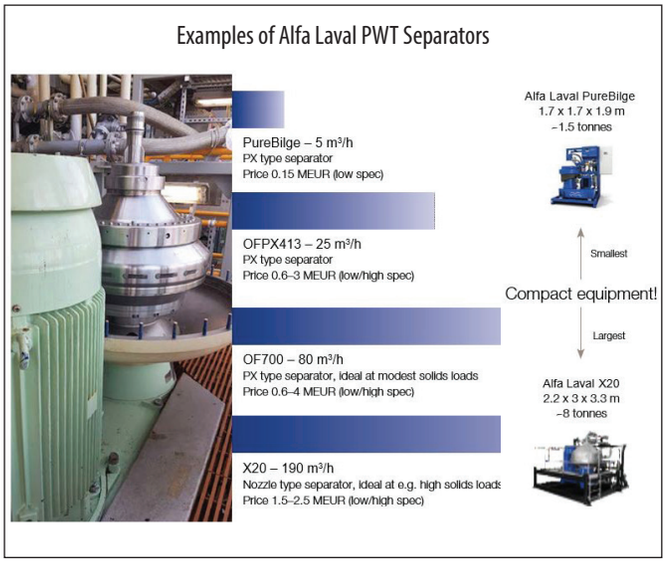


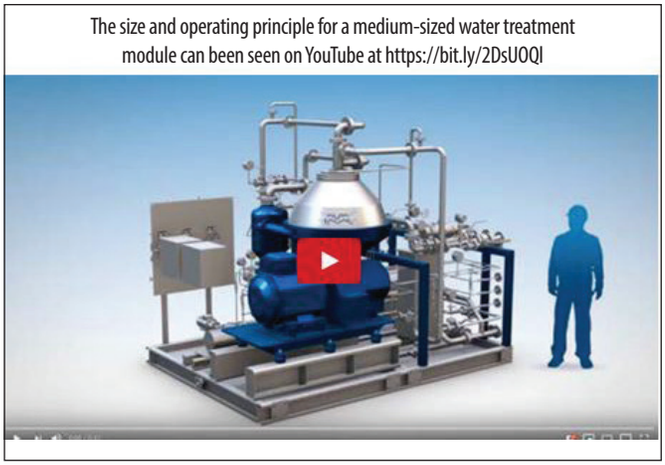
Fig 6: Typical installation using hydrocyclones for bulk flow and treatment and a centrifugal separator to treat reject streams to safeguard the total separation train and treat the more troublesome oily water streams. This type of installation is used, for example, at Ekofisk in the North Sea.

Greenfield and brownfield projects considered

The advantages of using centrifugal separators for greenfield and brownfield projects are similar, but also somewhat different. Brownfield projects tend to have stringent regulations that require compliance. Here centrifugal separation technology can drastically improve performance compared to the conventional technology typically used in existing greenfield and brownfield processes. Improvements to overall processes include doing away with the need to reroute reject streams and/or polishing the most difficult streams to specifications. Compact and lightweight, centrifugal separators generally meet the space and weight constraints of brownfield projects. Below is an overview of centrifugal separator capacities, sizes and weights.

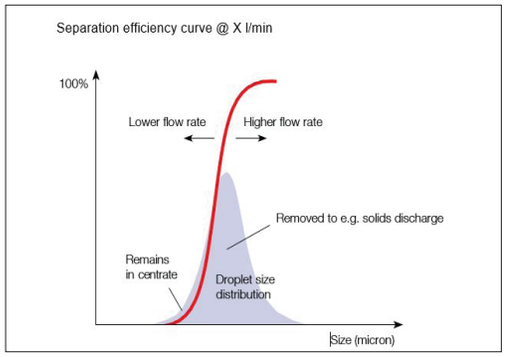
For greenfield projects, centrifugal separation technology reduces CAPEX by minimizing the footprint of the produced water treatment system and thereby reducing installation costs. Holdup volumes in centrifugal separators are negligible compared to static separators. Large centrifugal separators, capable of processing 190 m^3/h, offer a separation area equivalent to some 200,000 m^2 when compared to static equipment, but only require 70 litres of holdup volume in the separator bowl, and a residence time of two to three seconds. The entire centrifugal separator module uses only 6.6 m^2 of deck space and weighs just eight tons.





"The advantages of using centrifugal separators for greenfield and brownfield projects are similar, but also somewhat different. Brownfield projects tend to have stringent regulations that require compliance. Here centrifugal separation technology can drastically improve performance compared to the conventional technology typically used in existing greenfield and brownfield processes."

Operating Window

Inlet	
Throughput/capacity (per unit)	From 5 m^3/h up to 190 m^3/h, depending on the centrifugal separator model. See page 11.
Flux (where applicable)	Not applicable.
Temperature (operating range)	Typically 0–100°C. Some extensions to the operating range are possible, on a case-by-case basis.
Pressure (operating range)	Generally, 0–4 bar g. In some cases, 6 bar g. Note that pressure refers to the gas pressure in the feed, not to the hydraulic pressure. Pressure handling capabilities vary within the product range. The key aspect is preventing depressurization inside the centrifugal sepa- rator because the release of gas will have a negative effect on separation performance as internal fluid transport is disturbed. Typical pressures. Note that, based on model selection or project-specific design, variations may occur. Inlet: 2 bar g. Gentle pump speed-controlled flow rate recommended. Outlet oil phase: Typically 3 bar g. Outlet water phase: Typically 3 bar g. Solids outlet: Gravity fed or possibly solids pump, 3 bar g.
pH	pH only related to corrosion aspects. See section on salinity on page 14, as pH is one of several corrosion parameters (main parameters are salinity, temperature, oxygen and pH).
Inlet, oil-in-water content	Centrifugal separators are very insensitive to inlet oil-in-water (OiW) concentrations. The reason is related to separation being related primarily to droplet size. Separators, such as the compact IMO-approved PureBilge, are certified through rigorous testing with extreme variations in feed conditions – from 0% oil content to shorter intervals with 100% oil content. In general, the inlet OiW relates to a separator oil discharge capacity (pump capacity by paring disc = built-in centripetal pump). As long as the capacity of the paring-disc discharge volume is not exceeded, the OiW content in the feed does not present any issues. This means that the separator can handle high OiW content; many models can handle an OiW content of up to 10%.
Oil droplet size	Generally, centrifugal separators remove oil droplets and particles from one micron in size. By adjusting separator operation, target droplets and/or particles can easily be removed. Key parameters, such as flow rate and fluid properties, are matched against the centrifuge area equivalent and solids-handling capacity of a specific separator model.
Inlet, total suspended solids (TSS)	Centrifugal separators handle solids differently, depending on the design. Moderate volumes of solids, typically up to 2% by volume, can be handled by centrifugal separators with intermittent solids discharge. To process higher fluid volumes, separators with con- tinuous solids discharge are recommended. The largest separator has a maximum flow rate of 190 m^3/h and is capable of handling feed containing a solids volume of ~10 m^3/h.
Droplet size distribution (DSD)	The droplet size distribution in oily water is of great interest when designing or optimizing centrifuge operation. For instance, the Dv50 and sigma values in a feed stream can differ widely; yet a centrifugal separator will still perform, if designed or operated correctly. The influence can be viewed in two key ways. 1. *As a key parameter for selecting the right centrifugal separator.* DSD, fluid properties and performance requirements influence the selection of the right centrifugal separator. For instance, if the DSD is not known, Alfa Laval uses typical values for Dv50 and sigma based on decades of experience from working in the oil and gas industry. Here are a few examples of DSDs that Alfa Laval has experienced when using centrifugal separators in the field on the rare occasions where droplets have actually been analyzed with a Malvern instrument: Dv50 of 4–15 microns at a Brazilian installation. Dv50 of 12 microns at an Australian gas condensate installation. Dv50 of 4–6 microns at a North Sea gas condensate installation. The width of distribution varies, but the distribution number (sigma) often appears to be in the region of 0.8. 2. *As a signal that capacity must be adjusted when variations in droplet size distribution are noted.* Given a certain separator size, variations in droplet size distribution can be handled by adjusting capacity. Any variations upwards in size are less relevant as centrifugal separators will operate with a certain cut-off size, which are determined by various properties and separator selection. This means that 100% of the droplets larger than the cut-off size will be removed. Any variations downwards in size call for a reduction in flow rate to maintain performance in terms of discharge quality (see graph below). The effects are significant. Even a modest reduction in flow rates can have a positive impact on separation performance. It is important to note the specific position of the separation efficiency curve in relation to the droplet size distribution as shown below. 

Salinity	Salinity limits relate to corrosion parameters and the fluid density. The maximum density may vary according to the separator models but, at the most, up to 1,200 kg/m3. Corrosion limits of salinity relate to oxygen content and temperature. Case-by-case assessment is required, but separators generally cope with produced water treatment salinity requirements, such as 20–30 g/l. The presence of oxygen in combination with high chloride content significantly increases the risk of localized crevice corrosion on stainless steel and nickel-based alloys, and special assessments are required when the oxygen level exceeds 10 ppb. Material for process wetted parts, such as the wetted components of the rotating bowl, are made of Super Duplex stainless steel 2398 bowl body/bowl hood and 2349/2359 for interior components.
American Petroleum Institute (API) gravity	Separators operate on a very wide range of API gravities. It should be noted that, compared to conventional technologies, separators also work well on very low API oils, where the small differential in densities between heavy oil and water is handled efficiently with the high G-force combined with the very short settling distance of the internal disc stack.
Outlet	
Outlet OiW	The outlet OiW is well within acceptable range (< 29 ppm, 15 ppm or 5 ppm). Various offshore installations evaluated by the Norwegian multinational energy company Equinor for produced water and drain systems report levels of 2–3 ppm even at 24–36% oil into separators on Troll A. Others like Oseberg C and Åsgard B are reported at 10 ppm, and Sleipner at 2–3 ppm OiW in discharge. Many ships have a strict 5 ppm limit for OiW content and use centrifugal separators to comply with these limits. Of note, a centrifugal separator has the unique ability to finetune the flow rate, when required, in order to achieve extraordinary performance.
Outlet TSS	Only trace solids, which are normally not measured; therefore, no typical values are available. If particles are found to be oil-coated, then any TSS will be measured as a part of OiW water analysis.
Removal Efficiency	
Dissolved oil*	Centrifugal separation technology does not remove dissolved oil.
Dissolved oil*	Centrifugal separation technology readily removes dispersed oil, typically with separation efficiencies greater than 99%. In extremely hard-to-treat streams, the efficiency may be lower. Because removal above the cut size is 100%, and the cut size can be finetuned to 1, 5 or 10 microns or another size, the efficiency is determined by the actual DSD in relation to separator operating conditions and primary flow rate. Please refer to the Outlet/OiW and DSD sections on page 13. Several independent studies report that, compared to conventional equipment, centrifugal separation technology is able to treat difficult streams in oil and gas applications successfully. Shell reported in a paper from the 6th Produced Water Workshop, April 2008, "Large disc stack centrifugal separators were an ideal answer to break emulsions of small drop size caused by methanol or the shear produced in long subsea flowlines operated in a turbulent flow regime. When they were operating, they did an extraordinary job in resolving emulsions". The consultancy firm OPUS conducted a PWT technology study for a major North Sea operator, which covered the produced water technologies available in 2013. The study ranked centrifugal separators as number one, when summarizing 12 different decision parameters, ranging from performance, costs, risks, maintenance and ease of installation.
TSS (when applicable)	Suspended solids are removed simultaneously with the oil. Solids removal efficiency also relates to the particle size distribution and set operating conditions. In water treatment cases where solids removal is a primary target, such as the treatment of reinjection water, it is important to configure the centrifugal separators in a slightly different way than for oil-in-water removal. In oil-in-water removal, the disc stack internals are configured to allow the longest residence time for the fluid stream in order to remove the oil. This is achieved by feeding the water closer to centre of the disc stack and collecting the water closer to the periphery before routing it out of the separator. While this configuration also removes particles, it does not do so in an optimal way because the force of the flow rate tends to drag some particles into the water phase. In a centrifugal separator configured for highly efficient solids removal, the water phase enters at the periphery instead of at the centre of the disc stack; this allows for a longer residence time as the water flows between discs towards the disc stack centre. This eliminates the drag forces on the particles thereby enabling highly efficient particle removal of more than 99%. This is well within reinjection specifications in terms of particle sizes. Note that this configuration does not provide removal of oil from water. To meet very highperformance objectives for both oil and solids, the use of a dual separator system based on each of these two configurations is recommended.

System Integration Aspects

What are the considerations for inventory management for the centrifugal separator?

Inventory management considerations can be divided into two parts: the first revolves around the cleanliness of the bowl and maintaining the highest separation performance over time, and the second focuses on uptime, maintaining the mechanical integrity of the separator as well as its drive/spindle.

With regard to bowl cleanliness, separators operating on produced water tend to require cleaning of the disc stacks at regular intervals. These intervals range from several months to several years, depending on various factors. Disc stack cleaning has generally been resolved by Cleaning-in-Place (CIP), by manual cleaning of the disc stack offshore, or by replacing the offshore disc stack and/or bowl while sending the dirty disc stack/bowl for cleaning ashore.

Inventory management considerations typically address keeping a spare disc stack on hand and possibly adding a spare bowl to the inventory. Alfa Laval generally recommends keeping a spare disc stack in stock on site rather than keeping a spare bowl in stock to minimize inventory costs. Replacement of the separator bowl requires complete disassembly of the bowl; the disc stack is one component of the bowl, which means that there is no difference in time savings when replacing the bowl.

The advantage of bowl replacement lies in the ease in operation.

When using a separator with intermittent discharge capabilities, the discharge systems that operate using fresh water should be checked and/or cleaned when replacing the disc stack. In an effort to save time, operators responsible for replacing the disc stack do not always inspect and/or clean the discharge system. Over time – sometimes months or years, the discharge system may pose issues because the quality of freshwater offshore that is used as operating water varies greatly.

An important aspect of inventory management relates to installed redundancy. Oil and gas producers seem to approach redundancy for produced water systems in different ways; the most common approaches are 2 x 100% and 3 x 50%. Redundancy secures oil and gas production uptime

as well as adds greater flexibility to produced water treatment as the standby unit can be put into operation when required. This provides oil and gas producers with greater flexibility to cope with unforeseen events that result in upset conditions. During such conditions, deploying additional centrifugal separators at reduced flow rates can help oil and gas producers continue to treat produced water while complying with environmental regulations. Longer residence time in the separators – even if only seconds longer – further improves separation (see page 13 on droplet size distribution) and helps ensure that the oil-in-water content meets regulations for overboard discharge.

In Alfa Laval's experience, deploying redundant separators is a treatment strategy that is rarely used, mainly due to the operators' limited understanding of its functionality and how to make the best use of centrifugal separation technology.

With regard to aspects of mechanical integrity, inventory management strategies vary depending on the installation. With maintenance routines in place, there is generally no need to keep a spare spindle or other drive parts in stock. Centrifugal separators generally have long service lifetimes. Many installations using centrifugal separation technology have been in operation for more than 20 years. However, for installations where produced water treatment capabilities are extremely critical, keeping a spare spindle on hand should be considered.

Finally, any inventory management strategy for centrifugal separators should include stocking Alfa Laval Service Kits for separators for use at intermediate service and major service intervals. The recommended interval for intermediate service is every 2,000 hours of operation depending on the operating conditions; some models have longer intervals. Major service is recommended once a year, or every 8,000 hours of operation; this entails more comprehensive maintenance, including bearing replacement. Although fast global delivery of standard service kits is available, Alfa Laval highly recommends that oil and gas producers using centrifugal separators at offshore installations stock these kits on site.

Many oil and gas producers consider centrifugal separator maintenance a disadvantage compared to using conventional static produced water treatment technologies. In the past, offshore studies reported that rotating equipment maintenance was a concern. Overcoming these concerns requires a change of mindset. The offshore industry perceives the operation and maintenance of centrifugal separators as complex. However, just the opposite is true for other sectors of the oil and gas industry and other similar industries.

- In the tar sands in Canada, the most challenging onshore oil production environment, Syncrude has been operating a massive centrifugal separator installation for decades with a challenging and erosive feed that requires high maintenance. With a positive attitude and solid training, the Syncrude maintenance team conducts routine maintenance and keeps the equipment in good working order to ensure high performance and high production.
- In the shipping industry, there are more than 50,000 merchant ships in operation. All are equipped with centrifugal separators that have maintenance requirements similar to those operating at offshore installations. Ship maintenance routines are an integral part of crew duties and maintenance is performed accordingly, even though the crews on ships tend to be less well educated than those working in offshore production.

Maintenance of separators at offshore installations has the potential to work equally well. Some major North Sea operators that have a significant installed base of centrifugal separators provide training on regular basis to ensure their staff can operate and maintain the equipment. Repeat training is another way to ensure the right attitude and competencies are maintained among personnel over time due to the inevitable and gradual loss and replacement of employees over time.

Alfa Laval has noted that operators at many offshore installations tend to push separator performance beyond the operating limits of the equipment. This is due to the robust, reliable performance of the separators. Operators soon realize that centrifugal separators can cope with wide variations in operating conditions, particularly when troublesome streams are fed into the separators to try to solve operational problems temporarily. In these situations, employees put the separators to work – due to lack of training or lack of understanding about how separators work – without making the necessary adjustments to the flow rate, discharge intervals and other operating parameters. This often results in separators filling with sediments; when maintenance is then required, operators tend to view these events as equipment failures due to upset conditions rather than human error.

What pretreatment methods, if any, are required when using centrifugal separation technology?

Unlike conventional produced water technologies which require various pretreatment methods, centrifugal separators only require a strainer upstream to prevent oversized material from entering the separator. Such material may be anything ranging in size from large items, such as gloves, welding pins and tools, to large particles. A strainer with a 0.5 mm mesh is recommended to prevent particles larger than this size from entering the separator and adhering to distribution channel surfaces inside the disc stack; over time, these particles will block the flow and have a negative impact on the performance of the separator. If a specific installation does not use standard spacing between discs in the stack, the mesh size of the strainer may be slightly smaller or slightly larger (0.4–0.6 mm). In produced water streams with high solids loads and the use of a continuous-discharge separator with nozzles, the nozzle diameter determines the mesh strainer size. The nozzle size selection is based on the solids content; a mesh size that is approximately one-third the size of the selected nozzle size is recommended.

To further improve performance, there are some areas to consider, which contribute to higher separation efficiency. Using a pump that provides gentle pumping action to feed produced water into the centrifugal separator contributes to higher separation efficiency. This prevents oil droplets from splitting when fed into the treatment system.

A separator readily copes with small oil droplets in water; however, to improve performance and/ or capacity when separating larger droplets, it is important to take these factors into consideration:

- **Heat.** Heat has less impact on viscosity in water compared to oil. Even if the water has a low viscosity from the start, the reduction in viscosity through the use of a heater is negligible. Heat tends to improve separation performance; however, it is not necessary to install a preheater before a separator to achieve good separation efficiency.
- **Chemicals for flocculation or coalescence**. Unlike many produced water technologies that have difficulty handling small oil droplets and therefore require demulsifying chemicals, separators do not require chemical additives to treat produced water. However, as with any treatment equipment, the use of demulsifiers provide an opportunity to further improve performance. It is important to note, however, that centrifugal separators generally offer the possibility to treat produced water by reducing or eliminating chemical consumption.

What is the waste management impact with respect to quality, quantity, integration/treatment?

The key waste stream from a separator operated in a produced water treatment system is the separated solids stream. In most installations, this stream is remixed with the water discharged overboard, as the amount of oil attached to solids is still within discharge specifications. Before the solids are discharged from inside the centrifugal separator, they pass a zone of produced water that has been separated from oil. The volume and quality of solids, in terms of oil contamination, generally allow the solids to be remixed with produced water for discharge overboard. In some regions and/ or installations, this solid rich stream is collected in tanks and shipped for waste treatment at onshore facilities. This volume of solids is small compared to a produced water stream. Alfa Laval has equipment to further reduce the solids waste stream into solids with higher dryness, but so far this solution has not been requested for use offshore.

The separated oil stream is not generally considered to be a waste stream. The water content in the separated oil may often be as low as 1–2% and up to 20% in the toughest conditions. Because this stream is relatively small, it can be blended into the produced oil without impacting the quality of the produced oil. This is a critical difference between the performance of a separator and a conventional produced water treatment system. Using separators does not require rerouting reject streams to the water stream as conventional systems do (mentioned earlier in the article).

Finally, with regard to impact on offshore waste management, it is important to note that a centrifugal separator generally does not have any consumables, such as filters. The waste generated from operating a separator amounts to the small number of seals (o-rings) inside the process wetted bowl that must be replaced according to the recommended service schedule. Other waste material includes bearings that have been replaced, usually on an annual basis during maintenance, and a few litres of lube oil from annual lube oil replacement.

How does gas flashing from the produced water stream in the feed influence centrifugal separator performance?

Flashing inside the centrifugal separator does impact performance unless flashing is relatively limited. The effects of flashing are somewhat dependent the model of separator. In conventional models, so-called top-fed separators, the feed inlet is a static tube that leads into the centre of the rotating separator bowl. The water stream is usually depressurized in inlet zone, although sometimes it is depressurized before the inlet zone. Any significant gas release will cause internal overflow in the acceleration zone (the distributor), and eventually contaminate to some extent the outgoing produced water that has been treated. To prevent contamination due to flashing, depressurization before the separator is recommended. It is also possible to select a separator that allows operation of the rotating bowl with process liquid at pressures of up to 4 bar g, thereby preventing the release of gas from the produced water. Alfa Laval also has other separator models designed with an enclosed feed/acceleration zone, known as 'centre-to-centre' design. These models keep the liquid under pressures of up to 6 bar g, which prevents the release of gas from the produced water.

What other factors may impact separator performance?

Other factors that may have an impact on separator performance include production chemicals, corrosion inhibitors and the presence of heavy oil in produced water.

Production Chemicals

In general, chemicals used in conventional treatment systems to treat produced water tend to create and stabilize smaller oil droplets, making produced water treatment more difficult. This not necessarily true for treatment of produced water using centrifugal separators. Centrifugal separators are better equipped to remove small droplets; however, separators may experience poor performance when subject to extremely poor operating conditions. If a separator is sized to meet a performance target based on a specific oil droplet size distribution, for example, Dv50 = 15 microns, and the production chemicals generate a Dv50 value of 5 microns, it will be necessary to reduce the capacity of the separator in order to meet the performance target.

However, reducing separator capacity may not be possible, depending on the design of produced water system with regard to redundancy or spare capacity. Fluid properties from the production chemicals can have a negative impact on separation efficiency in conventional treatment systems including static separators, hydrocyclones, CFU units. In all likelihood, this means that the capacity of a downstream reject treatment separator is no longer sufficient.

Corrosion Inhibitors

Corrosion inhibitors have two mechanisms that are particularly relevant, which are related to their ability to create oil-wetted particles, where the apparent density becomes similar to water. The first mechanism is their ability during the production process to reduce the surface tension of the oil droplets, from about 30 dyne/cm to about 10–20 dyne/cm. This makes it easier to break up the droplets into smaller droplets due

to a reduction in pressure. As described earlier, small droplets are more difficult to separate, but also are more difficult to coalesce into larger droplets. The situation is further exacerbated by the surface charges caused by these surface-active chemicals, which also stabilize the droplets and, consequently, aid creation of emulsions.

The second mechanism is the ability of corrosion inhibitors to coat and protect internal metal surfaces. However, they may also cause oil droplets to attach to solids, making the solids density comparable to that of water. This may cause particles to follow the water stream unseparated, and the oil coating appears in OiW readings. This will cause a higher oil-in-water content on the produced water process side.

This phenomenon occurred at the Buckland field on the Beryl Alpha platform. An investigation by Alfa Laval found that the high OiW content in the discharge water was due to oil-coated particles approximately 10 microns in size that had a density similar to water. When the injection system for corrosion inhibitor was turned off, the separation performance of the produced water treatment system was spot on track. Later, when the injection system was turn on and corrosion inhibitor dosing again reached high levels, the performance of the separator was reduced.

Heavy Oil in Produced Water

A lesser-known parameter related to produced water treatment of water streams contaminated with heavy oil is the fluid dynamic effects that appear when removing a high-density oil phase from water. In general, the removal of high-density oils from produced water is very difficult in conventional process equipment due to the small difference in densities between the oil and water. Centrifugal separators are able to take on this task as they operate with high g-forces and short settling distances. However, the separation of heavy oils from produced water introduces a specific flow phenomenon described as "flush through". Flush through refers to the water phase, which at certain conditions and velocities inside the disc stack, manages to expel a small portion of the oily liquid film formed during separation into the separated water outlet; this results in poorer separation efficiency. Alfa Laval can readily model this fluid phenomenon and take it into consideration when sizing a centrifugal separation solution.

Utilities and Chemicals Consumption

What utilities and chemicals are required for centrifugal separation?

Utility consumption varies based on both the design and the size of the separator. This section provides the utility consumption for two separator designs and sizes. The first is a mediumsized separator with intermittent solids discharge and a capacity of 25 m3/h, commonly used for small-scale produced water treatment. The second is a large separator with continuous solids discharge and a capacity of up to 190 m3/h.

Weight and Footprint

What is the weight and footprint of centrifugal separators?

The weight and footprint of centrifugal separators vary depending on the model. In general, the weight and footprint are extremely small compared to conventional

Utilities for a medium-sized separator (25 m^3/h)

- Electric power, 3-phase 18 kW installed power for separator motor.
- Single phase power for controls instrumentation.
- Inert gas (use optional, for oxygen-free installations) for purge of system at approximately 400 Nl/h during operation and at approximately 40 Nm^3/h during purging just before start-up.

Most voltage/frequency options possible.

Water specifications	For water quality, please refer to the "Demand Specifications Water" section in the separator manual and the document, Alfa Laval Water Quality Requirements SFL 7608-05 Rev. 0, available upon request.
Operating water (each/total litres), medium-size separator	40 l/discharge each (approximately 40–80 l/h)
Specific water consumption/ separator at discharge sequence*	23 l/min (only during discharge cycle)

** The specific water consumption is used to discharge the separator within a few seconds. The discharging cycles will be adjusted, depending on the untreated product quality, and can be adjusted from a few minutes up to four hours. There is an additional need for makeup water for each separator of approximately 1.7 l/h during operation.*

Utilities for a large separator (190 m^3h)

- Electric power, 3-phase 150 kW installed power for separator motor
- Single-phase power for controls/instrumentation
  - Inert gas (use optional, for oxygen free installations) for purge of system at approximately 400 Nl/h during operation and at approximately 40 Nm^3/h during purging just before startup
- Freshwater for liquid seal, 45 l/h at 0.3 bar*

Alfa Laval X20

Most voltage/frequency options possible.

** Note that the large separator uses less freshwater than the medium-sized separator. The large separator discharges the solids through the nozzles, which do not require any operating water. In the medium-sized separator, the intermittent discharge is operated by a standard freshwater mechanism built into the separator bowl.*

Typical instrument air specifications for separators

This instrument air specification is common for most separator design

Air Consumption	Approximately 0.2 Nm^3/h
Air Pressue	600–1000 kPa / 6–10 bar g constant pressure
Air Quality	Instrument air, free from oil, dry and with dew point min. 10°C below ambient temperature
Air Requirement	Air is needed to operate pneumatic-actuated valves

produced water treatment equipment. Separators have small holdup volumes in the range of 6–70 litres; the difference in weight, wet and dry, is negligible.

Typical weights of small, medium and large separators*		
Maximum Capacity	Size (L × W × H)	Weight (Tonnes)
5 m^3/h	1.7 x 1.7 x 1.9 m	1.5
25 m^3/h	3.5 x 2.2 x 2.6 m	5
190 m^3/h	3.3 x 3 x 3.3 m	8.2

** Actual weight will vary depending on the final scope of supply.*

Is it possible to review the general arrangement of various of centrifugal separator capacities (dry and operating weight of the kit)?

General arrangement drawings detailing the package equipment, weight data and piping are available upon request. Contact your local Alfa Laval representative.

Capital Expenditures

What capital expenditures (CAPEX) are involved in purchasing centrifugal separator?

The CAPEX will vary, depending on various factors such as separator model, installation specifications, operating conditions, offshore location, requirements for regulatory compliance.

Typical CAPEX for small, medium and large separators*	
Maximum separator capacity	CAPEX (MEUR) per separator, span at different levels of specification
5 m^3/h	0.15**
25 m^3/h	0.8–4***
190 m^3/h	1.5–2.5

**Actual capital expenditures will vary, depending on the separator model, size and capacity.*
***No possibilities for high specification execution due to high degree of marine standardization.*
****4 MEUR is an extreme project example but shows the highest specification impact on cost.*

Operating Expenses

What are the operating expenses (OPEX) involved? (Utilities, chemicals, consumables/ maintenance?)

The operating expenses (OPEX) will vary, depending on the separator model. A key OPEX parameter is power consumption, which as a rule of thumb, can be set at 1 kWh/m3 of produced water processed. Some Alfa Laval separators using between 15% and 30% less power than conventional centrifugal separators. At higher flow rates, it is possible to achieve energy savings of up to 50%, in some cases.

OPEX in terms of instrument gas and water consumption has not been included in the estimates below due to differences in utilities prices. These costs are better assessed on an individual basis using utilities consumption and local gas and water prices. Chemical and heating costs also have not been included since neither chemicals nor heating are required for separator operation.

The remaining OPEX element is spare parts replacement based on standard maintenance intervals and prices. Alfa Laval offers a wide range of service alternatives – from all-inclusive performance agreements with condition monitoring to straightforward supply of spare parts. Alfa Laval works closely with operators to establish the best maintenance programme based on their individual requirements.

Typical annual maintenance expenses for centrifugal separators	
Maximum separator capacity	OPEX (EUR/year) per separator*
5 m^3/h	~4,800
25 m^3/h	~13,180
190 m^3/h	~37,000

** Based on spare parts, such as seal rings, bearings, lube oil, etc., replaced at typical maintenance intervals and based on 2018 prices.*

Benefits of Centrifugal Separators
• Highly efficient removal of the smallest oil droplets • Extremely small holdup volumes and short residence time (a few seconds) • Lightweight, compact footprint • Easy retrofitting to free up space • Compliance with environmental regulations • No use of chemicals • Energy efficient • Reduced waste handling and disposal costs

Conclusion

Oil and gas producers often face challenges in treating produced water for discharge overboard in compliance with environmental regulations. Conventional produced water treatment technologies are complex and require pretreatment in addition the main treatment. Reject streams are often returned directly to the process, making it difficult to identify and address the issue. In addition, chemical treatments, such as corrosion inhibitors, lead to the formation and stabilization of small droplets, making it very difficult for conventional equipment to separate oil from water. What's more, the physical and chemical characteristics of the produced water vary widely and change over time within a given field. Operators of conventional technologies must then constantly adjust treatment to comply with discharge requirements.

Centrifugal separation technology provides oil and gas producers with a compact, reliable and highly efficient alternative to treat produced water under challenging conditions and, more importantly, one that can eliminate the need to recirculate hard-totreat reject streams back into process. Platform and FPSO operators seeking alternative solutions to treat produced water should consider centrifugal separation technology as a viable option.

Centrifugal separators are straightforward automated systems that separate waste oil into three phases: cleaned oil, water and solids – generally without the use of pretreatment and posttreatment stages. Used in the offshore industry for three decades, centrifugal separators are widely used in the shipping industry to treat fuel lines and handle bilge water for discharge overboard in compliance with strict environmental legislation. ●

Article Courtesy : Alfa Laval

Latest Trends in Modularisation in Refinery & Petrochemical Plants

The modularization concept in Downstream Sector of Hydrocarbon industry is comparatively a newer trend. It is about configuring a plant through the assembly of multiple modules to make a complete plant – An effective alternative to traditional stick-built construction.

This article provides a valuable insight on this new trend. Not only that, it also emphasizes the best practices being followed by one of the leading engineering & Manufacturing company – Praj Industries Limited.

The paradigm of project execution has been rapidly changing due to the change in market and economic scenario in the Downstream Sector of Hydrocarbon Industry. Today, the expectation is to complete the project in shortest possible time to improve the payback period as well as Return on Investment. In addition to that, the safety norms and labour regulations at site are getting tougher and tougher.

In view of achieving the above, the industry has been trying to innovate the way the projects are being conceptualized and implemented.

Modularization

One of the new trends in project conceptualization in the industry is "Modularisation".

Modularisation is not a new concept in Upstream Oil&Gas Industry particularly in offshore applications as well as remote Oil&Gas processing plants in upstream and midstream sector.

However, in Refineries and Petro-Chemical industry, the concept of modularization is comparatively new because most of the plants are in the areas where labour availability, transportation etc have been favourable compared to remote locations.

What is Modularisation?

Simply putting, modular plant can be defined as "Process System contained within a frame" that allows the complete system to be transported".

Thus, a Module is an alternative to traditional stick-built construction where process system is shipped from the fabrication yard and installed at the site.

Interestingly, there is always a confusion about what exactly it means because module is a very generic term. Often, a module is imagined as a very large system which generally transported on a barge or ship. And as such, the modularisation concept is often considered not practical because many times the plants are located where such huge size equipment can not be transported on road.

Modularisation: Praj Perspective

At Praj, we have a very different perspective of modularisation and we define Modularisation as:

Configuring a plant in a way where multiple Modules are assembled to make a complete plant.

Thus, A modular Plant is:

a. Process System within a structure
b. Complete in all respect till structure limits / battery limits
c. Can be small or large depending on the transportation feasibility
d. Can be single or multiple levels
e. Transportable and easy to assemble at site

Large modules for Oil&Gas Offshore applications – Type 3

To simplify the understanding of the modular plant, we have internally defined modular plants in 3 different Types – These definitions are very helpful while imagining and explaining the configuration of a plant.

Type	Units	General Size	In the Shop / Yard	Transportation	At Site
Type 1	Single Process Unit	Containerised / Truckable	Complete assembly and Pre-Comm	As a Single Unit	Plug and Play
Type 2	Process Package Assembly of multiple units	Scalable and Flexible. Transportable by road (Containerised/ Truckable)	Complete Assembly, Pre-comm and Dismantling of individual units	In multiple units and spools of inter-connecting piping	Assembly of units + Spools (Like Lego)
Type 3	Process Package Single large Unit	Very Large Difficult to transport by road	Complete assembly and Pre-Comm	As a Single Unit – Generally by barge/ ship	Very large cranes

Type 1
Single Process Unit

Type 2
Multiple Process Units Assembled Together

Type 3
Multiple Processes in Single Large Unit

Praj way of Modularisation

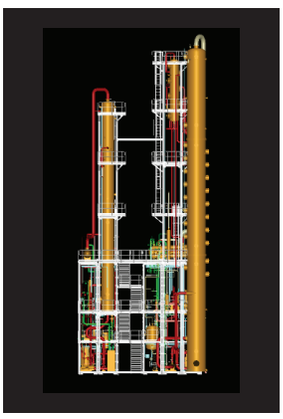
Being the Technology and EPC company along with our own manufacturing facilities, we - at Praj - are able to conceptualise and design the modular plant in a more construction friendly and cost-effective way. Praj specialises in converting Stick-Built process packages into Type-2 Modular Configuration for Refineries and PetroChemical Plants.

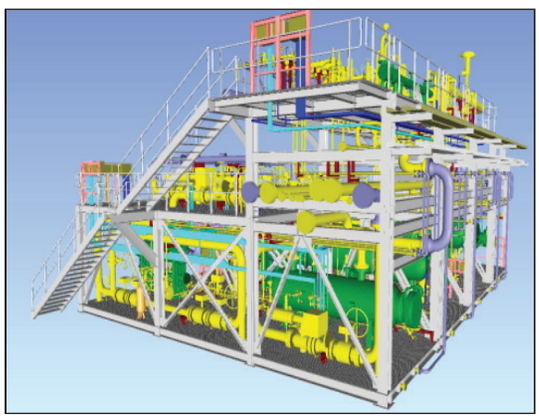
Praj is uniquely positioned to leverage in-house competencies:

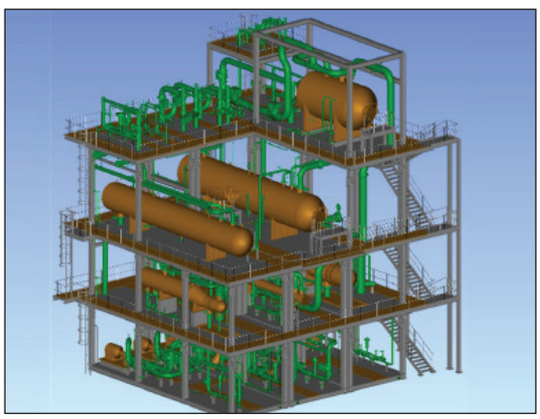
a) Process understanding – Being a Technology / Chemical Engg company
b) Multi-disciplinary Engineering
c) Manufacturing / Assembly shops
d) Experience of logistics all over the world
e) Experience of installation of plants – Both – Stick-built and Modular

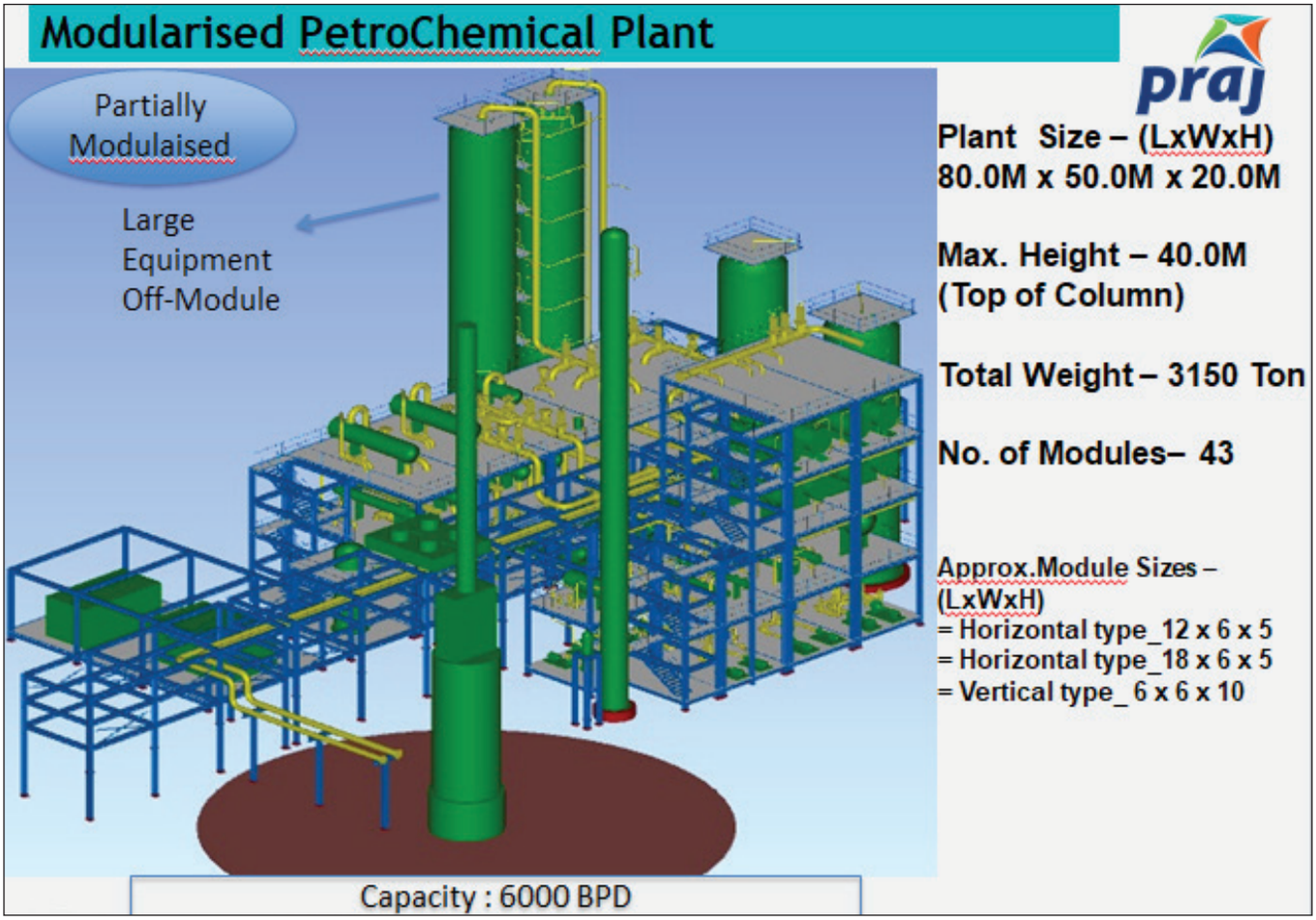
Over the years, Praj has modularized many packages in various configurations:

1. **Fully modularised – Container size –** All sub-modules are container size and can be transported in standard containers
2. **Fully modularised – Truckable size –** Sub-modules are of truckable size (approx. width 4.5 to 5 m)
3. **Mixed Modularised –** Containerised + Truckable – Some of the sub-modules are truckable size (4.5 to 5 m width) and some are container size
4. **Partially modularised** – Large Equipment Off-Module – Sub-modules are container or truckable size but large equipment like Columns or Reactors are kept stand-alone.









An example of Conceptualising a PetroChemical Plant in a modular configuration.

Size does not matter – BUT sizing matters

Irrespective of the size of the plant, the modularization is possible provided the sizing of individual sub-modules are done thoughtfully. While conceptualizing the sizing, following aspects are considered:

Location of site

a. Safety norms
b. Transportation Limits – From Shop / To site
c. Availability of Cranes

Process of Modularisation - A Joint Development

While developing the modularization concept, the most important activity is joint efforts between the client and modularization company.

At Praj, we always work together with client's team and follow a stage-wise process:

1. Understanding workshop - Detail understanding of Process Scheme, PFD, P&ID and other details
2. Concept sketches - Configuration
3. Equipment placement
4. Process Validation workshop – Client process team participates to validate the process including Safety norms validation
5. Preliminary Model with major lines
6. Optimisation workshop - Review sizing of modules / Possibility of resizing of equipment
7. Finalisation of configuration
8. Complete Modeling of Modular Plant

Steps 1, 4 and 6 are carried-out in a development workshop method where clients participate to validate the design. This creates a synergy in thought process and approach to the project execution.

Benefits of Modularisation

Areas	Benefits	Savings potential
Plant Design / Engineering	• Transportable Design • Smaller Footprint	20-30% Footprint savings possible
Procurement / Inbound Logistics	• Reduction of procurement items and subsequent logistics for EPC / End-client	Savings in co-ordination efforts and consequently manhours
Manufacturing / Assembly	• Safer conditions than site • Controlled assembly and QA • FAT before installation	Site labour cost saving from 25 upto 75 % possible depending on site
Overall Schedule	• Faster Installation at Site • Minimizing and controlling risk during construction • Accelerated schedule • Faster start of production	25 to 30% compressed schedule possible

Challenges in Modularisation

While modularization is a very effective way of configuring a plant, there are certain challenges which must be kept in mind and shall be mitigated.

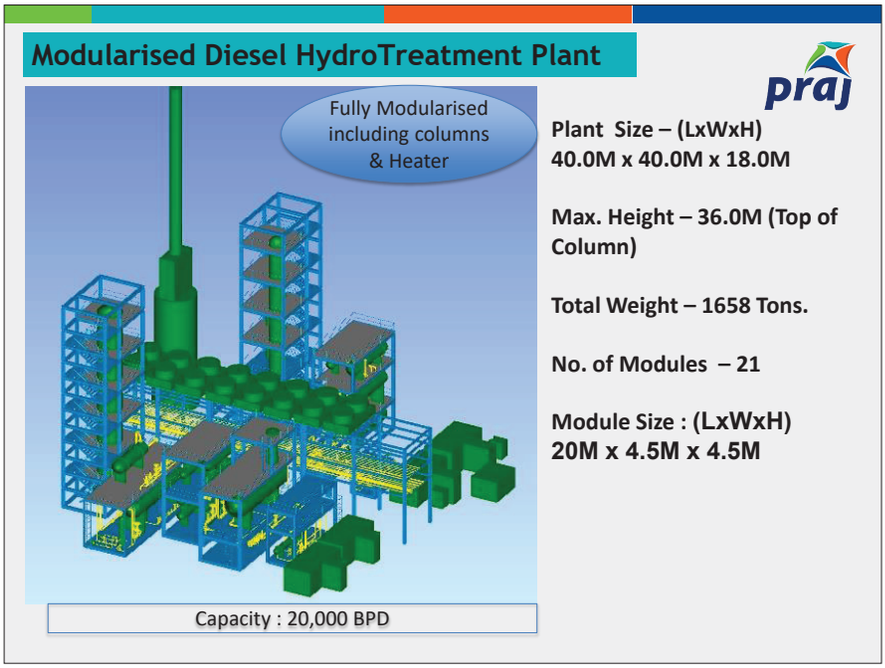
1. Concurrent Engineering at Client and Module supplier is a MUST.
2. Difficult to accommodate Process Design change after finalsation of configuration
3. Model Review workshops must be very intense and elaborate.
4. Weight and cost of structure may be higher (But many times it saves site civil construction cost)
5. Requirement of suitable space for assembly at shop / yard
6. Meticulous planning required for B/O items as there is less flexibility to accommodate at a later stage.

All these challenges can be overcome by proper planning and teamwork between modularization company and client.

The most important benefit is - Modularisation becomes a "No Surprise" project at site as complete assembly is carried-out in the fabrication shop before the FAT / Pre-commissioning phase.

Over the years of experience in modularization, Praj has developed a competency in conceptualising and manufacturing the modular plants for Refineries and PetroChemical Industry and can claim that:

Modularisation: A safer, faster and cost-efficient way of executing the project



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Need for Digitally Transformed EPC Projects in Oil & Gas Industry

EPC (Engineering, Procurement and Construction) in O&G (Oil & Gas) is trying to accelerate maturity in digital technology adoption. Digital & Innovation initiatives in EPC face sector specific challenges due to complexities in business requirements, pressure on return of investment, technology debt, change management, and ability to attract and retain the talent needed. Moreover, macroeconomics, geopolitics, energy transition and climate change impact the objectives of digital transformation journey. This paper aims to discuss few specific challenges across the lifecycle of the EPC projects, and suggests some innovative choices for project management and HSSE (Health, Safety, Security and Environment).

The catastrophic fall in oil prices from a peak above USD 100 per barrel in June 2014 to under USD 30 in February 2016, is often termed as one of the most important global macroeconomic changes in recent times. Fast forward to 2018-19, and there has been a recovery with the price of crude oil staying in a range of USD 50-USD 70 per barrel most of the time. The Energy Transition and the new normal in Oil & Gas prices have driven global transformations in the O&G sector such as large mergers and acquisitions, changes in work policies, business process simplification, new priority in return on CAPEX and technology adoption, reliability and operational efficiency. Capital projects in the O&G sector (and hence, the EPC providers) have witnessed the highest impact. EPC is characterized large outsourcing contracts where investments are very high, and the asset performance parameters primarily define the owner/operator's overall success and financial health. The sector also operates under stringent compliance requirements by the regulators.

Business Challenges in the EPC Segment

In the current business scenario, O&G companies are challenged to grow the production levels profitably and sustain the asset performance. New capital project funding has slowed down due to demands for stronger return of investment at lower prices and the need to move to low carbon forms of Energy. As a result, higher expectations are mounting on existing capital projects and their success at a lesser investment. To meet this expectation, organizations are relooking their business objectives, operational processes, outsourced contracts and technological aids so that predictable results, greater efficiencies and lower carbon footprint can be achieved at a lesser cost.

Some of the key EPC business challenges that can be managed effectively by deploying suitable digital technologies are discussed below.

1. Mobilization of Resources in Projects

In an EPC project, right staffing is always a challenge. From start of the bidding process till the contract is awarded, it may not be possible to keep the identified resources idle by the EPC vendor. Availability of skilled resources and need to make staff and assets productive from the beginning of a project is a constraint. Additionally, de-mobilizing a resource without a proper replacement plan during the critical phase of an ongoing project is also a challenge. Digital tools can be proved very useful in such resource planning and deployment activities, especially if combined with predictive analytics.

2. Real-time Project Management Tool for Monitoring of Cost, Schedule, Sites, Procurement, Logistics and Quality

In an EPC project, visual illustrations presented on the plan and the actual progress are more effective than a large descriptive document. For project planning and minimizing of errors, it is really helpful if the activities can be simulated before the actual construction starts. Hence, an effective project management tool integrated with simulation, analytics and visual displays help immensely to plan and manage activities in an EPC project.

3. HSSE Management - Proactively Rather than Reactively

It is often observed that in an EPC project, HSSE driven decisions are reactive. However, it is very important to identify the causes leading to the incident and take corrective action even before it occurs. Digital solutions today can be used to foresee and manage the HSSE needs very efficiently in an EPC project so that undesirable incidents and risks to the project can be restricted.

4. Managing Productivity of Workers

Construction in the O & G sector has a poor track record of workers' productivity management. Modular construction has helped the industry to overcome the problem, to some extent. Contract management is an important lever to optimize utilization of resources. Apart from deploying skilled workers, efficiency in managing the supply chain processes also helps in productivity gain. A strategically implemented digital framework that uses analytical and knowledge management tools can be very useful to train the workers and improve the productivity.

5. Integrated Engineering Support for Complete Asset Lifecycle

In a traditional EPC project, the scope of engineering is to construct the asset only and not to support the life of the asset. However, for better management and productivity, engineering should be planned to be integrated with the entire lifecycle including dismantling after the operational life of the asset. It has been also noticed that during the construction phase of the asset, often design changes are required to comply with changing regulations (e.g. BS IV to BS VI – a jump in step to meet the emission standards that needs upgradation of refineries). Strategically planned digital solutions are capable of managing such engineering needs very effectively. Further, a lifecycle view of assets helps EPC firms create new service lines for predictable revenue growth.

Let us discuss two areas where innovative digital technology can be effectively used in managing EPC projects and HSSE requirements in the O&G industry.

The 'BIM' Tool for Efficient Management of EPC Projects

Today, EPC Industry is focused on how the full lifecycle of a project can be managed in an integrated manner. This objective is driving the attention of the EPC community from tools to the data generated from past and ongoing projects. These data are not only used during construction but also for operations and maintenance phase. The tools that use these datasets are also going through major transformations to provide best-in-class analytical abilities. Analytics capability is vital to efficiently execute full project lifecycle including maintenance of the assets.

The Building Information Modelling system (BIM) has evolved from a 3D modelling tool to an integrated multi-dimensional tool to manage the entire lifecycle of the asset. BIM holds near real-time data and project information. The tool can create future-ready models from planning to monitoring stage of the project. Financial, Operations and maintenance data can be integrated with these models as well. Such models can be leveraged for the future design, cost estimation and training that can save time and effort during the project execution phase. BIM also helps to reduce inefficiencies associated with decision-making process of the management. Global EPC companies serving the O&G sector are adopting BIM to leverage datasets from their portfolio of projects to optimize operations, execute analytics, to reduce cost and achieve improved customer satisfaction.

EPCs are impacted by the lack of digital maturity of their sub-contractor ecosystem as well. Figure 1 represents a conceptual high-level business process-flow for the procurement function in an EPC project. The process-flow, if executed via online digital tools, can ensure seamless communication across the owner/operators/partners/subcontractors, transfer of data across various systems /decision frameworks and maintains transparency to the entire stakeholder community. BIM tool can help effective execution of such a business function. Digital enablers such as embedded sensors, drones, AI, automation tools, robotics, cloud infrastructure and datalakes further assist to ensure productivity, profitability, precision and safety in the entire EPC lifecycle.

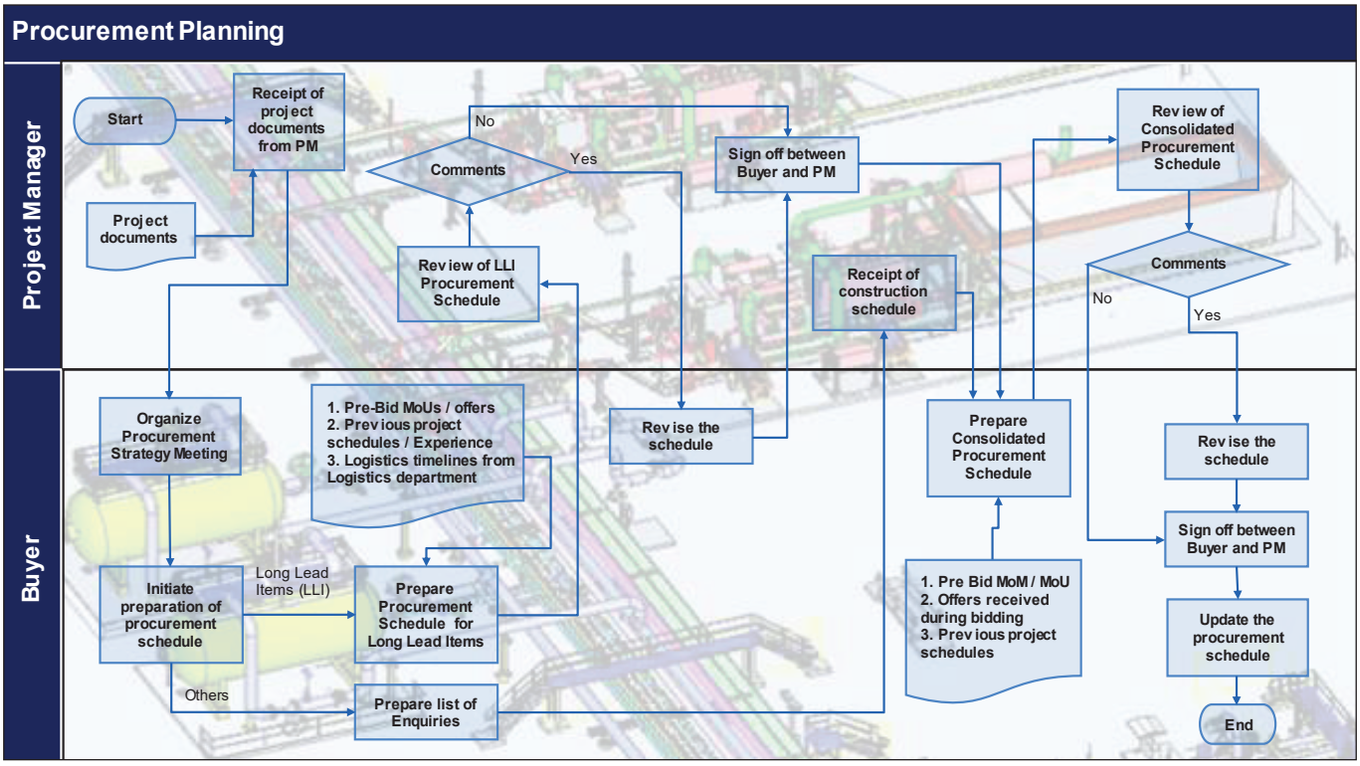

Figure 1: High-level business process-flow for the procurement function in an EPC project

Digital HSSE & Productivity for EPC - The 'Connected Worker' Platform

The Health, Safety, Security and Environment (HSSE) function in the EPC industry has three vital performance objectives - to ensure safety of the workers, to minimize negative impact on the environment and safe running of operations. Achieving these performance objectives need strict adherence to compliance requirements and operational excellence with decreased HSSE incident rates.

Traditionally HSSE units suffered from lack of cross-functional collaboration while executing the EPC projects in the O&G sector. Siloes in operations and lack of data driven decisions further restricted HSSE processes to deliver desired outcomes. The field workers of operations and maintenance units often encounter host of unexpected real-life scenarios that may also expose them to safety risks. To provide safer working environment to the field workers for supporting the operations, organizations are increasingly investing on new-age digital solutions. Digital transformations in the HSSE units primarily require use of cyber-physical systems that may connect their people, equipment, data and processes seamlessly during the project lifecycle. Revamping the asset reliability can also drastically reduce equipment-caused injuries and greenhouse gas emissions. For example, equipment health checks can be performed by analyzing the real-time sensor data acquired during the operations.

To ensure field workers' safety, eliminating accidents, reducing risk of errors, managing performance gaps and having real-time visibility into process flow; EPC industry globally is considering deployment of 'Connected Worker' platforms. Connected Worker is basically a field worker equipped with real-time, context-specific and actionable information which allows him/her to take better decisions while performing his/her job safely and efficiently.

The adoption of the solutions based on the Connected Worker concept has been slower in the past as the supporting technology either didn't exist, was not engineered for industrial use or was difficult to scale at the industrial level. With the advent of emerging technologies such as Industrial IoT (Internet of Things), wearables, Extended Reality (XR) along with communication protocols have made this transformational solution available to the field workers. Industrial IoT has facilitated the connected ecosystem for near real-time data capture about the equipment, assets and the field worker. This critical data is also used by business groups to perform analytics for decisions. The maturing wearable devices along with the XR ecosystem offers industrial grade safety compliant hand-held or head-mounted devices to seamlessly connect a field worker with the digitized enterprise.

The research conducted by World Economic Forum estimates that during 2016–2025, the Connected Worker is pegged to add value of USD 100 Billion while bringing down the safety incidents by 13 per cent in the O&G industry. By 2025, the Connected Worker is expected drive 15 per cent productivity gains in both upstream and downstream operations.

Conclusion

The fourth Industrial revolution is driving adoption of some state-of-the-art digital solutions to reimagine the current way of operations in the EPC segment. These transformational solutions can not only drive huge business benefits but also, capable of changing the age-old way of performing the tasks. This paper presented a brief review of the current business challenges faced by EPCs and the need of implementing transformational digital Solutions to meet these challenges. In this context, two important solutions viz. 'BIM' tool for Capital project management and 'Connected Worker' for safe operations are discussed. ●

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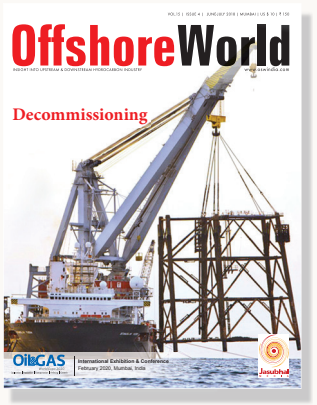

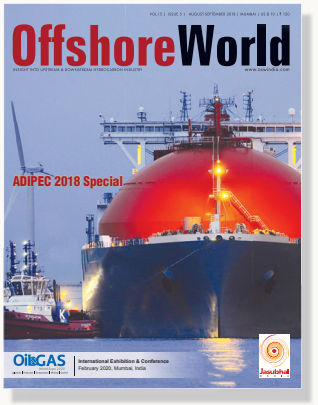

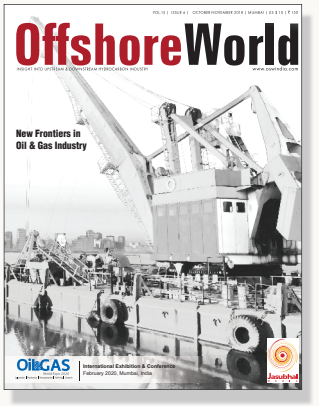

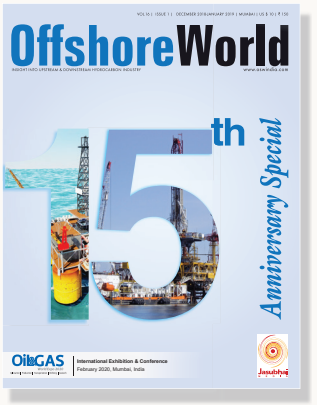

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BPMARRK®: Real-time Crude Oil Assay for Monitoring & Optimization of Crude Distillation Units

BPMARRK® is a patented technology for predicting detailed refining characteristics of oil within an hour. Refining characteristics of crude oil consist of key information such as distillate yields and their quality, residue-potential, crude oil/blends selection, and hydrogen consumption in Hydroprocessing etc. These characteristics are usually deduced from detailed analysis such as true boiling point distillation, ASTM distillation or detailed molecular and spectroscopic analysis. Although established and widely practiced worldwide, these methods often require significant time, large sample quantity and effort for analysis.

BPMARRK® requires only four physical parameters as input to generate about 500 data information of any unknown crude oil or mix. BPMARRK® is differentiated among any static crude oil database by profiling of unknown crude oils or mix in short time. The methodology has been validated with a large number of crude oils sourced from different origins at laboratory for accuracy. ASTM has recommended this innovation for developing a new standards in ASTM D02.04 K section. BPMARRK® application for real-time monitoring and optimization of crude distillation units has been validated in five different Indian refineries for real-time monitoring & optimization of plant performance on daily basis. The accuracy of predicted vis-à-vis actual plant distillation yields of the products observed to be within ±1.5 wt%. This has been used by Process Engineers to assist in Refinery Operations (currently implemented in BPCL refineries) for advance planning and regular monitoring, controlling and taking operational decision related to crude oils.

Crude oil is a complex hydrocarbon mixture which is obtained from geological formations beneath the earth. Therefore, quality of crude oils vary considerably from each other and knowing the potential of unknown crude oil/blends in advance can help in making wise business decisions for effective operation of a refinery[1, 2]. The classical evaluation method to identify the potential of crude oils is done through laboratory experiments and analyses, which are lengthy and time consuming processes. Typically, it requires 30-40 liters sample quantity for detailed evaluation and, usually, it takes three to four weeks to complete, and analysis costs over USD 30,000[9-12]. However, the detailed information is typically unavailable during the selection of crude oils. Even during actual refining operations where multiple feeds and blends are processed, the process and operation decisions are sub-optimal[13].

BPMARRK® Crude Oil Assay

In contrast, to get realistic assay for any unknown crude oil parcel or blend of two or three crude oils testing of only four physical parameters is required in laboratory which is then fed into BPMARRK®. This requires small quantity (25 ml) of sample and 45 minutes to analyze the parameters. BPMARRK® is a novel concept for predicting detailed refining characteristics of any unknown crude oil within one hour including device processing time (2-5 minutes) as depicted in Fig 1.

This generates detailed cut-wise data consists of distillation yields including gas composition and characterization of 6-Naphtha cuts (IBP-60, 60-70, 70-90, 90-110, 110-130-140), 4-Kero cuts (140-150, 150-180, 180-200, 200-240), 5-Gas Oil cuts (240-250, 250-290, 290-310, 310-350, 350-360), 6-VGO cuts (360-370, 370-450, 450-500, 500-525, 525-550, 550-565), LR (360+) and VR (565+) as depicted in Table 1. BPMARRK® predictions have been validated and accepted by third party for accuracy (Indian and global companies).

Real-Time Monitoring & Optimization of Crude Distillation Units

Real-time monitoring and unit-level optimization of crude distillation units using BPMARRK® has been established. During crude mix change and switch over, the transient value loss can be minimized as data for each tank is available in advance before processing through BPMARRK®.

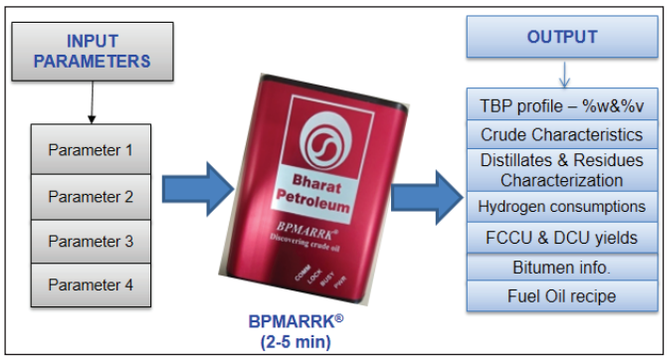

Figure 1: BPMARRK® Crude Assay

A simple methodology is depicted in Fig 2. The predictions of plant yields by BPMARRK® has been compared with Actual and conventional database for two months and found closely matching with Actual Plant as shown Fig 3. Along with distillation yields, other critical properties of the distillate streams especially feed to secondary processing units can also be monitored with the detailed data output generated by BPMARRK®. The present approach enables to maximize non-bituminous crude oil processing during bitumen production

Commercial Implementation

In general, unit-level optimization of crude distillation units wait for laboratory data or crude oil database approximation of crude mix feeding to the columns used during crude switchover. Crude tanks typically changes every 1-3 days depending upon capacity. During each crude switchover, it requires about 6-8 hours for stablization of the plant for optimization based on laboratory data. BPMARRK® provides data in advance even much before feeding to the colulm therefore, the stablization of the plants achieved very fast. This is much helpful when crude mix is drastically changing from low API (high Sulphur) to high API (low sulphur) when distillaiton profiles are signficantly different. The comparison of distillation profile of BPMARRK® and Actual (PLANT) data of one of the BPCL Refineries (crude distillation unit, CDU III) has been depicted in Fig 4. Recently, commerical trial runs conducted in different refineries other than BPCL, the comparison of distillation data of BPMARRK®, Actual Plant, DATABASE & SimDist for two different crude distillation units (AVU- I & II) have been depicted in Fig 5. Commercial trial runs concluded that BPMARRK® plant distillation predictions is superior among all currently used methods like database and SimDist. Implementation of BPMARRK® on daily basis is expected to result in savings up to USD 0.1-2.0/bbl depending upon the current operating practices along with quick stablization of the plant.

Ranking of Crude Oils

Oil price variations impact the selection process for refinery crude slates. When considering crude and product prices, product demand, refinery configurations and other constraints, the evaluation process can be exhaustive. Software tools are comprehensive and time-consuming to screen and rank crude oils on regular basis[20-23]. To simplify the process, a quick method has been developed and integrated for assessing & ranking of crude oils for making business decisions[4, 14, 15]. The differential in crude oils price (D1) and processing costs (D2) are the most influencing factors that determine crude oil selection. The differential in crude oil prices (also called discount) is influenced by Brent price and crude oil qualities (API, Sulphur). The differential in processing cost is mainly due to cost associated with hydroprocessing and residue evacuation at lower price. Using these basis, net differential (D1-D2) has been estimated. Further, this has been correlated with crude oil properties to estimate the coefficients to develop the model using aforementioned method.

Table 1. BPMARRK® Crude Assay

Property Names	Property Unit	Parameter Value	Parameter Unit	Cut Names																							
				WHOLE CRUDE	NAPH	NAPH	NAPH	NAPH	NAPH	NAPH	KERO	KERO	KERO	KERO	GAS OIL	GAS OIL	GAS OIL	GAS OIL	GAS OIL	VGO	VGO	VGO	VGO	VGO	VGO	LR	VR
Initial Boiling Point	C			IBP	IBP	60	70	90	110	130	140	150	180	200	240	250	290	310	350	360	370	450	500	525	550	360	565
Final Boiling Point	C			FBP	60	70	90	110	130	140	150	180	200	240	250	290	310	350	360	370	450	500	525	550	565	FBP	FBP
CutYieldByWt	%			100	4.22	2.72	3.31	3.75	3.64	1.64	1.59	4.92	3.4	6.41	1.56	6.08	2.96	5.89	1.39	1.35	9.94	5.89	2.76	2.55	1.47	44.82	20.85
CutYieldByVol	%			100	5.77	3.39	3.99	4.44	4.16	1.75	1.77	5.4	3.63	6.71	1.6	5.93	2.93	5.61	1.31	1.27	9.14	5.25	2.45	2.25	1.28	38.31	16.66
APIGravity	-			33.86	102.12	81.6	73.37	67.61	60.7	56.24	53.38	52.73	48.28	44.24	40.87	37.89	34.25	30.89	29.77	27.01	23.49	19.93	17.87	16.45	16.11	13.43	6.32
SpecificGravity	-	60/60°F		0.8565	0.6057	0.664	0.6907	0.7107	0.7362	0.7537	0.7654	0.7681	0.7871	0.8052	0.8209	0.8354	0.8537	0.8713	0.8774	0.8927	0.913	0.9344	0.9473	0.9564	0.9586	0.9763	1.0267
StdLiquidDensity	g/cm3			0.8557	0.6049	0.6632	0.6899	0.7099	0.7354	0.7529	0.7646	0.7673	0.7863	0.8044	0.8201	0.8346	0.8529	0.8705	0.8766	0.8919	0.9122	0.9336	0.9465	0.9556	0.9578	0.9755	1.0259
SulfurByWt	%			2.32	0.023	0.024	0.031	0.037	0.045	0.056	0.061	0.094	0.147	0.342	0.608	1.01	1.62	2.131	2.452	2.536	2.785	3.18	3.451	3.691	3.765	4.256	5.769
PourPoint	C			-40	-	-	-	-	-	-	-87	-77	-64	-48	-36	-24	-10	0	8	11	23	36	42	45	45	22	55
Watson K	-			11.98	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11.69	11.72	11.8	11.84	11.86	11.86	11.67	11.49
TotalAcidNumber	mg KOH/g			-	-	-	-	-	-	-	0.04	0.05	0.05	0.06	0.07	0.08	-	-	-	-	-	-	-	-	-	-	-
NitrogenByWt	ppm			1308	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	378	678	1057	1347	1542	1532	-	-
BasicNitrogenByWt	ppm			245	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	90	151	256	307	365	405	-	-
MercaptanSulfurByWt	ppm			234	-	-	-	-	-	-	87	118	69	51	-	-	-	-	-	-	-	-	-	-	-	-	-
RVP	kPa	38	C	39.03	353.61	39.36	23.8	12.14	5.45	2.54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N+2A	%			-	1.63	0	9.34	27.45	38.67	101.22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RONClear	-			-	85.91	52.64	49.34	46.86	39.97	69.32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MONClear	-			-	83.63	53.75	50.12	47.4	40.01	66.92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HYDROCARBON TYPES, wt%	-																										
SaturatesByWt	%			65.42	-	-	-	-	87.29	56.77	75.02	83.04	80.78	78.7	76.42	73.87	71	67.89	64.19	62.92	56.98	53.25	47.13	45.91	46.07	43.81	38.83
AromByWt	%			34.58	-	-	-	-	12.71	43.23	24.98	16.96	19.22	21.3	23.58	26.13	29	32.11	35.81	37.08	43.02	46.75	52.87	54.09	53.93	56.19	61.17
HYDROCARBON TYPES, vol%	-																										
ParaffinsByVol	%			40.39	98.37	100	90.66	72.55	71.87	38.05	57.19	58.03	53.28	48.49	45.05	42.67	39.81	36.01	31.81	29.98	23.01	14.57	11.78	10.75	10.42	11.41	6.74
AromByVol	%			29.87	0	0	0	0	10.54	39.27	22.37	15.32	17.29	19.38	21.11	22.94	25.24	28.27	31.87	33.13	38.89	46.24	49.08	50.25	50.7	51.71	57.39
NaphthenesByWt	%			29.74	1.63	0	9.34	27.45	17.59	22.68	20.44	26.64	29.43	32.13	33.84	34.39	34.95	35.72	36.32	36.89	38.1	39.19	39.14	39	38.88	36.88	35.87
VanadiumByWt	ppm			29.37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	0.42	3.61	10.5	75.21	179.24
NickelByWt	ppm			10.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	-	0.23	1.22	3.02	26.4	57.65
FIA	-																										
SaturatesByVol	%			-	-	-	-	-	-	-	74.85	83.76	82.32	80.48	-	-	-	-	-	-	-	-	-	-	-	-	-
AromaticsByVol	%			-	-	-	-	-	-	-	25.15	16.24	17.68	19.52	-	-	-	-	-	-	-	-	-	-	-	-	-
FlashPoint	C			-	-	-	-	-	-	-	36.22	47.51	65.71	83.12	104.5	103.58	119.28	129.63	140.5	-	-	-	-	-	-	-	-
FreezePoint	C			-	-	-	-	-	-	-	-80.39	-71.31	-59.43	-42.27	-	-	-	-	-	-	-	-	-	-	-	-	-
SmokePt	mm			-	-	-	-	-	-	-	29.95	28.1	25.94	23.2	-	-	-	-	-	-	-	-	-	-	-	-	-
CetaneIndex	-			-	-	-	-	-	-	-	35.67	44.72	46.17	49.85	52.52	54.14	55.67	56.33	57.36	-	-	-	-	-	-	-	-
DieselIndex	-			-	-	-	-	-	-	-	-	-	-	-	61.1	57.42	53.59	49.47	46.02	-	-	-	-	-	-	-	-
AnilinePoint	C			-	-	-	-	-	-	-	-	-	-	-	65.41	67.55	71.26	72.87	74.6	75.5	78.44	83.04	85.18	86.53	86.35	-	-
MicroCarbonResidueByWt	%			5.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0.17	0.7	1.97	3.43	12.3	26.92
RamsCarbonResidueByWt	%			5.24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0.12	0.72	1.81	3.28	11.38	24.83
KinematicViscosity	cSt	30	C	9.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
KinematicViscosity	cSt	40	C	6.97	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
KinematicViscosity	cSt	50	C	0.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4448280
DynamicViscosity	cp	60	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	411.56	29610.38
KinematicViscosity	cSt	100	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.89	4.62	8.12	8.53	18.4	-	138.61	9109.87
KinematicViscosity	cSt	135	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23.06	456.45
SofteningPoint	C			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17.97	44.02
Penetration	mm	25	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1345.3	10.28
AsphalteneByWt	%			2.72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.78	12.48
WaxContent	%			1.29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.54	5.85	4.95	4.5	4.23	3.44	0.13	-

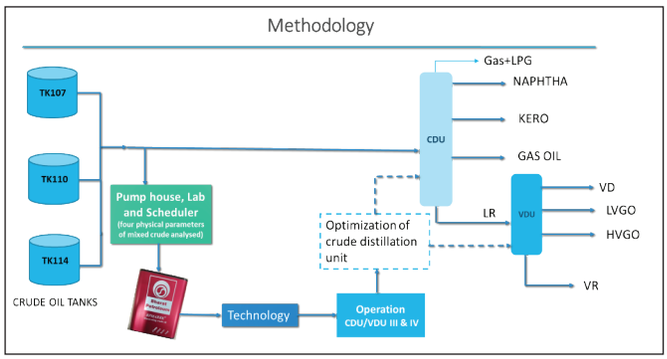

Figure 2: Methodology for real-time monitoring & optimization of Crude distillation units

Fig 6 depicts the ranking of crude oils vis-à-vis Brent crude price variations for given crude oils e.g., Arab Mix (source: Saudi Arabia), Brega (source: Libya), BH crude (source: India), Saharan Blend (source: Algeria) and Kuwait (source: Kuwait). The crude price variations are due to variation in net differential discounts (due to crude oil qualities and refinery processing cost) for various Brent crude price scenarios. As shown in the Fig 6, the cross over in net margin (ranking of crude oils) is evident due to variation in Brent crude oil price. Thus, measurement of physical properties of oil sample can be used for the ranking of crude oils for net margins at refineries with varying Brent crude pricing. The ranking of crude oils can be then used for selection of appropriate blend of crude oil. With this approach, refiners, crude-oil traders, supply-chain optimizers and crude schedulers can make quick and accurate business decisions.

Hydrogen Consumption in Hydroprocessing

Typically hydroprocessing involves removal of sulphur (S), nitrogen (N) and saturation of aromatics. Characteristics of distillate streams like kerosene, diesel, and VGO obtained from particular crude oil have been considered to estimate the hydrogen consumption. The affecting variables are C/H ratio, aromatics, sulphur, nitrogen and metals etc of that particular distillate streams. Further, to estimate the hydrogen consumption, Carbon (C), Hydrogen (H) and Impurities (I) balance has been considered across the Diesel Hydro-Desulphurization (DHDS) and Hydrocracker Unit (HCU) configuration while upgrading the straight run distillate streams to superior quality distillates[10, 17-19].

Table 2. Illustration of hydrogen consumption in HCU for VGO of Arab Mix

Hydrogen Consumption	Basis (AM VGO): Capacity 5200 TPD in HCU	T/D	% of Feed
For saturation	Difference of hydrogen content in feed and product	115	2.21
For 'S' removal	$C_9H_8S + 3H_2 \rightarrow C_9H_{12} + H_2S$ (Methyl-Benzothiophene) (1-ethyl-2-methylbenzene)	23	0.44
For 'N' removal	$2N + 3H_2 \rightarrow 2NH_3$	0.5	0.009
Total		139	2.67

Table 2 depicted the illustration of estimation of hydrogen consumption in HCU for VGO derived from Arab Mix crude oil. Similar approach has been opted for estimation of hydrogen consumption in DHDS. The total hydrogen consumption has been considered for both HCU and DHDS configurations. Further, the coefficients have been generated by regression between crude oil properties and total hydrogen consumption (including DHDS and HCU) for development of model using aforementioned method. Further, this has been used to estimate the total hydrogen consumption of Arab Mix-AM (source: Saudia), Kuwait-KW (source: Kuwait) and Kimanis blend (source: Malaysia) crude oils and reported Fig 7. The estimated total hydrogen consumption for AM crude is in agreement with plant data.

Summary

BPMARRK® is a rapid tool for generating Crude Oil Assay within an hour to facilitate decisions on real-time basis which has larger impact on overall economics of refining business. This enables fast business and

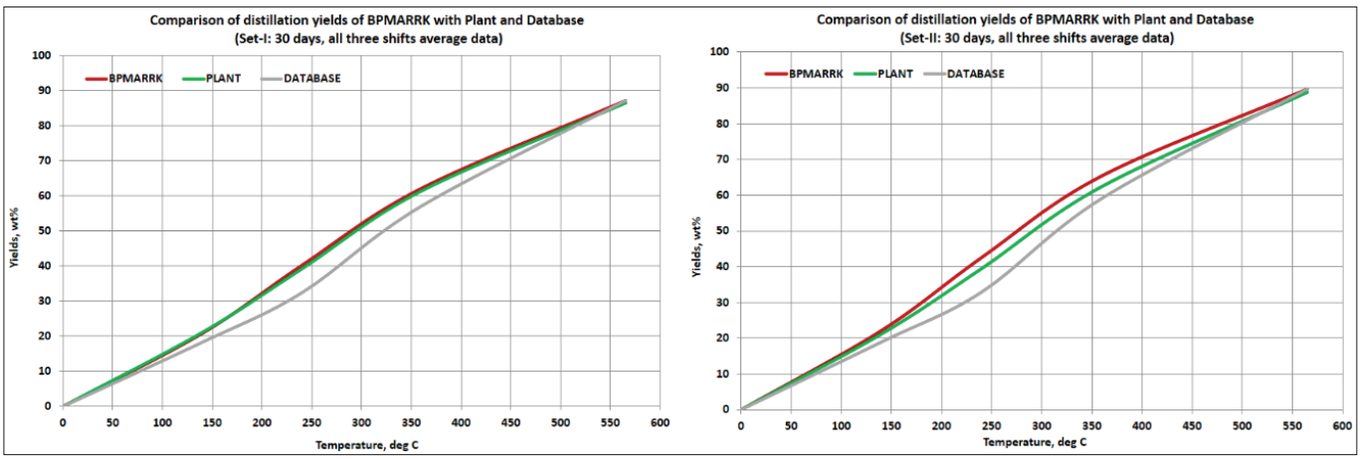

Figure 3: Comparison of distillation yields of BPMARRK, Actual Plant & Database

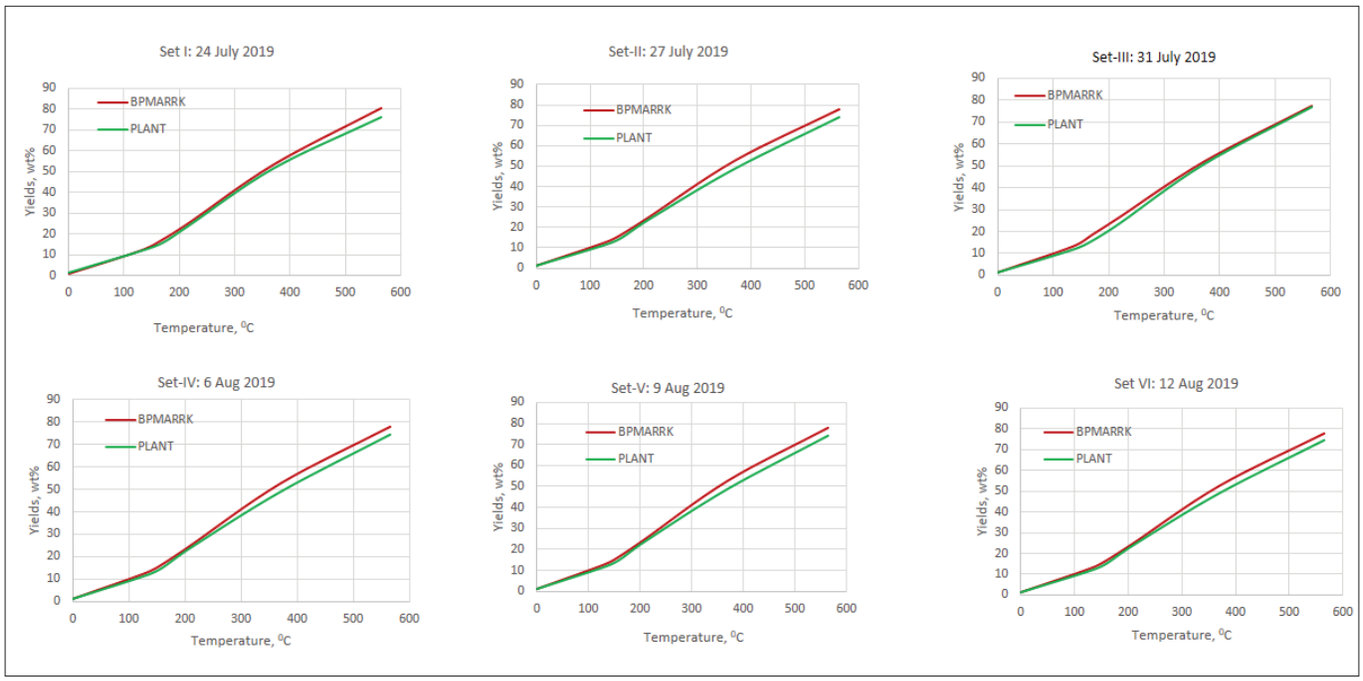

Figure 4: Comparison of distillation data of BPMARRK® and Actual Plant for one of the BPCL Refineries (CDU III)

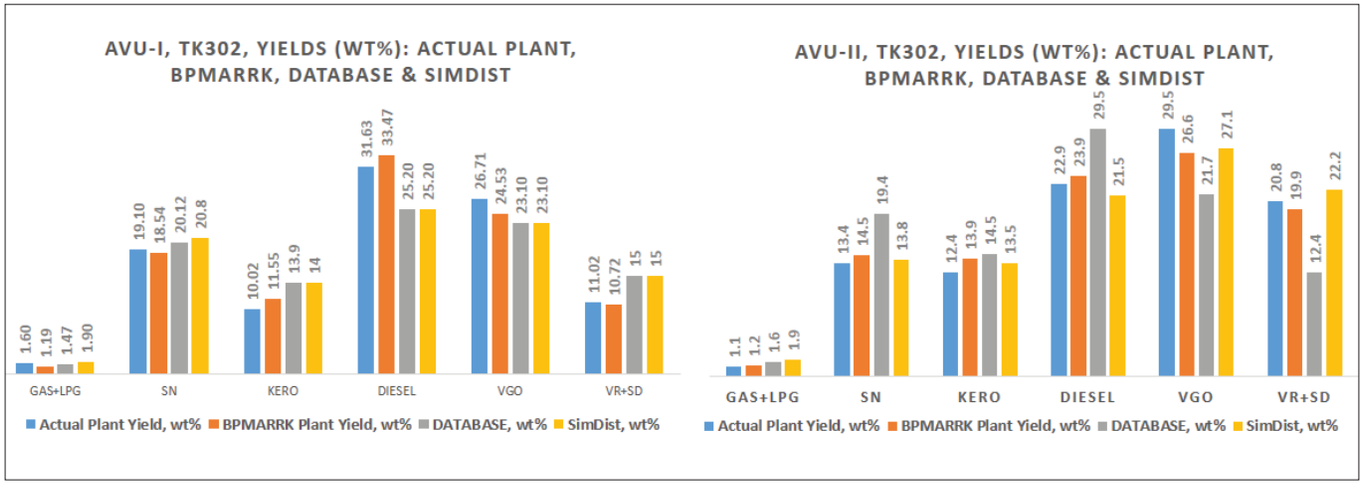

Figure 5: . Comparison of distillation data of BPMARRK®, Actual Plant, DATABASE & SimDist for one of the Indian Refineries (AVU-I & II)

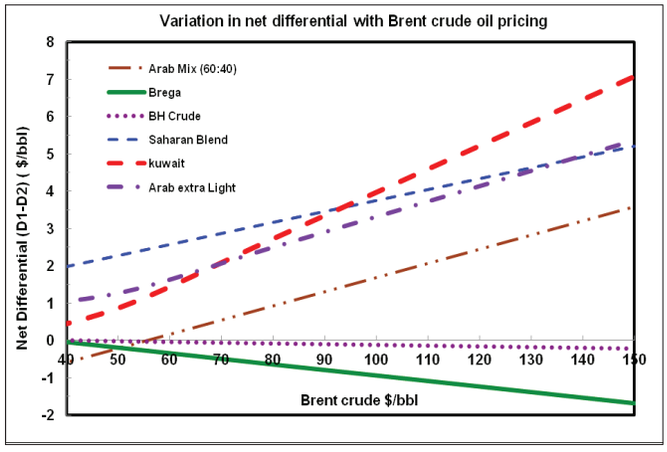

Figure 6 : Ranking of crude oils

operational decisions related to crude oils and enables Oil Suppliers, International Trades and Supply Chain Optimization for advanced planning, selection of crude oil and Process Engineers for real-time monitoring and unit-level optimization of refinery operations. Indeed BPMARRK® is significantly contributing to reduce human efforts for detailed crude oil characterization at laboratory by saving time. The accuracy of BPMARRK® output is acceptable to the Industry.

Awards/Accolades

BPMARRK® received several recognition at National/International forums viz. (i) Special Commendation Award for "Innovator of the Year – Team", by Petroleum Federation of India (now FIPI) in the year 2014, (ii) Innovation Award 2015/16 - Best Innovation in R&D instituted by Ministry of Petroleum & Natural Gas (MOP&G) and (iii) Jury's Special Mention Award

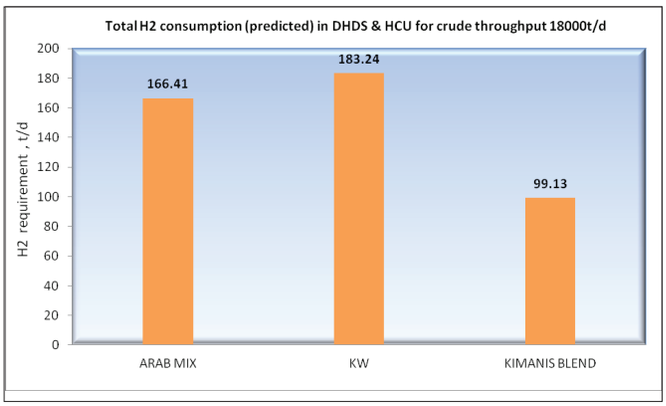

Figure 7: Prediction of hydrogen consumption in hydroprocessing

in 'Digital Modeling' category in Frost & Sullivan's Project Evaluation and Recognition Program 2018.

Acknowledgement

The authors express their sincere thanks to BPCL management for constant support in validation of the model at refineries and interest in commercialization. And many thanks to Refinery colleagues (Syed Imran Ahmed R & Mr. Rajan VR) for implementation of the work. ●

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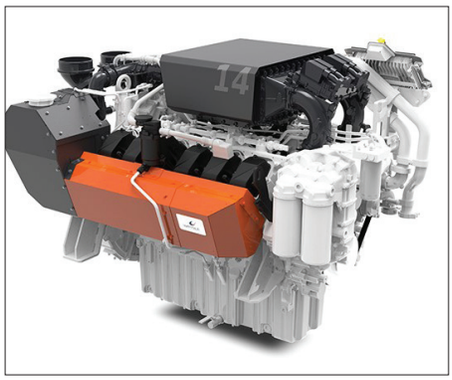
Wärtsilä broadens its Smart Marine portfolio with addition of Wärtsilä 14



Mumbai, India: The technology group Wärtsilä, a global leader in maritime markets, haslaunched its first Wärtsilä-branded high-speed engine, Wärtsilä 14, at the Wärtsilä Annual Technical Seminar in Mumbai held on 13th September 2019.

The Wärtsilä 14 is a high-speed, compact engine designed to fit requirements for limited space and weight. The engine is designed to lower capital expense, meet current and future global emissions regulations, and provide customers with improved efficiency, safety, and environmental sustainability.

The small but mighty Wärtsilä 14 is available in 12- and 16-cylinder configurations, delivering a power output of 755-1340 kW in mechanical propulsion, and 675-1155 kW in auxiliary and diesel-electric configurations. This latest genset offering is ideal for vessels, owners and operators, where power to weight ratio, fuel-type, efficiency, safety and environmental compliance are key considerations. Examples of such operating profiles include tugs, fishing vessels, offshore service vessels, small ferries and the merchant auxiliary market, to name a few.

The Wärtsilä 14 fosters Wärtsilä's Smart Marine vision as the company continues to offer customers increasingly wider options for meeting specific operational needs. It has been developed in close cooperation with Liebherr, one of the largest construction machine manufacturers in the world and a leading technology provider for a number of other industry verticals.

"This Wärtsilä high-speed engine heralds a new era of efficient and environmentally sustainable technology in India and across the globe. The unveiling of Wärtsilä 14 has reinforced the brand's position as a global leader in integrated technologies and hybrid solutions," said, Mr. Petteri Saares, Director, Middle East, India, SEA & Australia, Marine Business, Wärtsilä.

ExxonMobil, IOCL Ink Natural Gas Pact

New Delhi, India: Energy giant ExxonMobil has signed a preliminary agreement with Indian Oil Corporation to explore new models of delivering cost-effective natural gas.

"What really matters is how we accelerate India's access to affordable, cleaner energy," said Bill Davis, Lead Country Manager, South Asia, ExxonMobil.

This initiative focuses on exploring new models of delivering cost-effective natural gas in India where it is most needed to complement traditional pipelines," the company said in a statement.

Indian Oil is the second-biggest gas marketer in the country. It operates an LNG terminal at Ennore on the east coast.

India to Get USD 58 bn Investment in Upstream Sector: OilMin

New Delhi, India: India is expected to receive an estimated USD 58 billion of investment in the upstream sector by 2023, said Dharmendra Pradhan, Union Oil Minister, Govt of India. Speaking at an industry conference, the minister also highlighted the need to bring petroleum products, starting with gas and jet fuel, under GST, and asserted that no single form of energy can meet the growing demand in the country.

Pradhan was upbeat about fresh investments flowing into India's energy sector. His optimism was shared by finance minister Nirmala Sitharaman who said that India is becoming an attractive destination for foreign investors.

The oil minister said recent exploration blocks and oilfields would bring new investment. "We have successfully completed three bid rounds under Open Acreage Licensing Policy and two rounds of bidding under the Discovered Small Fields (DSF) policy," Pradhan said. "Through these successful biddings, India is expected to garner an estimated investment of USD 58 billion in E&P sector by 2023."

The Modi government has brought in several policy reforms, including single licence for all forms of hydrocarbons, gas price freedom in new fields and a revenue-sharing regime, to attract investment in the sector. India needs to heavily invest in exploration and production as its dependence on imported oil has been sharply growing following a steady decline in domestic output for years. India now depends for 85 per cent of its oil needs on imports.

Mundra LNG Terminal to be Commissioned by Dec'19

New Delhi, India: Gujarat government-backed LNG project at Mundra, built at an estimated cost of ₹ 5,500 crore, may finally get commissioned by December, according to sources.

The terminal was mechanically completed in mid-2018 and was inaugurated by Prime Minister Narendra Modi. However, the commissioning has been stalled due to delay in finalisation of certain lease and sub-commission agreements between the promoters and the Gujarat government.

A commissioning cargo from the US had arrived at Mundra LNG terminal last November, but it had to be diverted to Hazira after it was not allowed to discharge at Mundra, sources said.

GSPC and other state sector entities hold 50 per cent equity in GSPC LNG - the company that built the terminal. Adani Group holds 25 per cent in the firm, while the balance has been earmarked for strategic investors/ fuel supplier/financial institutions/public. Mundra will be the third import terminal in Gujarat to import super-cooled natural gas (liquefied natural gas) in cryogenic ships and then re-converting the liquid fuel into its gaseous state before transporting it by pipelines to customers.

India to Invest USD 60 bn in Developing Gas Supply, Distribution: OilMin

New Delhi, India: India is investing over USD 60 billion in developing natural supply and distribution infrastructure as it chases the target of more than doubling the share of natural gas in its energy base to 15 per cent by 2030, , Union Oil Minister, Govt of India.

Natural gas currently constitutes 6.2 per cent of all energy consumption in the country. Stating that the government has laid emphasis on developing a gas-based economy, he said natural gas is gradually becoming a bridging fuel for low carbon economy in India. The government is giving special impetus to develop gas infrastructure across the length and breadth of the country connecting north to south and east to west parts of India, he said.

"I am happy to inform you that as we speak, an estimated investment of 60 billion US dollars is underway in building gas pipeline and terminal infrastructure that are nearing or in advanced stages of completion," he said in his opening remarks at the third International Think Tank Meeting (ITT) here.

City gas distribution network will soon cover 70 per cent of India's population, he said. "Our government is exploring strategic partnerships for overall development of oil & gas sector. The role of private sector - both domestic and from abroad, for bringing in investments with necessary innovations for future energy landscape in the country, will remain crucial".

"These developments have an enormous impact on India's energy security and also on our economic, budgetary and investment dimensions," he said, adding India's import dependency on crude oil and LNG continues to rise unabated. Import dependence is now over 84 per cent for crude and 45 percent for natural gas.

TechnipFMC, JGC and Fluor Consortium Awarded LNG Project in Mozambique

Mumbai, India: TechnipFMC has announced that JFT – a consortium between JGC Corporation (JGC), Fluor Corporation (Fluor) and TechnipFMC has been awarded an Engineering, Procurement and Construction (EPC) contract by Mozambique Rovuma Venture SPA (MRV) for the Rovuma LNG onshore liquefied natural gas (LNG) production complex project located in Cabo Delgado, Mozambique.

MRV, a joint-venture composed of Eni, ExxonMobil and CNPC, holds a 70 per cent interest in the exploration and production concession of Area 4, with Galp, Kogas and Empresa Nacional de Hidrocarbonetos (ENH) each holding a 10 per cent interest. The Rovuma LNG Project will produce, liquefy and market natural gas from three reservoirs of the Mamba complex located in the Area 4 block in the Offshore Rovuma Basin. It includes the construction of two natural gas liquefaction trains, with a total LNG nameplate capacity of 15.2 Mtpa(1), as well as associated onshore facilities.

Nello Uccelletti, President Onshore/Offshore at TechnipFMC, commented: "We are extremely honored to have been awarded by MRV this new prestigious LNG project along with our long-time partners, JGC and Fluor. This award confirms the market recognition of TechnipFMC's expertise and track record in gas monetization and, in particular, in the LNG industry. It also reinforces the Company's positioning in the energy transition journey. TechnipFMC is a strong player in Mozambique, a strategic country for the Company, and already present through key LNG and Subsea on-going projects. We are proud to serve our customer for the Rovuma project and will continue to accompany the industrial growth of the country, leveraging its resources and human capital."

Total to acquire Stake in Adani Gas

New Delhi, India: French energy giant Total will buy 37.4 per cent stake in Adani Gas, marking another big-ticket entry of a global major in India's energy market after Shell and BP which are already in India, and Reliance Industries Ltd's talks for a possible sale of 20 per cent of its core oil-to-chemicals division to Saudi Aramco. Total will acquire the stake with an open offer to buy up to 25.2 per cent. The French oil & gas firm will top up its stake in Adani Gas to 37.4 per cent by buying the required number of shares from the promotors after the outcome of the open offer is known.

Adani operates networks in Ahmedabad, Vadodara, Faridabad, Palwal and Khurja, and has started operations in many cities including Prayagraj, Chandigarh, Ernakulam and Bulandshahar, apart from winning many new licences, which makes it attractive for firms like Total.

EIL to Soon Start Work at Mongolian Refinery Project

New Delhi, India: Decks have been cleared for state-owned Engineers India Ltd (EIL) to begin construction of a petrochemical refinery in Mongolia. EIL, a PSU under the Ministry of Petroleum and Natural Gas, is the project management consultant for the development of the oil refinery.

During the ongoing visit to Mongolia, Petroleum and Natural Gas Minister Dharmendra Pradhan is expected to finalise the roadmap to commence construction of the refinery, which is being touted as the largest project being undertaken by the government of India under its Lines of Credit programme. Sources said that after this visit, firm agreements are expected on work programmes for the refinery.

The petrochemical refinery - near Sainshand in southern Dornogovi province is to be built at an approximate cost of USD 1.25 billion. It is being developed under a line of credit of USD 1.236 billion extended by India during Prime Minister Narendra Modi's visit to Mongolia in 2015 and subsequently enhanced during the state visit of the President of Mongolia Khaltmaagiin Battulga to India in September.

The refinery is expected to be completed by 2022 and will help Mongolia to cut some of its dependence on Russian fuel. Though Mongolia is self-sufficient in oil and has its own oil fields, almost all of its crude oil is exported and all of its finished petrochemical products are imported. The refinery will reduce Mongolia's import dependence and will ensure energy security for the country.

The refinery is expected to have a capacity of 1.5 mmtpa (million metric tons per annum), with diesel and gasoline as the primary products and LPG (liquefied petroleum gas), fuel oil and jet fuel being produced as secondary products.

Sushil Chandra Mishra appointed as CMD of Oil India

New Delhi, India: Sushil Chandra Mishra has taken over the charge of Chairman and Managing Director (CMD) at Oil India Limited (OIL), India's second government-owned oil exploration company.

Mishra has taken over the charge of CMD from Utpal Bora, who had been the CMD of the company since 18 July 2016.

"Mishra with over 35 years' experience in upstream sector, has deep expertise in commercial matters and played a key role in framing and implementing procurement policies and procedures for inventory management, vendor development, framework agreement and its related strategies," the company said in a statement.

According to the company, Mishra, prior to his ascension was an Executive Director heading Oil India's Rajasthan project. Mishra during his stint as ED at Rajasthan oversaw the country's first and deepest Cyclic Steam Stimulation (CSS) process - a technology to produce heavy crude oil.

ONGC to Invest to Drill 656 Wells in Gujarat

New Delhi, India: Oil and Natural Gas Corporation (ONGC), the country's largest petroleum explorer, is planning to invest ₹ 4,254 crore to drill 656 wells in 52 Petroleum Mining Lease (PML) in the company's Ahmedabad asset in Gujarat.

"656 wells are planned to be drilled in various fields of Ahmedabad Asset from 2019-20 to 2025-26. The incremental Oil gain from the drilling of these development wells is 3.81 Million Tonne and incremental gas gain is 329.75 Million Standard Cubic Meter (MMSCM)," the company said in an application to the environment ministry. The asset is among the major onshore projects for ONGC and is spread over four revenue districts, covering Kheda, Ahmedabad, Gandhinagar and Mehsana. The company has 22 oil fields across the asset with proved in-place oil of over 559 MT, of which it has already produced around 59 MT of crude oil till April 2019.

The company has prepared a roadmap for its growth over the next two decade. It plans to double oil and gas production over the plan period with 4-5 per cent growth against the present growth rate of 2 percent, it said in the application.

Indian Oil to Set-up its Second R&D Centre in Faridabad

New Delhi, India: Indian Oil Corporation (IOC), the country's largest fuel retailer, is planning to open its second Research and Development (R&D) facility adjacent to an existing facility in Faridabad, Haryana, at a cost of ₹ 2,282 crore. The proposed facility - to be called IndianOil Technology Development and Deployment Centre -- will be spread across 59.32 acres of land in Industrial Model Town in Faridabad, the company said in an application to the environment ministry.

It will house facilities which will research on alternative & renewable energy, industrial bio-technology, nanotechnology, refining technology, petrochemicals, applied metallurgy, pipeline research, catalytic interventions for clean energy processes and carbon nanotube & batteries.

IOC's R&D vertical employs over 400 scientists and the completion of the second campus would take the strength to 1,000 scientists, according to an official spokesperson. The project is expected to be completed in 36 months from the date of receiving Environment Clearance (EC).

GAIL to add New Unit at its Uttar Pradesh's Petrochemical Complex

New Delhi, India: GAIL (India) Ltd, the state-owned natural gas transportation and distribution utility, is planning to spend ₹ 751 crore to add a new 60 Kilo Tonne Per Annum (KTPA) polypropylene unit at its Pata petrochemical complex in Uttar Pradesh.

The complex produces low and high density polyethylene from ethylene produced from the cracking of ethane and propane. In the process, the cracker also produces around 50 KTPA of polymer grade propylene which the company expects to use as a feed-stock for the proposed polypropylene unit.

"GAIL is planning to utilize this propylene to set up a 60 KTPA Polypropylene unit in the existing complex at Pata. The proposed facility will be set-up along with the existing facilities at Pata," the company said in an application seeking clearance from the environment ministry.

The integrated gas-based petrochemical complex at Pata has been operational since 1999. It recovers ethane-propane from natural gas coming from Hazira-Vijaipur-Jagdishpur pipeline and converts it into petrochemicals.

The polymer production capacity of the Pata petrochemical complex doubled to 810 KTA last financial year (2018-2019) from 410 KTA earlier, according to GAIL's latest annual report.

India Signs Pact with Bangladesh for LPG Import

New Delhi, India: India has signed three pacts with Bangladesh, including one for importing liquefied petroleum gas (LPG), with Prime Minister Narendra Modi saying the motto behind such initiatives is to ensure ease of living in both the countries and strengthening bilateral ties.

The pacts were signed after detailed talks between Modi and visiting Bangladesh Prime Minister Sheikh Hasina. The other two pacts relate to vocational training and setting up of a social facility in Bangladesh.

Addressing the media, along with Hasina after their talks and signing of the pacts, Modi said, "We have launched a dozen joint projects in a year by adding three projects today".

He noted that nine projects were launched earlier via video links.

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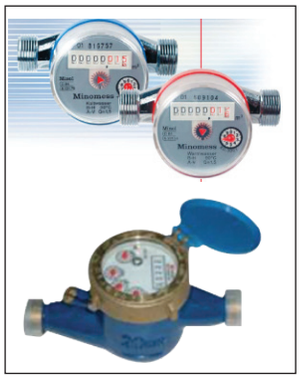
Taj Building, 3rd Floor, 210 D N Road, Fort, Mumbai 400 001
Tel: 91-022-40373636, Fax: 91-022-40373635
industrialmags@jasubhai.com

Residential Water Meter



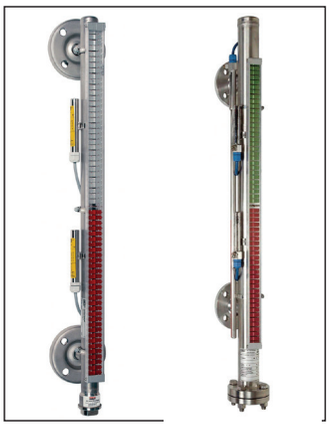
In India, every person use on an average 155 litres of water a day compared to 20 litres in developing countries.

Toshniwal provides a comprehensive residential meter portfolio to meet the world's water utility requirements. Toshniwal's Series continues to be in the water industry standards. Their quiet, rugged and reliable apartment and domestic water meters achieve ultra low flow measurement and meets or exceeds all standards.

The ISO standard assures you that they have achieved the highest possible standard for both manufacturing and customer service quality: meter with 8 number register allowing precise and easy reading in m^3 and litres; horizontal and vertical installation; rising and down pipes, meter head completely turnable; dry type, single jet impeller with magnetic drive; a perfect measuring technique for cold and warm water; high measuring accuracy and reliability; and approved in 16 countries.

For details contact:
Toshniwal Hyvac Pvt Ltd
267 Kilpauk Garden Road
Chennai 600 010
Tel: 044-26445626, 26448983
E-mail: sales@toshniwal.net

Visual Level Indicators



Visual level indicators combine up to three functions in one instrument: level indicator, level switch and level transmitter. The display can be read even over large distances and works without energy and this automatically results in the physical law of liquids in communicating vessels.

The visual level indicators are characterised by their compact design and has wide range of applications from a vacuum up to 500 bar. These applications are utilised for cryogenic liquid gases as well as in water hydraulics and steam boilers. It has flexibility through choice of suitable materials, energy-free automatic operation and accurate reading.

Visual level indicators offer the ideal solution for almost all operating conditions for applications in the area of chemical and pharmaceutical industries, ship building and water management.

For details contact:
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Electro Magnetic Meter

The instrument works on the principle of Faraday's law of Electromagnetic Induction. A magnetic field is generated by the instrument in the flow tube. The fluid flowing through this magnetic field generates a voltage that is proportional to the flow velocity. This voltage is measured by the electronics and a corresponding output provided.

Universal power supply accepts any voltage from 90 to 265 V AC. Bi-directional flow measurement measures the flow in both forward and reverse directions. Built-in totaliser provides a separate totalized volume value for flow in each direction. Remote monitoring is easy monitoring of the process even in hard to reach places. Conforms to International Standards - designed to meet global requirements and available with international approvals.

It can be used to measure flow rate of all conductive liquids and in effluent treatment plants. It has PTFE lining option for corrosive liquid applications. Effective flow measurement of slurries owing to zero obstruction to flow.

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Qdos Metering Pump

Building on its highly successful Qdos Series of chemical metering pumps, Watson-Marlow Fluid Technology Group (WMFTG) offers a version for mobile and remote applications that can be powered by a 12-24 V DC power supply. The latest Qdos pump will aid any user requiring a precise, closely-controlled metering pump where mains power is not readily available or practical to use.

Qdos pumps boost productivity and cut chemical wastage via more accurate, linear and repeatable metering than conventional solenoid or stepper-driven diaphragm metering pumps. As a result, Qdos users can reduce chemical costs even when metering difficult fluids or when pressure, viscosity and solids content vary. This capability combines with peristaltic technology to ensure precise, continuous, smooth flow for optimal fluid mixing.

Suitable for both remote static and mobile battery-powered applications, typical uses of the new 12-24 V DC version include agricultural seed coating and crop irrigation, remote water treatment/sampling, potable water refining and on-truck pumping operations, to list just a few. For very remote applications, the pump is able to run from batteries that can be recharged via solar cells, other renewable energy sources or split charge relays. The product is reliable, self-contained and does not require any additional components. Ultimately, with the addition of this new variant into the existing WMFTG range, Qdos is now the first choice when it comes to accurate chemical metering in applications and locations where there is no practical access to grid electricity.

For details contact:

Watson-Marlow India Pvt Ltd

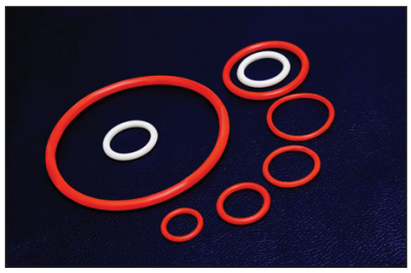
S No: 81/7, Opp: JSPM Institutes

Pune-Mumbai Bypass Road

Tathawade, Pune, Maharashtra 411 033

E-mail: info@wmftg.in

O-rings/FEP Encapsulated O-Rings (Silicone/Viton/EPDM/Neoprene/Nitrile)



APPL offers its wide range of O-rings from 1.0-mm ID to 600-mm ID from its 5,000 single piece moulds. APPL's O-rings are manufactured on a hydraulic press with tightly controlled temperature, pressure and time which ensures accurate dimensions, glossy finish and invisible flash line, properly post-cured and absolutely defect-free articles. These O-rings are also manufactured as per the dimensional tolerance specified by the customers and available from Nitrile, Neoprene, Silicone, EPDM, Hapalon, NBR, Viton and Butyl rubber or in any other rubber as per customer's specification. It is also available in Viton O-rings from 1-mm ID – 3,000-mm ID or in any sizes through step moulding process which gives jointless O-rings of dimensionally accurate, excellent workmanship and finish. APPL's Silicone, Viton and EPDM Encapsulated O-rings with FEP encapsulation are designed to address the growing problem of sealing in the most hostile chemical and temperature environments. It combines the best qualities of FEP material on the outside with its chemical inertness and an elastomer on the inside for resilience. This unique combination forms a highly effective, long lasting seal for the most demanding applications. These O-rings are comprised of FEP over Silicone, Viton or EPDM and can be used in temperatures from -75°F to +400°F (-60°C to +205°C) depending upon the choice of elastomer core.

There are certain applications which prohibit the use of conventional rubber O-ring seals. The use of hostile chemicals or extreme temperature (both high and low) during various processes can make effective sealing very difficult. The main advantage encapsulated O-rings have over solid PTFE is that it has the chemical inertness whilst with its energising core, the O-ring returns to its original form.

For details contact:

Ami Polymer Pvt Ltd

319 Mahesh Indl Estate, Opp: Silver Park

Mira-Bhayander Rd, Mira Road (E)

Thane, Maharashtra 401 104

Tel: 022-28555107, 28555631, 28555914

E-mail: mktg@amipolymer.com

Full Bore Cement Head

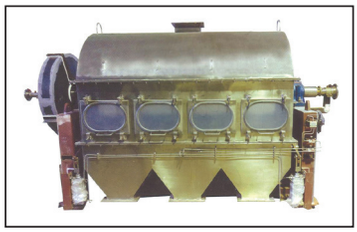
Halliburton Company offers the Commander Full Bore Cement Head, a product that enables rotation and reciprocation of 4½ - 6 inch production strings to help increase reliability and reduce risk during the well cementing process. Advanced wireless functionality and faster rig-up time help increase efficiency and improve safety for land-based cement jobs, particularly in unconventional formations.

The Commander Full Bore Cement Head can rotate pipe during a cement job to improve cement coverage, prevent channeling, reduce communication between frac stages and help maximize production. Wireless capability allows for less cost-prohibitive equipment on site, and helps eliminate the requirement for personnel to hoist, load, and manually deploy plugs on active rigs. The head prevents casing wiper plugs from being launched out of sequence and offers real-time verification that the plugs have launched successfully. This helps improve safety and efficiency while setting dependable cement barriers.

Over 100 jobs have been executed to date with the Commander Full Bore Cement Head, with average rig-up times as fast as 30 minutes and a reduction in time personnel spend in the red zone.

For details contact:
Halliburton Company
A-18, MIDC Estate
Cross Road B, Andheri (E)
Mumbai 400 093
Tel: 022-67809500
E-mail: info@solutions.halliburton.com

Flaker



Flakers which are also known as cooling drums are used for solidifying molten material. After processing on flakers, such materials can be obtained in the form of films or easily handled flakes which are suitable to further processing or packing into containers for transport. A great advantage of flaker is that they offer a continuous process.

The hot material is applied to the cooling drum by direct immersion into a trough, indirectly using doctor/applicator rolls, etc. The molten liquid is cooled after application on the cooling drum and after a partial revolution the cooled and solidified product is removed by a scraper in the form of flakes or film. The cooling drum of the flaker is specially designed to provide an even cooling effect by having uniform and effective internal distribution. As a result, both high output and homogeneity of the product are possible.

A variable speed drive arrangement enables adjustment of the drum speed for optimum performance. Material of construction of wetted/contact parts can be SS, carbon steel hard chrome-plated or special metals such as Monel, Inconel, Hastealloy, etc. Optional include hood, rear scraper, flake breaker, flake conveyor, etc. Hood can be of SS, aluminium, FRP, etc.

For details contact:
Tech-Mech Engineers
A-227, 16th A Road, Wagle Indl Estate
Thane, Maharashtra 400 604
Tel: 022-25828749
Telefax: 91-022-25827883
E-mail: info@techmecheng.com / techmecheng@gmail.com

Stirred Reactors

Parr offers a wide choice of design options to meet the user's individual installation or operating requirements. Stirred reactors have two different vessel mounting styles, fixed head design for users with multiple fed, vent and instrumentation need. The movable head design to users who wish to charge or recover reactants and products away from the operating area. Magnetically coupled stirrer drives are offered in high and low speed designs in four operating torque ranges. Heaters range from electric to circulatory jackets. Temperature controllers are available to fully integrate the process controller or as simple controls. Other available accessories for stirred reactors include internal cooling coils, bottom drain valves, condensers, custom stirrers, explosion-proof components, liquid gas filling and monitoring systems and many more.

For details contact:
Orbit Technologies Pvt Ltd
B-50 Indl Estate, Sanath Nagar
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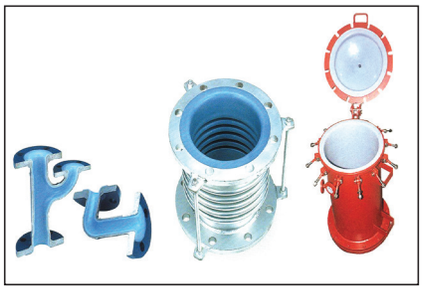
Tel: 040-67216354
Fax: 91-040-23801579
E-mail: orbit@orbitindia.com

Fluon ETFE Powder Coating & Lining



Fluon ETFE is a thermoplastic fluoropolymer, a copolymer of tetrafluoroethylene and ethylene, developed by Asahi Glass Co Ltd. Fluon ETFE is widely used in various industrial applications for its outstanding processability in addition to excellent chemical resistance and electrical properties associated with fluoropolymers generally, such as PTFE, PFA and FEP.

Various anti-corrosion equipment are made by Fluon ETFE powder by various moulding methods such as electrostatic powder coating, rotolining, fluid bed, etc. Seamless coating is easily available in each process.

Fluon ETFE is stable against most chemicals, including acids, alkalies and solvents, across a wide temperature and at various pressures. ETFE has the benefit of outstanding processability enabling various shapes and sizes, and thick coatings of over 1-mm to be achieved. The IL primer Series increase Fluon ETFE adhesive properties, thus increasing the potential applications of Fluon ETFE.

Powder grades of ETFE are electrostatically charged then sprayed on to the substrate and subsequently baked in an oven. Powder grades of ETFE are placed inside a double-axial rotating container and subjected to a heating and cooling cycle. Standalone tanks may also be coated using an appropriate release agent. The substrate is heated and dipped into a container of fluidized powder. FM Global provides an approval standard for fume exhaust ducts (Class 4922) regarding controlling the spread of a fire. Fluon ETFE has excellent inflammability and is widely adopted as the material of choice for FM duct material.

Fluon ETFE has excellent anti-stick properties and significantly reduced odour transfer index compared to other polymer materials.

For details contact:
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Fax: +81-3-3281-7856

Glass-lined Steel Tanks

GLS tanks are glass-lined steel tanks, also known as glass-fused-to-steel-tanks. The reason of fusing glass with steel is to enhance the properties of latter. Single steel is vulnerable to environmental conditions, hence the fusing is required. After fusing the steel with glass, the strength increases, the acceptable bracket of pH value for alkaline solutions widens and the resistance of abrasion inflates.

The tank panels are lined inside and outside with the glass enamel. The enamel is a solid, smooth and shiny cover of silicate. It is fused in a special furnace having a temperature range from 780 to 900°C. The steel rounded (cylinder) shell of the tank is built from two layer glass fused sheet coated on both the sides. The sheets are attached with special high grade bolts and sealed by constantly flexible sealants. The connecting material and shell accessories are equipped by the surface treatment. The glass fused tanks can be used to store fluid or loose material. The tanks are also a fundamental building element of environrnental technological facilities such as waste water treatment and biogas stations. Rostfrei follows EEA (Europenan Enamel Authority) quality standards. The spark test for each panel is conducted according to EN 14430:2004. For Mohs Hardness and Chemical Resistance, Rostfrei follows EN 15771 and EN ISO 28706 respectively.

For details contact:
Ketav Consultant
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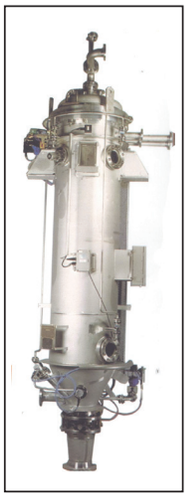
Tal: Dahegam, Dist: Gandhinagar
Gujarat 382 305
E-mail: ketavconsultant@rediffmail.com

Dry and Wet Discharge



The filtered solids are dewatered and discharged by as blow-back. As an alternative, the cake can be reslurried into another liquid.

This filter type allows continuous filtration without interruption of flow. The solids are flushed back into the liquid and discharged in slurry form. This filtration process mainly applies for processes where continuous flow is required.

This is a variant of the FUNDABAC design to comply with the high production standards of pharma and biotech industries. Surface finish and design of internals allow effective cleaning of all parts in contact with product.

For details contact:

DrM Filter Technology Pvt Ltd
Plot 46, 1 & 2, Village Pungam
Ankleshwar, Dist: Bharuch
Gujarat 393 020
Tel: 02646-652774
E-mail: info-in@drm.ch

Zero Liquid Discharge

Zero liquid discharge describes a process that completely eliminates liquid discharge from a system. The goal of any well-designed ZLD system is to minimise the volume of wastewater that requires treatment, process wastewater in an economically feasible manner, while also producing a clean stream suitable for reuse elsewhere in the facility. Interest in zero liquid discharge technology has grown in the industrial manufacturing sector over the past decade.

KEP is providing the turnkey solution for zero liquid discharge, which includes the process like primary treatment, secondary treatment, tertiary treatment and evaporator and dryers. Based on the effluent characteristics KEP will select the process of treatment to recycle 100 per cent water to process.

For details contact:

KEP Engg Services Pvt Ltd
6-A-52, Opp: Park, Nr Vedant International School
Apurupa Colony, Jeedimetla
Hyderabad, Telangana 500 055
Tel: 040-23096275
E-mail: info@kepengg.com

Multi-stage Centrifugal Blowers/Exhausters

With 22 models to choose from and the ability to specify a variety of manufacturing options, one can be assured that the blower or exhauster one order will deliver the performance one expects. In addition to the base models available, customers can choose from a variety of design options such as special coatings, alternative component materials, oil or grease lubrication, special seals, drive couplings and power sources. The Hoffman and Lamson blowers/exhausters one specifies is then manufactured according to ones unique application and requirements.

In water and wastewater treatment, air is provided to water and wastewater aeration systems and air scouring/filter back-washing. Hoffman and Lamson blowers can be specified for coarse/fine bubble diffuser systems, reactor batch supplemental air, digester gas boosters, grit channels and sludge digestion applications. In the industrial market, their blowers provide air or gas for sulphur recovery, combustion air, process gas boosting, coal mine venting, fluidised bed combustion systems, vapour and gas extraction, composting, sludge incineration and printing systems, to name a few.

Gardner Denver Engineered Vacuum Systems are used to pick up, convey and capture a myriad of materials ranging from aluminium granules to corn flakes.

For details contact:

Gardner Denver Engineered Products India Pvt Ltd
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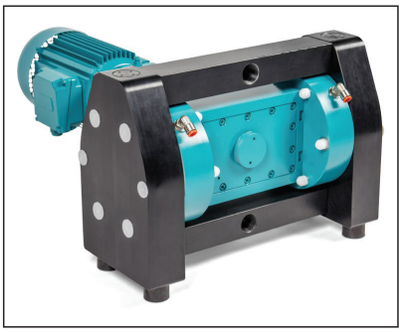
E-mail: info.pune@gardnerdenver.com

Motorised Double Diaphragm Pumps



The DELLMECO DME Series is an electro-mechanical double diaphragm pump, which is highly energy-efficient. Instead of running the double diaphragm pumps on compressed air or Ni gas which is the most expensive plant utility, DELLMECO offers energy-efficient electric geared motor as the driver for the double diaphragm pumps.

The pump technology is especially designed for universal applications which require low pressure - up to 6 bar. It is compact, special design does not require hydraulic fluid and where preventive maintenance is easy to carry out.

The DELLMECO DME unique design concept and low energy consumption enable us to combine high-tech with proven reliability and quality for the most demanding of customers.

DME Series pumps housing is machined from PE and PTFE conductive blocks and also in aluminium, cast iron, AISI 316 industrial and AISI 316 L hygienic combinations; temperatures are up to 120°C; capability to run dry, low shear and to handle fluid; smooth product transfer; low operating costs through highly efficient electric drive; withstands corrosive chemicals against constant flow rate against variable pressure and viscosity; fully enclosed long life diaphragms; abrasion resistance with robust design; capacity up to 650 l/min without variable frequency drive (VFD) flow control; optional VFD flow control for process performance (from 35 to 70 Hz); availability of wide range of optional accessories; and compact design means less space required compared to ecc screw and peristaltic pumps.

For details contact:
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Fax: 91-022-40365712
E-mail: info@shanbhags.com

Drum Pumps

Shanbhag & Associates is the authorised, national distributor for the entire range of Lutz products. Lutz Pumpen GmbH & Co KG, Germany is the premier manufacturer of electric and pneumatic drum/container pumps in the world.

The Lutz concept allows the complete pump (drive motor and pump tube) to be used in different containers and liquids as long as components in the pump tube are approved for use in the liquids. Lutz drum pumps can handle liquids which are aggressive, flammable, thin, viscous, hot or cold, hazardous to ground water and the environment, and vary with respect to their density. Liquids up to 100,000 cp can be unloaded from drums or IBCs.

The wide variety of liquids and container types/dimensions necessitates an extensive range of drum pump models. They are available in a variety of materials, equipped with electric/air motors adapted to the output requirements, for different voltages (AC/DC), explosion-proof for hazardous applications, pneumatically-operated, with the required delivery rate and a suitable sealing system. Added to this are pump tubes in varying lengths and wide range of accessories permitting, eg, adaptation to problematic containers or operating conditions. Pump tubes are available with centrifugal impeller or with eccentric screw principle constructions. Tube materials are in PP/PVDF/Alu/SS-316 (Ti) / Hast-C. Tube drivers are available in electric (FLP/Non-FLP) and pneumatic options. Drum pumps can be offered in sanitary and non-sanitary constructions including 3A Certified construction.

For details contact:
Shanbhag & Associates
B-50 Nandbhuvan Indl Estate
Mahakali Caves Road, Andheri (E)
Mumbai 400 093
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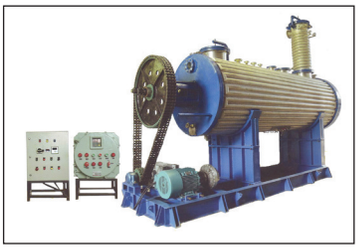
Fax: 91-022-40365712
E-mail: info@shanbhags.com

Rotary Vacuum Dryer



Rotary vacuum dryer offers clean, simple and effective method of drying filtered/centrifuged wet cakes, wet powders and slurries. Operating under vacuum, the dryer effectively dries heat sensitive materials to very low LOD levels. Solvents are condensed and recovered. Operation is batch and drying time depends on material being dried, amount of solvent or water to be removed, desired LOD level, permissible jacket temperature, etc.

Rotary vacuum dryer is a horizontal cylindrical jacketed shell with hollow agitator, rotating in close clearance. A batch operation, drying is done under vacuum, heating is through jacket. The dryer offers a simple but effective method of drying wet cakes and sometimes slurries. Due to vacuum and agitation, it is possible to dry heat sensitive materials.

For details contact:

Tech-Mech Engineers

A-227, 16th A Road, Wagle Indl Estate

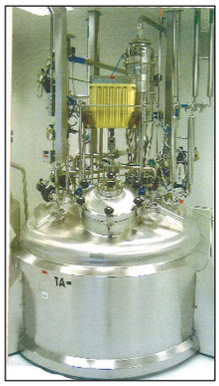
Thane, Maharashtra 400 604

Tel: 022-25828749

Telefax: 91-022-25827883

E-mail: info@techmecheng.com / techmecheng@gmail.com

Mixing Device without Rotation



The FUNDAMIX is a universal device for mixing liquids in open or closed vessels under vacuum or pressure, even in sterile conditions. FUNDAMIX can be operated continuously without overheating or amplitude variations.

The electro-magnetic drive operates at 50 to 60 cycles and transmits the vibration via the mixing device or mixer plate attached to a special clamp coupling into the medium. The amplitude resp mixing effect is controlled by a thyristor controller and adjusted by approximately 0 to 3 mm. The flow direction can be adapted to suit the medium and the required mixing effect.

Standard mixers are SS-316, but can be manufactured from a wide range of materials including Hastelloy, Titanium and various plastics.

For details contact:

DrM Filter Technology Pvt Ltd

Plot 46, 1 & 2, Village Pungam

Ankleshwar, Dist: Bharuch, Gujarat 393 020

Tel: 02646-652774

E-mail: info-in@drm.ch

Heating Cooling Systems for Multi-reactors

The user can get closed repeatable temperature control in a wide temperature range can achieve -120 to 300°C temperature control. Avoid replacement of traditional equipment and facilities and the maintenance of jacket the small fluid volume also ensure the rapid response of the control loop and the thermal reaction delay is small.

Built-in electric heating heat transfer oil auxiliary systems, which can automatically turn on the auxiliary heating system according to the demand to reduce the steam use pressure. It can achieve accurate energy saving by accurately matching the heat demand with fast operation.

Control the temperature of the whole reaction process through precise and fast calculation, and perform rapid response for the exothermic and endothermic reactions in the whole reaction process.

Reserve the standardised interface which can increase the heat source heat exchanged module according to actual needs.

Optionally controlling the reaction process temperature and single fluid heating temperature, and the temperature difference between the reaction process temperature and the thermal single fluid temperature is settable and controllable.

It can carry out recipe management and production process records.

For details contact:

ATR-ASAHI Process Systems (P) Ltd

668 GIDC, Makarpura, Vadodara

Gujarat 390 010

E-mail: prosys@atrasahi.com

Batch Controller

Fluidwell offers N413 batch controller with full numerical keypad and receipt printing functionality. This is very useful for situations where you need a locally printed ticket as evidence of the delivered quantity like tank and truck (un)loading applications.

End-of-batch tickets and reprints can easily be printed automatically or on demand. Even in the unexpected event of an uncompleted batch, it is possible to print a ticket.

The N413 is a versatile and powerful batch controller, with a printer output, 2 field replaceable, heavy duty relays and three configurable transistor outputs. Relay 1 is fixed as main batch control output. Relay 2 and the transistor outputs can be configured as pump control with time delays, 2-stage batch control, and alarm or pulse outputs. This makes the N413 a powerful and versatile batch or delivery controller. The combination of the user-friendly numerical keypad with the compact, clear display, make this N413 very attractive to the customers. The crystal clear LCD display, provides multiple batch control data simultaneously at a glance, including a graphical indication of the vessel, the batch process and the relay status. The bright back light is standard, ensuring perfect readings in all lighting conditions.

Fluidwell users all around the world appreciate the simple, intuitive menu structure of the various product series. It saves significant time and cost in installation and programming. It is really easy to start, stop, pause or terminate a batch or set a new preset value, especially with the numerical keypad. Those familiar with a Fluidwell product, can therefore also program and install the N413 without the use of a manual or hiring technical experts.

Key information at a glance as the display simultaneously shows actual value, preset value, batch process indication, switch point indication and measuring units. Fluidwell designs and manufactures a wide range of flow computers, indicators, totalizers, transmitters, monitors and controllers.

For details contact:
Toshniwal Hyvac Pvt Ltd
267 Kilpauk Garden Road
Chennai 600 010
E-mail: sales@toshniwal.net

Pumps for On-board Exhaust Gas Cleaning Systems

To curb global marine and air pollution, stricter limits on the sulphur-dioxide content of marine exhaust gases stipulated by the EU and IMO (International Maritime Organisation of the UN) will apply from 2020. From an engineering point of view, this can be achieved by using natural gas or fuels with a low sulphur content, and by cleaning the exhaust gases with a scrubber.

For such on-board exhaust gas cleaning systems KSB ITUR Spain SA, a company of the KSB Group located in Zarautz, has further developed its ILN Type Series of vertical in-line centrifugal pumps with closed impeller and mechanical seal. With their redesigned hydraulic system, the pumps meet the extremely tough requirements specified by the authorities regarding operating behaviour and efficiency. Up to the size 250 the back pull-out design allows the impeller to be dismantled without removing the piping and motor, which is of great importance given the restricted space on board. A self-venting wide mechanical seal chamber ensures durable sealing at the shaft passage. Replaceable casing wear rings in the pump casing and casing cover facilitate servicing if necessary. The water-tight rolling element bearings require neither re-lubrication nor maintenance. The casing materials are aluminium bronze and super duplex steels. The max flow rate of the (60-Hz) pump sets is 3,700 m^3/hr. The highest head is 160 m.

According to an estimate by the EGCSA (Exhaust Gas Cleaning Systems Association) only 1,000 vessels at sea are currently fitted with a scrubber or prepared for such an installation. This means about another 70,000 vessels worldwide will have to undertake measures ensuring compliance with the new exhaust gas standards by the start of 2020.

For details contact:
KSB Pumps Ltd
Mumbai-Pune Road
Pune, Maharashtra 411 018
Tel: 020-27101231
Fax: 91-020-27426000
E-mail: Yagnesh.Buch@ksb.com

Mechanical Vacuum Booster

The vacuum boosters are of state-of-the-art design with many unique features ensuring complete vacuum tightness and leak-proof construction. The boosters are provided with highly reliable sealing system consisting of piston ring type labyrinth seals along with rotary seal between the conveying and bearing chambers along with a neutral chamber. The drive-end shaft is provided with double acting rotary seal and is properly sealed with O-ring seals.

The lubrication on both ends is by splash oil and the drive arrangement is either direct coupled or V-belt depending on the model and the operating condition.

Standard and special models are available suiting specific application. The standard construction is out of high quality cast iron inoculated for vacuum duty. Optionally it can be out of SS, ductile iron with or with special coating of Nickel/Teflon, etc.

For details contact:

Swam Pneumatics Pvt Ltd

C-2, Sector-3, Gautam Budh Nagar
Noida, Uttar Pradesh 201 301
Tel: 0120-4696222
E-mail: sales@swamatics.com

Electrostatic Spray Dryer

PolarDry Electrostatic Spray Dryer utilizes electrostatic technology that lowers the evaporation temperature and helps in eliminating active ingredient loss, degradation and denaturalization. PolarDry feature all-in-one modular equipment design features, which means a small footprint reducing maintenance and installation costs. The product is also scalable from R&D to production.

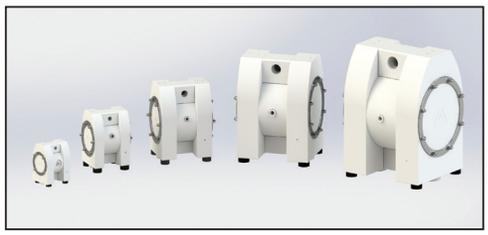
PolarDry system operates at low temperature, which allows for temperature efficiency and reduces heat degradation of molecules and other components. Recycled process gas with negligible emissions makes it environment-friendly and eliminates regulatory issues.

For details contact:

Spraying Systems (India) Pvt Ltd

Plot No: 303 & 304, 2nd Cross
5th Main, 4th Phase
Peenya Indl Area, Bengaluru
Karnataka 560 058
Tel: 080-39853200, 39853201
E-mail: ashwath@sprayindia.com / ssipl@sprayindia.com

AODD Pumps



Almatec, part of PSG, a Dover company, has extended its line of solid plastic C-Series air-operated double-diaphragm (AODD) pumps to include new C 40 (1-1/2") and C 50 (2") Models. Engineered to be a more cost-effective alternative to similar plastic pumps, Almatec C-Series pumps feature an industry-leading design that increases bolt torque to improve pump safety when compared to competitive pumps. What further separates the C-Series is the incorporation of Almatec's exclusive Perswing P air control system, which offers superior efficiency to optimize production rates and lower energy costs.

Ideally suited for the most difficult pumping applications, C-Series pumps ensure the suction and discharge ports are available as separate housing parts with different footprints. This feature allows the C-Series to be quickly and easily matched to existing installations. C-Series pumps do not have any mechanical seals, drives or rotating parts that cause wear over time, which improves reliability and extends product life. C-Series pumps feature self-priming and dry run capabilities, critical considerations for most pumping applications. The C-Series pump line now consists of five pump sizes – C 10 (3/8"), C 15 (1/2"), C 25 (1"), C 40 (1-1/2") and C 50 (2"). The wetted housing parts are made of either abrasion-resistant polyethylene or chemically-resistant PTFE. For applications in explosive atmospheres, C-Series pumps are available in versions that conform to ATEX requirements according to the 2014/34/EU directive.

For details contact:

Dover India Pvt Ltd – PSG

40 Poonamallee By-pass Sanneerkuppam
Chennai 600 056
Tel: 044-26271020, 25271023
E-mail: sales.psgindia@psgdover.com

ADIPEC 2019

Date: 11-14 November 2019
Venue: Abu Dhabi International Petroleum Exhibition & Conference, Abu Dhabi

Event: ADIPEC 2019, the largest Oil & Gas in Middle East, will bring together the global leaders of Energy, Power, Oil and Gas, Petroleum, Drilling, Offshore and Natural Gas, and Marine industries in a single platform to discuss and deliberate the current issues and trends in entire hydrcarob industry and the future opportunities laying in the industry. Since its inception in 1984, ADIPEC has provided an unrivalled platform for industry experts to come together and share knowledge and meet with peers.

The multi-disciplinary conference is intended for international and regional oil and gas professionals, who are involved in both the technical and non-technical functions within the industry.

For details, contact:
DMG Events
5th Floor, The Palladium,
Cluster C, Jumeirah Lakes Towers,
P.O. Box 33817
Dubai United Arab Emirates
Tel: +971 4 438 0355
Email: info@dmgevents.com

Oil & Gas World Expo 2020

Date: 4-6 March 2020
Venue: Bombay Exhibition Centre, Goregaon (East), Mumbai, India

Event: The 9th edition of Oil & Gas World Expo is scheduled from March 4-6, 2020 in Bombay Exhibition Centre, Goregaon (East), Mumbai, India. The Global Hydrocarbon show is aiming to connect, discuss and comprehend the views of leaders, policy makers, regulatory authorities, and service providers of the Indian and Global hydrocarbon industry. The 3-days Exhibition and dedicated conference will provide a platform to showcase innovative technologies and services, encompassing current and future trends in the entire value chain of hydrocarbon industry ranging from upstream to midstream and downstream.

Oil & Gas World Expo 2020 along with GASTech + Refining & Petrochemicals World Expo 2020 will provide a holistic platform to showcase latest trends in technologies, equipment & services to the right buyers from E&P, Natural Gas, LNG, CNG, CGD, Refining & Petrochemicals along with hydrocarbon infrastructure & services providing sectors.

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Fax: +91-22-40373535
Email: conference@jasubhai.com
http://chemtech-online.com/oil-gas-world-expo-2020/about-event

BioPharma World Expo 2019 (South)

Date: 4-6 December, 2019
Venue: HITEX Exhibition Centre, Hyderbad, India

Event: BioPharma World Expo 2019 is the best platform for both Indian and international manufacturers/service providers/ startups connected with pharma machinery, CRAMS, CROs/ CMOs, packaging, logistics, exports, APIs, generics, biotech, regulatory affairs, etc . It offers a unique opportunity to meet, network, and establish business partnerships. The concurrent conference tracks would highlight latest technological developments, market trends, investment opportunities, and challenges facing the industry. The technical sessions would cover pharmaceutical technology, biosimilars, green chemistry, compliance, etc.

For details, contact:
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Fort, Mumbai - 400 001
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Email: amrita_patil@jasubhai.com

OPES 2020

Date: 8-11 March 2020
Venue: Oman Convention & Exhibition Centre Muscat, Oman

Event: OGWA is a biennial international exhibition and conference that brings together local and international oil and gas companies from the GCC, technology and service providers, equipment suppliers, and other companies directly serving the industry's requirements.

It is a platform for discussing the latest developments and directions of the industry, as well as for trade and business opportunities among the local and international oil and gas companies. Launched in 1998, it has since been under the patronage of the Ministry of Oil & Gas and has consistently received the support of Petroleum Development Oman (PDO), Oman LNG, and many other leading oil and gas companies.

For details, contact:
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OmanExpo
P.O. Box: 20,PC:117 Wadi Kabir 1st Floor, SABCO Building, Wattayah, Muscat, Sultanate of Oman
Tel: +968 24660124 Fax: +968 24660125/126
Email: ebrahim.taher@omanexpo.com

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&

Society for Surface Protective Coatings India

Present

SURFACE ENGINEERING

PAINT & COATING FORUM South 2019

4th December 2019

HITEX Exhibition Center, Hyderabad, India

Theme: Surface Engineering – focus on industrial applications

Chemtech is organising one day conference on **"Surface Engineering"** to address challenges in the surface modification for some of the perennial problems in manufacturing, construction, chemical and pharma industries in Co-operation with "The Society of Surface Protective Coating, India" concurrently during **"CHEMTECH South World Expo 2019"** on **December 4, 2019** in HITEX Exhibition Centre, Hyderabad, Telangana.

Conference Highlights

- Knowledge Sharing with Technical experts on Functional Coatings, Smart Coatings, Sustainable Coatings & Green Coatings.
- Insights into futuristic trends viz. Role of Nano Technology in Advanced Paints and Special Coatings for Industrial applications.
- Network with 150+ delegates from array of buyer industries, stakeholders from value chain of paints & coatings manufacturing, surface engineering technology & services providers and application equipment & technology providers
- Engage with the Stalwarts from Chemicals, Paints & Coatings and Surface Engineering industries.

Session I : Green Coatings & Sustainability

Session II: Functional Coatings

Session III: Graphene and Nano Technology

For more information, Email: **sudhanshu_nagar@jasubhai.com**

Inaugural Session

Chief Guest

Mr. Raghavendra Rao (IAS)
Secretary, Department of Chemicals & Petrochemicals, Ministry of Chemicals & Fertilizers, Govt. of India

Guest of Honour

Mr. B Narayan*
Group President
Procurement & Projects
Reliance Industries Ltd

Keynote Address

Mr. Adnan Ahmad
Vice Chairman &
Managing Director, Clariant

Keynote Address

Dr. Shubh Gautam*
Managing Director
American Precoat Ltd.
California, USA

*** Invited**

Concurrent Events

ChemTECH SOUTH WORLD EXPO 2019 · Bio Pharma SOUTH WORLD EXPO 2019 · LAB ANALYTIX South World Expo 2019 · Industry AUTOMATION & Control South 2019 · PVF Pumps, Valves & Fittings SOUTH WORLD EXPO 2019 · WaterEX SOUTH WORLD EXPO 2019

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Oil&GAS World Expo 2020

Exploration | Production | Transportation | Refining | Gastech

4-6 March 2020

Venue: Bombay Exhibition Center, Goregaon (East), Mumbai, India

Concurrent Events

GASTech World Expo 2020 | Refining & Petro CHEMICALS 2020 | POWER World Expo 2020 | SMP WORLD EXPO 2020

Facts & Figures - Oil & Gas World Expo 2018

EXHIBITORS	VISITORS	SPEAKERS	DELEGATES	STUDENTS
150	6000	100	500	100

Guidance of Leaders

Chairman, Central Advisory Board, Oil & Gas World Expo 2020

Mr. Sanjay Kumar Moitra
Director (Onshore)
Oil and Natural Gas Corporation Ltd

Technical Chairman, Central Advisory Board, Oil & Gas World Expo 2020

Mr. P K Sharma
Director (Operations)
Oil India Limited

Chairman, Central Advisory Board, GASTech World Expo 2020

Mr. Rajeev Mathur
Executive Director (Corporate Affairs)
& OSD to CMD, GAIL Ltd

Chairman, Central Advisory Board, Refining & Petrochemicals World Expo 2020

Mr. Prasad K Panicker
Executive Director - Kochi Refinery
Bharat Petroleum Corporation Ltd

Chairman, Central Advisory Board, Power World Expo 2020

Mr A K Gupta
Director (Commercial)
NTPC Limited

Convener, Power World Expo 2020

Mr A K Jha
Former CMD
NTPC Limited

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