BHARATHIDASAN UNIVERSITY

Tiruchirappalli - 620 024
Tamil Nadu, India

Programme : 6 year Integrated M.Tech in Geological Technology and Geoinformatics

Course title : Petroleum Geology
Course code : MTIGT 0701

UNIT – V
Offshore drilling

D.Ramesh, Ph.D
Associate Professor, Dept. of Remote Sensing

Offshore drilling is a mechanical process where a bore hole is drilled below the seabed. It is typically carried out in order to explore and extract petroleum which lies beneath the seabed.

Most commonly, the term is used to describe drilling activities on the continental shelf/ continental slopes, though the term can also be applied to drilling in lakes, inland seas etc.

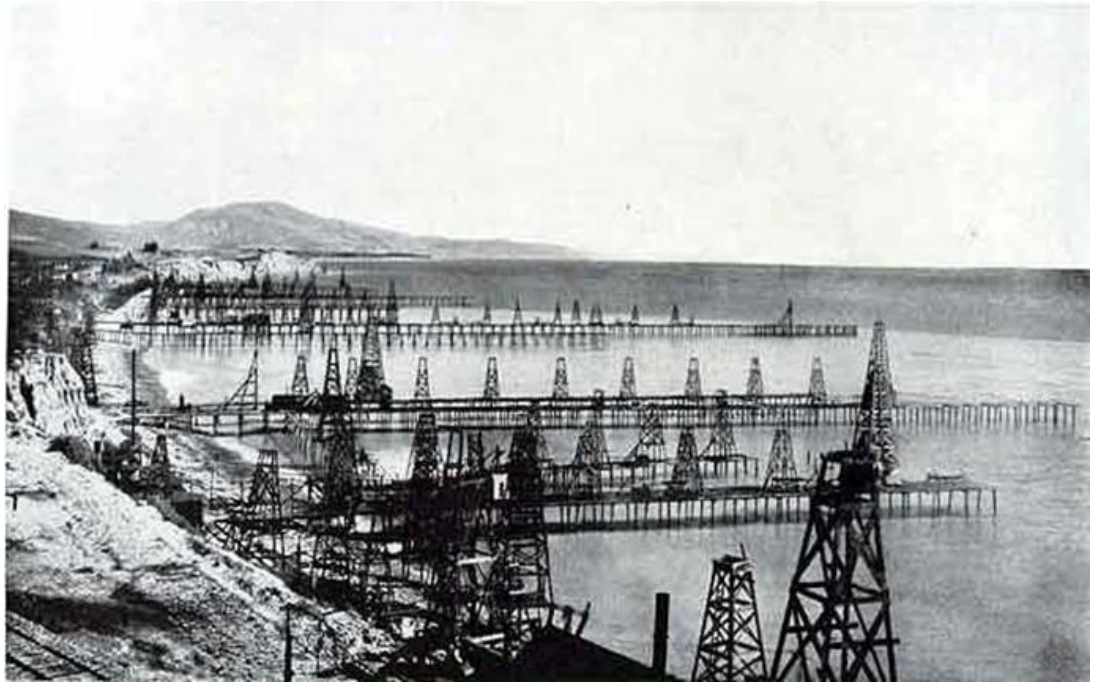
Offshore drilling presents environmental challenges, both offshore and onshore from the produced hydrocarbons and the materials used during the drilling operation.

There are many different types of facilities from which offshore drilling operations take place. These include bottom founded drilling rigs (jackup barges and swamp barges), combined drilling and production facilities either bottom founded or floating platforms, and deep-water mobile offshore drilling units (MODU) including semi-submersibles and drill ships.

These are capable of operating in water depths up to 3,000 m. In shallower waters the mobile units are anchored to the seabed, however in deeper water (more than 1,500 m) the semi-submersibles or Drill ships are maintained at the required drilling location using dynamic positioning

Around 1891, the first submerged oil wells were drilled from platforms built on piles in the fresh waters of the Grand Lake in Ohio, USA

Around 1896, the first submerged oil wells in salt water were drilled in the portion of the Summerland field extending under the Santa Barbara Channel in California. The wells were drilled from piers extending from land out into the channel.



One of the oldest subsea wells is the Bibi Eibat well, which came on production in 1923 in the present day Azerbaijan.

In the early 1930s, the Texas Co., (now Chevron) developed the first mobile steel barges for drilling in the Gulf of Mexico.

In 1937, Pure Oil (now Chevron) and its partner Superior Oil (now ExxonMobil) used a fixed platform to develop a oil field 1.6 km offshore of Louisiana in 4.3 m of water.

When offshore drilling moved into deeper waters of up to 30 m, fixed platform rigs were built, until demands for drilling equipment was needed in the 30 m to 120 m depth of the Gulf of Mexico, the first jack-up rigs began appearing from specialized offshore drilling.

The first semi-submersible resulted from an unexpected observation in 1961. Blue Water Drilling Company owned and operated the four-column submersible Blue Water Rig No.1 in the Gulf of Mexico for Shell Oil Company. As the pontoons were not sufficiently buoyant to support the weight of the rig and its consumables, it was towed between locations at a draught midway between the top of the pontoons and the underside of the deck. It was noticed that the motions at this draught were very small, and Blue Water Drilling and Shell jointly decided to try operating the rig in the floating mode.

The first purpose-built drilling semi-submersible Ocean Driller was launched in 1963. Since then, many semi-submersibles have been purpose-designed for the drilling industry mobile offshore fleet.

A Global Industry

Today, the offshore drilling activity is a multibillion-dollar industry capable of operating in water depths over 3 km. There are currently around 500 mobile and fixed offshore oil rigs worldwide.

The majority of the world's offshore rigs are located in the North Sea, Gulf of Mexico, Persian Gulf, Far East, Southeast Asia, Mexico, Western Africa, South Asia, Brazil, Venezuela and the Caspian Sea.

The installation of Deepwater wells can take years of planning and preparation.

After identifying potential reservoirs using seismic survey, a drill site is selected, and an exploratory well is installed.

Offshore oil rigs are equipped with a hoisting system to raise and lower the drill pipe, tools needed to drill the well, a Blow Out Preventer (BOP stack), and a pumping system used to circulate fluids in and out of the well while drilling.

The process of penetrating the sea floor and extracting oil and gas involves multiple steps in which cement, drilling mud, and engineering techniques.

Pros and Cons

Offshore drilling is a highly lucrative business, but it is also a highly dangerous activity with high environmental and health risks. Some of the worst environmental disasters the planet has ever seen were associated with offshore drilling.

On April 20, 2010, the Deepwater Horizon semi-submersible Mobile Offshore Drilling Unit (MODU) exploded and caused the largest marine oil spill of all time. The $560 million offshore drilling platform spilled over 130 million gallons of oil (3.19 million barrels) into the Gulf of Mexico over 87 days.

Exxon Valdez Oil Spill

10.8 million barrels of oil spilled off the shore of Alaska.

Offshore drilling is an important activity for many countries. It provides economic self-sufficiency, creates jobs, boosts the economy of oil-based products, and attracts investment funds.

However, offshore drilling accidents can destroy the marine life ecosystem in a matter of days.

It is also a significant source of several air pollutants, requires large kick-off investments, and has negative impacts on our health.

Shallow water drilling is the process of oil and gas exploration and production in less than 150 m of water.

Shallow water drilling differs from deep-water drilling in several key aspects. Shallow water rigs have legs that reach the bottom of the sea floor and have blowout preventers (BOPs) above the surface of the water that are accessible for inspection, maintenance and repair, and can be controlled either remotely or manually in case of an emergency. Shallow water wells primarily produce natural gas, and are drilled in known areas and mature reservoirs.

Following the Deepwater Horizon oil spill, the U.S Department of the Interior imposed a moratorium on all offshore drilling, both deep-water and shallow water. The ban on shallow water drilling was lifted in May 2010. However, new regulations imposed on shallow water drilling have slowed the issuance of permits for new shallow water wells.

Offshore drilling is an extraction technique which allows companies to access oil deposits under the ocean floor. Offshore drilling sites are typically situated over the continental shelf, although advancements in drilling technology have made platforms even further out to sea economically and physically feasible.

Types Of Mobile Offshore Drilling Units (MODU)

MODU or mobile offshore drilling unit is a term for floating drilling units such as semi-submersibles, jack-up rigs etc.

Offshore drilling and platform development has catered billions of tons of natural resources to the global markets over time. Subsea drilling and the related work are considered operationally challenging and financially taxing.

Locating the offshore oil and gas reservoirs and use of MODU

To decide on a site with a potential oil/gas, Geologists and engineers work their ways in and around the information collected off the areas with possible oil or gas reservoirs.

Survey vessels with Dynamic Positioning systems are hired for seismic surveys. These maritime vessels are equipped with sophisticated equipment, machinery and laboratories, which are able to scan the sea bed to understand the rock formations and find out the resources lying underneath.

Site acquiring

Once the site is identified and selected, boundaries are surveyed and earmarked by the local governing body for Energy and Resources. Studies for impact on the environment are carried out. After determining the potential energy sites, oil companies are then called for auctions on unleashed blocks and are asked to submit their bids for a particular block. Naturally, the highest to bid gets the right to drill.

Drilling techniques

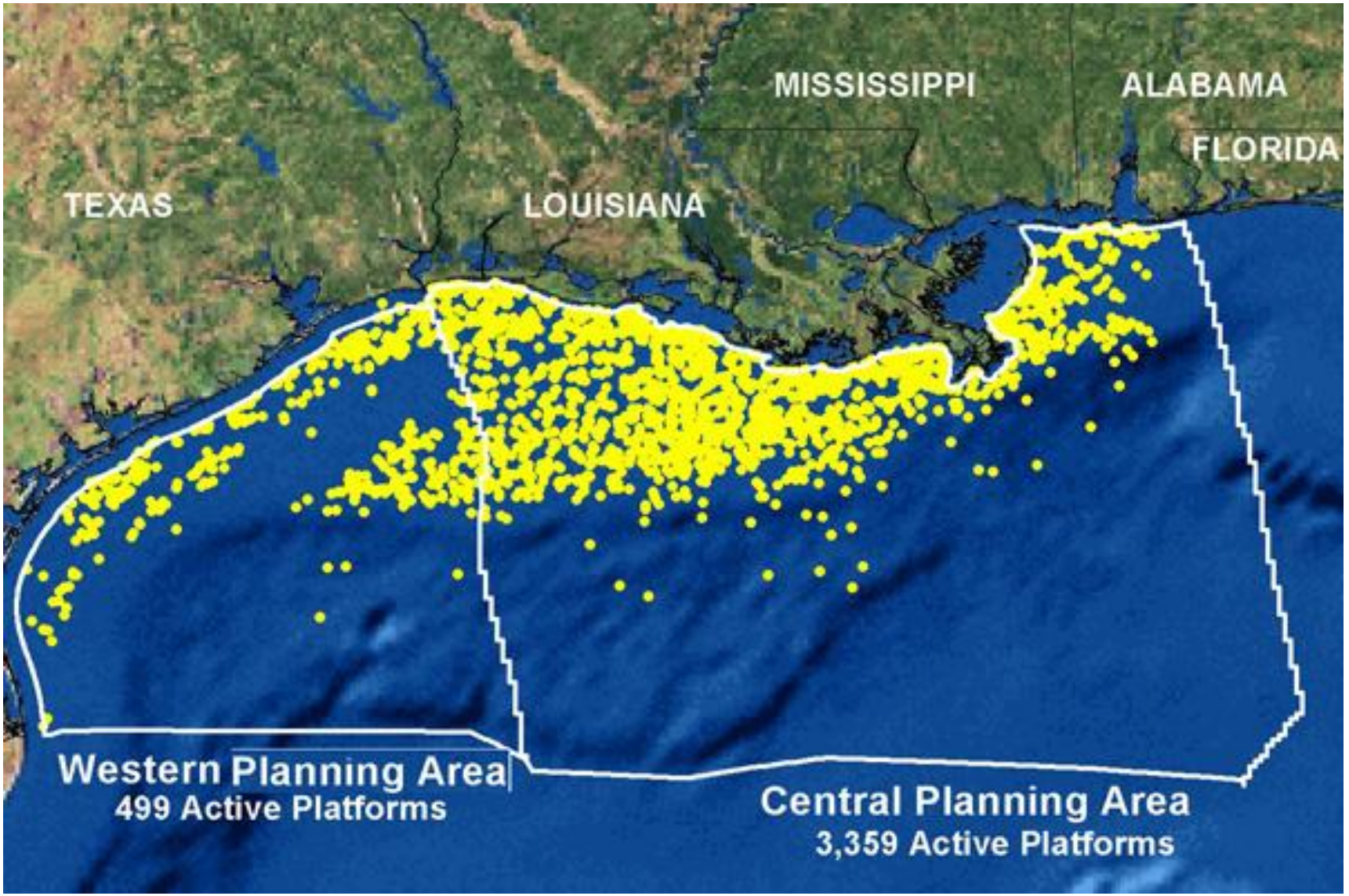
After the potential energy-rich blocks are legally cleared, oil companies pursue their investments by employing mobile drilling units that are temporarily acquired and are able to move on to other sites. Permanent structures such as Oil and Natural Gas Platforms are fitted if a location proves energy affluent.

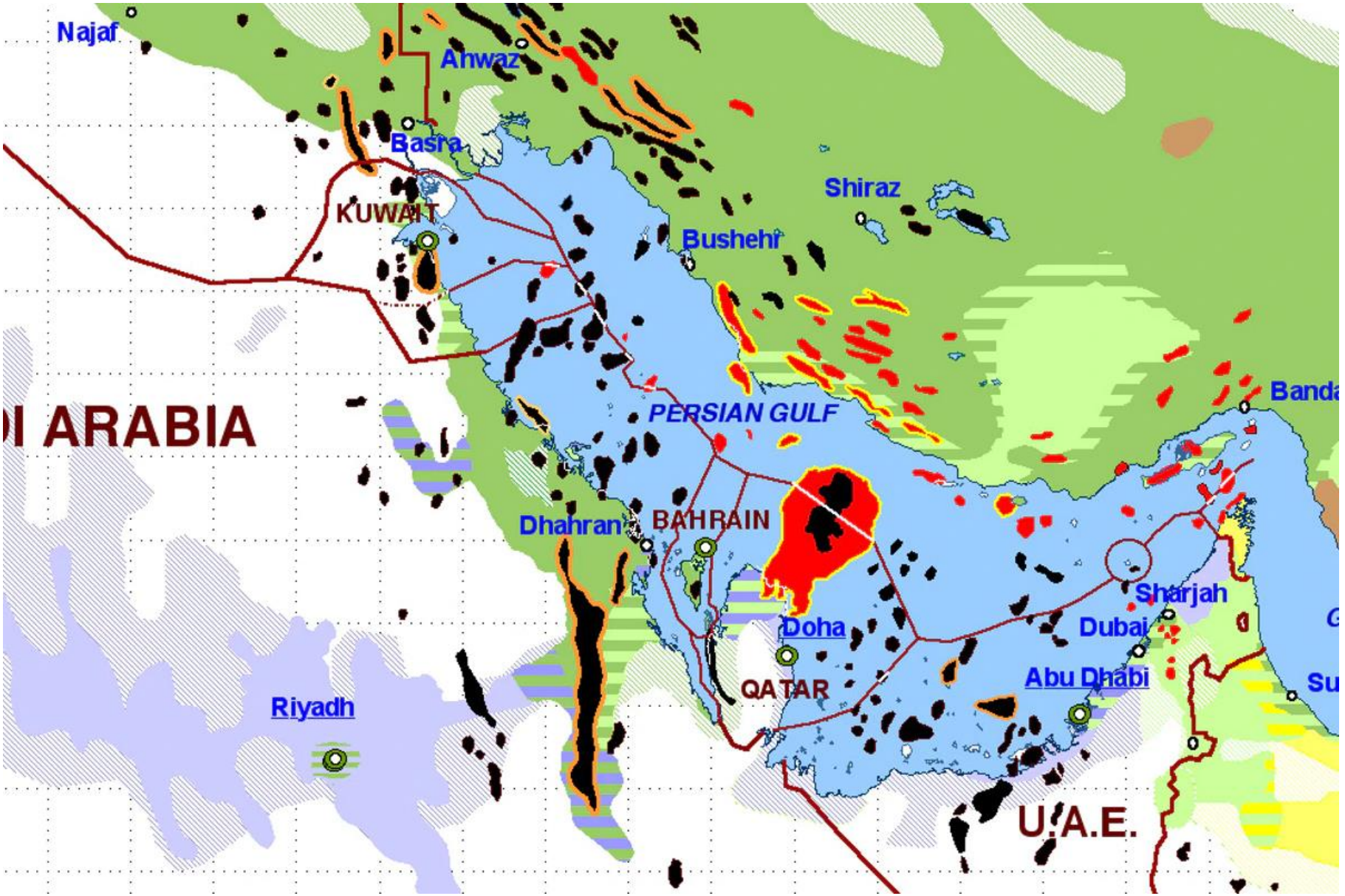
Types of Mobile Offshore Drilling Units Or MODU

*There are two main categories of offshore drilling units, **fixed** and mobile offshore drilling units (MODUs). MODUs are used for exploratory drilling as fixed rigs require a platform/structure and therefore are used for development or near field expansion and cannot be easily moved to new drilling locations. Mobile offshore drilling units (MODU) are classified into a number of structures, namely:*

Drilling barges

They are mostly utilized for shallow water drilling in calm water conditions. Drilling equipment is placed on to the barges' decks and towed to the site by tugs. Anchors hold the barges in the position where drilling is to be carried out.


MISSISSIPPI
ALABAMA
FLORIDA
TEXAS
LOUISIANA
Western Planning Area
499 Active Platforms
Central Planning Area
3,359 Active Platforms


Najaf
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Basra
KUWAIT
Shiraz
Bushehr
I ARABIA
PERSIAN GULF
Banda
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BAHRAIN
Sharjah
Doha
Dubai
QATAR
Abu Dhabi
Riyadh
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World's Five Largest Offshore Oil Fields

The three largest offshore oil fields are located in the Persian Gulf, off the coasts of Saudi Arabia and the United Arab Emirates.

Located about 165 miles north of Dharan, Saudi Arabia in the Persian Gulf, the Safaniya oil field contains an estimated total reserve of more than 50 billion barrels (36 billion of which are said to be recoverable). It is the world's largest offshore field.

Saudi Aramco, Saudi Arabia's state-owned oil and natural gas company, owns and operates the oil field, which was discovered in 1951 and has been producing oil since 1957. The field produces up to 1.5 million barrels of heavy crude oil per day.

The fourth and fifth largest offshore oil fields are Brazil's Santos Basin and the Kashagan oil field in the in the North Caspian Sea.

2- Upper Zakum Oil Field, Location: Persian Gulf

Owner: Abu Dhabi National Oil Company (60%), ExxonMobil (28%) and Japan Oil Development Company (12%), Recoverable Reserves: 21 billion barrels

The Upper Zakum Oil Field, the world's second largest offshore oil field, is located about 50 miles northwest of the United Arab Emirates (UAE) in the Persian Gulf. The current production capacity of the field is 500,000 barrels of crude a day.

3 – Manifa Oil Field, Location: Persian Gulf

Owner: Saudi Aramco, Recoverable Reserves: 13 billion barrels

The Manifa oil field sits slightly southeast of the Safaniya field in the Persian Gulf off the coast of Saudi Arabia. The field was discovered in 1957 and started production in 1964 with a daily capacity of 200,000 barrels.

4 – Kashagan Oil Field, Location: Caspian Sea

Owner: Kaz Munay Gas (16.81%), Eni (16.81%), ExxonMobil (16.81%), Shell (16.81%), Total TOT +0% (16.81%), ConocoPhillips (8.40%) and INPEX (7.56%), Recoverable Reserves: 9 billion barrels

The Kashagan oil field is located the North Caspian Sea, Kazakhstan. Containing more than 35 billion barrels of oil in total and an estimated recoverable oil reserve of 9 billion barrels, it is the world's largest offshore field outside the Middle East. It was discovered in 2000.

5 – Lula Oil Field, Location: Santos Basin, Brazil

Owner: Petrobras PBR +0% (65%), BG Group (25%), Galp Energia GLPEY +0% (10%), Recoverable Reserves: 6.5 billion barrels

The Lula field was discovered by Petrobras in 2007. Production from the first phase of pilot production project in the Lula field began in 2010. Production from the north-east area of Lula field started in 2011.


Kazakhstan
Uzbekistan

Subsea is a general term frequently used to refer to offshore underwater environment and the equipment, technologies, and methods employed in offshore oil and gas developments and production.

Why Subsea?

As easier onshore oil/gas discovery and production become less and less, the world demand for energy is ever greater due to increase in population and prosperity. The society as a whole has to look else where to extract hydrocarbon to meet the demand, places that are increasingly hostile and less accessible.

Subsea Under water oil field facilities are generically referred to using a subsea prefix, such as subsea well, subsea field, subsea project, and subsea development.

Subsea oil field developments are usually split into Shallow water and Deepwater categories to distinguish between the different facilities and approaches that are needed.

The term shallow water or shelf is used for shallow water depths where bottom-founded facilities like jackup drilling rigs and fixed offshore structures can be used, and where saturation diving is feasible.

Deepwater is a term often used to refer to offshore projects located in water depths greater than around 600 feet, where floating drilling vessels and floating oil platforms are used, and unmanned underwater vehicles are required as manned diving is not practical.

Subsea completions can be traced back to 1943 with the Lake Erie completion at a 35-ft water depth. The well had a land-type christmas tree that required diver intervention for installation, maintenance, and flow line connections.

Shell completed its first subsea well in the Gulf of Mexico in 1961.

The first known subsea ultra-high pressure waterjet system capable of operating below 5,000 ft was developed in 2010 by Jet Edge and Chukar Waterjet. It was used to blast away hydrates that were clogging a containment system at the Gulf oil spill site.

Systems

Subsea production systems can range in complexity from a single satellite well with a flowline linked to a fixed platform, FPSO or an onshore installation, to several wells on a template or clustered around a manifold, and transferring to a fixed or floating facility, or directly to an onshore installation.

Subsea production systems can be used to develop reservoirs, or parts of reservoirs, which require drilling of the wells from more than one location. Deep water conditions, or even ultra deep water conditions, can also inherently dictate development of a field by means of a subsea production system, since traditional surface facilities such as on a steel-piled jacket, might be either technically unfeasible or uneconomical due to the water depth.

The development of subsea oil and gas fields requires specialized equipment. The equipment must be reliable enough to safe guard the environment, and make the exploitation of the subsea hydrocarbons economically feasible. The deployment of such equipment requires specialized and expensive vessels, which need to be equipped with diving equipment for relatively shallow equipment work (i.e. a few hundred feet water depth maximum), and robotic equipment for deeper water depths. Any requirement to repair or intervene with installed subsea equipment is thus normally very expensive. This type of expense can result in economic failure of the subsea development.

Subsea technology in offshore oil and gas production is a highly specialized field of application with particular demands on engineering and simulation. Most of the new oil fields are located in deep-water and are generally referred to as deep-water systems.

Development of these fields sets strict requirements for verification of the various systems' functions and their compliance with current requirements and specifications. This is because of the high costs and time involved in changing a pre-existing system due to the specialized vessels with advanced onboard equipment. A full scale test (System Integration Test – SIT) does not provide satisfactory verification of deep water systems because the test, for practical reasons, cannot be performed under conditions identical to those under which the system will later operate.

The oil industry has therefore adopted modern data technology as a tool for virtual testing of deep-water systems that enables detection of costly faults at an early phase of the project. By using modern simulation tools models of deep-water systems can be set up and used to verify the system's functions, and dynamic properties, against various requirements specifications. This includes the model-based development of innovative high-tech plants and system solutions for the exploitation and production of energy resources in an environmentally friendly way as well as the analysis and evaluation of the dynamic behavior of components and systems used for the production and distribution of oil and gas. Another part is the real-time virtual test of systems for subsea production, subsea drilling, supply above sea level, seismography, subsea construction equipment and subsea process measurement and control equipment.