Introduction to Drilling Engineering

An Online Continuing Education Course for Engineers

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Introduction to Drilling Engineering

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Petroleum Engineers combine chemistry, physics and geology with engineering methods in the development, recovery and field processing of petroleum. They are concerned with finding deposits of oil and gas in quantities suitable for commercial use and with the economic extraction of these materials from the ground. The petroleum engineer will design methods for transporting oil and gas to suitable processing plants or to places where they will be used. The function of petroleum engineering is to provide a basis for the design and implementation of techniques to recover commercial quantities of natural petroleum. It is of necessity to broadly based technology drawing upon the foundations of engineering, geology, mathematics, physics, chemistry, economics and geo-statistics. As an engineering subject, it is a little anomalous in that design is based on observation of production performance and on a representation of the reservoir inferred from very limited sampling.

Petroleum engineers are divided into several groups:

- **Petroleum geologists find** hydrocarbons by analyzing subsurface structures with geological and geophysical methods.
- **Petrophysicists Analyze** log data after drilling to check the hydrocarbon availability and the rock types.
- **Reservoir engineers** work to optimize production of oil and gas via proper well placement, production levels, and enhanced oil recovery techniques.
- **Drilling engineers** manage the technical aspects of drilling exploratory, production and injection wells. It also includes mud engineer who manage the quality of drilling fluid.
- **Production engineers**, including subsurface engineers, manage the interface between the reservoir and the well, including perforations, sand control, downhole flow control, and downhole monitoring equipment; evaluate artificial lift methods; and also select surface equipment that separates the produced fluids (oil, gas, and water).

Teamwork is essential because the staggeringly complex nature of a subsurface operation means that the various disciplines have to integrate their specific areas of expertise for the venture to be successful. Some oil companies have separate geology and well engineering departments, although this rarely works in practice. Short lines of communication should exist

within a subsurface team such that an inclusive atmosphere of shared purpose is created. Any problems that arise can then be quickly recognized and solved by common directed action (Satteretal, 1994; Neate, 1996).

Drilling Engineer Functions and Contributions

A drilling engineer's main responsibility is to manage the drilling of a well to produce oil or gas as safely and efficiently as possible. Drilling Engineers are involved from the initial well planning and design, through well testing, completion, and finally abandonment. Designing and maintaining the equipment used for oil and gas extraction is another one of their responsibilities, as well as performing cost estimates and keeping track of drilling rates. Drilling engineers work in both the office and the field, which could be either onshore or offshore.

Drilling Engineers are typically involved in:

- estimating the value and accessibility cost of the reserve
- acquiring necessary property by lease
- conducting a geological survey
- designing a wellbore plan
- providing a layout of the type of equipment required to reach the depth of the well.

Drilling Engineers work in office and field environments including well sites, which can be on land, offshore or on mobile drilling units. They are employed either by the operating oil company, specialist drilling contractors or a service company.

Types of Drilling Engineers

- Completions Engineer
- Workover Engineer
- Well Abandonment Engineer
- Deepwater Drilling Engineer

Drilling is the process of making a hole or a well in the earth for some purpose. A drilling rig is a machine which creates holes in the ground. Drilling rigs can be massive structures housing equipment used to drill water wells, oil wells, or natural gas extraction wells, or they can be small enough to be moved manually by one person and are called augers. sample sub-surface mineral deposits, test rock, soil and groundwater physical properties, and also can be used to install sub-surface fabrications, such as underground utilities, instrumentation, tunnels or wells. Drilling rigs can be mobile equipment mounted on trucks, tracks or trailers, or more permanent land or marine-based structures (such as oil platforms, commonly called 'offshore oil rigs' even

if they don't contain a drilling rig). The term "rig" therefore generally refers to the complex of equipment that is used to penetrate the surface of the Earth's crust.

Drilling rigs can be:

Small to medium sized and mobile, such as those used in mineral exploration drilling, blast-hole, water wells, and environmental investigations. Large and capable of drilling through thousands of meters of the Earth's crust. Large "mud pumps" circulate drilling mud (slurry) through the drill bit and up the casing annulus, for cooling and removing the "cuttings" while a well is drilled. Hoists in the rig can lift hundreds of tons of pipe. Other equipment can force acid or sand into reservoirs to facilitate extraction of the oil or natural gas; and in remote locations there can be permanent living accommodation and catering for crews (which may be more than a hundred). Marine rigs may operate many hundreds of miles or kilometers distant from the supply base with infrequent crew rotation or cycle. The purpose could be:

- Oil and gas production
- Water production/injection
- Collecting earth samples
- Disposal of liquid wastes
- Disposal of gases such as CO2, H2S etc.

Drilling engineers design and implement procedures to drill wells as safely and economically as possible. They work closely with the drilling contractor, service contractors, and compliance personnel, as well as with geologists and other technical specialists. The drilling engineer has the responsibility for ensuring that costs are minimized while getting information to evaluate the formations penetrated, protecting the health and safety of workers and other personnel, and protecting the environment.

Well location can be on:

- Land
- Offshore
- Shallow water bays / Swamp
- Deep oceans

Rig Type:

The most commonly used rigs in the industry are Jack-ups, used to drill in shallow water, Semi-submersible, used to drill in deep water and land rigs, which are moved on trailers and spotted on concrete bases on land, we will also mention fixed platforms, which can have drilling facilities on board. The most expensive to run is the semi followed by the jack-up and finally the

land rig. This is all down to the size, equipment differences and also the difficulty with logistics to and from the rig. There are a few more types of rigs but these will get a mention in later articles. Each rig will have similar drilling equipment onboard but some will vary due to the nature of the rig.

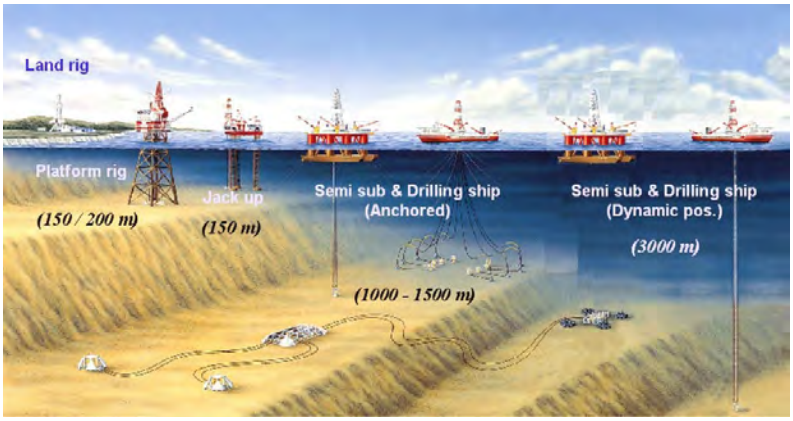

Figure 1: Types of Rigs

Land Rigs

Figure 2: Land Rig

This type of rigs come in a variety of sizes depending on the type of well you will be drilling. The rig breaks down into many parts so that it can be transported with trucks and trailers. First, a concrete base will be laid at the location of the well, and a pit will also be dug next to the location for the cuttings from the well to be temporarily dumped into. These rigs can be assembled very quickly usually within 3-7 days and can be transported in as little as 12 truckloads.

Jack-Ups

Figure 3: Jack-Ups Rig

These rigs are towed into location and then jack their 3 legs down until the legs reach the sea bed. Some larger rigs can have up to 5 legs. The rig will then raise itself out of the water to the deserved height. Jack-ups are good in water depths of up to 400 ft. (120 m) and can be found most commonly in the North Sea because of the seas shallow nature. Once settled the Jack-up rig has a static base in which to drill from. Occasionally rocks have to be placed around the legs to keep the platform from sinking or tilting into the seabed.

Semi-Submersible

Figure 4: Semi-Submersible Rig

These rigs sit on pontoons and float high above the water. The ballast tanks can be adjusted to raise or lower the rig and they can be moved under their own power or towed into place. Once in place the rig will deploy its six anchors and they will be tensioned accordingly to move the rig over the drilling location. Semi-Submersible rigs can be used in water depths from 200 ft. – 10,000 ft. (60 m – 3000 m). The main difference with drilling from a Semi is that the rig is not static and is constantly moving with the swell, therefore the drill pipe moves up and down with the swell.

Therefore, the rig is fitted with heave compensators which keep the drill pipe firmly at the bottom whilst drilling. When the rig moves upwards, the heave compensators push down the drill pipe and vice versa.

Fixed Drilling Platforms

Figure 5: Fixed Drilling Platforms

Fixed drilling platforms offer stability but not mobility. Today they're usually used to tap shallow, long term oil deposits. These platforms are permanently anchored directly to the seabed with the use of a steel structure known as a "jacket". This rises up from the seabed to support a surface deck which is above the ocean. The jacket provides the rig's sturdy base and holds everything else out of the water, while the drilling modules and crew quarters are located on the surface deck. They can drill to depths of about 1,500 feet below the surface, but are expensive to build, so they usually require a large oil discovery to justify their construction.

Drillship

Figure 6: Drillship rig

A drillship is a merchant vessel designed for use in exploratory offshore drilling of new oil and gas wells or for scientific drilling purposes. In most recent years the vessels are used in deepwater and ultra-deepwater applications, equipped with the latest and most advanced dynamic positioning systems. Drillships have the functional ability of semi-submersible drilling rigs and also have a few unique features that separate them from all others. First being the ship-shaped design. A drillship has greater mobility and can move quickly under its own propulsion from drill site to drill site in contrast to semi-

submersibles and jack up barges and platforms. Drillships have the ability to save time sailing between oilfields worldwide.

Equipment Use in Drilling Rig

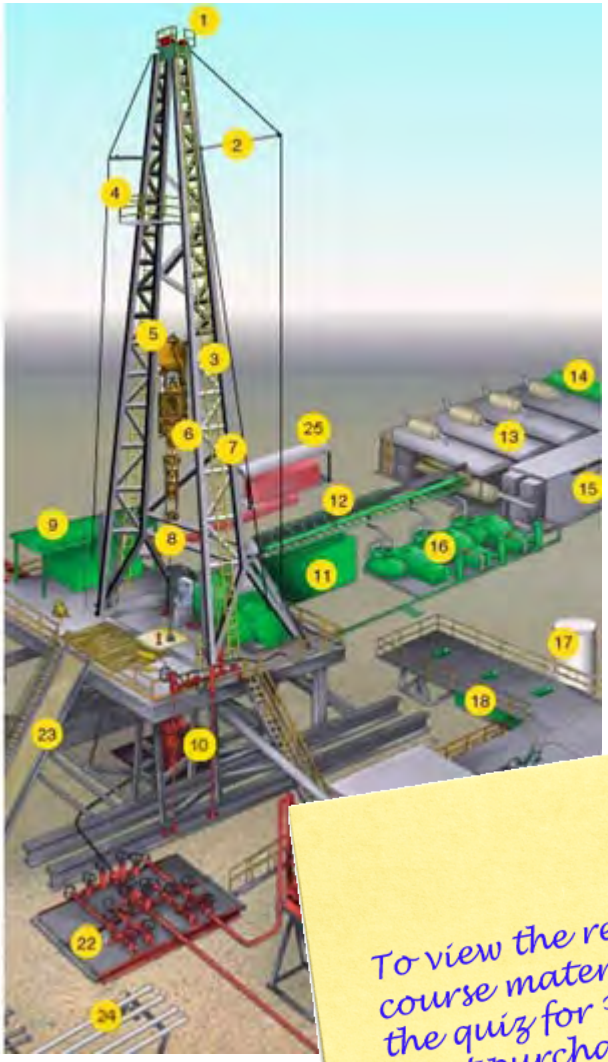

Figure 7: Drilling Rig Equipmer

1. ***Crown Block and V*** unted on beams at the top of the derri the hoisting drum.
2. ***Catline Boom and H*** top of the derrick for lifting material.
3. ***Drilling Line***: a wire wn block and traveling block (in ef mary purpose is to hoist or lower drill pipe or casing from o well. Also, a wire rope used to support the drilling tools.