



Figure RT-1: With the advent of steel rig construction, derricks were replaced by masts. A mast has fewer pieces to assemble and a smaller footprint than a derrick. Importantly, it remains open on one side, allowing traveling equipment to run freely up and down and has fewer pieces to assembly. IADC image.

Introduction

This chapter will explain the various types of drilling rigs used today. It will try to touch on the unique features of each rig type and their relative advantages and drawbacks. This chapter is not meant to be an exhaustive narrative on each rig type, but strives to provide the reader with an overview of each. The one overriding theme that holds true, regardless of rig type, is that the drilling industry has made big changes in the design and layouts of all rig types to improve safety for the people working on these rigs, safeguard the environment, and improve the efficiency to minimize the time it takes to construct the well.

Land rigs

As mechanization made the hunt for hydrocarbons more efficient, it had a direct effect on land rig design. The first land rigs were permanent wooden structures and would be left in place after the well was drilled. Many were just tall poles or simple V-frame structures. As well depth increased, drilling required stronger structures and rig construction from steel became the norm.

Fabricating rigs from steel meant that no longer would the



Figure RT-2: At top is a mast being raised by the bull lines and drawworks (Courtesy Nabors Industries Ltd.). The photo below shows the mast being raised by hydraulic cylinders (Courtesy Precision Drilling Oilfield Services Corp.).



structure be abandoned at the well site. Now, rigs could be moved from site to site, a major advantage. To enhance rig mobility, the original, bulky derrick was replaced with masts. A mast has fewer pieces to assemble and a smaller footprint than a derrick. Importantly, it remains open on one side, allowing traveling equipment to run freely up and down and has fewer pieces to assembly.

Once on location, masts can be raised either by bull lines and the drawworks or by using cylinders. Cylinder-raised masts feature 2-3 fully constructed sections that pin together before the hydraulic cylinders raise them or a two-section telescoping mast where the top section is telescoped up after raising.

Fit-for-purpose rigs

Drilling rigs often go where few people wish to venture, such as burning deserts and frozen tundra. Because few or no highways exist to transport rigs in deserts, industry designed fit-for-purpose rigs. To move these rigs across the



Figure RT-3a: Winterized Arctic rigs are often modular in design and capable of skidding from wellhead to wellhead. Courtesy Bentec.



Figure RT-3b: Desert drilling rigs were purpose built to traverse the roadless sands of this tough environment. Note the size of the tires relative to the people in the foreground. Courtesy Nabors Industries Ltd.



Video RT-1: Views of modern Arctic rig. Courtesy Bentec.

sands, the entire drilling structure is placed on wheels, many of which can reach 12 ft in height. The huge wheels allow the rig to be pulled to the next location by truck or tractor.

Industry has adapted the “standard” drilling rig for other specialized environments. For example, Arctic rigs are winterized, with heating and cooling systems for the rig floor, drillpipe and casing storage and other areas. Often modular for easier fabrication, Arctic rigs are often capable of skidding from wellhead to wellhead.

With current mechanization, wells on land can be drilled in as little as 14 days, and drilling speed is now a rig design factor. However, this rig complexity has increased the share of rig moving time, relative to total operating days. Drilling contractors today often seek designs that shorten rig-up times.

Walking rigs

Industry’s improved understanding of accessing tight-permeability formations, especially shale rock, has also impacted rig design. In today’s shale operations, many wellsites are configured for multi-well drilling. The entire rig mast and substructure walks or “skids” short distances to the next location. As a consequence, rigs require additional structural reinforcement, adding weight and increasing design com-



Figure RT-4: Trailer-mounted rig working on location. Courtesy Drillmec Drilling Technologies.



Figure RT-5: One of the latest trends is “walking” rigs, used in multi-well locations to access drill sites that might be 100 ft apart (left). Photo above shows a close up of a rig “foot”. Photo at left courtesy Entro Engineering. Photo above an IADC image.



Video RT-2: Example of walking rig. IADC video of Wisco Moran drilling rig.

plexity. However, the mud system does not move with the mast and substructure, as with desert rigs. Consequently, heavy and complex festoons and flowline systems are being added to allow the rig to “walk” 100 ft without rigging down.

The search for the land rig design that accommodates all the latest drilling equipment and can still move quickly from wellsite to wellsite continues. Today, the industry box-on-box substructures, telescopic substructures, as well as designs featuring cantilevered masts in which the mast and rig floor are elevated in a single step. (This was originally introduced as the “Dreco Slingshot”). Rigs are being built to handle single stands of drillpipe, as well as doubles and triples. Many of the smaller single style rigs being mounted on trailers for easy transport.

Offshore rigs

Explorers began finding and drilling for oil in the ocean early in the 20th Century. The earliest offshore wells were drilled by equipment that differed little from land rigs, except that

they were mounted at the end of piers protruding into the ocean. Platform rigs have come a long way since then, and other types of marine rigs evolved to meet varying water depths and other environmental demands offshore.

Platform rigs

As industry stepped out beyond the reach of land-based piers, platform rigs were installed on large steel “jackets”, the bottom-supported frames supporting the rig substructure, derrick and, often, fluid-processing equipment for produced oil or gas (**Figure RT-6**).

Platform drilling rigs themselves are essentially of the same type and construction as land based rigs, with BOPs on surface verses subsea, and special considerations to minimize weight that needed to be supported by the platform. Depending on the size and capacity of the particular platform, if it was not of sufficient size to support the complete drilling package, plus all of the equipment, materials, and liquids necessary for the drilling operation, the use of a tender vessel was often required. The tender vessel, be it a barge, semisubmersible or ship, would maintain station alongside the platform, and all of the necessary manpower, electrical power, mud pumping capacity, equipment and materials stored/located on the tender is transferred to the platform rig as required.

With the advent of extended-reach and horizontal drilling, enabled by steerable drilling technology, a significant number of wells (typically 8, 12, or 16) could be drilled from a single platform, maximizing oil recovery. Platform drilling rigs were deployed onto these large platforms.

Eventually, drilling operations proceeded in water far too deep to ever land a bottom-supported steel jacket. Indus-



Figure RT-6: Platform rig.



Figure RT-7: As industry stepped out into deeper water, platform rigs were installed on large steel “jackets”, the bottom-supported frames supporting the rig substructure, derrick and, often, fluid-processing equipment for produced oil or gas. This jacket was constructed for Shell’s Bullwinkle platform in the US Gulf of Mexico. The jacket was landed in 1988 in 1,360 ft of water, setting a world record for deepest water for a production platform.



Figure RT-8: The tension-leg platform can drill and produce in deepwater. The Olympus TLP sits above 3,000 ft of water in the US Gulf of Mexico. Courtesy Shell.



Figure RT-9: Example of tender-assist rig.

try adopted different approaches, the most popular design being the tension-leg platform. A TLP uses a floating platform, much like a semisubmersible, permanently moored to the sea floor. **Figure RT-8** shows Shell’s Olympus TLP, over the Mars field in about 3,000 ft of water in the US Gulf of Mexico.

Tender-assist platform rigs

Older versions of the tender-assist type platform rigs utilized a moored barge alongside the platform, with a ramp that led from the barge to the platform for dragging materials (tubulars) onto the drill floor. This ramp was also used for personnel transfer to and from the platform. However, traversing the ramp in rough weather could result in personnel injury.

On modern tender-assist vessels, the deployment of an articulated/telescoping walkway is used to safely transfer personnel between the platform and the tender vessel.

MODU types

Today’s MODUs fall primarily into four water-depth categories:

- Shallow water: Either sitting on bottom in water depths ranging from very shallow to 300-400 ft, or floating with a traditional mooring system in 400-1,000 ft;
- Mid-water: Primarily using a traditional mooring system attaching the hull/barge to the ocean floor with chain/wire/rope to maintain stationkeeping, in water depths ranging from 1,000-4,000 ft;
- Deepwater: Primarily using a dynamic position system to maintain the rig over the well center, with some specialized mooring systems in water depths from 4,000-7,500 ft;
- Ultra-deepwater: Exclusively dynamically positioned stationkeeping for water depths in excess of 7,500 ft. Current rig designs have a maximum water depth rating of 12,000 ft.



Figure RT-10: At left is a typical BOP for land operations (Courtesy Cameron). At right, a rendering of a subsea BOP stack. Courtesy Maersk Drilling.

The move to deepwater locations required placing the blow-out preventer (BOP) on the ocean floor. This “subsea” BOP stack initially used a conventional method for controlling the BOP functions from the MODU. In shallow water and mid-water depths, this is accomplished using a straight hydraulic system in which hydraulic fluid was pumped down the umbilical lines to the control pods located on the top of the BOP stack. The subsea stack comprises the same conventional hydraulic rams and annular bags, without the added component of the lower marine riser package (LMRP). The LMRP allows the driller to pull the control pods to the surface without removing the critical hydraulic rams from the wellhead on the ocean floor. (For a more complete discussion of LMRP, read the separate Floating Drilling Equipment and Operations Chapter of the IADC Drilling Manual, 12th edition, or the IADC Deepwater Well Control Guidelines.)

With the move to deepwater and ultra-deepwater depths, emergency hydraulic power is stored in subsea accumulators attached to the subsea BOP stack. Controls went from pure hydraulics to multiple electronic controls (“multiplex” or “MUX”) to account for the increased pressures in deepwater.

A riser pipe running from the top of the LMRP to the rig on

surface allows drilling fluids and wellbore cuttings to be returned to the surface for treatment and recirculation. This riser pipe is made from high-tensile steel, traditionally fabricated in 50-ft lengths. Wall thickness in the older riser systems ranged between $\frac{1}{2}$ - $\frac{5}{8}$ -in. wall thickness. More modern deepwater risers come in lengths of 75 ft or longer, with wall thicknesses of 1 in. or more. These changes were driven by the tremendous tensions required at the top, and the significant external pressures pushing in on the tube at deepwater depths. Typical top tensions pulled from the surface rig range from 3,000-4,000 kips to keep the riser straight and vertical in the water column. Buoyancy modules are also attached to the riser to decrease the weight in water of these massive tubes. Drilling in deepwater and high currents requires special considerations to eliminate vortex-induced vibrations (VIV), similar to the spiral cowlings found on the top of tall exhaust stacks on land.

Today’s modern drilling techniques require more capacity, higher flow rates, and better cleaning abilities for the latest drilling fluids. It is not unusual to have two separate mud systems on a modern deepwater rig, and even have the ability to connect a completions fluid system into the circulation system onboard. While two mud pumps have sufficed in the past, most modern deepwater rigs are outfitted with