TDS - Top Drive System, new drilling technology

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Nové vrtné technológie - vŕtanie hlbokých vrtov na vrtných súpravách bez rotačného stola

Je jasné, že počas posledných desiatich rokov sa hlbinné vŕtanie bez rotačného stola stalo dominantnou metódou na morských vrtných plošinách pri vŕtaní prieskumných a ťažobných sond na uhľovodíky.

Odkedy boli tieto jednotky vyvinuté rozšírili sa po celom svete. Väčšina týchto systémov bola inštalovaná na mori. Je však zaujímavé, že aj vrtný priemysel na pevnine sa v súčastnosti dostáva do štádia adaptácie tejto technológie.

Dnes je vrtné zariadenie bez rotačného stola vitálnou súčasťou vrtného procesu.

Ku klasickému vŕtaniu bez rotačného stola firmy Maritime Hydraulics bola vyvinutá prenosná verzia Portable Top Drive (PTD). Zariadenie je kompaktné, mobilné a prispôsobivé pri prenose z jednej vrtnej veže na druhú.

Cieľom tohoto článku je poskytnúť najnovšie poznatky o technológii Top Drive - vŕtania bez rotačného stola.

Key words: Top Drive System, Portable Top Drive, Drilling rig, Offshore, Onshore

Introduction

A historical review and general description of Top Drive System

In 1983 the development of the Derrick Drilling Machine (DDM) started, to replace the conventional way of rotating the drill string with a Kelly rotary table. The first model released in 1984, was the DDM 650 DC, an electrically DC driven top drive with 650 ton load rating, designed for offshore installations.

A further development lead to the introduction of the hydraulically driven top drive, the DDM 500/650 HY, released in 1987.

The demand for increased torque capacity resulted in developing a 2 - gear version of the DDM 500/650 EL and the DDM 650 HY Height torque, both released in 1989.

In 1993 the extreme 2 - motor DDM 650 EL „Frontier“ was introduced into the market, developing 2.100 Hp and 8.800 N.m torque output. The unofficial goal for one of our „Frontier“ customers is to drill a directional well of 12.000 m.

It is obvious that over the last decade the Top Drive way of drillings has become the predominant method of drilling offshore wells. At present we are also experiencing that the critical parts of onshore wells are drilled with Top Drive.

The Portable Top Drive System (PTD) was developed as an attempt to introduce Maritime Hydraulics into new markets worldwide, and so far it seems like we have succeeded. Maritime Hydraulics are now able to offer well proven technology to the Land rig and compact Offshore rig market at a reasonable cost.

A „Slim - hole“ version of the PTD is also developed to accommodate the need for „high - speed“ (600 r.p.m.) top drive drilling with small OD tubulars. This unit was tested in a join venture test including 6 Operator Companies in corporation with Rogaland Research in Stavanger, Norway.

We will now have a further look at the different top drive models supplied by Maritime Hydraulics as per today.

Top Drive System

PTD philosophy

Maritime Hydraulics utilities its expertise, gained from the beginning of a major offshore drilling equipment supplier, when recently developing the Portable Top Drive System (PTD). This system is a

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tailor made but at the same time, standardised product which allow the operators of Land rigs and Compact Offshore rigs to enjoy all the benefits the Top Drive Drilling Technology offers and a reasonable cost.

- The PTD is specially designed to fit into typical Land rig applications or other compact and narrow derricks of masts.
- The portable Top Drive is developed to fit any rig in any area with a minimum interface to the rig and at a reasonable cost.
- The name „Portable Top Drive“ shall reflect one of the main benefits of this system.
- The choice of components is made based on the availability of the worldwide cost efficiency and high endurance.
- The variety of options allow for always finding suitable system for any customer. Further more, for the design allows.
- Fast rig up/rig down, utilising quick disconnects on all hydraulic and electric connection, and use of modularised skids.
- The PTD is fully „self - propelled“ system, which includes all necessary equipment and power supply to fit into any rig.
- The PTD is truly portable system with minor or now modifications required for the derrick or the mast.
- Complete installations have been carried out in less than 15 hours.

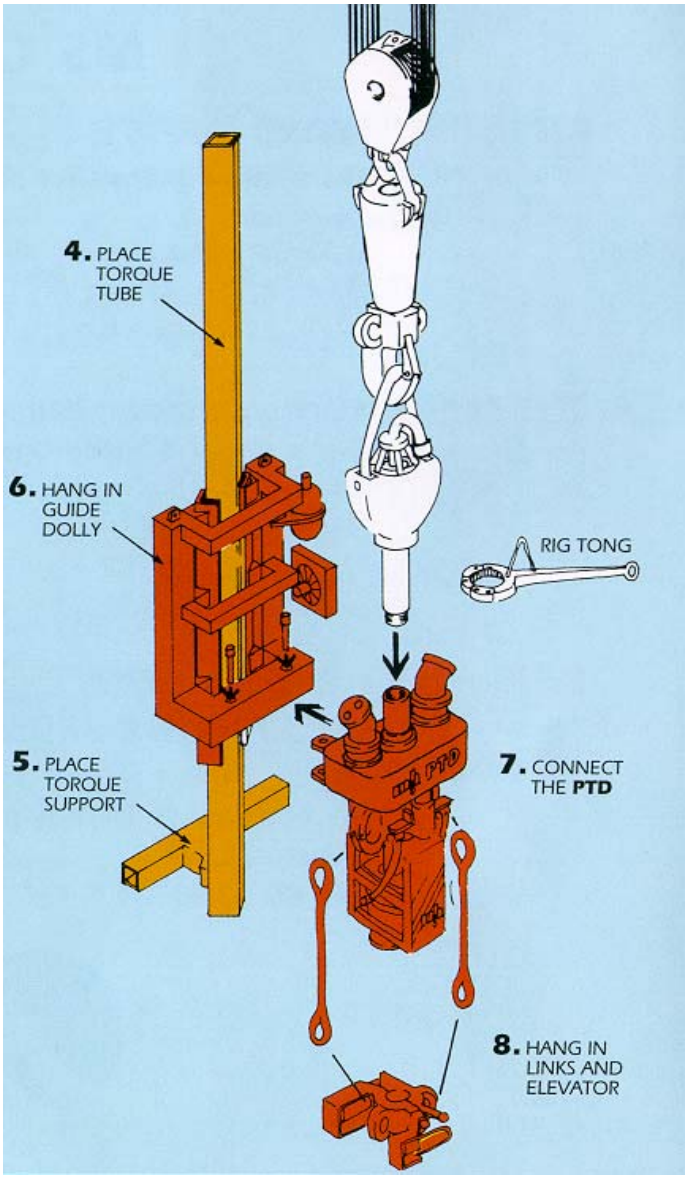

Fig.1. Typical portable top drive rig interface.

System description

The PTD System (Fig.1) consists of the following components: OVERHEAD:

- The Portable Top Drive including guide dolly.
- Operator’s panel including suspension accessories.
- The Torque tube system.
- The Diesel - hydraulic power unit.
- Transportation equipment for the complete system.

PTD Description

The PTD itself includes:

- a gearbox including main shaft.
- one or two hydraulic motors.
- a pipe handler including torque arrestor.
- quid dolly including cooler for gearbox oil.
- I.B.O.P. valve.
- elevator links incl. elevator.

Top Drive Gearbox

The Top drive gearbox is an integrated assembly including a main gear and one or two pinions complete with seals and bearings. The main gear wheel is hollow to accommodate the main shaft

inside a spine drive. The basic model is an equipment with one pinion powered by a hydraulic motor located on top of the gearbox. For greater drilling torque, an additional motor and pinion or bigger motor(s) are mounted on the gearbox. The various combinations of motors enable the PTD system to give various drilling torque on speed output .Reference the technical specification, A PTD with drilling speed up to 600 rpm for slim - hole drilling is also available. The gears and bearings are lubricated by a forced circulation lubrication oil circuit. The lubrication oil is cooled by an air cooler.

The Transmission and Main Shaft

The Top drive gearbox is an integrated assembly including a main gear and two pinions complete with seals and bearings. The main gear wheel is hollow to accommodate the main shaft inside a spline drive. The basic model is equipment with two pinions powered by a hydraulic motor located on top of the gearbox. To accommodate requirements for less or higher drilling torque and speed, various alternatives of drive motor in circulation of lubrication oil circuit.

The main shaft is extended 300 mm (1 ft.) above the top of gearbox. The extended top has a 6 5/8“ API reg. LH box connection to the swivel sub. (Optional Nc 61 for 500 ton lifting capability). The shaf is mounted to the hollow main gear from underneath, and held in palace by a clamping ring (the stop ring) above. The weight of the gearbox and motors is supported by a shoulder of the main shaft. The gearbox has a bearing system designed to carry the top drive weight and the dynamic loads from drilling.

Below the gearbox the shaft has another shoulder to support the link hanger. The main shaft lower end is a 6 5/8“ API reg. RH box to connect the Kelly valve and the mud saver/cross over sub.

Pipe Handler

The Pipe handler consists of:

- the Link hanger including a spring system to clear it off the main shaft while drilling.
- hydraulic cylinders and an actuator arm for link tilt system to clear to elevator from the drill string while drilling and to pick up the pipe from the mouse hole.
- rotation head to enable 360° positioning of the elevator.
- a backup tong to enable Makeup/Break - out of the connection with the hydraulic motors. The backup tong may be hoisted to break out the saver suband the mud saver valve. It may also be utilised for orientating the drill string at directional drilling.

Guide and Torque Track

The Torque/Guide track consists of:

- square beams split into five or six sections, depending on the actual derrick/mast height.
- when installed acts as one beam from top of the derrick mast/down to drill floor level, alternatively terminated 7-9 feet above drill floor.
- a torque transfer beam between the torque track and the derrick/mast top (crown).

Diesel - hydraulic Power Unit (HPU)

Diesel driven, AC driven and DC driven power units are available. Included in this section are a description of a diesel driven, a short description of a DC driven unit utilising existing DC motor for the rotary table, and a driving of a DC driven HPU.

The air cooled diesel hydraulic power unit is available with one or two diesel engines/pump assemblies. The following specifications are made for one engine skid. The unit is self-contained and Taylor - made to meet MH - Portable Top Drive requirements. The unit is mounted to a rigid framework build for both offshore lifting and road transport by means of truck. The diesel engine installed is a standard air cooled caterpillar 3412 DITA.

Generally the power unit consist of:

- A diesel engine with a skid mounted fuel tank, fuel pump, filter, cooler etc.
- A split gear with 3 power take off.
- Two main pumps in a closed loop transmission system with the top drive motor (s).
- One tandem pump where one pump supplies replenishment oil to the closed loop system and the other supplies oil to the pipe handler.

- A hydraulic reservoir which is vented through a breather filter with integrated moisture separator.
- Air cooler for hydraulic oil.

Driller's Control Panel

The Control System, includes:
- Operator's panel, including:
- Hydraulic remote control of drilling and pipe handling functions.
- Readout of drilling speed and torque.
- Control loop interfacing the PTD and the HPU.
- Control System Options.
- Electric control of pipe handler functions.

Transportation Equipment

- Handling frame for the PTD.
- Hose basket for the Power and Control loops.
- Options.
- Hose reel, pneumatically driven.
- Transportation skid for the PTD, torque tube and hose reel.

Advantages of Top Drive Drilling

A Safer Drilling Operation:
- The top drive make-ups and breaks-out many connections, thereby reducing the hazards of rotary tongs and spinning chain.
- The pipe handling features use hydraulic arms to move drill pipe and drill collars to and from the V-door and monkey board, thereby reducing strenuous work and increasing pipe handling safety.
- The automatic, driller operated pipe elevators eliminate accidents caused by drilling crews operating elevators manually during under balanced drilling operations. The top drive increases safety by reducing BOP wear and allowing the BOP/rotating head to pack off against round tubulars, not a square or hex Kelly.
- Well control capability is greatly enhanced because of the ability to scew into the string any point in the derrick to circulate drilling fluids.
- Remote operated Kelly valve reduces (optional) mud spillage when back reaming or breaking off after circulating above the rig floor. Reduce total drilling costs by increasing drilling efficiency.
- No drilling downtime caused by the inability to engage the kelly bushing in the rotary table.
- Eliminate time lost due to picking up or racking back the swivel and kelly when going from tripping to drilling or vice versa.
- Increase penetration rates when spilling in or drilling the surface hole.
- Eliminate rathole contractor charges and costs of rathole, mouse hole and conductor pipe in many cases.
- Make connections on the bottom while directional drilling, eliminating the need to re -orient the tool face after each connections.
- Spend more time on bottom making the hole and less time making connections, tripping, surveying, reaming and other non drilling rig functions. Continuous rotation and circulation during full movement of The Drill String.
- The most important feature of the top drive is the ability to rotate and pump continuously while reaming into or out of the hole.
- Continuous rotation means substantially reduced friction when removing the string from or tripping back into directional or horizontal wells.
- Reduce total directional or horizontal costs by using less or cheaper lubricate agents and drilling fluid systems and additives.
- Less reservoir damage due to reduced usage and subsequent entry of gel/clay particles into the producing formation.

- Reduce total drilling costs by reducing the chance of sticking the drill string or losing expensive bottom hole drilling assemblies.

Drill with Stands increased of Singles:
- Reduce drilling time when reaming to the bottom in sloughing shales or cleaning to bottom.
- Reduce drilling time during hole-opening and underreaming procedures, because the drilling string does not have to be laid down or stands broken down when changing holes sizes.
- Reduce drilling time when reaming undergauge hole, or reaming full stabilisers into the hole for the first time.
- Multiple wells can be drilled from the same pad without laying down the drill string or breaking down stands while drilling.
- Eliminates out two of every three connections.
- Continuous coring up to 90 ft. without any intermediate connection.
- Substantially reduce directional orientation time after each connection while directional drilling with a downhole motor.

Torque the Drill String Safely while still using the Weight Indicator:
- Safer way to back ream than drill string with the rotary table slips.
- Safer and easier way to apply a torque and stretch to the string simultaneously as required during free point and backoff operations.
- More efficient and successful procedures when fishing, including using an overshot, screwing into or out of a fish, engaging or releasing downhole tools such as liner hangers, or rotating and reciprocating casing during running or cementing.

Connections can be made-up or broken-out at any point the derrick:
- Driller has positive well control at all times, being able to screw-in and circulate the string at any position in the derrick, instead of relying on a manual stabbing valve and picking up the swivel and Kelly.
- Instant stabbing and well shut-in at any position in the derrick/mast, when tripping (Remote operated Internal Blow Out Preventer (IBOP) valve).
- Allows immediate rotation and circulation when hole problems are encountered.
- Eliminates the dangerous procedure of breaking the kelly off up in the derrick, when the string becomes stuck at that point.
- Eliminates the use of dangerous drill steam test plugs.

A Better System for Underballanced Drilling:
- Drill with stands instead of singles, reducing connections by 50 to 66 percent for double and triple rigs, respectively. This benefit is increased substantially when drilling with air or natural gas, since the drill string does not have to be bled off as often.
- Make connections on the bottom, reducing cycling tool joints through the annular or rotating blow-out Preventer.
- Prolong BOP or the rotating head element life by packing off on round drill string, not a square or hex kelly.
- Enhanced well control capability with top drive position over hole centre at all times.

Back reaming:
- Full rotation and circulation ability while tripping out.
- Pull through tight spots.
- Eliminate or reduce the possibility of „Stuck pipe“ incidents.

Forward reaming while tripping into the hole:
- Drill through bridges and tight spots without any need for picking up the kelly.
- Controlled stand connection
- Connections made up by the Drilling motor using the Torque Arrestor as back-up.

Decreased possibility of „Stuck pipe“ incidents:

- It is generally accepted that „Stuck pipe“ costs the Drilling industry somewhere between 200 and 500 million USD a year. Analysis performed by BP indicate that as much as 90% of the „stuck pipe“ incidents occur either during tripping or while the Drill string is stationary.
- This means that compared to a conventionally equipped rig, the probability of a „stuck pipe“ situation on a Top Drive equipped rig is reduced to 1/3 and consequently the cost is reduced by 2/3.

Further items:

- Mud saving, rotation and circulation during running of casing.
- Ability to apply a smooth and accurate make-up torque.

We are convinced that several of the very long horizontal wells drilled lately, could never be drilled without a Top Drive.

Summary of Time Savings With Top Drive

1. Eliminates laying down and picking up 9“ BHA and drill pipe twice.
2. Eliminates laying down drill pipe to open hole and ream to bottom.
3. Slight saving in handling BHA.
4. The drill string is not pulled to the maximum during back reaming with the top drive eliminating the chance of parting the BHA. Drill pipe would not have to be laid down after plugging back.
5. During side-track operations, drilling operations can be performed with stands. Saves survey time.
6. Back reaming is accomplished quicker and safer. No slips used and no time wasted breaking down stands.
7. Back reaming out stands eliminates the dangerous use of slips and having to pump out and lay down singles.
8. Stands do not have to be broken down while reaming stiff, locked up BHA´s through the build section of the well.
9. Savings can occur if tight spots are encountered.
10. Engaging stabbing valve is quickly and safely accomplished with a top drive. Circulation can be established in seconds, thus eliminating internal blowouts and plugged drill strings. Free point and backoff is easier and safer since tongs are not required.
11. Drill pipe does not have to be laid down during washover operations. Pumping washover pipe out of the hole with a top drive is much simpler and less risky than doing it with the Kelly.
12. Slight savings if reaming bridges or reaming to bottom is required.
13. Unintentionally side tracking a wells is eliminated with a top drive if it was caused by having to continuously work the bit in one place, because the Kelly drive bushings could not be lowered to the table after attempting a connection.
14. Drill pipe does not have to be laid down it side track. Orientation time reduced by drilling with stands.
15. With a top drive, the liner can be rotated while running in and during cementing. Reaming rathole can be quickly accomplished with stands instead of singles.
16. With a top drive, the bit could be reamed to bottom while stripping in. Therefore, no mud weight increase would be required and lost circulation could have been avoided.
17. Reaming to bottom is accomplished faster with a top drive. In addition, running the liner and cementing could be performed while rotating.

Future Development of Top Drive Technology in the Years to Come

If no radical changes arise in the downhole technology, the Top Drive Systems will continue to be the predominant method of drilling offshore wells also in the future. The onshore drilling industry will adopt this technology and Top Drive machinery will be developed to meet the special requirements for this industry. Once again we will see that the development of equipment is closely linked with the industry’s demand.

Electric PTD

Maritime Hydraulics is now introducing its state-of-art Electric PTD.

With this new Electric PTD the compact and proven Portable Top Drive as manufactured by Maritime Hydraulics is available with an alternative electric drive system.

A new electric motor design has been used to provide a PTD with the same overall dimensions as the standard MH PTD. These new motors provide an excellent control of torque and speed over a wide range, at a drastically reduced size and weight. each motor weighs only 179 kg (395 lb) and outputs are up to 590 hp. The motors are incredibly rugged with few moving parts and are virtually sealed from all environmental impacts. They are almost maintenance free and certified for hazardous areas.

Further new developments are the on-board hydraulic units, made as a part of the guide dolly. The HPU powers all PTD pipe handling functions and greatly reduces any interface. New electric power plugs for the service loop cables are based on a patent pending construction and avoid any termination errors and considerably reduce installation time.

The electric PTD can be powered from both DC and AC sources. This means that the system is very flexible and can be driven off an SCR unit, of the 600V bus bar, off genets or even a public supply cable.

Two models are available, a medium torque model and a high torque model:

- An AC-powered Top Drive application may also be anticipated in the nearest future. The fact is that an AC-powered Top Drive was developed by Maritime Hydraulics as early as 1983, but at that point of time this development proved to be too early in order to be adapted as general industry practice.
- Compared to the conventional SCR controlled DC driven system, a frequency controlled AC-driven system has advantages such as:
  - Reduced maintenance due to general simplicity of design.
  - No brushes, hence no sparks from commutators.
  - No supply of cooling water.
  - Full torque at standstill.
  - Accurate regulation around standstill and improved efficiency.

Due to these advantages, it's anticipated that the AC system will gradually take over market shares from the DC system.

Soft Torque:

- Another topic for improving the overall efficiency is a system to decrease the torsional drill string vibrations. A „Soft Torque"-system is developed in a corporation between Maritime Hydraulics and Shell/Den Haag to be utilised on hydraulically driven Top Drive. A system for electrically driven Top Drive is also available.

Conclusion

The history of the Top Drive development clear by shows that the industry's demands has been the key factor of the direction of development. We will see the same effect on the future direction of development.

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