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WORKING RIG MACHINES FOR DEEP DRILLING
7500 PSI RATED DRILLING EQUIPMENT FOR THE FUTURE****

1. INTRODUCTION

Oil and natural gas resources are not unlimited. They may turn out to be close to be depleted some time in the nearest future. This mainly applies to oil. A very important question of the magnitude of the oil and natural gas resources arises, but nobody knows the answer to it. According to one of the present theories we know about ca. 1000 mld barrels (ca. 140 mld ton) in reservoirs, and some 500 to 800 mld barrels of oil are still left “under surface”. These data have not been verified yet, and only discovering new fields and reservoirs can prove their existence. Another problem is related to the uneven distribution of oil and gas. The OPEC countries have ca. 60 to 70% of World’s resources. One of the ways of solving the problems resulting from the depletion of hydrocarbons is intensification of prospecting. There are still places where hydrocarbons can be discovered, as practice reveals.

New deposits can be now found at greater depths, either on land or offshore. In the latter case the depth of water is greater, therefore rig vessels of higher deadweight capacity are needed. Drilling works in such conditions require on the part of the Operator the multifunction ability to perform them best and also to have equipment providing safe performance of a given operation. The efficiency of finding new deposits and their exploitation depends on drilling more complex and longer directional boreholes. Especially for marine drillings, where exploration will concentrate in the nearest future, the efficiency of finding

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new deposits is conditioned by drilling more complex and longer directional boreholes in places where the sea is deeper. This will require higher deadweight capacity of the rig vessel, more powerful mud pumps and machines of high torque on the string.

The practice reveals that greatest investments on the technical and technological development are directed to research institutions specializing in designing marine drilling equipment as the operations in the sea are most costly.

Prospecting at greater depths (land) and at greater water depths (seas and oceans) is technologically more challenging for the designers, producers and users for a number of reasons, e.g. difficult geologic conditions, unfavorable siting, technological obstacles, complex climatic conditions, smaller size of productive reservoirs as well as strict environmental and safety regulations.

This necessitates using more efficient technical solutions.

The basic design parameters of a drilling rig, i.e. hoisting capacity, hydraulic capacity of mud pumps or torque of driving machines on the string [3] are difficult technical obstacles. Designer’s works concentrate on equipment to be used for safe and reliable prospecting in areas which have not been checked out with drilling wells so far.

Among such areas are:
- Spitsbergen,
- Barents Sea,
- Arctic Area,
- Brasil Shelf,
- deeper areas of the Gulf of Mexico.

Further development of oil fields is one of the most difficult and most expensive power projects.

The designers face these challenges. At present novel designs of rig vessels for prospecting operations in the above mentioned perspective areas are realized, e.g. Aker MH apart from on shore drilling equipment is involved in delivering 30 new drilling units for offshore drilling industry. Apart from commonly used vessels, there are also new designs (semi-submersible platforms and rig vessels). These are, e.g. Sevan (presently used for drilling in deep waters to 3 048 m (10 000 ft), or newly designed ones for frilling in water depths to 3 657 m (12 000 ft) and more: Larsen Rig I (Fig. 1) and PetroRig 1, 2, 3, Aker Spitsbergen & Aker Barents – drilling unit with a dual hydraulic mast (Fig. 2), which is not equipped with a traditional hoist, is an example of a new trend in the drilling rig design based on power hydraulics [1, 2]. Other producers also actively get prepared to explorations at deeper sea areas, e.g. MPF Corp. (vessel MPF01) or Stena, (drilling vessel Stena DrillMAX) (Fig. 3).

The designers are faced with the need of meeting high requirements regarding exploration and exploitation equipment that can manage the tasks.
2. **RIGS**

Rigs (Fig. 1, 2 and 3) are sets of machines making up the following subsystems:

- Hoist systems,
- Systems transmitting torque on the string and drilling tool [3],
- Mud systems,
- Cementation systems,
- Piping (drilling strings, casing, risers),
- Systems for moving pipes, BOP and production heads [5],
- BOP heads systems,
- Control, registration, monitoring and communication systems,
- Compensating systems,
- Driving and positioning systems,
- Other subsystems cooperating with above mentioned ones, as well as tools and auxiliary drilling equipment.
The above reveals that rigs are systems of complex subsystems and machines, where the transmission of the forces and torques is the basic principle of its design. Generally, driving of a rig is reduced to finding an appropriate motor or set of motors with a control system, and protection of working machines to provide correct performance of a technological task. The drive is responsible for putting working machines in operation, depending on their function. Driving system of a rig consists of a set of high power machines, the energy of which is supplied to specific working machines. Above-mentioned rigs should be equipped with working machines having high-technological parameters, which have not been applied to drilling operations so far. When drilling longer boreholes, the mud pump becomes a very important drilling technology factor. It should provide an uninterrupted movement of drilling mud in the borehole and also overcome considerable pumping resistance to provide sufficient amount of energy to the downhole motor driving the rig. The hoist system with a driving head [3] should provide safe and efficient performance of high-load hoisting operations. Therefore high power and highly reliable working machines have to be used.
For instance, the new drilling rigs presented are equipped with the following working machines: mud pumps (Fig. 4), drilling hoist (Fig. 5) and drive heads (Fig. 5), with automated manoeuvreing systems [4] produced by: Aker MH and Aker Wirth, which have newest design, enabling exploration explorations with very high technical parameters of capacity of hoist systems 1250 T and power of mud pumps 3300 KM [5, 6].
Fig. 4. Mud pump by Aker Wirth 2 200 KM of power and 7 500 psi of pressure [5]

Fig. 5. Drilling hoists of 3 300 KM of power and top drive MDDM of 1 250 tones capacity and 2550 KM power [1, 3, 5]
3. CONCLUSIONS

The decreasing number of easily accessible reservoirs, the growing number of drilling operations, increasing complexity of drilling operations, more complex drilling wells, more multidirectional and directional boreholes, wells with high reservoir pressure, extreme drilling conditions, new technologies, increasing efficiency, growing oil and natural gas prices are the most important technological challenges set before designers of drilling equipment. The more and more severe requirements: higher hoist capacity, higher mud pressure, higher power of mud pumps, hoists and driving heads require specialist technical knowledge at the highest level of design and realization.

The presented rig and its basic working machines are examples of such equipment, thanks to which exploration and exploitation of hydrocarbons can be performed at great depths, unavailable for traditional rigs so far.

REFERENCES

[5] Stationery Aker Wirth, 2009