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Drillmec HH – Automatic Hydraulic Hoist Series Rigs

designed to improve safety and performance

By Marco Cercato

Today's on land drilling activity for oil and gas exploration and production requires dramatic improvements of its safety standard and environmental impact, as well as fast moving and enhanced performance. The aim is to achieve an overall reduction of the finding costs and better working conditions.

The design and technology of land drilling rigs has remained very conservative and traditional for too long. In comparison, downhole tools and well drilling technologies have undergone significant changes that require innovative approaches towards drilling rigs' design components. Such changes are needed in order to meet new challenging objectives requested by all industry that is hungry for better safety conditions, enhanced performance and competitive costs.

For a few years, many new technologies including technologies drawn from offshore rigs, have been applied to new design of land rigs. Some of the new rigs are already fairly well known in the worldwide industry. The results seem to indicate that their efficiency is related to an extended use of automation, mostly applied to those actions that are repetitive, such as tripping drill string in and out. Automation consequently reduces the number of crew necessary, resulting in an increase in safety for the working conditions on the rig floor.

A new type of drilling rig

The HH Rigs are a series of hydraulic rigs that allow safe working conditions for the crew, only leave a small environmental foot print and have a high level of operational efficiency. The unusual characteristic of their design make their shape far different in comparison to a conventional rig (Figures 1 and 2).

The rigs were designed to achieve high levels of safety and performance. They integrate various hydraulic equipment in a drilling process that is largely automated and has all drilling functions centrally controlled from driller's cabin.

The HH Rigs range from 150 000 – 600 000 lbs of static hook load capacity, which translates into a drilling capacity of wells up to 15 000 ft depth, depending on the well design and its casing .

The rig is integrated into a trailer that does not need to be disassembled when moved. It is self-erecting to the required position by means of dedicated hydraulic pistons.

Figure 1, HH200 rig and conventional 200 HP rig.

Figure 2, HH300 rig in New Zealand

Automating routine operations

An advanced automation concept allows most of the routine drilling operations to be performed including tripping in and out the drill string and tubulars, with an almost unmanned rig floor, where the workers presence is basically limited to thread doping and to the BHA handling. Therefore a smaller than usual crew is needed to operate the rig. It is 'hands off' work, with nobody exposed to direct contact with rotating tubulars, tongs and wrenches, or to falling objects.

The most apparent characteristic of the HH Rigs is the self-erecting hydraulic telescopic mast. It's made of a powerful hydraulic cylinder that as an integrated hydraulic to drive built in. There is no derrick man, and no monkey board is needed.

Therefore the HH Rigs do not have the conventional mast structure, nor drawworks and long wires or travelling equipment instead, these are replaced by a powerful hydraulic cylinder, which is the main hoisting element of the rig. It is a self-standing telescopic mast with reduced height.

After the rig is raised to the required substructure level, the mast is raised to its vertical position by two hydraulic pistons.

This puts the top drive already in work position.

The top drive is equipped with a torque wrench; it has a horizontal displacement capability, which allows it to move the pipes from the centre hole to the mouse hole and vice versa. The top drive has an automatic pipe handler, which rotates inside a unique vertical pipe racking that surrounds the rig floor. The pipe racking is made of a number of mobile bins, and the number varies with the size and type of rig.

The arms of the pipe handler are installed on a vertical rotating tower; they have two clamps that take the drill pipes from any container of the vertical pipe rack and transfer them to the mouse hole or vice versa, depending on an electronically present order.

The system works automatically in a

Figure 3, Drilling Console

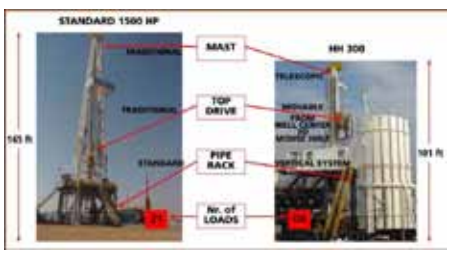

Figure 4, Comparison between conventional 1500HP rig and HH300 rig features.

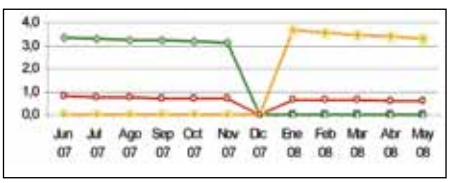

Figure 5, Loss time frequency index-accumulated 12 months - HH102.

programmed logic controlled (PLC) sequence but the driller retains the capability of driving the full system from his chair in the dog house, through the controls and the touch screens installed on the drilling console (Figure 3). A hydraulic power tong and automatic slips are also integrated with the rig.

The vertical pipe racking system is assembled in a semicircular array around the rig floor, and this contributes to quick rig up and rig down. Furthermore the containers can be transported and handled full of drill pipes (usually 16 pipes per rack), with considerable saving in time and reduction of the risk connected with the pipe handling on the rig.

Pipes can be changed easily by replacing some containers, which already filled with the new pipes, and without interrupting the drilling work. The HH Rigs normally drill with Range 3 drill pipes, however Range 2 can also be used without any changes in the rig equipment.

Another element that allows an unmanned rig floor activity is a hydraulic power tong that is stored in the back of the fixed part of the mast base. It is adjustable in height and driven from the drilling console, rotating back and forth from the centre hole to break or to make up connections with no need of manual intervention. The hydraulic hoist can also supply a pull down pressure, ranging from 44 000 – 66 000 lbs, depending on the rig size. The overall dimensions of the HH Rigs are much smaller than conventional rigs of corresponding power (Figure 4).

All the major rig modules are permanently mounted on semi-trailers and are self-erecting for fast and safe transport between locations. Much less loads than those of a comparable conventional rig are needed.

The drilling parameters can be controlled during operations by the hydraulic top drive, which allows automatic drilling with a constant WOB or constant rpm, selected by the driller on the control panel. Predetermined values of over-pull can also be set.

Such features, coupled with the back reaming allowed by the top drive while tripping out, considerably reduce the risk of stuck pipes.

Fewer accidents

The most common accidents on drilling rigs happen on the rig floor. They mostly affect hands and fingers including squeezing between the hanging pipe and pipe on the slips, impact and dragging by rotating tubulars, and crushing caused by tongs, wrenches and chains. These accidents can happen to people who work closely with moving equipment and are exposed to the hazard of impacting with it. Accidents often happen while tripping string on a conventional rig, where there are many people doing heavy manual work in the fairly restricted space of a drill floor.

On a HH Rig, with a smaller crew and most of the routine activities automatic or remotely controlled, the possibility of casualties is dramatically reduced. The possibility of being hurt by falling object is basically nonexistent because there is no man presence or activity above the rig floor and hoisting action is carried out through the telescopic movement of the hydraulic mast instead of drawworks and their lines as with conventional rigs.

The small number of recorded accidents demonstrates that activity on these rigs is always done with the highest possible level of safety for the entire crew (Figure 5).

The automated systems, the central control and the reduced number of people allow for easier and more effective handling of the rig, with very beneficial effects on the overall performance and costs. People work more comfortably and in less tiring conditions, resulting in a safer and more productive approach to their duties.

More regular and with higher accuracy

The length of time of each repetitive activity becomes regular, predictable and faster, mostly because it is not effected or conditioned by the human behaviour. Tripping in and out is done almost entirely automatically, without depending on manual labour and regardless of time, of day or weather conditions.

Figure 6 shows the regularity of the tripping activity. It is usually made at an average of 40 joints/h. As range 3 drill pipes (Supersingles) are normally used, it means approximately 1680 ft/hr (more than 500 m/hr), which is competitive with any conventional rig using Range 2 drill pipes, either in tandem or in stands. The time to make the connections in adding pipes while drilling is also very short, with a very good impact on the total drilling time.

Furthermore, working on the hydraulic pressure of the main cylinder, allows accurate control of the WOB – a 'fine tuning' system that can preset the desired weight, keeping it constant through the entire section to be drilled.

Therefore, any changes in the ROP will depend only on the changes in the characteristics of the formations being drilled.

This can give us useful indications to the driller and the geologist.

Figure 7 clearly indicates the positive effects of being able to keep a constant WOB.

Such a feature is particularly effective in high angle directional wells and in horizontal wells, where characteristics of the HH rigs and the WOB control in particular allow much more accurate, easier and faster drilling in all conditions (Figure 8).

Last but not least, it's important to highlight that the much safer and less labour intensive working environment of the new automated rigs and their advanced technology may be interesting to young engineers with a high level of education, which the industry has increasing difficulties to attract.

If so, a new workforce may become available that can be trained more quickly and easily that the traditional workforce.

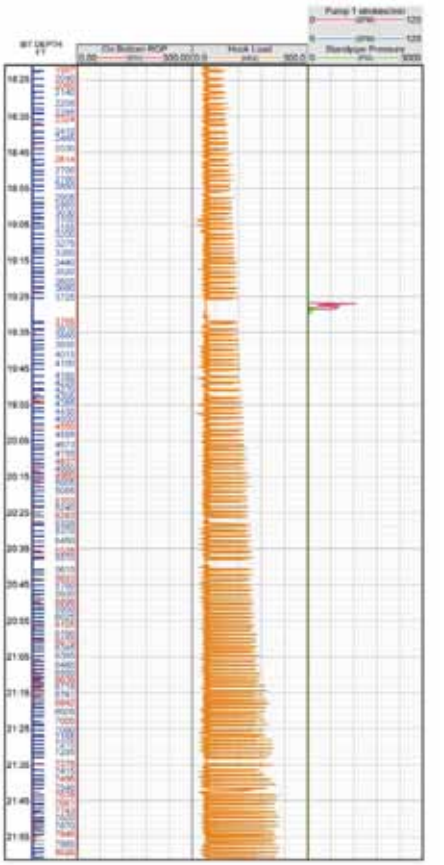

Figure 6, Tripping in log - HH300.

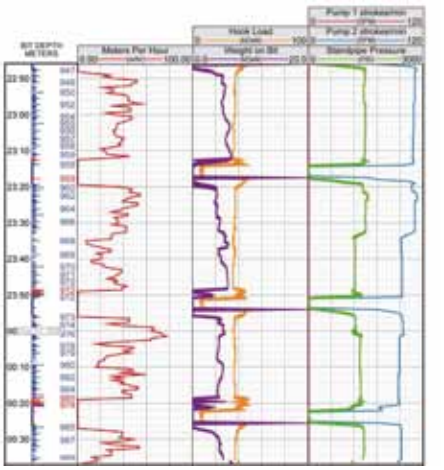

Figure 7, Drilling log (costant wob) - HH102.

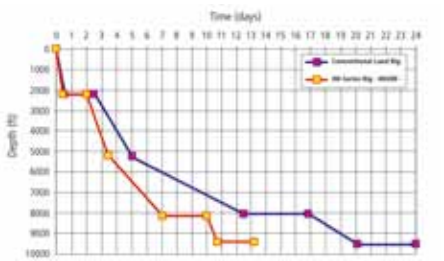

Figure 8, Performance comparison between average of conventional rigs and new HH200 rig.

Massimo Contini, Drillmec SpA (Italy) - Area Sales Manager Far East-Australia-New Zealand Email: m.contini@drillmec.com