Highly automated drilling fluids system improves HSE and efficiency, reduces personnel needs

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IN AN INDUSTRY where the need for precision is ever driving the re-evaluation of proven and traditional technologies, a drilling rig's mud-mixing operation is a system worthy of revisiting. Where the majority of today's MODUs have drilling fluid systems that rely on a high degree of manual operations, the incentive to migrate the process improvements found on the rig floor to the mud pits is readily apparent.

Typical drilling fluid systems predicated on manual operations increase the risk of imprecision in the mud-mixing process. They also impact mud quality, increase the operator's exposure to chemicals and other hazards, and make the whole system more susceptible to human failure.

The incorporation of automated processes into drilling fluid mixing control systems offer opportunities for major improvement in personnel safety and mud quality, as well as greater efficiencies in resource use.

Following extensive field trials with automated mud-mixing systems in the North Sea, performance-based feedback from the Valhall water-injection platform (WIP) illustrates that automated processes can result in practical benefits. Not only was there an improved technical process, but there also was a potential increase in operational efficiency and stability because automation reduced both opportunities for human error and the operator's contact with hazardous chemicals.

The Valhall WIP experience demonstrated that a highly automated drilling fluid system can provide more efficient mixing, reduce overall environmental impact and provide a tool for cost savings by reducing manpower needs.

A BRIEF HISTORY

The sentiment that used to question the beneficial nature of standardization and automated processes in the oilfield has diminished. For the oil and gas industry, automation has become a means to optimize drilling processes. It has introduced safer and more reliable drilling systems and reduced many environmental and occupational hygiene and safety issues. The benefits of automation within HSE and systems reliability are axiomatic, whereas the benefits of cost efficiency are not always as obvious in analysis. The initial investment required discourages some automation supporters to replace the manual systems.

Manual mud-mixing equipment have a higher risk of imprecision in the mixing process compared with highly automated systems.

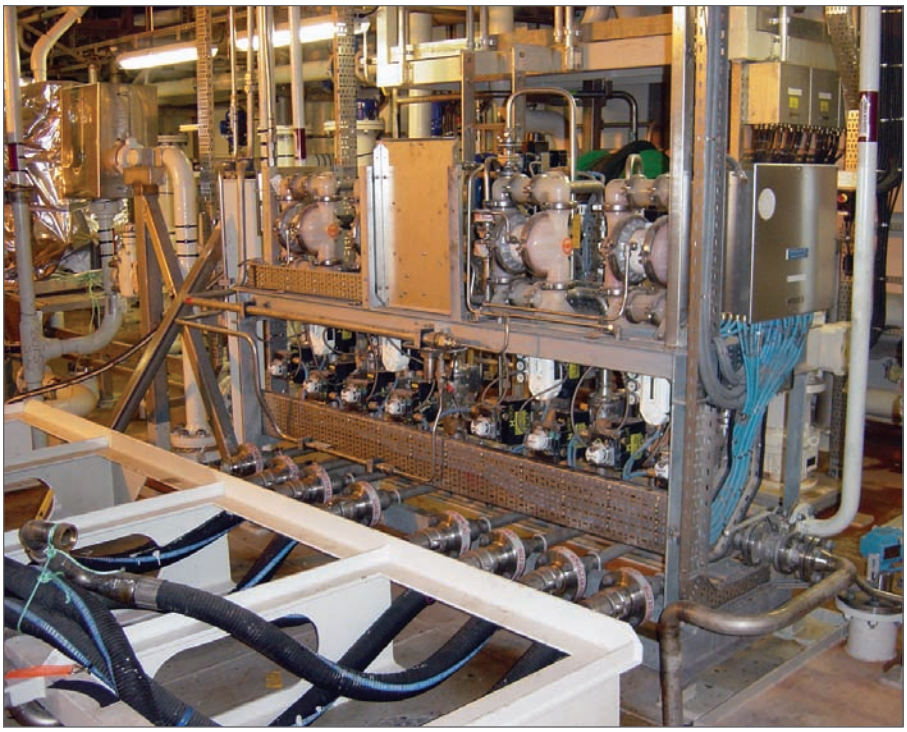
There is, at times, a tendency of referring to the oil and gas industry as severely traditional and conservative – one that innovates only when a legislative framework is in place. Contrary to this label is the technology brought by automated processes that have been acquired without a prepared legislative framework.

At the First International Conference on Health, Safety and Environment in 1991, Minton, R.C., and Bailey, M.G., presented an article on the automation of drilling systems and its impact. The authors stated that the introduction of automated drilling systems was leading to reassessment of all safety and occupational hazards of the drilling fluid surface systems because their use allowed higher reliability and speed, ease of mixing and consistency of the drilling fluid.

Our industry continuously gets asked to reduce costs and produce more with fewer people, and to increase the precision and reliability of drill floor equipment. In general, automation in the oil and gas industry appears to be a way to improve the majority of well-site processes. With continuous optimization, the integrated automation mud systems permit several benefits in safety and the environment. Other main benefits include the avoidance of human errors, improved performance, consistency and quality of operations, manning levels and costs (Murch, D.K., et al).

Drilling optimization and automation has gone through three phases – the fully manual phase, the fully supervised automated phase and the current minimally supervised automated phase (Reinhold, W.B., and Close, D.A., 1997). Each of these eras represents efforts by service companies and drilling contractors in addressing inefficiencies and cost-related limitations in their technologies. They have undertaken redesigns in order to make them more reliable, efficient and suitable for today's needs. This is the case of **National Oilwell Varco**'s fully automated mud system.

Operational experiences with automated mud-mixing systems have proven to provide the following benefits: a more effective product mixing, minimized chemical losses, optimized mud use and an improved working environment. The need to become a safer industry has been the impulsion to this reinvention.



The addition of liquids is fully automated on the Valhall water-injection platform.

Automation has allowed higher access to the needed information and to the right people with the push of a button.

The researchers asserted that mud-mixing processes should be automated as much as possible. This would make operations simpler and more flexible and equipment more reliable and less labor-intensive.

VALHALL EXPERIENCE

Produced by **BP**, the Valhall field in the North Sea has been in operation since 1982. The field consists of four separate platforms connected by bridges: a quarter platform (QP), a drilling platform (DP), a production and compression platform (PCP) and a wellhead platform (WHP). A water-injection platform (WIP) was linked to the field in 2003.

The WIP is a state-of-the-art automated drilling rig linked to the existing Valhall wellhead platform by a fixed steel bridge and contains integrated topsides with water-injection facilities, seawater and produced water treatment facilities, and power generation. It can skid on beams from WIP to WHP, including the mud-mixing module. The platform configuration allows for drilling and maintenance of wells on the new platform (24 wells total) and on the existing WHP (19 wells total).

The BP-operated Valhall field in the North Sea has been in operation since 1982.

The WIP is also linked by a fiber-optic line to an onshore operations center in Stavanger. This allows offshore information to be accessible onshore and offshore, involving more on-hand expertise, enhancing safety and requiring fewer POB offshore.

When designing the WIP, National Oilwell Varco Asker's objective was to significantly improve the HSE standard and rig efficiency while reducing offshore personnel and providing a standalone well intervention platform.

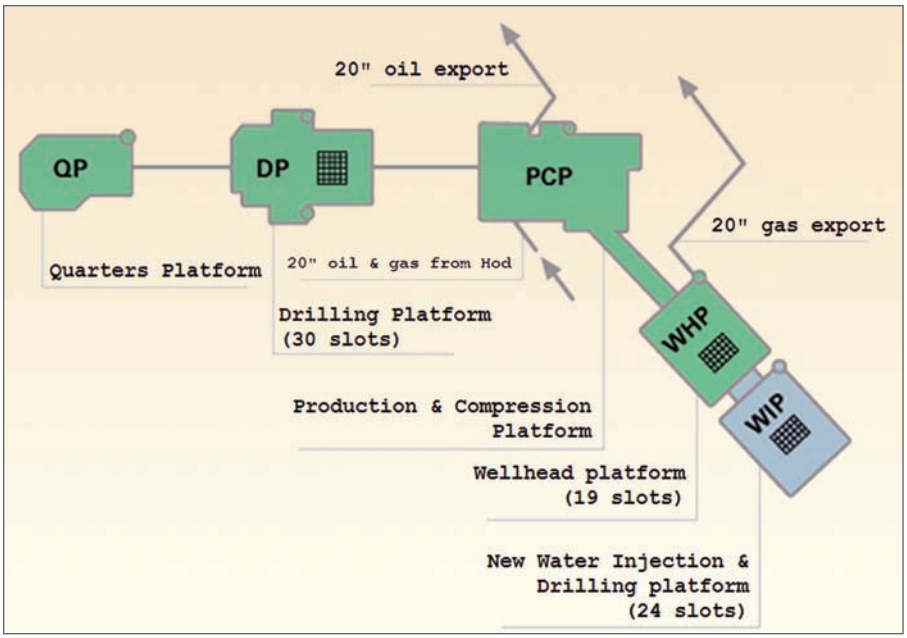
MUD SYSTEMS

A drilling rig's mud systems can be broken down into three categories.

Category 1 is a fully manual system. Equipment such as motors, pumps and valves are operated locally and manually by users. These mud systems require users with extended process knowledge and rely on their judgment and experience to maintain operation. They require barite and chemical to be added by hand, and the system is ultimately constrained by the condition and amount of physical labor available. Although Category 1 mud systems are the most common in the industry, their operational efficiencies and HSE concerns leave much to be improved.

Category 2 is a fully supervised automated system where subsystems and equipment are operated by a central control, either a control room or operator station. Users are able to monitor process status and operate valves, pumps, motors and equipment. Some subsystems can be operated automatically by the control system logic. Operations such as density control by adding barite is initiated by users, and the control system executes the necessary addition of barite to maintain the mud weight.

Category 3 is a minimally supervised automated system where all equipment and sequences of operations are operated by the control system. An example is the automatic mixing of mud in mud pits. The user is able to select a mud pit and mud-mixing pump, and the control system will perform all line-up of necessary valves, check all interlocks, all status and start mixing until aborted by the operator.



The Valhall complex consists of platforms connected by bridges – a quarter platform, a drilling platform, a production and compression platform, a wellhead platform and a water-injection platform.

The mud-mixing system on the Valhall WIP is a minimally supervised system, with most of the mud mixing performed automatically by the control system after user initiation.

The mud system at the Valhall WIP is a Category 3 system. Most of the mud-mixing operation is performed automatically by the control system after being initiated by operators. Several subsystems can be operated simultaneously without influence from users. The following are examples of functions:

• Automatic transfers between tanks. Bulk tanks, liquid mud tanks, trip tanks and base oil tanks have an automatic transfer function. Transferring between bulk tanks and filling to/from boat-loading stations is possible by automated sequences. Transfer between bulk tanks or filling to/from boat-loading stations requires the use of valves/piping that may interfere with other operations or automated sequences. If auto mode to/from the tank is selected, the amount is entered by the mud operator, then the control system opens/closes all applicable valves and pumps until the desired amount has been transferred. During these operations, all interlocks will be checked, and any error on valves or pumps will result in an aborted transfer.

• Automatic circulation. This enables the operator to circulate a mix from any active or reserve tank via a mixer and back to the same tank. The control system opens applicable valves, closes and disables valves that can interfere with the transfer, and starts the applicable mud-mixing pump. Continuous circulation is performed until aborted by the operator, who stops the mud-mixing pump and closes applicable valves.

• Automatic weight maintenance. This is performed on one active suction tank. Automatic weight increase ensures that the density is kept at a constant value, regulated by adding barite if the density is too low and adding premix if the density is too high.

• Addition of liquids. Each of the dosing stations is equipped with metering pumps that are fed by liquid containers or drums. Valves on the suction lines are used to dedicate one of the two liquid tanks to each of the pumps. The metering pumps are the air-driven diaphragm type fed with constant drive air (compressed rig air). A flow meter and flow control valve controls the rate of flow and batch size.

• Automatic flushing of liquid additive skid. The control system records the amount flushed past the flow meter. Once this amount equals the set point entered for "amount to flush," the pump stops.

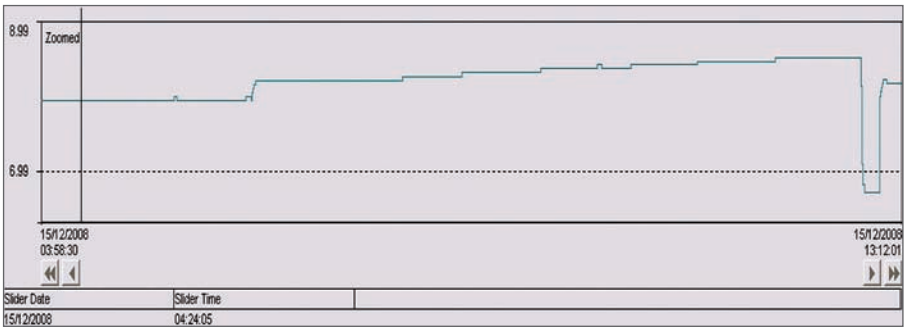
In addition, agitators, degassers and the base oil jockey pump are operated by the control system based on process measurements. Refilling of barite and barite/bentonite/calcium carbonate surge tanks is performed automatically, as well as the flow transfer on the cement surge tank and automatic emptying of dust collectors.

Functions like sea water control in active suction tanks, sack handling unit with reservoir, and recipe systems are also provided automatically.

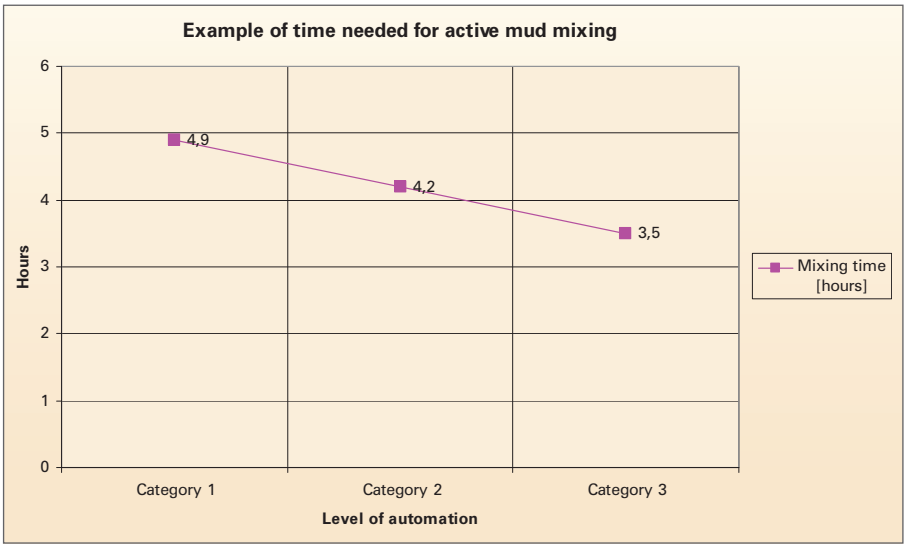
Users estimate that as much as 30% of the time needed to perform a mixing was saved with the use of all automated functions active compared with fully manual mixing. In addition, less barite was needed during mixing due to the accuracy of the control functions.

FUNCTIONAL, OPERATIONAL AND HSE ADVANTAGES

Feedback from operators at Valhall confirms that the automated functions in the mud system have several operational benefits. For example, automatic circulation on mud pits allows operators to obtain a better overview of the system from the control room. It also reduces



Above: This live trend picture shows a mud weight increase on a slug pit of 40 bbl at Valhall. During the 6 ½ hrs used to increase the mud weight from 7.97 ppg to 8.37 ppg, the user was free to perform other operations. Below: This figure outlines time consumption and effectiveness within each automation category. It is based on an example during active downhole mixing, where the mud density was increased from 14.6 ppg to 14.7 ppg, and automatic circulation and automatic weight maintenance were used.



the risk of overfilling mud pits due to incorrect valve line-up or malfunctioning equipment. Automatic line-up of valves when transferring bulk material between tanks allows new or inexperienced users to familiarize themselves with piping routes, pumps, etc. This reduces the time needed for training new personnel.

Functions like automatic addition of liquids, level control and automatic circulation of mud allow operators to perform several operations at the same time without the need for manual and hands-on operation. According to users interviewed, overfilling of mud pits and tanks has never occurred at the Valhall WIP when auto functions were in use. The automatic system will also perform a more steady operation (i.e., on the weight maintenance compared with manual weight maintenance).

From an HSE perspective, the ability to operate the mud-mixing system from a control room results in reduced stress for the users, as well as reduced exposure to hazardous materials and chemicals, which often are stored in the confined spaces of the mixing area. Systems such as level control and automatic agitating reduce the risk of overfilling and settling, which can lead to excessive emissions and exposure to hazardous materials.

CONCLUSION

The experience from the Valhall WIP has demonstrated that the cost of control systems with built-in automatic functions, automated valves, and equipment adapted to automatic control is an investment keeping in-step with process improvements typical on a modern rig floor.

The minimally supervised automated mud system provides efficient solutions for the oil and gas industry by presenting reduced overall environmental impact, more efficient product mixing and safer and more reliable drilling systems. It also requires less training and provides cost savings by reducing offshore manpower needs.