

Automation aims for higher efficiency wells

Martin Hofschroer, Bentec Drilling & Oilfield Services

HISTORICALLY THE DRILLING industry has tended to take a conservative approach to implementing of new technologies. However, the challenges thrown up by more and more difficult formations, extended reach drilling, extreme environmental conditions on the rig locations and the need to explore increasingly smaller reservoirs calls for a new approach.

All parties involved in the drilling process need to consider combining their efforts through the application of their experience and the innovative state of the art technologies that are now available.

Offshore installations have been quicker to adopt a range of sophisticated technologies, but there seems to have been a slower uptake in mobile land rig operations.

Since everyone wishes to avoid down time, anything that can improve well quality and drilling performance, especially in difficult well conditions, can only benefit both the drilling contractor and the operator.

In the past, drilling appeared to be a

simple process. The drill bit, pushed downwards by heavy weight drill pipes, is rotated either top drive or via rotary table, high-pressure mud powers the downhole motors, carries the cuttings upwards and cools the bit.

Drilling in the future promises to become a more difficult and complex process. Mud needs to be available on higher volume and higher pressure.

Deeper wells are calling for longer drill-strings putting higher stress to the materials used.

Some formations can only be drilled with very low pressure, called under balanced drilling (UBD).

Downhole data needs to be transferred to the surface whereas the drilling process itself has to be as smooth as possible to keep the bit life high to avoid unplanned round trips.

Drill pipe is opposed to very high friction over almost the whole length since extended reach wells are more often drilled horizontally then vertically. The pipe is just laying on the bottom of the bore hole.

The handling of the string on the surface asks for bigger set-back capacity on the

rig floor, gear-driven drawworks are the preferred choice for powerful and flexible operation.

The standard approach to drilling is to make use of the physical limits of the equipment. Globally, engineers and designers are continually researching more efficient ways to drill.

Until these solutions are available to the field, it is a "must" to optimize the drilling process as we know it today. Experienced staff is definitely as important as the application of improved technology. So every change can only be made step by step.

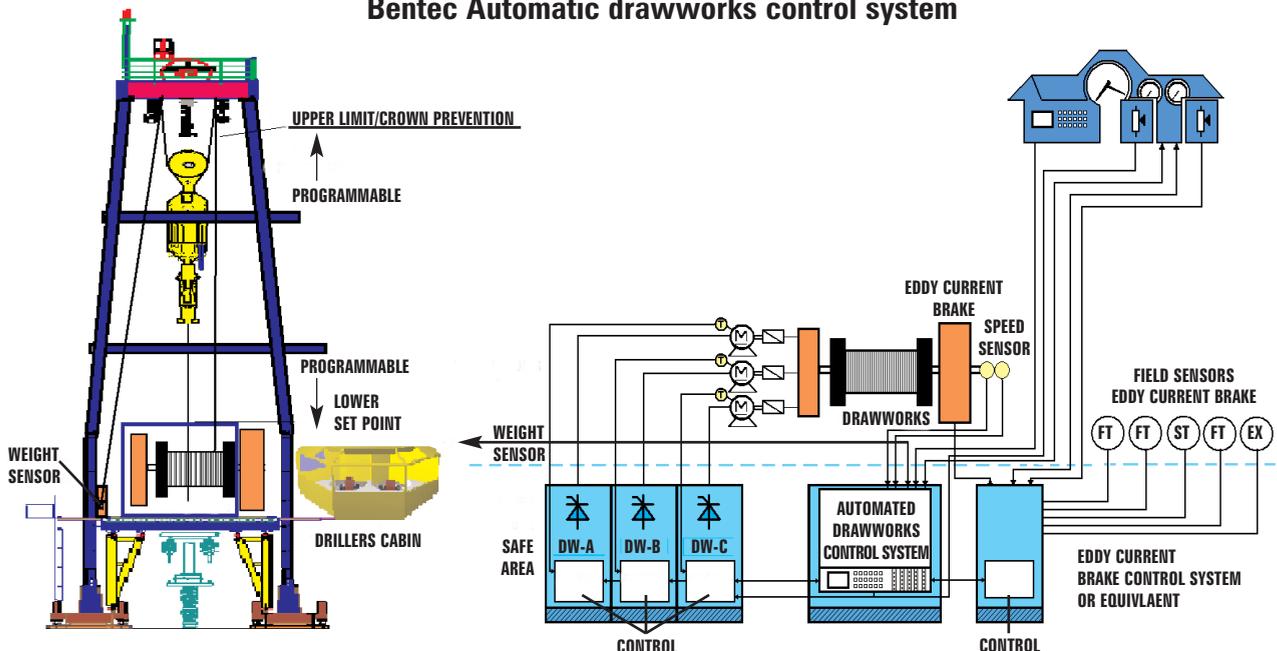
Upgraded standard land rigs and new land rigs that are able to work according to future requirements are available today.

CHALLENGES UNMET

Standard rigs are still equipped with chain driven drawworks. They are reliable, known to all drillers and accepted in the oilfield.

The weight on bit control (WOB) is done manually, just through opening and closing the mechanical brake, according to the information supplied through the hook-load indicator.

Bentec Automatic drawworks control system



The torque and the RPM-value of the drillstring is set manually as well, not taking care enough of the responses from down hole. Mud volume/pressure, the third important factor for the quality of the bore process, is again just manually controlled.

As we face the limits of this way of operation for drilling rigs, some very important adaptations should be taken into consideration.

ENHANCING APPLICATIONS

The "stop and go" operation of the brake handle in order to keep the WOB within the required limits is not only exhausting but also unacceptable for the quality of the hole.

Stress on the material and vibration within the drillstring will reduce the service life of the whole equipment in use.

The rate of penetration is poor since parameters will not be set to the optimum.

One way out of this situation would be a retrofit gearbox kit available to any kind of drawworks, attached to the extended shaft of the eddy current brake.

Controlled via Variable Frequency Drive (VFD) driven AC motors, hoisting and lowering of the drillstring is achieved.

Closed loop control with respect to WOB and ROP can be set easily by the driller.

Hands-off operation with continuous feed-off takes care of best possible hole quality on optimized drilling speed. As a side effect, the system can be used for erecting the mast or as emergency hoisting system.

It offers a complete redundant drawworks drive connected to the emergency generator. If the downhole motor is used for directional drilling, the actual mud pressure can also be used as input for control of the string release rate.

JOYSTICK DRAWWORKS

State-of-the-art SCR (Semi Conducted Rectifier) or VFD systems with regenerative braking capacity are used for drawworks braking purposes. A joystick rather than a brake handle controls the movement of the travelling block assembly (TBA).

Applying this solution speeds up the operation, round trips are much faster, and open hole periods can be reduced.

Beside the effect of using a joystick for the drawworks operation, a monitoring system for the actual kinetic energy within the system assures the highest possible standard of safety for staff and equipment.

Braking distances are continuously supervised and interlocked against any equipment, which can move into the travelling path of the TBA. Upper and lower limits will not be exceeded.

Flexible defined working points can be used with a very high accuracy for standard operation during round trips or during the drilling period.

KEEP THE BIT ON BOTTOM

Listening to the feedback information out of the hole is the next step for increasing the overall quality of the bore hole. Top drives or rotary tables are mostly set to a constant RPM, putting just torque into the drillstring but do not adjust these values in order to get a constant revolution on the bottom hole assembly (BHA). Depending on the formation, the drill bit very often shows the so called stick-slip behavior, resulting in torsional drill-string vibration.

If the torque is exceeding a certain limit, the bit is released, revolving with a very high RPM value until the torque is almost zero. The same behavior will then start again. Applying a mathematic algorithm invented by Shell Research, it is now possible to read the feedback data of the top drive or rotary table.

This information is processed and adjusted through the drive control system (SCR or VFD), inducing a behavior of the top drive or rotary table to dampen these vibrations.

This information can be computed automatically, without any manual input. The former mass-spring model, which was used to receive the relevant data, is now replaced by the real data, optimizing the vibration "filter" function.

The effect of this system is again an increase in bore hole quality and a reduced number of round trips since service life of bits and pipes are higher.

Overtorqued connections resulting from pipe vibration or even twist-offs can be avoided. The rate of penetration is significantly increased (60-100%) since the bit revolves on the bottom working with controlled constant speed.

MUD PRESSURE PULSES

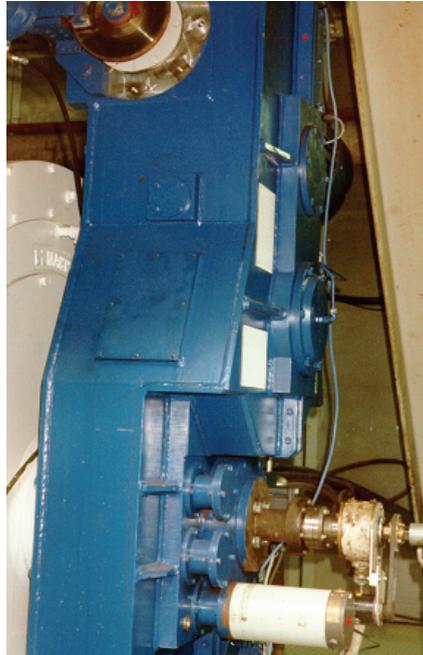
Extended reach wells require high mud pressure. Beside the drill bit operation, the mud consistency and treatment has a very high impact on the bore hole quality.

One prerequisite for achieving this required quality is constant mud flow, avoiding pressure peaks or volume fluctuation.

Whenever more than one mud pump is in operation, the common three-piston type pump needs to be controlled in

order to shift the pressure peaks of every piston in a defined pattern.

Aiming for the smallest possible overall amplitude within the high pressure system, all pumps involved are operated in a way that the stroke sequence of all mud pumps is phased in correctly, i.e. three Triplex pumps work like one nine-cylinder pump.



The feed off control system with an Emalgo brake is controlled via variable frequency drive (VFD) driven AC motors to hoist and lower the drillstring. A retrofit gearbox kit is available for any kind of drawworks and is attached to the extended shaft of the eddy current brake.

Advantages of the application of such a system are seen in reducing stress to the pulsation dampeners and to the discharge valves and piping. Knowing this pattern, LWD or MWD measurements will deliver much better results since noise, i.e. pressure peaks, can now be filtered out.

In extended reach wells, sometimes it might even be impossible to receive true MWD information without the synchronisation of the mud pumps.

WHAT ELSE?

All electrically driven land rigs, equipped with any standard machinery, can be upgraded with one or all of these systems.

The sum of all single approaches will end up in a very efficient, simple drilling machine, delivering the best possible hole quality results.

Investment that really pays off very fast will be beneficial to all. Operators can reduce the development phase due to fast-track drilling. The delivered holes are of high quality, even under difficult drilling conditions. Contractors can treat their equipment with much more care that in turn will save maintenance and spare parts costs.

Finally, applying state-of-the-art technology increases the safety on the rig. LTT's are prevented and job satisfaction is increased.

These drilling performance enhancing applications can be seen as essential to meet today's challenges. Looking beyond the immediate focus of the direct relation to the hole quality, there are other innovative systems that will bring some additional benefits with respect to overall performance and safety.

Closed loop controlled mud farms with integrated alarm and data logging can indicate a possible kick or other down-hole problems. Recorded values from wells in the same area can be displayed as a guideline for the actual job.

Cylindrical mud tanks guarantee a high homogeneity of the mud, zero spill requirements and fast changes from water-base to oil-base mud can be achieved.

Remote access to drilling data via the Internet is easily available. Real-time information fed to the teams at headquarters can be valuable for supporting the rig team onsite in finding the right solution to actual problems.

Much of this new technology is already in use, but is not being fully exploited. Introducing rig automation must be linked to systematic training programs for the drill crews.

This investment in technology and training for the future of new rig technology is both necessary and worthwhile.

It is of utmost importance to start immediately with the integration of such systems in order to be prepared for the next jobs to come. The standard rigs of today may well be assessed as no longer fit for purpose sooner than we think. ■