Evaluation of a rig's fluids handling system pays off

A COMPREHENSIVE and quantitative evaluation of the mud mixing, solids control and waste management system on a rig prior to the start of drilling can dramatically improve operational efficiency and fluid-related costs.

This is the conclusion of the authors of a paper at this year's SPE/IADC Drilling Conference in Amsterdam.

In "Intensive Evaluation of a Rig's Fluid Handling System Shown to Dramatically Improve Efficiency, Lower Costs," authors **D P MacEachern**, **Shell E&P Co** and **C E Hudson** and **B Toups**, **M-I LLC**, discuss the evaluation process.

It includes an audit of the total fluids system, aimed at assuring that the solids control, fluids handling and mixing systems are functioning to specifications and configured properly for the well objectives.

The evaluation also includes as safety audit of all areas where fluid engineers will be working.

The authors reported that on one deepwater rig in the Gulf of Mexico, the operator saved $48,000 in fluid-related costs when the evaluation revealed that the solids control equipment was not operating at peak efficiency.

MATCHING THE EQUIPMENT

Critical to the effective performance of a fluids handling system is having equipment that is properly sized, installed and operated as per the objectives of the well, said the authors.

For example, the ability to circulate at high flow rates, thereby increasing penetration rates, can be restrained if cuttings removal cannot match the circulating rates.

Also, environmental regulations—especially those concerned with oil-on-cuttings retention—and the cost of synthetic-based muds and other expensive drilling fluids mandate a handling system that will optimize fluid recovery.

Total containment and cuttings slurrification are also becoming more popular, increasing the requirements of the fluid handling system.

INTEGRATED APPROACH

Auditing the fluids handling capabilities of rigs is a fundamental component of an integrated program aimed at optimizing the design, delivery and management of fluids and wastes.

A technician checks out the length of the U-tube on a mud/gas separator to determine if it will be able to handle the required flow.

The integrated fluids program exploits the natural grouping of fluid-related products and services which includes drilling, drill-in and completions fluids; solids control and filtration equipment and waste treatment and remediation services.

This integrated service incorporates total fluid and waste management planning procedures, best practices, benchmarking, specifically developed software and other fluid technologies, thereby differentiating it from normal service bundling approaches.

This approach includes an integrated data management system, a key to continuous analysis and improvement.

The rig inspection covers 3 primary categories: Solids control, fluids handling and mixing systems.

A trained inspection engineer conducts the evaluation, and manufacturer representatives are often called in if it is necessary to examine equipment such as centrifuges, desanders, desilters and mud cleaners. The inspector also conducts the safety audit.

The solids control system is examined to determine if there is sufficient diameter and drop to allow for the expected flow rate.

Location of a gumbo box is evaluated for usefulness, ease of access and mechanical operation.

Other elements of the solids control system inspection include:

- Age and condition of the shakers;
- Direction of motor rotation;
- Belt tension;
- Conditions of the jacks, cushions and seals;
- Desander, desilter and mud cleaner operating pressure at the manifold;
- Wear on the inside of the cones;
- Motor operating horsepower and speed;
- Degasser installation;
- Plumbing and pump sizing;
- Need for additional solids control equipment.

In the fluid handling system inspection, the engineer determines if the dimension of the mud pits is sufficient for processing the volumes required on the project.

He also determines whether the equalizer lines will allow enough drilling fluid to flow from pit to pit at the maximum planned flow rate, and if sufficient agitation capacity exists to maintain a uniform mixture.

The inspection determines the most efficient locations for storing the base fluid, liquid mud and the "tote tanks" which contain large volumes of drilling fluid chemicals.

In examining the mud mixing system, the engineer determines if there is a sufficient number of hoppers for the amount of chemical and bulk material needed for the fluid system to be run on the individual well.

The ability to perform simultaneous mixing is analyzed.

And it is important, said the authors, to note whether dry bulk material can be added while taking on or mixing dry bulk cement.

The authors also cited other items to be checked during the inspection of the system components.

FIELD RESULTS

Inspections were conducted on the fluid handling systems of 6 rigs designed to drill in 2,500 to 4,000 ft of water in the Gulf of Mexico to ensure the systems were matched to the parameters of the individual well programs.

Typically, said the authors, the general fluid design parameters were: Flow rate, 1,300-1,600 gpm; standpipe pressure, 5,000 psi maximum; ROP, 100 ft/hr normal with 300 ft/hr instantaneous; fluid density, 12-14 lb/gal maximum; riser volume, 1,000 bbl; and resupply time, 24-48 hr.

Salt/polymer water base and synthetic base fluid systems were used.

Key results of the audit indicated the following about the equipment:

Flowline: The flowline should be as short as possible, with limited turns and no cuttings traps.

Audit results were generally positive for most of the rigs, said the authors, although one rig had a long and nearly flat flowline between the gumbo scalper and the shakers. The scalper was difficult to remove and could not be bypassed.

Shakers: The shakers on all the rigs examined were operating very close to specifications and were in superb operating condition. An additional shaker was recommended for only one rig, the authors report.

The main recommendation for all shakers was to improve the flow distribution by inserting a flow divider. The main limitation was space.

On this rig, the gumbo scalper was disassembled in order to add a bypass that was missing in the original configuration.

Hydrocyclones: Normally, these units are sized to the maximum flow rate of the system. Minimum acceptable process rate is 100% of the flow rate, while the recommended process rate is 125% of the flow rate.

The key to proper installation of these units is the centrifugal pump supplying the feed, said the authors.

Here, extra lines for flow distribution were added to shakers when it was discovered during the inspection that the original setup was inadequate.

Pit systems: The pit system should be divided into 3 parts: solids processing, treatment and suction. The size of the active system must be large enough to allow efficient progression of the drilling process.

Generally, there are 3 methods of sizing the action pits. The Cased Hole method uses twice the cased hole volume at TD, allowing for good displacement to completion fluids. In the Plugged Bit method, the volume required to fill the hole if all mud is lost when tripping for a plugged bit at maximum depth is calculated.

The Fast Hole method is based on 5 times the volume of hole drilled in a 24-hr period.

The IADC Deepwater Well Control Manual recommends reserve storage sufficient to contain the riser volume. Many times, the reserve pits are equal in volume to the active system.

All the rigs inspected were designed with enough piping to allow routing of mud returns to any of the active pits and some of the reserve pits. Recommended velocity through these lines is 4-6 ft/sec.

All pits should be as close as possible to a 1:1 length to width ratio for efficient agitation. Pits with ratios greater than 1:1.5 may require 2 mechanical agitators.

Mixing and storage: The speed and efficiency of mixing should match the needs of the project; mud type, hole diameter, ROP, lost circulation, solids removal equipment and daily rig cost should all be considered. Product storage requirements depend on the solids removal efficiency of the rig, hole volumes to be drilled, mixing equipment on location and resupply time.

There is no hard rule for storage, said the authors. But since many of the sections drilling in the Gulf of Mexico are completed in a few days, the rig should be able to carry most of the material required for these short intervals.

Mud pumps: Capacity of the mud pumps often limits penetration rate on Gulf of Mexico wells. Some new generation floaters use 2,200-hp pumps that can circulate at up to 7,000 psi and 2,000 gpm; some rigs carry as many as 4 of these pumps. Rigs that operate in less than 7,000 ft of water normally only have three 1,600-hp pumps.

INSPECTION SUMMARY

Early in the development of the process for integrating all fluid-related activities, a rig was selected to serve as the model for determining the value of the rig inspection.

This rig was equipped with 6 shakers that had simply been pieced together and included 4 different types of shakers from 2 manufacturers.

Early in the inspection it was obvious something needed to be done. The shaker system was evaluated and the performance monitored.

One set of older shakers operated to specifications, but was underperforming compared with new models.

An upgrade package was recommended and the upgrade reduced mud lost at these shakers by $48,000 for the remainder of the well. These initial results prompted the evaluation of the rest of the fleet.

Generally, all of these rigs needed to improve the distribution of flow to the shakers.

However, this normally should be done when the rig is in the yard for upgrading.

Some improvements in solids control were recommended. Finally, report the authors, the mixing capabilities of the older rigs needed to be improved.

Several improvement were made with the rigs on location, the most notable of which were:

- Addition of a fourth cascading shaker to one of the TLP rigs, increasing the circulating rate from 1,100 gpm to 1,300 gpm and improving penetration rates;
- Installation of a bypass system for the gumbo scalper that had previously required 5 hours for removal to prevent loss of expensive synthetic fluid;
- Adding larger motors and impellers to desilter/mud cleaner units, a change that was most effective in the water-base sections of the wells.

This article is based on 2001 SPE/IADC Drilling Conference paper 67738, "Intensive Evaluation of a Rig's Fluid Handling System Shown to Dramatically Improve Efficiency, Lower Costs."