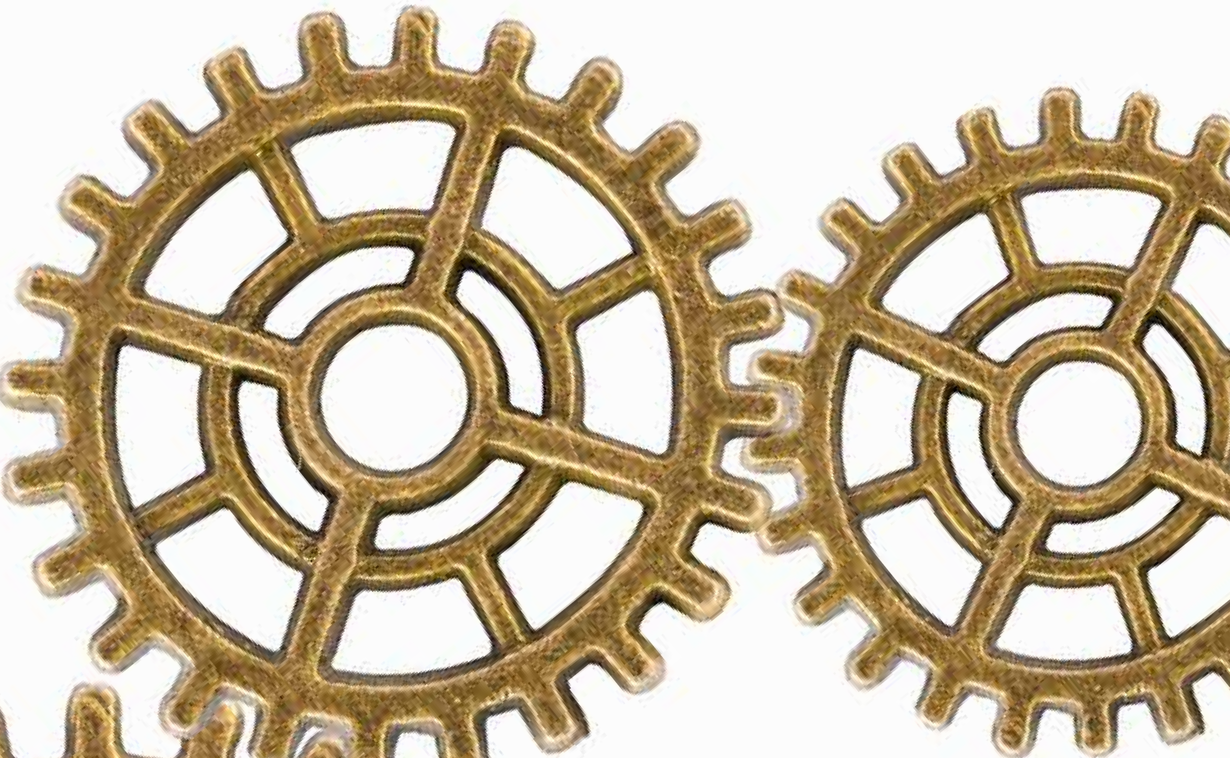
OILFIELD TECHNOLOGY

MAGAZINE | JANUARY/FEBRUARY 2025



GEARING UP FOR NEXT-LEVEL DRILLING EFFICIENCY.

Discover how advanced drilling fluid management — sensor-driven optimization, magnetic debris removal, and next-gen lubricants — work together to drive performance, reduce downtime, and set a new standard in efficiency.

AES DRILLING FLUIDS

SYSTEM-WIDE THINKING

Richard Toomes, Strategic Business Development Manager, and Matthew Offenbacher, VP Marketing and Technology, AES Drilling Fluids, argue that a holistic viewpoint of drilling fluids' impact on the drilling process is required to drive efficiency.

In the drilling fluid domain, tremendous resources are spent designing products to address wellbore challenges, reviewing offset data to optimise the drilling fluids programme, and managing logistics to minimise potential downtime. Those resources are well-spent, but to leverage drilling fluids for the greatest impact, operators must think system-wide.

Data and the drillstring

Drilling fluids are part of the larger drilling system, but their impact within the system is challenging to isolate. By marking key changes to the fluid while drilling, it is possible to review the impact across the suite of data acquired by multiple rig sensors on the electronic data recorder. This includes new methods to measure drilling fluids and marking treatment times in the rig electronic data recorder system.

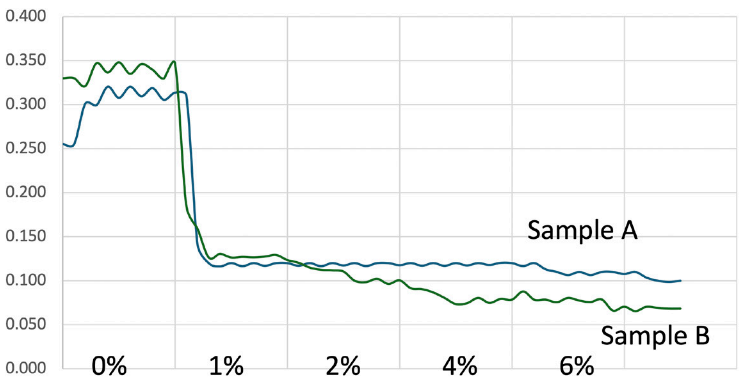


Figure 1. *LEM graph, showing relatively similar coefficient of friction reduction.*

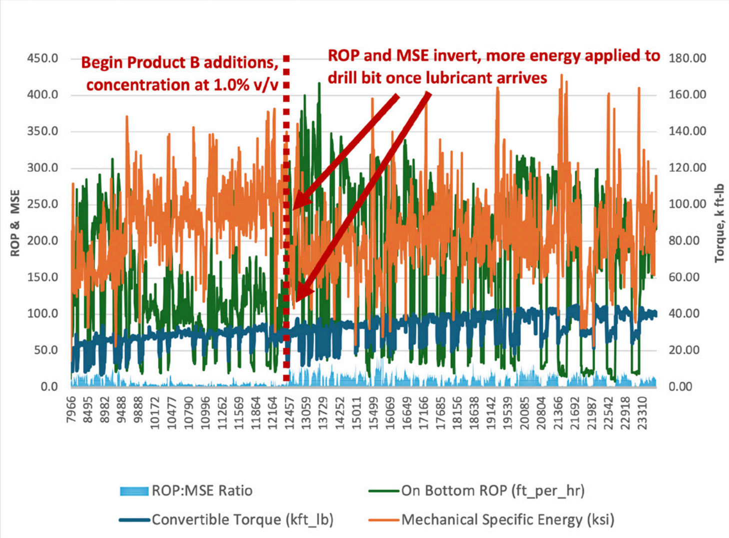


Figure 2. *MSE and ROP graph, where Product B is added and its impact on the drilling parameters is observed.*

Table 1. Elemental analysis of magnet debris from three magnet trials

Element	Trial 1 (12.5 lbm/gal.) metal abaundance	Trial 2 (15.9 lbm/gal.) abundance	Trial 3 (10.3 lbm/gal.) abundance
Si, mass%	12.9	9.6	15.7
P, ppm	913.0	592.0	908.0
Ti, ppm	1130.0	1060.0	1520.0
Cr, ppm	1470.0	1250.0	0.3
Mn, ppm	0.4	0.3	0.2
Fe, mass%	20.2	21.6	24.7
Co, ppm	168.0	499.0	115.0
Ni, ppm	208.0	139.0	227.0
Cu, ppm	342.0	255.0	235.0
Zn, ppm	277.0	131.0	229.0
Nb, ppm	63.4	49.4	167.0
Mo, ppm	207.0	133.0	455.0
W, ppm	1180.0	3160.0	779.0

Automated drilling fluid measurement systems capture changes in temperature, rheology, and density, providing faster responses to changes in well and fluid condition. This helps with faster resolution to challenges like water flows or density fluctuations. Relating these changes to data on the electronic data recorder provides improved context to drilling events for early detection and prevention of these issues.

Electronic data recorder information can capture lubricant performance, including effective concentration and application methods. A lubricant is designed to reduce torque in the drill string, but evaluation methods vary. In many situations, the lubricant is added as the rig torque limit is reached, limiting rate of penetration. Any torque reduction is then offset by increased rate of penetration, increasing the torque once more.

Electronic data recorders capture the lubricant contribution to the system through broader context of the drilling system. Mechanical specific energy (MSE) is a standardised equation to measure the energy per unit of rock drilled. In an efficient system, the drill rate increases in a linear relationship with weight on bit. Outside of the efficient region, energy is wasted through issues such as balling or whirl. These forms of dysfunction are regularly addressed through MSE trends where the energy required to drill falls off the linear path.

MSE analysis also aids in identifying when a lubricant is not the solution. In some cases, a lubricant is added when lubricity is not the primary issue contributing to excess torque. This assists in identifying the root cause of the issue while avoiding cost and misattribution of poor performance to the lubricant.

Ongoing studies combine lubricant addition times and rates with mechanical specific energy (MSE) trends to highlight the performance contribution of the lubricant. When dysfunction is addressed and the system remains in a stable drilling regime, MSE changes during lubricant addition can capture the energy efficiency delivered by the lubricant that was once lost to the drill string. More energy at the bit and less energy lost through the drill string appears as a lower MSE.

Laboratory equipment has many limitations. Most equipment cannot measure at temperature or pressure, and torque readings are far below drilling conditions. The coefficient of friction of most lubricity meters is calibrated with water, with no calibration at the lower coefficients of friction where many lubricants perform. This makes it difficult to distinguish materials once they reach lower coefficients of friction.

In the example below, two lubricants provide relatively similar coefficient of friction reductions. The lower the readings, the more inherent measurement error. This makes the two products effectively identical in performance.

Both products were trialled in the field, and Sample B outperformed Sample A on every single well of the trial. MSE demonstrated lower energy at higher rate of penetration – at lower concentrations. None of the laboratory data indicated this possibility, and drilling torque trends, while encouraging, would not clearly identify the impact of the lubricant on the drilling system.

In Figure 3, the rate of penetration and MSE appear along with a marker when the lubricant is added. The drop in MSE – even with a faster drilling rate – confirms the lubricant lowers friction to improve system efficiency. This aids to quantify the value of the lubricant to the system – and to identify when an increase in concentration no longer improves system performance.

Extending tool life

Drilling fluids carry drilling fluid additives, cuttings, and anything else introduced to the system – intentionally or otherwise. Some of these materials may not impact drilling fluid properties, but they can impact drilling fluid performance through tool incompatibility.

To further drive cost and sustainability goals, recycled and recovered base oils are used in many invert emulsion systems. The wide variety of materials and quality risks incompatibility with elastomer materials found in power sections and sealing elements of downhole tools. This can undermine tool function or result in equipment failure.

A new area of focus is fine magnetic material from casing and pipe wear. This material is continually generated throughout the drilling process, and it has the potential to accumulate over time. These particles risk interfering with measurement-while-drilling (MWD) tools and logs (including NMR). They also risk jamming tools including rotary steerable systems (RSS), leading to failure. Numerous analytical tests in the laboratory, including X-ray fluorescence, demonstrated that many RSS failures were the result of jamming from metal debris.

While magnet systems are recognised as best practice, their power and placement are often inadequate. This new system, deployed on numerous rigs downstream of existing conventional magnets, has demonstrated a surprising increase in debris removal, capturing finer particles often missed by traditional methods.

A new, high-powered magnet system reveals that traditional magnet systems leave large quantities of abrasive and magnetic materials in the fluid system undetected. Traditional ditch magnets remove larger particles (above 100 - 150 microns), while the new system utilises geometrically aligned neodymium magnets and a specialised flow path to capture a wider range of sizes, including much finer particles (D50 as low as 11.4 microns).

Multiple case studies have shown the scale of metallic debris removal from the magnet system. In one instance, the system retrieved over 1100 lb of debris in 30 days - compared to 375 lb collected by the conventional ditch magnet system. In another trial, more than 2000 lb of magnetic debris was removed over 29 days. In another case study, the reduced magnetic debris eliminated a dedicated magnet run prior to open-hole logging.

The same system was installed at AES Drilling Fluids' liquid mud plant in Kermit, Texas to maximise fluid quality sent to customer rigs (Figure 3). Multiple 500 bbl batches of oil-based drilling fluid returned from the rig site were processed through the magnet system. Significant debris was captured and removed from the fluid. Figure 4 shows the amount of debris caught by one of nine magnet rods after 1 hour circulation.

The magnetic material was sent to the AES Drilling Fluids lab for analysis. X-ray fluorescence (XRF) analysis revealed abundant concentrations of iron, silicon, phosphorus, titanium, and other metal ions found in casing and drill pipe (Table 1).

Fluid quality for tool compatibility remains a focus towards increasing reliability and extending drilling performance. These methods may prove more impactful on longer laterals where RSS is used, fluid exposure times increase, and the cost to trip and replace tools is higher.

Pipe protection

Drill pipe has a limited life, encountering various costs to prevent failure during drilling. Hard banding requires periodic replacement, and inspections are required to ensure pipe will not fail under continued stress.

Figure 3. *A total of nine magnet rods are positioned in the flow box, affixed above a 500 bbl mix pit at AES Drilling Fluids' wellsite in Kermit, Texas.*

Figure 4. *Magnet rod with metal debris attached after 1 hour circulation of 500 bbl used oil-based mud at the mix plant.*

Corrosion control is the most common fluid option to extend pipe life through monitoring and fluid treatment. This includes corrosion coupon analysis, corrosion prevention additives, and keeping water-based drilling fluid at higher pH – usually above 9.0.

Anti-wear compounds developed as motor oil additives exhibit the potential to limit pipe wear. When materials slide past one another, asperities form in the smooth surface. These peaks and valleys rub against one another, increasing friction and resulting in metal loss. The anti-wear material bonds to the valleys of these asperities, and, over time, the peaks wear, resulting in a smooth metal surface.

Combining select chemistries with conventional lubricant additives results in superior lubricity with a strong, lubricating film between smooth surfaces. The strength of the lubricating film prevents galling and other forms of metal loss under extreme drilling conditions.

Summary

Drilling fluids contact everything in the drilling process. A holistic viewpoint of how fluids and fluid additives interact drives efficiency in all parts of the system.