Intelligent Fluids Monitoring System

Automated analysis of critical parameters in challenging and remote applications
Wellsite personnel requirements are further aggravating continually rising costs and associated liabilities, particularly in remote and challenging applications. In addition, more complex well plans, mature field development and advanced hydraulic simulation technologies demand better control over the drilling fluid process. The Intelligent Fluids Monitoring (IFM) service from M-I SWACO comprises sensors and tools that collect, analyze and monitor essential fluid properties with immediate data transfer to onshore operational centers. IFM allows for more reliable and frequent testing during ongoing operations.
Features
- Fully-automated and remotely-controlled fluid sampling sequences and procedures
- Programmed statistical analysis of measurements for improved data quality
- Seamless data transfer to any preferred knowledge hub of operators, partners and/or service companies
- Integrated with Schlumberger InterACT high-speed data transfer technologies
- Real-time continuous monitoring of critical fluid parameters, including emulsion stability, density, temperature, particle size distribution and multi-temperature rheology
- Onshore operation centers can be fully integrated to provide real time support to ongoing drilling operations

Benefits
- Precise and reproducible data flow
- Fewer wellsite personnel required
- Higher data quality
- Optimized data reliability
- Increased testing frequency
- Reduced operational costs
- Minimized HSE risks

Operators have long envisioned the full automation of the drilling process, particularly for technically challenging and remote locations like deepwater and mature field development.

Much of the focus has centered on automating the measurement of critical well parameters, reducing the costs and liabilities of wellsite personnel and generating higher-quality and more frequent data that are required of today’s complex and high-cost operations.

The M-I SWACO Intelligent Fluids Monitoring (IFM) system moves operators closer to realizing that vision. IFM is a package of new-generation sensors and associated instruments that capture pertinent data on fluid performance for continual, high-speed transmission to onshore support centers. IFM allows the automatic sampling, monitoring and analysis of critical fluid properties throughout an ongoing operation, including such parameters as:

- Density and temperature
- Rheology
- Water content of invert emulsion drilling fluids
- Electrical stability
- Chemical composition
- Particle Size Distribution (PSD)

Many of the instruments within the IFM inventory capture and transmit data continuously. Fluid properties can be analyzed at a rate far more frequent than the standard four daily manual tests and once-a-day reporting. The data captured also has been shown to be of much higher quality than that possible with conventional manual testing techniques and equipment.

Given the advancements in hydraulic simulations used in ultra-extended reach, Managed Pressure Drilling (MPD) and similar applications, the frequency and quality of data captured during an operation are of paramount importance.

As importantly, IFM frees up rig site fluids specialists to concentrate on ways to better control the process and improve your overall efficiency.
The IFM ensemble raises the bar in analytical instrumentation

M-I SWACO knows what it takes to get the most out of a drilling, reservoir drill-in and completion fluid. The IFM system, we capitalize on that expertise for a cradle-to-grave solution that focuses on the very latest in sensor technology, measurement transmission, monitoring and interpretation.

The patented and patent-pending instruments within the IFM system, are engineered to give you a choice. You can install the system as an all-inclusive package that would include the Schlumberger InterACT high-speed data transference system. Or you can install individual components on your offshore or onshore operation. For example, if you are using PRESSPRO RT® real-time downhole measurement software package, the automated rheometer can export data directly into the engineering package to ensure continually updated pressure simulations.

Whether you want a complete package or an individual component, M-I SWACO offers an extensive portfolio of laboratory and field-proven instrumentation technologies designed to meet your specific requirements.
- Automated Electric Stability meter (AES)
- Focused Beam Reflectance Measurement (FBRM)
- Water Content Measurement unit (WCOM)
- Coriolis Density and Temperature Sensor
- Advanced RheoMeter (ARM)
- Automatic X-Ray Fluorescence (AXRF)
Automated Electric Stability Measurement (AES)

The remotely controlled and programmed AES delivers electric stability (ES) measurements of the highest precision and frequency rate.

AES comprises three main sections: an electronic compartment, the test chamber assembly and the sampling and cleaning system with an associated pump, valves and piping. In operation, the AES draws a fluid sample from the active circulating mud system. The sample is then run through the heating/cooling jacket within the test where it is heated or cooled to the set standard temperature, typically 122°F (50°C).

The AES is programmed to perform up to nine API-standard ES measurements and afterwards remove the highest and lowest values and average those that remain. The averaged measurement data is then transmitted through a WITSML data platform, which is fully compatible with Schlumberger InterACT. Afterwards, it’s just a matter of setting the waiting period for the next round of sampling. All the settings can be adjusted by remote control.

Compared to manual ES meters, the AES offers a host of advantages, not the least of which is its capacity to be remotely operated and controlled through off-site data networks. This ability frees up rig site personnel who otherwise would be occupied with fluid testing. The AES unit also can run tests at a much higher frequency than manual testing. In addition, the ES probe within the test chamber is a radically improved version of the standard manual ES probe and is designed to reduce voltage leakage which historically disturbed measurements performed with handheld units.

Focused Beam Reflectance Measurement (FBRM)

Focused Beam Reflectance Measurement (FBRM) is a classic example of technology transfer from other industries to the oilfield. The rugged ATEX-approved FBRM represents a new generation approach to determining the particle size distribution (PSD) of an active drilling fluid system. Unlike the laser diffraction method used in conventional particle size distribution measurements, FBRM takes a count-based approach, rather than the standard normalized values where a change in one area can alter completely the particle size distribution in other areas. In other words, with FBRM, variation in a given particle size range is independent of changes in other size ranges of the distribution.

The FBRM is a laser beam split through a pneumatically-powered rotating optic circumscribing a circle 0.28-in (7 mm) in diameter. The rotational speed of the instrument measurement settings can be altered between 2 and 4 m/sec (7-13 ft/sec). The laser beam is focused close to the surface of a sapphire window that is exposed directly to the drilling fluid, thus eliminating the accuracy and preparation issues associated with fluid sampling.

Typically, the instrument measures 50,000 – 200,000 particles/sec, and despite the variation in particle shape, delivers a robust representation of the actual particles. Depending on the application, the FBRM can be set to run in either a coarse or fine mode. This capability has been shown to be useful in determining the concentration of bridging materials for a drilling fluid used in depleted zones.

Water Content Measurement unit (WCOM)

The Water Content Measurement unit (WCOM) unit continuously measures the capacitance, or the ability of the fluid to store an electrical charge, in an oil base drilling fluid. Capacitance is nearly linear to the water content of the fluid. Once installed in a continuously running mud stream, the WCOM automatically delivers output that essentially is a continuous 4-20 mA signal at a rate of 1/sec. As opposed to a standard manual retort analysis, the allows the analyst to quickly detect changes in the water concentration within the fluid system. As a redundancy, however, it is recommended being that a manual retort analysis be run in parallel to generate sufficient oil-water content data.
Once captured, the data is transferred through the rig sensor system to the onshore support center for immediate analysis. The output is a standard 4-20 mA powered loop signal transmitted to a field server and made available in WITSML data format.

**Coriolis Density and Temperature Sensor**

To measure the density and temperature of an active fluid, the IFM system relies on the micromotion/emerson coriolis flow meter, an extremely precise analytical instrument. The sensor comprises a fluid temperature probe that allows for the subsequent correlation of density with the varying temperatures tracked. The ability to directly correlate density with temperature is critical in determining chemical mixing requirements and reduces the chance of misinterpreting weight variations. This is an especially advantageous feature when drilling in depleted formations or similarly demanding operations where maintaining the precise density is a critical priority.

The Coriolis Density and Temperature Sensor consists of an omega-shaped full-bore tube that vibrates sideways. Filling the tube with fluids of varying density changes the vibration pattern. The fluid density is correlated continuously to the vibration changes, allowing early detection of even small density variations. With early detection, you save time and the costs of over-treating with weight material and chemicals.

What’s more, by automating the density and temperature measurements, you eliminate the inaccuracies intrinsic with manual testing following a crew change when incoming personnel may employ different procedures and equipment. Automation removes uncertainty and improves the overall quality of measurements.

**Advanced RheoMeter (ARM)**

The Advanced RheoMeter (ARM) is built on the AES unit after the ES probe and electronics are removed and replaced with a motor and torque sensor. Afterwards, the ARM carries out a sampling sequence identical to that of the AES unit. A mud sample is heated to various temperatures, after which the analyst can determine rheology, including gel strengths, for all the temperatures. What this does is produce an extended rheological profile of the working drilling fluid.

Using the ARM offers a host of advantages over manual rheology testing, including the capacity for remote operations as the instrument can be controlled via data networks from any offsite location. The ARM also allows for continuous rheology testing at frequencies much higher than the rates that are practical with manual testing. In addition, the test data can be exported directly into logging software as well as VIRTUAL HYDRAULICS® and PRESSPRO RT hydraulic simulation packages.

**Automatic X-Ray Fluorescence (AXRF)**

The patented Automated X-Ray Fluorescence (AXRF) unit represents a new generation of instruments for ascertaining the elements of various drilling fluid components. Like the ARM, the AXRF is built into the AES chassis where mud is purged through the unit where a sample is irradiated with x-rays. The absorbed energy is later released with the frequency and amount of energy emitted is detected and recorded in a spectrum. Afterwards, the captured data is processed and the quantitative numbers exported via WITSML.

The elements targeted with our AXRF technology include:

- Barium, Ba
- Cesium, Cs
- Bromine, Br
- Calcium, Ca
- Potassium, K
- Chlorine, Cl
- Sulfur, S
- Silicon, Si
- Aluminium, Al
A network of sensors and instruments that deliver

The amount of elements being present in the mud sample is correlated with a database and the ensuing numbers are interpreted as the overall chemical component concentration of the fluid.

The AXRF represents a step-change improvement in precise analysis of drilling fluid components. Earlier generation element analysis instruments relied on low radioactive sources. The later development of new-age sensors and high-voltage sources revived investigations into element analysis, which the HSE ban had put on the shelf for a time.

With AXRF, M-I SWACO can automatically determine important drilling fluid parameters without the need for conventional retorting and chemical analysis, thus saving both time and costs.

IFM also provides safer option for fluid testing

Besides reducing rigsite personnel requirements, the IFM delivers added HSE advantages. For instance, the AXRF automatic x-ray fluorescence element Analysis module eliminates or reduces significantly the risk of explosions and other inherent hazards associated with conventional HPHT retorting for analyzing drilling fluid elements. With the IFM, most tests are run without requiring personnel to handle potentially harmful solvents and test chemicals.

Norway: FBRM provides solution for real-time PSD monitoring in depleted zones

The Situation
An ongoing development campaign in the mature portions of the Tampen area in the Norwegian North Sea employs Managed Pressure Drilling (MPD) to reduce overbalance while drilling. Due to the highly depleted reservoirs, the operator increased emphasis on preventative treatments for induced and natural fractures. The focus intensified during pre-drill planning for the depleted reservoir section of the HPHT Kvittebjørn Field, characterized by highly localized pressure depletion and high overbalance between the wellbore and formation, resulting in a greatly reduced fracture gradient and increased risk of lost circulation. Accordingly, the monitoring and maintenance of PSD size and concentration in the drilling fluid was critical to affect efficient bridging and plugging/sealing of drilling-induced fractures and prevent fluid loss.

The Solution
After a series of successful yard tests and comparative studies, the operator recommended M-I SWACO employ its Focused Beam Reflectance Measurement (FBRM) instrument for remote real-time monitoring and management of PSD in the depleted field.

The Results
The field trial, in which the FBRM was monitored remotely from the operator’s onshore support center, was judged a complete success. Actual drilling rates were faster than those recorded in offsets. How much faster? The FBRM system proved useful for establishing guidelines for solids control management and procedures for maintenance of particle size distribution via the addition of formation bridging and fracture plugging materials. As importantly, tests demonstrated the instrument was able to monitor concentrations as low as 10g/l of coarse to extra coarse particulate material in an opaque drilling fluid. Following completion of the drilling project, the FBRM data was shown to corresponded well with slot plugging test data using a Production Screen Tester (PST), wet sieve analysis and with the laser diffraction analysis. A further advantage of the test instrument was that it required no mechanical modifications and no changes to the software or format of the user interface/data output. The FBRM with its rugged and ATEX-approved design was adapted easily into the harsh environment typically experienced around the circulation of a drilling fluid system.

Questions? We’ll be glad to answer them.

To learn more about how the IFM system can lower your costs and improve your efficiency, please contact the M-I SWACO representative nearest you.
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