LFA Live Fluid Analyzer

Confidence in sampling
Applications
- Downhole fluid identification
- Fluid sampling
- Oil and gas condensate sampling in oil-based mud (OBM) environments

Benefits
- Monitors OBM filtrate contamination for fluid sampling
- Allows informed decision-making for timely sample acquisition
- Increases and optimizes sampling efficiency
- Assures single-phase fluid sampling

Features
- Independent, real-time, quantitative contamination monitoring using color and methane content
- Predictable cleanup period for quality sample collection
- Reliable discrimination between water, oil and gas
- Differentiation between various reservoir hydrocarbons
- Dependable identification of free gas using two independent detectors
- Timely detection of phase change onset

LFA overview
Since 1991, Schlumberger has used optics for downhole fluid identification in the MDT* Modular Formation Dynamics Tester. The LFA* Live Fluid Analyzer is a new MDT module that utilizes new downhole optical techniques to analyze fluids as they flow through the MDT tool. The term “live fluid” is commonly used to refer to pressurized reservoir fluid samples that remain in single phase. The LFA fluid analyzer builds on and improves existing optical fluid analysis with its unique ability to detect and measure dissolved methane in live fluids. Oils of different types can be differentiated based on both their methane content and color.

Importance of samples
Reservoir fluid samples are normally evaluated in the laboratory to measure their physical and chemical properties. The accurate determination of these properties is critical, not only to characterize and produce a reservoir, but also to design well completions, subsea tiebacks and topside facilities. Error in these measurements can be significant even with relatively small levels of miscible contamination. To acquire a representative downhole fluid sample, the unwanted drilling fluids that have invaded the formation have to be removed by extracting fluid until the level of contaminant is acceptable. Then the fluid sample can be acquired.

Today, many wells are drilled with oil-based muds (OBM), which are miscible with formation hydrocarbons. The use of this type of OBM, or synthetic OBM, creates the need to quantify and monitor the level of oil-based filtrate that is mixed with the reservoir hydrocarbons as it flows through the MDT tool. The ability to analyze and monitor the flowing fluid allows real-time decisions to be made during the operation.

Optics and reservoir fluids
The LFA module employs an absorption spectrometer that utilizes visible and near infrared light to quantify the amount of reservoir and drilling fluids that are in the flowline. Light is transmitted through the fluid and measured as it flows past the LFA spectrometer. The amount of light absorbed by the fluid depends on the composition of the fluid. Water and oil are reliably detected by their unique absorption spectra. A second sensor in the LFA module is the gas refractometer, which can be used to differentiate between gas and liquid.

The LFA spectrometer uses light in the visible and near infrared range to characterize the fluid flowing through the flowline. The refractometer provides discrimination between the liquid phase and the gas phase.
**OBM filtrate and sample contamination**

Since methane is present in all naturally occurring hydrocarbons and is absent in drilling fluids, any methane detected is due to reservoir hydrocarbons and not filtrate. By detecting the methane, the LFA module can ensure that a quality sample can be captured once the oil-based filtrate contamination is reduced to a level specified by the customer. As a result, high-quality fluid samples, which meet customer requirements, are acquired efficiently and cost effectively.

**Bubblepoint and sampling**

Quantitative monitoring of OBM filtrate contamination is not sufficient to ensure that the sample will be valid. During the sampling process, care must be taken to ensure the flowing pressure remains above the bubblepoint. Initially, the fluid flowing from the reservoir will be largely contaminated with OBM filtrate, which will tend to lower the bubblepoint of the mixed fluid. As the flow from the reservoir continues, the contamination level of the produced fluid is reduced, and the bubblepoint will increase to that of the virgin reservoir fluid. If the bubblepoint unknowingly rises above the flowing pressure, the sample collected will not be representative of the reservoir fluid. The LFA module includes a sensitive and reliable gas detection system that monitors the fluid as it flows from the reservoir. This ensures that a single-phase fluid sample is captured by adjusting the flowing pressure as needed.

The LFA gas detector, in combination with the methane measurement capability of the LFA module, is a unique system that can determine if the bubblepoint of the produced fluid rises above the flowing pressure. The methane measurement responds to the entire fluid volume within the MDT flowline and improves the sensitivity to free gas.

Oil samples from around the world have been analyzed by the LFA module.
**Principles of methane measurement**

At certain wavelengths of near-infrared light, the molecular bonds that are specifically associated with a hydrocarbon fluid will vibrate. This vibration results in an absorption of light. Measuring the light absorption at these wavelengths can identify a fluid as a hydrocarbon.

The dead oil spectrum (black) at the right, which is hydrocarbon with no methane, has its strongest absorption peak at 1720 nm. This wavelength is specific to carbon compounds with two hydrogen atoms for every carbon atom. The methane spectrum (red) has its strongest absorption peak at 1670 nm. This wavelength is specific to methane, which is the only molecule with four hydrogen atoms for each carbon atom.

The live oil spectrum (green), which is a mixture of methane with dead oil, exhibits absorption peaks at both 1670 nm and 1720 nm.

The optical sensor in the LFA tool uses this principle to measure the absorption of light at both 1670 nm and 1720 nm. The resulting graph accurately identifies live oil for quality sampling.

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**Optical density spectra can be used to uniquely identify different fluids.**