article

Development and Real-Time
Monitoring of the Rheological Properties of Frac Fluids

author

Charles Wesley
For information, please contact:
Steve Cicchese or Charles Wesley
800-628-8139, or 508-946-6200
www.brookfieldengineering.com

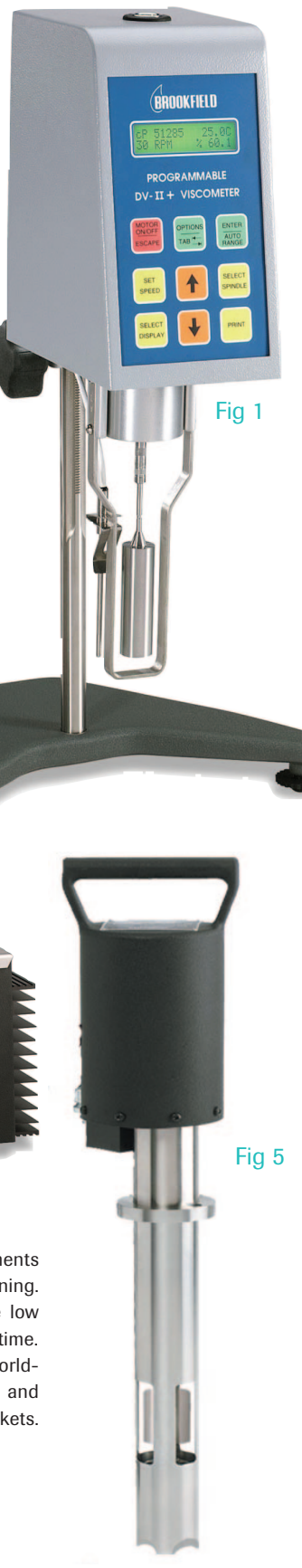

Fig 1

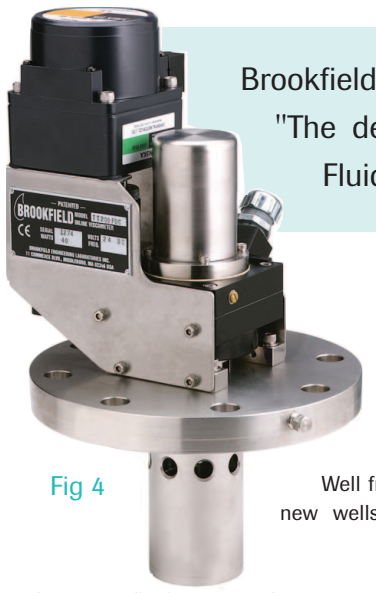

Fig 4

Brookfield Engineering's Regional Sales Manager, Charles Wesley, recently presented "The development and Real-Time Monitoring of the Rheological Properties of Frac Fluids using Laboratory and in-line instruments", at Oceantex in Mumbai, India.

Well fracturing operations, which increase the yield from existing and new wells, require proper rheology of the fracturing fluid which is introduced "down the hole" at pressures up to 1400 bars. Under this pressure and assuming correct rheology, the fracturing fluid ruptures the surrounding strata. Suspended sand (called "proppant") carried by the fluid, is released into the small cracks and fissures created by the fracturing process and increases the porosity and oil/gas flow in both land and off shore drilling operations.

To optimise fracture operations that increase porosity in the underground strata around the well, the fracturing fluid's viscosity must be high enough under low shear conditions to suspend and carry proppant to the smallest crevices in the fractured rock. In addition, its viscosity must be low enough under high shear rates so that adequate flow to these newly fractured strata is obtained and the proppant is released.

As part of the laboratory development of the fluid, its rheology must be measured, evaluated, and understood over the majority of shear rates likely to be experienced at the well site so that an understanding of the fluid's behaviour is known before it is pumped through the system. Simple tests at low shear rates are often done with the Brookfield's LVDV-II+ Viscometer (see figure 1); when used with cylindrical spindles or a Small Sample Adapter, the DV-II+ measures at the lowest required shear rates - below 0.1 sec^{-1}. With the LVDV-II+ Viscometer a change in viscosity that might affect the suspension properties of the fluid can be clearly seen. Proper control of low shear rate viscosity (LSRV) measurements can improve hole cleaning, reduce torque and drag, and improve hole stability. In addition to controlling how the proppant is moved.

However, more sophisticated tests require a computer based, software driven rheometer (like the Brookfield PVS Rheometer (see figure 2)) that measures viscosity under pressure, and in addition can determine yield stress, provide the means to test at different shear rates, time spans, temperatures, pressures, and provides data analysis, recording and plotting capabilities.

Traditionally, field engineers at the well site used a small bench top viscometer with coaxial cylinder geometry to test grab-samples of the fracturing fluid. This frequently, failed to detect, in real time, variations in viscosity as the fluid was blended and pumped into the well, possibly resulting in flawed conclusions about what was actually going on in the well.

The solution to this is to install process viscometers (like the Brookfield pipeline mounted TT100 (see figure 3), and flange mounted TT200 (see figure 4) which are widely used in the oilfield services industry) employing the same geometry and operating at the same shear rate (usually 511 sec^{-1}) as the bench top coaxial cylinder viscometers. A process viscometer provides real-time, in-line measurements for gels moving in pressurised lines from blenders before being pumped down-hole. It will continuously verify, at the well site, that the rheology of the fracturing fluid is within established specifications and provide an alarm indication when it is not, thus providing the means for precise, real time, viscosity control along with a complete and accurate record of the fracturing process. The result is reduced costs, less wear on equipment, better control, and lower risk of damage to the underground geological formation.

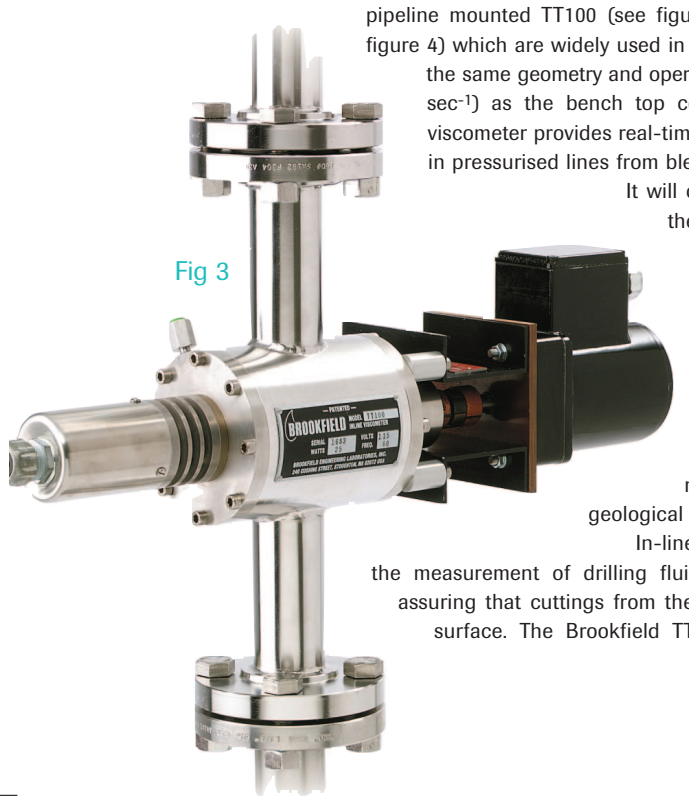

Fig 3

In-line process viscometers are also used for the measurement of drilling fluids. Fluid viscosities are important for assuring that cuttings from the well bore are transported back to the surface. The Brookfield TT-220 Probe Viscometer (see figure 5) provides quick, direct low shear rate viscosity measurements in drilling fluid tanks, and can be easily removed for cleaning. Successful in-line monitoring of drilling fluids at these low shear rate viscosities can save well owners costly down time.

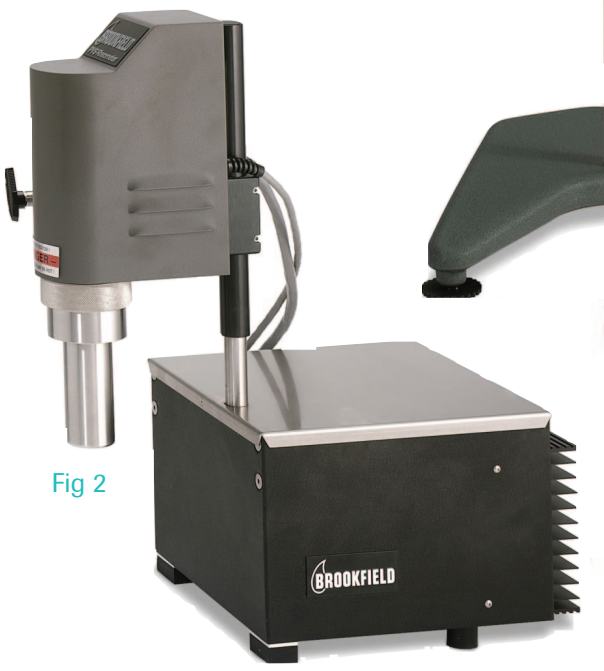

Fig 2

Brookfield Engineering Laboratories, Inc. is a world-recognised leader in viscosity measurement and control and has a 70-year history serving a broad variety of markets. Brookfield is an IS09001 certified company.

Fig 5

For information about the PVS, TT100, TT220, or the TT200 Viscometer or other Brookfield products and services, contact Steve Cicchese or Charles Wesley at 800-628-8139, or 508-946-6200, or visit the website at www.brookfieldengineering.com.

Steven Cicchese is the General Manager, and Charles Wesley is a Regional Sales Manager with Brookfield Engineering Laboratories for Process Sales.

Captions

Figure 1: DV-II+ Programmable Viscometer Measures at the lowest shear rates.

Figure 2: PVS Rheometer for measuring Viscosity at high pressure & temperature

Figure 3: TT100 Pipeline Mounted Viscometer

Figure 4: TT200 Flange Mounted Viscometer

Figure 5: TT220 Probe Viscometer Direct low shear rate viscosity measurements

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