

HPHT Lubricity, Dynamic Filtration, and Drilling Simulation Multifunction Tester

The M2200 HP/HT Lubricity, Dynamic Filtration, and Drilling Simulator provides multiple test functions in one compact unit, offering a computer-controlled test environment which can realistically simulate high pressure high temperature downhole conditions while allowing the user to perform multiple test functions, saving money, training and research time, and the laboratory space that multiple test devices would otherwise require.

The **M2200** is engineered for laboratory HP/HT testing of fluid lubricity, filtration, and the simulation of a downhole drilling environment.

- ☑ fully-customizable test parameters
- ☑ automatic pressure & temperature control
- ☑ automatic data collection
- ☑ fully compliant with API 13B

Real HPHT Dynamic Lubricity Test

The M2200's very repetitive COF (coefficient of friction) measurement of plus or minus 0.01 is due to its unique, patented design. The M2200 is the only HP/HT lubricity tester available in the USA that is reliable in evaluating dynamic lubricity performance on different types of drilling fluids, and can do so at high pressure and high temperature reservoir conditions that are completely user-controlled. The M2200 can evaluate all oil-based drilling fluids, water-based drilling fluids, and synthetic-based drilling fluids. Additionally, chemical additives can be blended into the drilling fluid to evaluate the change in the lubricity performance.

The M2200 tests the lubricity of the drilling fluid by axially rotating a rubbing shoe while a metal or core sample is pressed against it. Rotating torque and upward force yields the friction factor and lubricity. The user can also test customized geometries and materials by replacing the shoe component, such as drilling string and casing materials. From this information, the user can recommend proper mud systems, determine optimum lubricant concentrations, develop new lubricant additives, predict drill string loads, minimize torque and drag, and improve drill string design techniques.

Differential Sticking Test

A differential sticking test can be performed whereafter the filter cake has been deposited, the load is applied and then the rubbing shoe is rotated. The torque required to move the rubbing shoe is measured.

Lubricity and Differential Sticking Test Specifications:

Temperature Range:	Amb. to 500°F
Working Pressure:	2,000 psi
Max Torque:	120 Pound per Inch (14 N.m)
Max Power Requirement:	1,200 W

Power Supply:	220-240V AC at 50-60 Hz
Sample Volume:	350 mL
Filtrate Volume:	45 mL
Shear Bob Speed:	0 to 600 rpm
Coefficient of Friction (COF) Accuracy:	+/- 0.01 (when COF < 0.15)



U.S. Patents: 9,194,784 and 10,215,001

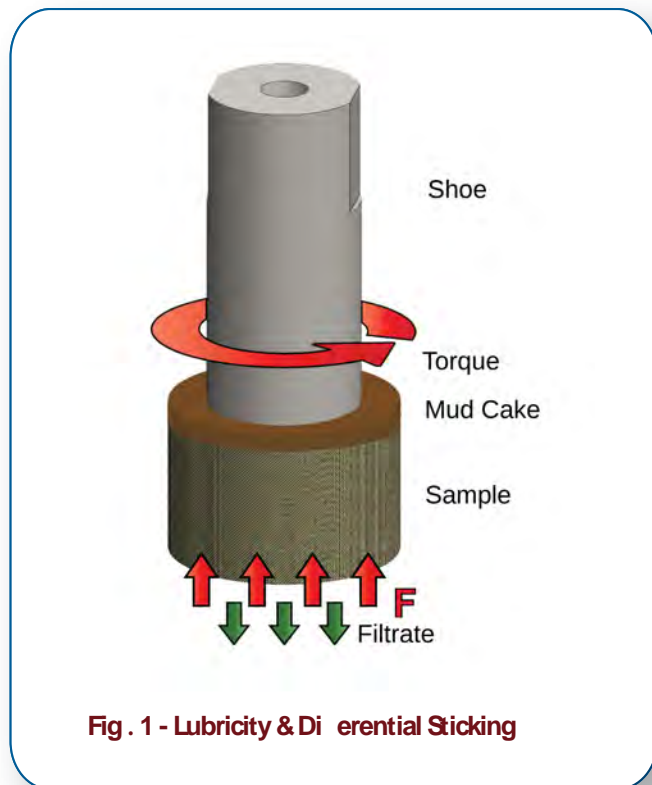


Fig. 1 - Lubricity & Differential Sticking

Dynamic HPHT Filtration Test

The M2200 includes a pressurized, temperature-controlled environment containing a filtrate medium which realistically simulates a downhole well bore. When the simulation chamber is filled with drilling fluid under either static condition or re-circulation condition, a shear bob simulates the drilling string centrally or off-centrally rotating inside of the filtrate medium to produce a shear inside of the filtrate medium. The filter cake deposit becomes visible on the interior of the filtrate medium as the fluid is sheared, and the resulting build-up can be examined following the completion of the test. An optional mud circulation pump is available at reduced temperature and pressure conditions.

Dynamic HPHT Filtration Test Specifications:

Temperature Range: Amb. to 500°F
 Working Pressure: 2,000 psi
 Max Differential Pressure: Determined by core strength
 Max Power Requirement: 1,200 watts

Power Supply: 220-240V AC at 50-60 Hz
 Sample Volume: 350 ml
 Filtrate Volume: 45 ml
 Shear Bob Speed: 0 to 600 rpm
 Max Penetration Depth: 0.8 in.

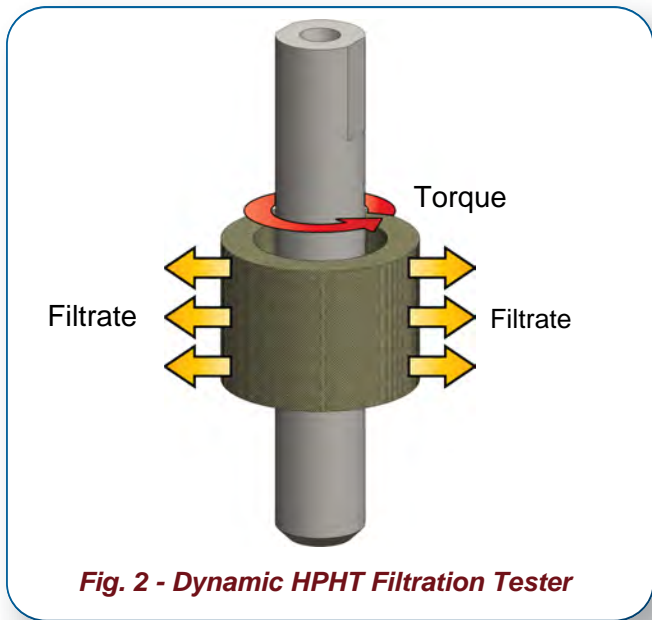


Fig. 2 - Dynamic HPHT Filtration Tester

Particle Plugging Test

Lost circulation is the uncontrolled flow of whole drilling fluid into a formation with no return to surface, especially within those formations that are inherently fractured, cavernous, or have high permeability. Lost circulation also occurs when improper drilling operations damage the mud cake as drilling fluid invades and further damages the formation.

The M2200 includes a specialized filtrate medium with an artificial fissure that can be used to perform particle plugging tests, which determine the effectiveness of additives to help prevent lost circulation in the filtrate medium (see Fig. 3). Particle plugging tests also determine the effectiveness of bridging materials. M2200 simulates an off-centric drilling string rotating and damaging the filter cake, and thus, measures the performance of bridging materials on improvement of fluid loss.

Particle Plugging Test Specifications:

Temperature Range: Amb. to 500°F
 Working Pressure: 2,000 psi
 Max Differential Pressure: Determined by core strength
 Max Power Requirement: 1,200 watts

Power Supply: 220-240V AC at 50-60 Hz
 Sample Volume: 350 mL
 Max Filtrate Volume: 45 mL
 Shear Bob Speed: 0 to 600 rpm

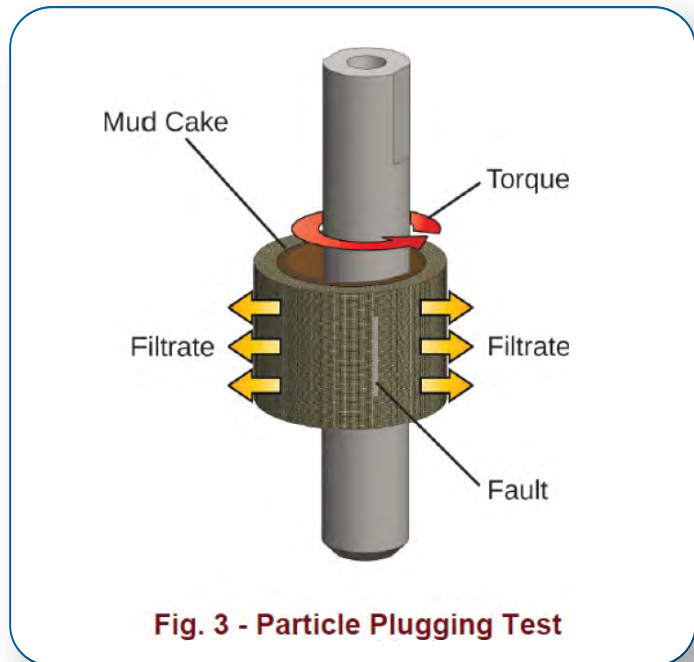


Fig. 3 - Particle Plugging Test

Real HPHT Drilling Simulation System

The M2200 can be also used to simulate drilling operations and optimize mud systems to reduce overall drilling costs. (Refer to Fig. 4.) The M2200 hardware includes an ultra-realistic well-bore simulation chamber, which allows the user to test the penetration rate on actual core samples using a real drill bit (shown in Fig. 5).

The core sample options can be different types, such as sandstone, limestone, ceramic, etc., allowing the user to select for the matching rock parameters of the reservoir to be drilled. The penetration rate is measured through linear transducers. The pressure and temperature of the simulation chamber are controlled by custom M2200 PC software, which monitors and records test results in real time. Filtration during the drilling process is measured and recorded as well.

Drilling Simulator Specifications:

- Temperature Range: Amb. to 500 °F
 - Working Pressure: 2,000 psi
 - Max Differential Pressure: 500+ psi (or determined by core strength)
 - Max Power Requirement: 1,200 W
 - Max Torque: 120 lb./in. (14 N.m)
 - True measurement of rate of penetration (ROP).
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- Power Supply: 220-240V AC at 50-60 Hz
 - Sample Volume: 350 mL
 - Filtrate Volume: 35 mL
 - Shear Bob Speed: 0 to 600 rpm

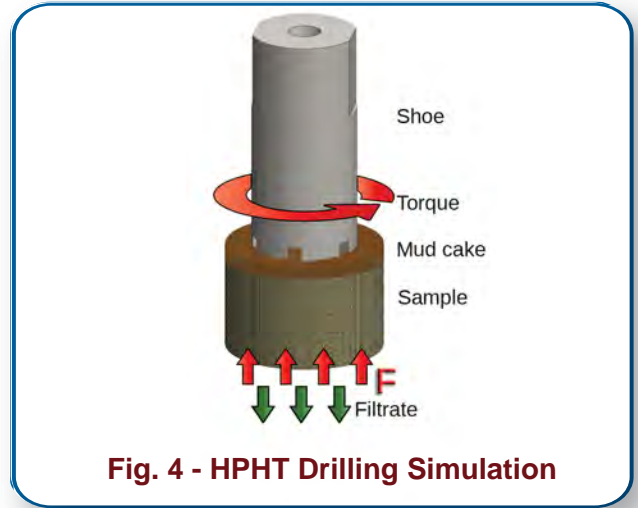


Fig. 4 - HPHT Drilling Simulation



Fig. 5 - A real drill bit is used to simulate drilling

M2200 PC Software

The M2200 instrument includes custom software called M2200 PC (refer to Fig 6), which gives the user the ability to create test sequences with these parameters:

- Temperature
- Pressure
- Differential pressure
- Shear rate

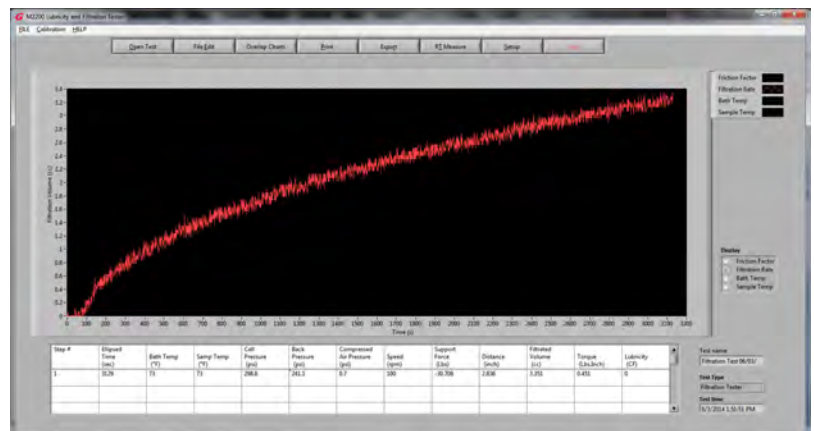


Fig. 6 - M2200 PC software