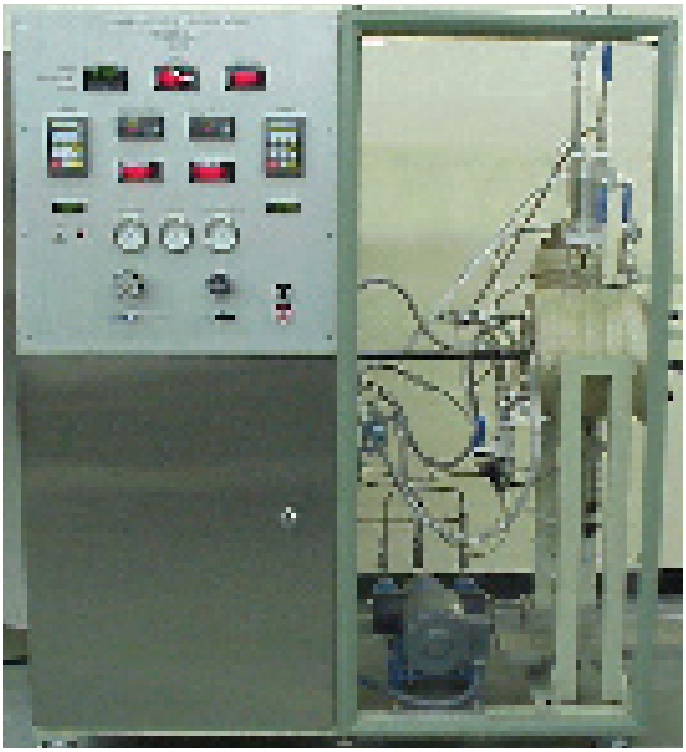
Temco, Inc.

Design Excellence in Core Analysis Instrumentation

Lubricity Evaluation Monitors

LEM Series



The LEM Series of lubricity evaluation monitors are designed for the static or dynamic testing of drilling fluids or muds and lubricants at atmospheric and reservoir conditions. Excessive torque and drag can have many adverse effects during the drilling process. To optimize the drilling process, various drilling mud and lubricant combinations need to be evaluated. This series of instruments is designed to allow the end user to measure the mud lubricity or friction coefficients between a simulated tool joint and a well bore surface under simulated reservoir conditions. The instruments are designed to test reservoir core samples as well as various drill pipes or 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. From this information, the end user will be able to optimize the drilling process to reduce the overall drilling costs.

Applications

These instruments can be used for the testing of the following properties:

- Mud Lubricity or friction coefficient between the drill bit and the reservoir rock
- Mud Lubricity or friction coefficient between the drill bit and the reservoir rock with filter cake buildup
- Mud Lubricity or friction coefficient between the drill pipe and the casing
- Effects of chemical additives to lubricity
- Drill Bit sticking tests with and without filter cake buildup
- Mud Lubricity or friction coefficient as a function of temperature and pressure

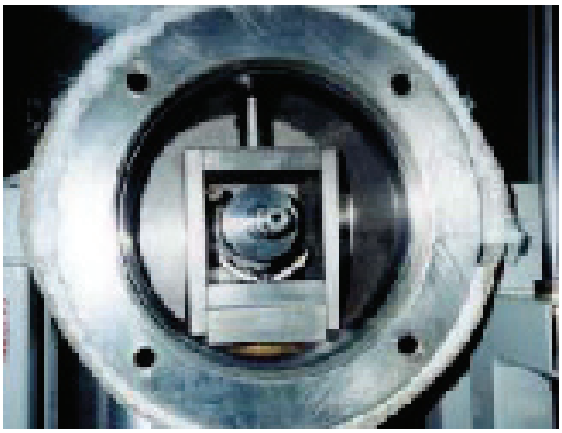
Instrument Operation

The series of LEM instruments all operate in a similar fashion. A test sample of sandstone, limestone, quartz glass, ceramic, field core, or casing is installed into the sample holder within the mud test cell. A carbon steel bob, which simulates the drill stem or tool joint, is inserted into the mud test cell. With the bob rotating at the desired test speed, a constant load is applied to the test sample, forcing the test sample up against the rotating bob. The torque on the rotating bob and axial load are both measured and recorded. From this information, the torque as a function of the friction or axial load can be determined. These measurements can be performed as a function of pressure and temperature. Chemical additives can then be blended into the drilling fluid to evaluate the change in the friction factors.

A fluid leak-off test can be performed with certain models and a filter cake can be deposited on the test sample under static or dynamic conditions. The drilling fluid can be either static or re-circulating, depending upon the instrument. Once the filter cake has been deposited, the load can be applied and the friction values can be determined in the presence of the filter cake buildup. A differential sticking test can also be performed where after the filter cake has been deposited, the load is applied and then the simulated drill bite is rotated. The torque required to move the simulated drill bit is measured.

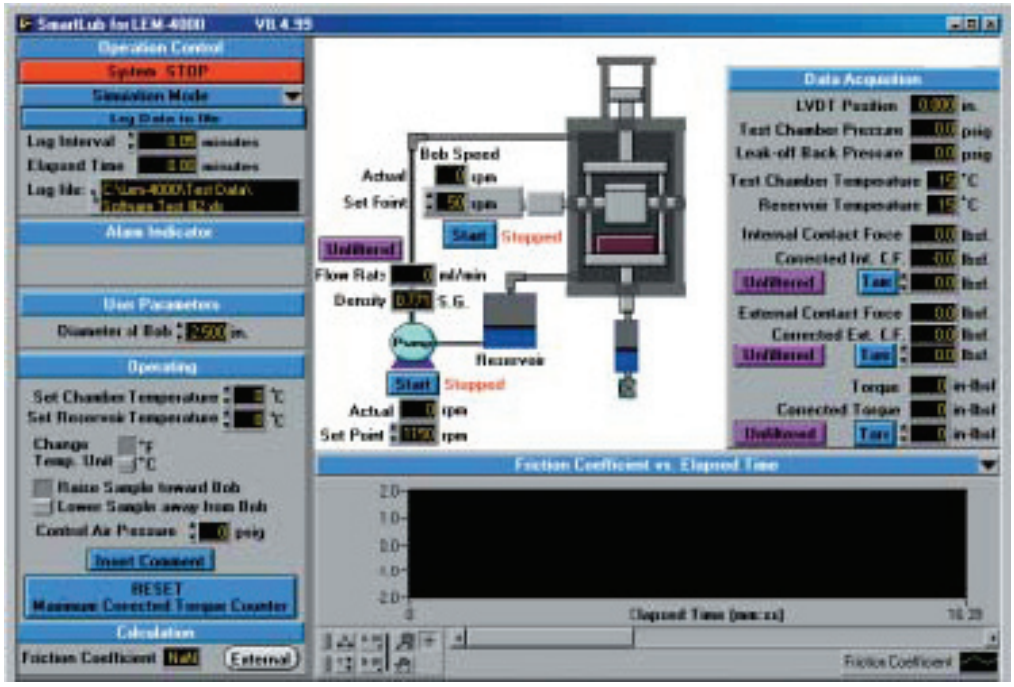
The load being applied to the test sample in the LEM-2000 is a direct measurement by weights. The load being applied under pressure with the LEM-3000 and 4000 series is measured with an electronic load cell. The movement of the test sample is measured with a linear transducer so the rate of wear on the sample can be determined. Pressures are measured with electronic pressure transducers and temperatures are measured with thermocouples. The computer control software for the Model LEM-4100, SmartLub™, controls the instrument and collects all of the data.

The picture to the right shows the measurement portion of the LEM-4000 or 4100 instrument. The simulated test bob is in the center of the picture and the test sample is located below the test bob. As the load is applied to the test sample, the sample is pulled upward and against the simulated test bob. The load is measured with the addition of a load cell and the sample position is measured with a linear transducer. The drilling fluid enters the chamber directly at the point of contact between the simulated drill bit and the test sample and then exits the chamber out of the top of the chamber.



Automation Software, SmartLub™

Temco offers an automation and data acquisition program for the operation of the LEM-4100 series instrument. The software is used for the control of the various parameters of the instrument for the measurement and data collection of the tests being performed. The software offers all of the features of the SmartSeries™ software as shown in its literature. Below is an example of the control screen for the software.



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Specifications and Ordering Information for Lubricity Evaluation Monitors

	LEM-2000	LEM-3000	LEM-4000	LEM-4100
Temperature	Room Temp	Room Temp	70-400F (21-204C)	70-400F (21-204C)
Pressure	Atmospheric	0-100 psig (0-690 kPa)	0-100 psig (0-690 kPa)	0-1000 psig (0-6900 kPa)
Contact Force	5-50 lbf (22-223N)	25-200 lbf (111-890 N)	25-200 lbf (111-890 N)	25-200 lbf (111-890 N)
Test Bob: Material Hardness Dimensioins	Carbon Steel Rockwell C-37 1" diameter (25.4mm) 1" length (25.4mm)	Carbon Steel Rockwell C-37 1" diameter (25.4mm) 1" length (25.4mm)	Carbon Steel Rockwell C-37 2.5" diameter (63.5mm) 3" length (76.2mm)	Carbon Steel Rockwell C-37 2.5" diameter (63.5mm) 3" length (76.2mm)
Rotation Speeds	50-380 rpm	50-380 rpm	50-380 rpm	50-380 rpm
Torque	3-200lbf-in (0.34-22.6 N-m)	3-200lbf-in (0.34-22.6 N-m)	3-200lbf-in (0.34-22.6 N-m)	3-200lbf-in (0.34-22.6 N-m)
Test Material	core or steel	core, steel, ceramic, or quartz	core, steel, ceramic, or quartz	core, steel, ceramic, or quartz
Filtration	static	static or dynamic	static or dynamic	static or dynamic
Differential pressure	----	0-100 psig (0-690 kPa)	0-1,000 psig (0-6900 kPa)	0-1,000 psig (0-6900 kPa)
Fluid leak-off testing	----	----	Yes	Yes
Back pressure regulator	----	----	----	0-200 psi (0-1379 kPa)
Mud circulation pump	----	100 psi	100 psi	1,000 psi
Re-circulation rate	----	4.50 liters/hour	450 liters/hour	450 liters/hour
Electrical	110/240 VAC 50/60 Hz 1 Phase	110/240 VAC 50/60 Hz 1 Phase	110/240 VAC 50/60 Hz 1 Phase	110/240 VAC 50/60 Hz 1 Phase
Computer, monitor, printer, SmartLub software	----	----	----	Yes

Technical References

"New Technique Evaluates Drilling Mud Lubricants," Stan E. Alford, Magcobar Division, Dresser Industries, Inc., World Oil, July, 1974

"New Device Measures Drilling Mud Lubricity Under Simulated Downhole Conditions," Andrew Dzialowski and Ken Slater, M-I Drilling Fluids Co. and John Toups, BP Research, American Society of Mechanical Engineers, January 1992