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EP (Extreme Pressure) and Lubricity Tester

#111-00 115-Volt

#111-00-1 230-Volt

Instruction Manual

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Ver. 2.4

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Introduction

When there is relative motion between two contacting bodies, frictional forces that resist motion always come into play. Frictional resistance to rotation of the drill string is called torque, and is especially enhanced when drilling a deviated hole. Many different materials, such as graphite, fine mica, and diesel or crude oil, have been used as mud additives to improve lubricity. Since evaluation of the various materials cannot realistically be done on a drilling rig, a lubricity test was designed to simulate the speed of rotation of the drill pipe and the pressure with which the pipe bears against the wall of the bore hole. The OFITE combination EP (Extreme Pressure) and Lubricity tester is a high-quality instrument used to measure the lubricating quality of drilling fluids, provide data to evaluate the type and quantity of lubricating additives that may be required, and predict wear rates of mechanical parts in known fluid systems. The test consists of measuring the torque of a steel block while being pressed against a rotating steel ring. The torque limit is 600 inch-pounds.

Description

Lubricity (Surface to Surface Drag) Test

The more common lubricity test measures fluid resistance of various lubricating additives. For the standard lubricity coefficient test, 150 inch-pounds of force (the equivalent of 5,000 to 10,000 PSI (34,500 - 69,000 kPa) pressure on the intermediate fluid) are applied between two hardened steel surfaces, a block, and a ring rotating at 60 RPM.

EP (Extreme Pressure) Test

This test produces an indication of the film strength of the fluid being tested by applying a measured force to a torque-sensitive bearing cup with the torque arm. The EP test is typically run at a high shear rate, 1,000 RPM, with fluid pressures ranging from 5,000 to 10,000 PSI (34,500 - 69,000 kPa) between the steel surfaces.

Specifications

- Belt-Driven Motor: ½ hp, 90 Volt DC, 5.5 Amps
- Maximum 600 inch-pounds of torque
- 1,000 RPM Maximum
- Size: 19" × 15" × 14" (48.3 × 38.1 × 35.6 cm)
- Weight: 56 lbs. (25.4 kg)

Components

#111-02	Test Ring for Lubricity Test
#111-04	Test Block for EP Test
#111-06	Test Ring for EP Test
#111-08	Test Block for Lubricity Test
#111-09	Sample Cup
#111-10	Torque Wrench
#111-13	Fine Grinding Compound, Grit 280, 16 oz Can
#111-14	Coarse Grinding Compound, Grit 120, 16 oz Can
#111-16	$\frac{3}{4}$ " Service Wrench
#111-17	$1\frac{1}{4}$ " Service Wrench
#111-18	$\frac{15}{16}$ " Combination Wrench
#164-32	Male Connector for Power Cable (230 Volt Only)

Optional:

#111-01 Padded Transport Case

#111-00-SP Spare Parts for #111-00:

#111-02	Test Ring for Lubricity Test; Qty: 6
#111-04	Test Block for EP Test; Qty: 6
#111-06	Test Ring for EP Test; Qty: 6
#111-08	Test Block for Lubricity Test; Qty: 6
#111-09	Sample Cup
#111-11	7x Measuring Magnifier with Inch Scale
#111-13	Fine Grinding Compound, Grit 280, 16 oz Can
#111-14	Coarse Grinding Compound, Grit 120, 16 oz Can



Top Row (Left to Right): Retainer Nut, Lubricity Test Ring, Lubricity Test Block
Bottom Row: EP Test Block (Left), EP Test Ring (Right)

Lubricity Test



1. Clean the lubricity test ring (#111-02 with a flat outer surface) and the lubricity test block (#111-08 with a concave groove on one side) with Acetone and rinse them thoroughly with deionized water. All parts of the machine in the sample area must be clean before starting a test.

Do not touch the metal contact areas with bare hands.

2. Place the lubricity test ring squarely onto the tapered portion of the main shaft. Using a $\frac{15}{16}$ " wrench, secure the test ring retainer nut. Make sure the ring seats squarely on the taper of the shaft.
3. Turn on the power and let the machine run for approximately 15 minutes.
4. Place the lubricity test block in the block holder with the concave side facing out and align it with the test ring.



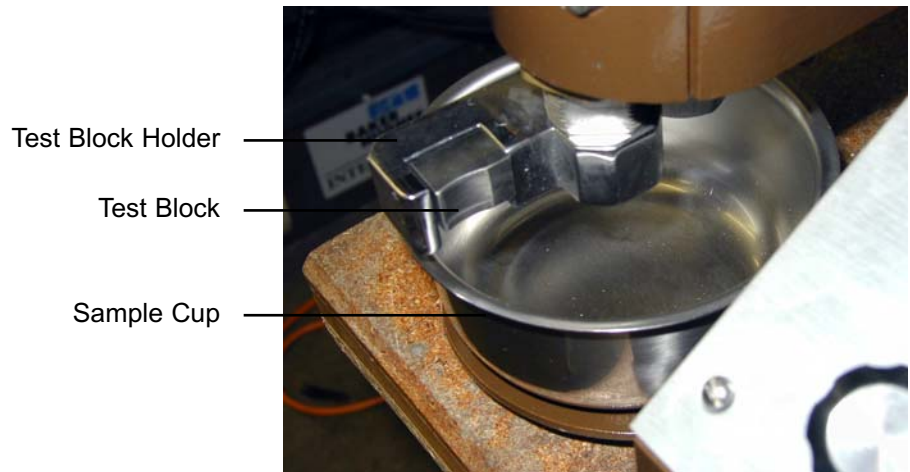
5. Rotate the speed control knob until the indicator registers 60 RPM.
6. After the unit has been running for 15 minutes, rotate the torque zero adjustment knob until the torque registers zero. Run the unit approximately 5 more minutes and adjust again if required.
7. Fill the stainless steel sample cup with deionized water (260 - 280 mL) and place it on the lowered cup stand. Raise the cup stand until the test ring, test block, and block holder are fully submerged. Tighten the thumbscrew to secure the cup stand.



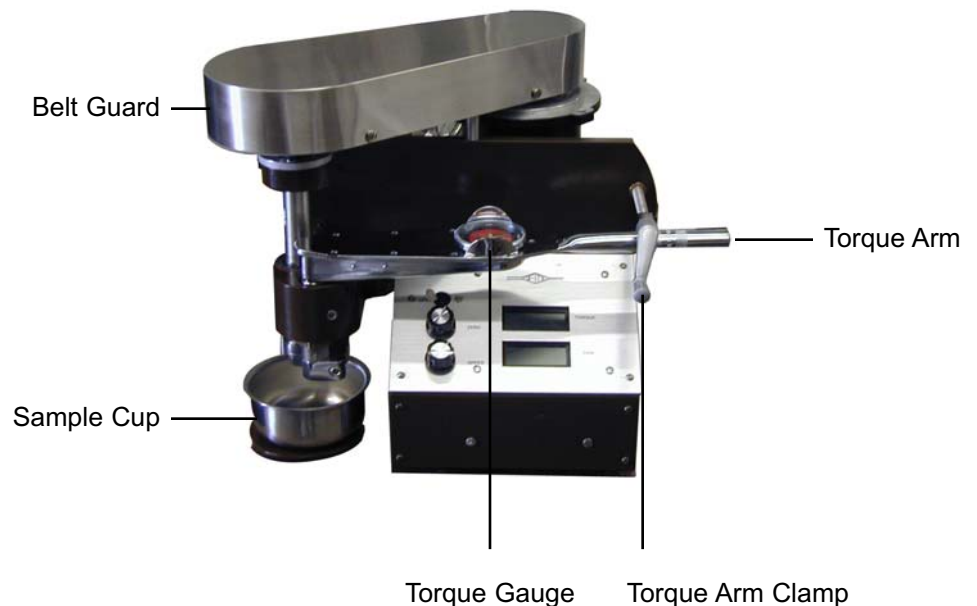
8. Position the torque arm so that it fits inside the concave portion of the torque arm clamp. Turn the torque adjust handle clockwise until the torque gauge on the arm reads 150 inch-pounds. If necessary, readjust the rotational speed to 60 RPM.

Never apply torque to the test ring unless it is submerged in fluid.

9. Let the machine run for 5 minutes and then record the torque reading. The torque reading should be 34 ± 2 (between 32 and 36). If the torque reading is outside this range, see the "Standardizing the Test Block" section on page 11. Otherwise, proceed to step 10.



10. Rotate the torque adjustment handle counter-clockwise until the torque registers zero. Lower the cup stand and discard the fluid. Wipe any remaining fluid from the sample cup, block, block holder, and test ring.





11. Mix your test fluid (260 - 280 mL) for at least ten minutes. Pour the test fluid into the stainless steel cup. Place the cup on the stand and raise it until the block holder and test ring are fully immersed in the fluid. Secure the stand in place with the thumbscrew.
12. Turn the speed control knob until the indicator registers 60 RPM. Adjust the torque zero adjustment knob until the torque registers zero. Run the machine for approximately 5 minutes and adjust again if necessary.
13. Turn the torque adjustment handle clockwise until 150 inch-pounds of torque have been applied to the test block. Let the machine run for 3 to 5 minutes.
14. **After 3 to 5 minutes, record the torque reading and release the torque on the arm.**

EP Test



Before the test can be accurately run, the machine must be in proper adjustment. To test for proper adjustment, or to run a standard test, proceed through the following steps.

1. Clean the EP test ring (#111-06 with a raised narrow surface) and the EP test block (#111-04 cube with smooth surface) with Acetone and rinse them thoroughly with deionized water. All parts of the machine in the sample area must be clean before starting a test.

Do not touch metal contact areas with bare hands.

2. Place the EP test ring squarely onto the tapered portion of the shaft. Using a $\frac{15}{16}$ " wrench, secure the test ring retainer nut. Make sure the ring seats squarely on the taper of the shaft.
3. Turn the power on. Let the unit run for 15 minutes.
4. Place the EP test block in the block holder.
5. Rotate the speed control knob until the RPM indicator registers 1,000 RPM (± 100).
6. Rotate the torque zero adjustment knob until the torque registers zero.
7. Run the machine at 1,000 RPM for approximately 3 minutes, or until the torque zero reading appears to stabilize and no longer drifts appreciably. Reset the knob to zero if necessary.
8. Position the torque arm so that the arm fits inside the concave portion of the torque arm clamp.
9. Fill the stainless steel sample cup with test fluid (260 - 280 mL) and place it on the lowered cup stand. Raise the cup stand until the test ring, test block, and block holder are submerged. Tighten the thumb-screw to secure the cup stand.
10. Rotate the torque adjust handle clockwise so that torque is increased at a rate of no more than 5 inch-pounds per second until the torque meter indicator reaches the desired torque reading, or until a seizure occurs. If a seizure occurs, remove the load quickly.



Due to the extreme friction between the ring and the block, the fluid will get very hot and may reach the boiling point.



A seizure is defined as tearing and galling (scarring) of the metal to metal contact between the test ring and the test block surface. This represents a complete breakdown of the extreme pressure lubricating ability of the fluid or mud under the test conditions. A seizure is identified by a rapid rise in the torque reading. It may also appear as a sharp, substantial increase in current, which then drops back to normal.

This type of seizure usually occurs at a relatively low torque reading or during tests of highly abrasive muds or muds containing a high solids content. A seizure is also accompanied by an obvious change in the pitch (sound) of the machine (a rasping sound). After a seizure, the wear surface on the test block will be very large and will appear rough and scarred.

11. Repeat steps 1 through 10 until a pass is obtained. A pass is identified in one of two ways.
 - a. A five minute run at a constant load during which the torque meter reading remains essentially constant and the wear surface is small and polished.
 - b. A five minute run in which there is a moderate amount of torque meter deflection and the wear surface is moderate, and may either be polished or dull, depending upon the abrasiveness of the test fluid.
12. After removing and cleaning the test block (see "Disassembly" below), examine the test block for wear. With the aid of a magnifying glass (part #111-11), observe the scar left on the block by the test ring. If the scar is rectangular, the test block is properly aligned in the holder. Your test is complete. If the scar is triangular or trapezoidal, the alignment is off and must be corrected. Refer to the "Repositioning the Test Block" section.

EP Test

Reporting Test Results

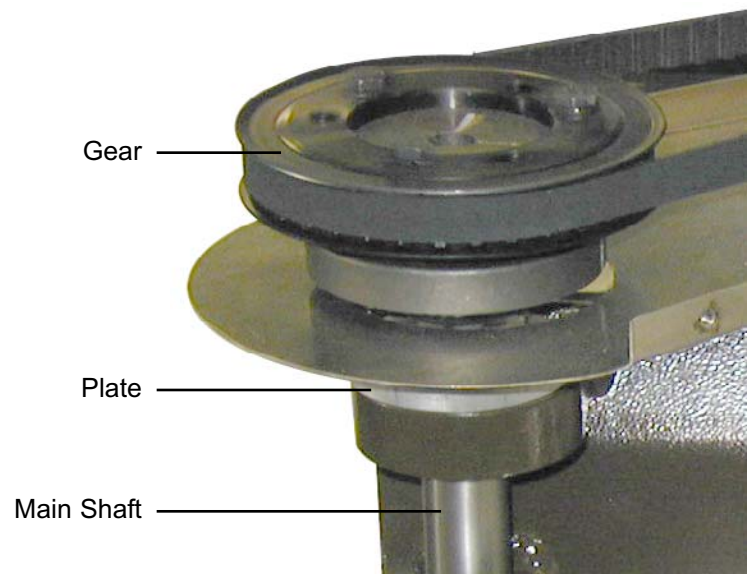
1. Record the lowest load (torque meter reading) in inch-pounds and the average torque in pounds at which the seizure occurred.
2. Record the following at the conclusion of a pass or if a 5-minute test does not produce a seizure.
 - a. Load (torque meter reading) in inch-pounds.
 - b. Scar width in inches.
 - c. Film strength in PSI.
 - d. Average current (torque meter reading in pounds divided by 10) in amps.

Disassembly

1. Turn the power off.
2. Lower the cup stand and turn the torque arm clamp up and away.
3. Swing the torque arm back to allow removal of the test block.
4. Remove and thoroughly rinse the test block with deionized water.
5. Remove the cup and discard the test fluid.
6. Remove the retaining nut and test ring.
7. Use Acetone, deionized water, and a brush to clean the entire test area, including the test ring, test block, and block holder. To prevent rust, ensure that the entire unit is clean and dry. If the machine is to be stored for a long period of time, coat all components with oil.

Maintenance

1. The roller bearing in the main shaft may occasionally need to be greased. If you notice a squeaking noise coming from the main shaft, add a high-temperature bearing grease (such as Lubriplate No. 12601) via the zerk fitting on the back of the unit.
2. The upper main shaft ball bearing is sealed and will need replacement only when the shaft end-lay can be detected. Shaft end-lay is indicated by excessive oscillation in the torque reading. To replace the bearing:



- a. Remove the belt guard.
 - b. Remove the gear from the main shaft.
 - c. Unscrew the four screws beneath the gear and remove the plate to reveal the bearing.
 - d. Press the bearing upward from underneath and slide it up and off the main shaft.
 - e. Slide the new bearing down the main shaft and into place.
 - f. Re-install the plate and secure it tightly in place.
 - g. Re-install the gear, belt, and belt guard. Check the belt tension as described below.
3. Keep the control panel clean and dry. Fluids on the panel can seep around electrical components and cause damage.
 4. Periodically remove the belt guard and check the belt tension. Ensure sufficient tightness so that when the motor is stalled, the belt will not slip. To increase the belt tension, loosen the motor mount bolts on the back of the unit, slid the motor towards the torque adjust handle and then retighten the mounting bolts. Re-install the belt guard.

Maintenance

Standardizing the Test Block

If the Coefficient of Friction of deionized water is not in the 32 to 36 range, the ring and block surfaces must be reconditioned or standardized. In order to standardize the block, a substantial portion (at least ½) of its curved surface must be worn to a shiny condition with a minimum of groove lines throughout this polished area.

1. Using a black marker, color the contact area of the test block. Install the test block.
2. Turn the unit on and set the speed to 200 RPM.
3. Turn the torque wrench to bring the block into contact with the ring and apply about 150 lbs. of pressure for 10 seconds.
4. Release pressure and reduce the speed to 0 RPM.
5. Remove and inspect block the contact area. The markings left by the ring should be centered top to bottom and left to right in the contact area.
6. If the markings are not centered, complete the appropriate Block Adjustment Procedure (page 12).
7. Repeat Steps 1 through 6 until the markings are centered.
8. Fill the sample cup about ¾ full with de-ionized water.
9. Cover the surface of the ring and the contact area of the block with course grinding compound (part #111-14).
10. Turn the torque wrench to bring the block into contact with the ring.
11. Place the sample cup onto the cup pedestal and raise it to submerge the ring and block.
12. Set the speed to 100 RPM and the pressure to 150 lbs. Run the unit at these settings for six hours, changing the water and grinding compound every two hours.
13. After six hours, switch to the fine grinding compound (part #111-13). Increase the speed to 120 RPM and reduce the pressure to 75 lbs and run the unit for another four hours. Change the water and grinding compound every hour.
14. The complete burn-in process should take 10 hours. Clean the block and ring with acetone to remove all of the grinding compound.
15. Return to step 9 of the Lubricity Test (page 4) and continue.

Maintenance

Block Adjustment

The test block can be adjusted horizontally (left to right) or vertically (up and down).

To adjust the block from left to right:

1. Loosen the socket head bolt located in the brown housing.
2. Using the supplied wrench turn the torque bushing. This will move the shaft either left or right depending on the shaft position inside the housing.
3. Tighten the socket head bolt in the brown housing.

To adjust the block up and down:

1. Loosen the socket head bolt in the brown housing.
2. Loosen the lock nut located on the torque bushing.
3. Center the block against the ring and adjust the lock nut (up or down) so the lock nut is in contact with the brown housing while the block is centered on the ring.
4. Tighten the socket head bolt to hold the adjustment.
5. Tighten the lock nut against the housing.

Measurements / Calculations

Follow these steps to calculate the **Film Strength** of the test fluid:

- A. To measure the scar length on the block, use a magnifier (part #111-11) calibrated to read 0.005" (0.0127 cm). Place the magnifier at the center of the scar parallel to the edges. This will allow you to obtain the average width of the scar. Record the scar measurement in inches.
- B. To calculate the pressure on the block:
 1. Begin by computing the total area of the scar on the block. Multiply the width of the scar (in inches) by the length (in inches). If you are measuring a trapezoidal scar, use the average width.
 2. Calculate the force acting on the scar area by dividing the torque meter reading at which a pass was obtained by 1.5 (the travel distance of the arm).
 3. Calculate the pressure on the test block at the time the test was stopped by dividing the force (2) by the scar area (1). This pressure is the film strength of the mud. In equation form it is written as follows:

$$P = \frac{T}{1.5 \times L \times W}$$

Where:

- P = Film Strength (PSI)
- T = Torque Meter Reading (Pounds)
- W = Scar Width (Inches)
- L = Scar Length (Inches)

- C. The Coefficient of Friction value for Deionized Water would be a constant if the metallurgical structures of all rings and test blocks were the same. At 60 RPM and 150 inch-pounds of torque, the torque meter reading should be 34. However, since every ring and test block are different, a correction factor is required to achieve accurate results. To calculate the correction factor, divide the standard meter reading for water (34) by the actual meter reading, which you recorded in step 8 of the Lubricity Test (Page 5).

$$\text{Correction Factor} = \frac{\text{Standard Meter Reading for Water}}{\text{Actual Meter Reading for Water}}$$

$$\text{Mud Lubricity Coefficient} = \frac{\text{Meter Reading}}{100} \times \text{Correction Factor}$$

$$\text{Percent (\%) Torque Reduction at a Given Load} = \frac{A_L - B_L}{A_L} \times 100$$

Where:

A_L = Torque reading of untreated mud under force equal to B_L

B_L = Torque reading of treated mud under force equal to A_L

$$\text{Coefficient of Friction} = \frac{F}{W} = \frac{\text{Meter Reading}}{100}$$

Where:

F = The frictional force required to slide the block and ring surfaces across each other at a given rate and is measured by the number of amperes required to turn the test ring at a prescribed number of revolutions per minute.

W = The load or force with which the test block is pressed against the test ring through the torque arm.