



RHEOLOGICAL MEASUREMENTS

In conventional field practices the steady state rheological description of a drilling mud is given in terms of the parameters, which describe the fluid as an ideal Bingham Plastic. These parameters are the plastic viscosity and yield point (or yield stress). The time dependent nature of the drilling mud (thixotropy) is measured in terms of gel strength. The temperature at which rheological measurements are taken should be constant and always be recorded.

PLASTIC VISCOSITY AND YIELD POINT TEST PROCEDURE

1. Place a recently agitated sample in a suitable container and lower the instrument head until the sleeve is immersed in the drilling mud sample exactly at the scribed line of the sleeve.
2. With the instrument set at 600 rpm rotate the sleeve until a steady dial reading is obtained, (for highly thixotropic muds this may take some time). Consistency of results can be achieved if the 600 rpm dial reading is taken at the point for which the change in dial reading is less than one degree (one dial division over a stirring time of one minute).
3. When the dial reading has reached this steady value, record this as the 600 rpm dial reading, D_{600} .
4. Lower the speed to 300 rpm and stir the sample at this speed until a steady reading is obtained using the same criterion for the steady state point. Record this value as the 300 rpm dial reading, D_{300} .

CALCULATIONS

$$\text{Apparent Viscosity (mPa s)} = \frac{D_{600}}{2}$$

$$\text{Plastic Viscosity (mPa s)} = D_{600} - D_{300}$$

$$\text{Yield Point (Pa)} = \frac{D_{300} - PV}{2}$$

GEL STRENGTH TEST PROCEDURE

Gel strength measurements can be made as a continuation of the steady state measurements. Measurements are taken at two rest periods, 10 seconds and 10 minutes.

1. Stir the mud sample at 600 rpm until a steady reading has been achieved. (If all time dependence has been taken out of the mud sample, this reading should be the same as the previous 600 rpm dial reading).
2. Stop rotation of the sleeve. (For the FANN Models HC34A or 34A, the shift knob must be simultaneously brought to the neutral position).
3. Allow a rest time of 10 seconds, then slowly (at 3 rpm) and steadily rotate the gel strength wheel (counter clockwise for the FANN instruments, clockwise for all others).

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4. Record the maximum dial deflection as the initial gel strength dial reading, D_0 .
5. Repeat steps (1)-(2) and in step (3) allow a rest time of 10 minutes.
6. Record the maximum dial deflection as the 10 minute gel strength dial reading, D_{10} .

CALCULATIONS

Initial gel strength, G_0 (Pa) = D_0

Ten minute gel strength, G_{10} (Pa) = D_{10}

NOTE

If the initial and 10 minute gel strengths are equal, the mud has no thixotropy, i.e., the mud has no ability to build structure while it is at rest. This type of mud does not have any real gel strength or increased suspending power while it is at rest. For this type of mud the gel break is not very evident, rather it will be a gradual increase to a steady value. This is indicated by a lower ten-minute gel strength in comparison to a higher initial gel strength.

INSTRUMENT CARE

After every usage the instrument should be thoroughly cleaned.

1. Run the rotor immersed in water (or solvent for oil based muds) at high speed for a short period of time.
2. Remove the sleeve:
 - hold the spindle, twist and carefully pull straight down for the FANN instruments.
 - hold the spindle and unscrew the sleeve for all other instruments.
3. Wipe the bob and other parts thoroughly clean with a dry, clean cloth or paper towel.

CAUTION: The bob is hollow and from time to time accumulated moisture inside the bob can be eliminated by removing the bob and drying it out. Immersion of the hollow bob in extremely hot mud can result in a serious explosion.

Care should be taken not to immerse the sleeve deeper into the mud than the scribed line on the sleeve. This may result in damage to the bearings holding the bob shaft in place. Similarly, care must be taken not to splash water or solvent up into the sleeve housing when the bob and its shaft are cleaned.

In the field, the rheological characteristics of a drilling mud are determined with a concentric rotational viscometer having an industry standardized bob and sleeve. Shear stress, viscosity or gel strength is determined from the degree of rotation of the bob under the influence of the shear rate created in the mud by the action of the outer, rotating sleeve. Because most drilling muds are non-Newtonian in behavior, (pseudoplastic and thixotropic), stress, viscosity and gel strength measurements must be performed at prescribed shear rates (rotational speeds). The industry standard rotational speeds are 600 and 300 rpm for any steady state rheological parameter and 3 rpm for gel strength (an indication of thixotropy) measurements.

The most common field viscometers are:

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BAROID RHEOMETER MODEL 280

The operation of these models is similar. These hand cranking models have three speeds, which are changed by a shift lever and internally controlled by a slip clutch. The stirring speed is obtained by moving the shift lever counter clockwise as far as possible, the 600 rpm speed is obtained by moving the shift lever clockwise from the stirring speed to the first detent position and the 300 rpm rotational speed is obtained by moving the shift lever to its next detent clockwise from the 600 rpm position. Gel strength is obtained by rotating the knurled hand wheel.

FANN MODEL HC34A

This hand cranking model has two speeds, which are changed by a shift knob (or wheel) on top of the instrument. The 600 rpm speed is obtained with the shift knob pushed down while the sleeve is rotating and the 300 rpm rotational speed is obtained by moving the shift knob all the way up while the sleeve is rotating. A neutral position is located by a detent half way between the 600 and 300 rpm position. Gel strengths are determined by rotating the knurled wheel (located below the shift knob) by hand with the shift knob in the neutral middle position.

FANN MODEL 34A

This model is a 3 speed electric version of the FANN Model HC 34A. The stirring speed is obtained by pressing the button on left side of the upper body. The 600 rpm speed is obtained with the top shift knob pushed down while the sleeve is rotating and the 300 rpm speed is obtained by moving the top shift knob all the way up while the sleeve is rotating. A neutral position is located by a detent half way between the 600 and 300 rpm position. Gel strengths are determined by rotating the knurled wheel (located below the shift knob) by hand with the shift knob in the neutral middle position.