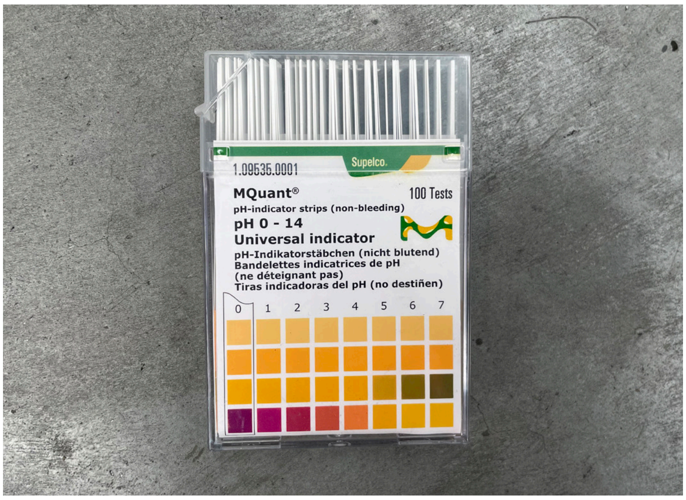
PH INDICATOR AND WATER HARDNESS STRIPS



Testing the pH and hardness of make-up water and drilling fluids is fundamental to the performance of drilling fluids.

The recommended method is using pH indicator strips from 0-14. Using these test strips is easy; the pH value is determined by the four zones on the test strip; round the result to half, such as 9.0 or 9.5.

The water hardness test strips measure calcium, magnesium and other metals.

Before mixing drilling fluids, you need to adjust the make-up water to increase pH to the effective range and reduce water hardness. We recommended testing the make-up water for pH and hardness before treating it, carefully measuring the amount of soda ash required to adjust the hardness and pH into the recommended range. You should follow this process for your fresh fluid mix for the remainder of that job when mixing new fluid.

Because the tests are quick, it is helpful to test once a day to confirm nothing has changed with the make-up water.

When recycling, testing will be required more often as you will need to test the return fluid to determine the necessary soda ash to move the liquid into the correct range before adding other drilling fluids.

Using soda ash reduces water hardness and increases pH quickly. The most effective process is to add it slowly and retest it to determine the amount required to deliver the effective pH range. For example, if you can increase the pH to 9, then the hardness will have been reduced or removed. When drilling through clay formations it is important not to over treat with Soda Ash. Elevated pH promotes swelling of clay and also damages some polymers used to control clay hydration.

In each case, your drilling fluid plan should recommend maintaining a range for pH and hardness.

VISCOSITY (USING A MARSH FUNNEL AND CUP)

The Marsh Funnel and Cup evaluate viscosity by measuring the time it takes a known volume of liquid to flow from a cone through a short tube.

The Marsh Funnel viscosity is the number of seconds required for 946ml of drilling fluid to flow out of a Marsh Funnel into a Marsh Cup.

Marsh Funnel readings are relative measurements done frequently. Variability in the results will alert the drilling fluid engineer to changes in the viscosity that could require corrective action.

TEST PROCEDURE

Before beginning, the Marsh Funnel and Marsh Cup should be clean and dry.

- Collect a fresh drilling fluid sample.
- Holding the funnel erect with a finger over the outlet tube, pour the drilling fluid into the funnel through the screen until the fluid level reaches the bottom of the screen. (The screen will filter out the larger particles that could clog the outlet tube.)
- Hold the funnel over the Marsh Cup.
- Remove the finger from the outlet tube and time the fluid outflow.
- Allow the drilling fluid to drain from the Marsh Funnel into the measuring cup. 946ml is to the line on the Marsh Cup. Stop timing when the liquid reaches the line.

RESULTS

Report this time in seconds as the Marsh Funnel viscosity (sec/qrt).

FILTRATION CONTROL (USING A HALF-AREA FILTER PRESS)

TEST PROCEDURE

- Unscrew the end cap from the cell. Ensure that the rubber boot diaphragm is seated correctly around its top edge to ensure a tight seal. The leading edge of the boot provides the seal to the filter paper and end cap.
- Pour the drilling fluid sample into the boot within 1.5 mm of the top. Place a 6.35cm filter paper across the top of the boot and screw down the end cap. Hand tightening is sufficient.
- Holding the cell with the T-screw up and end cap down, mount the cell in the bracket. Then, put a 10 ml graduated cylinder directly under the filtrate tube (to catch the filtrate).
- Open the cell valve by pushing it toward the back of the cell. After checking that the regulator adjusting screw is backed out (counter clockwise), remove the barrel and insert a CO_2 cartridge. Turn the barrel until you feel contact with the puncturing pin. Advance an additional one-fourth turn.
- Rapidly screw the regulator T-screw into the regulator so that 100 ± 5 psi is applied. If it does not reach this pressure, replace the CO_2 cartridge.
- Timing starts as soon as the 100 psi pressure is applied.
- After 30 minutes, close the cell valve by pushing it toward the front of the cell. This will bleed the CO_2 out of the cell and relieve the pressure on the boot.
- With the cell valve closed, unscrew the T-screw to its maximum outward position. Remove the end cap, and discard the drilling fluid sample.

RESULTS

Record the volume of filtrate collected in the cylinder in millilitres (to the nearest 0.1 ml).

The calculations are for a full-area filter press. If using a half-area filter press, you must multiply the result by two to get the total filtrate.

An alternative process is to run the test for 7.5 minutes. If you run the test for 7.5 minutes, you multiply the results by two to approximate the filtrate of a full 30-minute test.

To be clear, if running a half-area filter press and doing the test for 7.5 minutes, you will multiply the result by four to adjust for the filter press surface area and the length of the test.

Record the initial filtrate and show the adjusted result.

FILTER CAKE

- Wash the filter cake on the paper with a gentle stream of water
- Record the cake's consistency using descriptions like hard, soft, tough, rubbery, firm, etc.
- **Measure the thickness of the filter cake. Record to the nearest mm.**

RHEOLOGY; FLUID SHEAR AND GEL STRENGTH (USING A RHEOMETER)

PREPARE THE RHEOMETER FOR USE

- Loosen the leg locknut while restraining the instrument, then allow the head to rise slowly.
- Assemble the dust shield onto the bob shaft (flange up) and hold it in place.
- Thread the (tapered end up) bob onto the bob shaft by screwing it clockwise until it is hand tight.
- Assemble the sleeve onto the rotor by screwing it clockwise. Ensure the threads in the sleeve and the rotor are clean so the sleeve will shoulder on the rotor by hand tightening.
- Fill the sample cup to the line scribed with a recently agitated fluid sample.
- Set the cup in the forward alignment holes in the base.
- Lower the instrument head until the sleeve is immersed to the line scribed, then tighten the leg locknut.

PLASTIC VISCOSITY AND YIELD POINT

Set the speed shift lever to the stirring speed position (down), crank for 15 seconds to mix.

- Set the speed shift lever to 600 rpm (centre) and crank Wait for the dial to read steadily. Record this value.
- Set the speed shift lever to 300 rpm (up) and crank. Wait for the dial to read steadily. Record this value.
  Plastic viscosity (PV) = 600 rpm - 300 rpm
  Yield point (YP) = 300 rpm - PV

GEL STRENGTH

Set the Speed Shift Lever to the stirring speed position (down), crank for 15 seconds to mix.

- Wait the required time (10 seconds or 10 minutes) then turn the gel knob slowly but steadily clockwise while observing the dial.
- **Record the maximum dial reading before the gel breaks and drops dial reading. This is the 10 second or 10 minute gel measurement.**

PERCENTAGE OF SAND (USING A SAND CONTENT KIT)

Sand is any particle larger than 74 micron. As part of a drilling fluid we aspire to have as close to zero as possible. Sand content increases wear and tear on pumps, tooling, forms thicker filter cakes and increased pressure in the hole.

The kit includes;

- API 200-mesh (74 micron) sieve 63.5mm
- Small funnel
- 100ml glass measuring tube (graduated to read from 0 to 20%)
- 500ml wash bottle

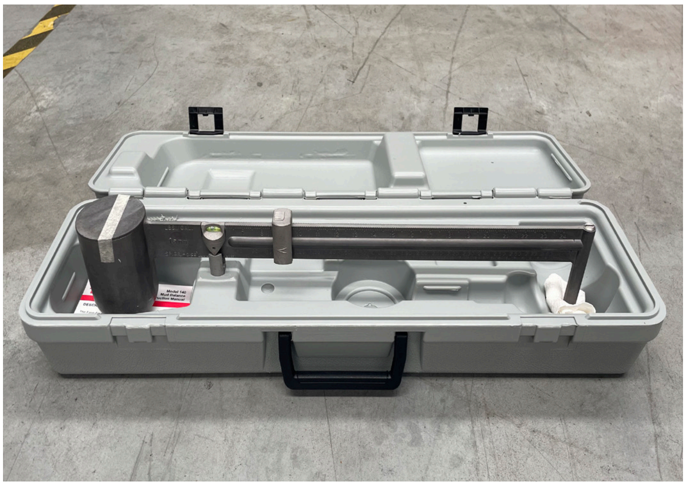
TEST PROCEDURE

- Fill the measuring tube with drilling fluids to the bar labelled “mud to here”
- Use the wash bottle to add water to the bar labelled “water to here”.
- Close the mouth of the tube with the thumb and shake vigorously.
- Pour the mixture through the screen.
- Continue adding water to the tube, shaking it, and pouring the contents through the screen until empty
- Tapping the side of the screen holder will help the mixture pass through the screen.
- Flush the screen with fluid from the wash bottle to wash away the remaining drilling fluid and shale particles until all that remains on the screen is sand.
- Fit the large end of the funnel over the top of the screen holder and slowly invert the screen and funnel assembly, fitting the tip of the funnel into the mouth of the glass measuring tube.
- Using a fine spray of fluid from the wash bottle, wash the sand from the screen back through the funnel into the glass measuring tube and let the sand settle.

RESULTS

Record the sand content percentage.

MUD WEIGHT (USING A MUD BALANCE)



The Mud Balance consists of a constant-volume sample cup with a lid connected to a balance arm. It measures density in specific gravity on the front and pounds per cubic foot and pounds per square inch per 1000 feet of depth on the back. The cup should be clean and dry before filling the drilling fluid sample.

CALIBRATION

Calibrate using fresh water. At 21 C, fresh water should give a reading of 1.00 on the specific gravity scale (or 8.33 on the lbs/gal scale and 62.3 on the lbs/cu ft scale).

TEST PROCEDURE

Follow this test procedure to measure the density (weight) of drilling fluid.

- Collect a test sample and fill the cup with drilling fluid.
- Seat lid on the sample cup and ensure a small amount of fluid is displaced up through the small hole in the lid.
- Clean off any excess drilling fluid on the cup and lid.
- Fit the knife edge on the balance arm into the slot in the base fulcrum, and balance by moving along the scale.
- The Mud Balance is horizontal when the bubble fluctuates an equal distance to either side of the centre line.
- **Record Specific Gravity.**

RESULTS

(MW – 1) x 100 divided by 1.6 = % of drilled solids in your mud system

Eg; (1.13 – 1) x 100 divided by 1.6 = **8.125% drilled solids**

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MUD WEIGHT (USING A MUD BALANCE)

CALCULATING CLEANING EFFICIENCY

To calculate how well the borehole is being cleaned, you will need to know the amount of soil per joint of drill pipe and the amount of fluid pumped over the length of the drill pipe being the pump rate multiplied by the time required to drill the entire length of pipe.

With this information and a mud balance, follow these steps to determine hole cleaning efficiency. By running this check, you can reduce the risk of getting drill pipe or product pipe stuck in the hole and also reduce the risk of hydro-fracture.

1. Use the M-I SWACO App, "Annular Volume" calculator to determine the drill solids (0% pore space) encountered per length of drill pipe, **e.g. a 3m joint of drill pipe with 300mm ream following a 127mm (5") pilot hole = 174.09 L/joint.**
2. Account for pore space to estimate drill solids volume per joint of drill pipe, e.g. for clay with 35% pore spacing**, (1 – 0.35) x 174.09 L/joint = 0.65 x 174.09 L/joint = 113.16 L/joint solids**
3. Calculate the amount of fluid pumped during drilling of one joint of drill pipe, **e.g. 200 L/min x 4 min/joint = 800 L/joint**
4. Calculate the drill solids in returns for a perfectly clean borehole, **e.g. (113.16 L/joint ÷ [800 + 113.16] L/joint) x 100 = 12.39 % drill solids**
5. Weigh mud in fresh mix tanks or solids control system suction tank and use M-I SWACO app, "Estimated Solids in Mud" calculator to determine "Mud Weight In" solids %, **e.g. SG 1.07 in suction tank = 4.38 % solids**
6. Weigh mud in the return pit (pull the sample from close to the point of entry) and use the M-I SWACO app, "Estimated Solids in Mud" calculator to determine "Mud Weight Out" solids %, **e.g. SG 1.28 return flow density = 17.50 % solids.**
7. Calculate the increase in solids % by deducting "Mud Weight In" from "Mud Weight Out", **e.g. 17.5 % - 4.38 % = 13.12 %**
8. Compare increase in solids % (point 7) to solids % (point 4) for a perfectly clean borehole **e.g. 13.12 % vs 12.39 %**
9. The % solids achieved vs % estimated should align as they do in the worked example.
10. If the actual solids content is below the calculated expected concentration, cuttings may be left in the hole. The YP and 10sec gel strength of the fluid may need to be increased or ROP (min/joint) reduced. If the concentration is higher than the calculated expected concentration, washout may be occurring. In this case, reduce the rate of penetration and flow rate.