Chapter 2: Drilling Fluid

Field Tests

Field Tests of Drilling Fluids

Drilling Fluid Density (Mud Weight)

The mud density test is conducted in order to determine the weight per unit volume of the drilling mud. Mud density must be great enough to provide sufficient hydrostatic head to prevent influx of formation fluids, but not so great as to cause loss of circulation, damage to the drilled formation or reduced penetration rates.

Field Tests of Drilling Fluids

Drilling Fluid Density (Mud Weight)

The mud density test is conducted using a **mud balance**, which consists of a base and a balance arm with cup, lid, knife edge, rider, level glass, and counterweight. The cup is attached to one end of the balance arm and the counterweight is at the opposite end.

Field Tests of Drilling Fluids

Drilling Fluid Density (Mud Weight)

1. Before beginning, check calibration (calibration mark provided on scale for fresh water, 8.33 lb/gal or 1.0 S.G.), and make sure that the cup is clean and dry.

2. Remove the lid from the mud cup and fill the cup to overflowing with the mud to be tested. If air bubbles have been trapped in the mud, tap the cup briskly on the side until air bubbles break out.

3. Replace the lid on the cup and rotate it until it is firmly seated. Do not cover the vent hole with your finger. Make certain that some mud squeezes out the vent hole in the lid.

4. Wash and wipe excess mud from the exterior of the mud balance, covering the vent hole, then dry the balance. Vent hole must be covered during Step 4.

5. Place the balance in its base with the knife edges on the fulcrum rest.

6. Move the rider until the beam is balanced. The spirit level bubble should be on the center line.

7. Read the mud weight and hydrostatic pressure or mud gradient at the edge of the rider nearest the fulcrum (toward the knife edge).

8. Clean and replace the instrument.

Field Tests of Drilling Fluids

Drilling Fluid Density (Mud Weight)

1. Mud weight can be reported as:

   pounds per gallon (ppg);

   pounds per cubic foot (lbm/cu ft);

   specific gravity (g/cm^3).

2. Record the mud gradient in pounds per square inch per foot of depth (psi/ft)

   (Mud weight in ppg x 0.052 = mud gradient in psi/ft)

   (Mud weight in lb/cu ft)/(144) = mud gradient in psi/ft)

Field Tests of Drilling Fluids

Funnel Viscosity

The Marsh funnel viscometer and graduated cup are routinely used to measure viscosity.

The marsh funnel is 6 in. in diameter at the top, 12 in. long, and tapers to join a tube 2 in. long with an inside diameter of 3/16 in. A 10-mesh screen fitted across one-half of the top filters foreign matter and cuttings from the mud to be tested. The capacity of the funnel to the bottom of the wire screen is 1500 cc. Its dimensions are such that one quart of fresh water at a temperature of 70(±15)° F flows through the funnel in 26 (±0.5) seconds.

Field Tests of Drilling Fluids

Funnel Viscosity

Test Procedure

1. Using the graduated cup, take a sample of mud from the flowline or mud pit.

2. Determine the temperature of the mud sample by inserting a thermometer into the sample for 30+ seconds.

3. Make a note of the temperature.

4. Hold the marsh funnel in an upright position with your index finger over the bottom outlet.

5. Pour the mud sample through the screen into the marsh funnel until the mud level just reaches the underside of the screen.

6. Immediately remove your finger from the bottom outlet, and begin timing with a stopwatch.

7. Measure the number of seconds required for one quart (or liter) of the sample to flow from the marsh funnel into the graduated cup.

Field Tests of Drilling Fluids

Funnel Viscosity

Reporting Results

Record the funnel viscosity on the API Standard Drilling Mud Report as follows:

Seconds per quart at X °F (API Standard); or

Seconds per 1000 cc at X °F.

While the most common use is for drilling muds, which are non-Newtonian fluids, the Marsh funnel is not a rheometer, because it only provides one measurement under one flow condition. However the effective viscosity can be determined from following simple formula.

$\mu_a = \rho\ (t - 25)$

μ_a = apparent viscosity in centipoise

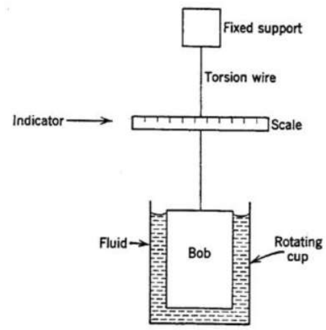
ρ = density in g/cm^3

t = quart funnel time in seconds

Field Tests of Drilling Fluids

Apparent Viscosity, Plastic Viscosity, Yield Point, Gel Strength

The result of the funnel viscosity test is called the funnel viscosity of the mud. The viscosity of a mud is made up of two variables: plastic viscosity (PV) and yield point (YP) . These values, as well as timed gel strength, are measured with a direct-indicating viscometer, such as the rheometer.



Field Tests of Drilling Fluids

Apparent Viscosity, Plastic Viscosity, Yield Point, Gel Strength

Test Procedure for AV, PV and YP Determination

1. Fill the test cup to the scribed line with the mud sample. (Normally this is the same sample used in the funnel viscosity test.)

2. Measure the temperature of the mud sample and record it.

3. Loosen the leg lock nut and raise the rheometer assembly.

4. Place the cup filled with mud below the rotor sleeve.

5. Lower the rheometer until the rotor sleeve is immersed exactly to the scribed line on the rotor sleeve.

6. Tighten the leg lock nut.

7. Start the motor by placing the switch in the high-speed position with the gear shift all the way down. Wait for a steady indicator dial value, and record the 600 RPM reading. Change gears only when motor is running.

8. Change switch to the 300-RPM speed. Wait for a steady value and record 300-RPM reading.

Field Tests of Drilling Fluids

Gel Strength

Procedure for Gel Strength Determination

Shut motor off and wait 10 seconds.

Flip switch to the low-speed position and record maximum deflection units in lbf/100 ft[2] as initial gel. If the dial indicator does not return to zero with motor off, do not reposition.

Repeat 1 and 2, but allow 10 minutes, then place switch in the low-speed position and read maximum deflection units as the 10-minute gel. Report measured temperature.

Field Tests of Drilling Fluids

Plastic Viscosity and Yield Point

$$\mu_p = \frac{\tau - \tau_y}{\gamma}$$

$$\mu_p = \frac{\theta_{600} - \theta_{300}}{300}, \frac{lbf/100\,ft^2}{RPM} = \frac{\theta_{600} - \theta_{300}}{300 \times 1.73}, \frac{lbf/100\,ft^2}{1/s}$$

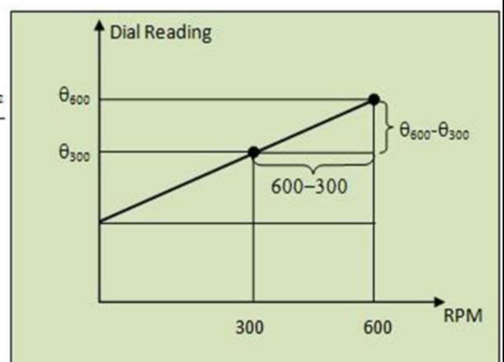
$$1\frac{lbf \times s}{100\,ft^2} = 479\ cp$$

$$\boxed{\mu_p = \theta_{600} - \theta_{300}, cp}$$

$$\frac{\theta_{600} - \tau_y}{600} = \frac{\theta_{300} - \tau_y}{300}$$

$$\tau_y = 2\theta_{300} - \theta_{600} = \theta_{300} - (\theta_{600} - \theta_{300})$$

$$\boxed{\tau_y = \theta_{300} - \mu_p}$$



Field Tests of Drilling Fluids

Plastic Viscosity and Yield Point

Record the results in the API Standard Drilling Mud Report as follows:

Subtract the 300-rpm dial reading from the 600-rpm dial reading. Record this difference as the PV in centipoise (cp) at X° F (or °C);

$$\mu_p = PV = \theta_{600} - \theta_{300}$$

Subtract the PV from the 300 rpm dial reading. Record this difference as the YP in pounds per 100 square feet (lb per 100 sq ft);

$$\tau_y = YP = \theta_{300} - \mu_p$$

Initial (10-second) gel strength is recorded as the first peak dial reading; it is recorded as pounds per 100 square feet (lb per 100 sq ft) . Ten-minute gel strength is recorded in the same manner.

Field Tests of Drilling Fluids

Standard API Filtration Test

The filtration and wall-building properties of drilling mud are determined by means of a standard filter press.

The standard filter press unit consists of a mud reservoir mounted in a frame, a filtering medium, a means of catching and measuring the filtrate, and a pressure source.

Field Tests of Drilling Fluids

Standard API Filtration Test

The flow of mud filtrate through a mudcake is described by Darcy's law. Thus, the rate of filtration is given by

$$\frac{dV_f}{dt} = \frac{kA\Delta p}{\mu h_{mc}}$$

Combining with the continuity equation gives $V_f = \sqrt{2k\Delta p\left(\frac{f_{sc}}{f_{sm}} - 1\right)}\frac{A}{\sqrt{\mu}}\sqrt{t}$

V_f - the volume of the filtrate, cm^3 ; t – time, s ; k – permeability of the mudcake, Darcy
A – the area of the filter paper, cm^2 ; Δp – the pressure drop across the mudcake, atm.
According to API standard, Δp = 100 psig
μ – the viscosity of the mud filtrate, cp ; h_{mc} – the thickness of the filter cake
$f_{sm,}$ f_{sc} – the volume fraction of solids in the mud and the volume fraction of solids in the cake

The standard API filter press has A = 45 cm^2; operated at a ΔP = 100 psig (6.8 atm).

The filtrate volume collected in a 30-min time period is reported as the standard water loss.

Field Tests of Drilling Fluids

Standard API Filtration Test

Test Procedure

1. Loosen the T-screw until the filter cell can be removed from the frame.
2. Remove the filter cell and disassemble it.
3. Be certain that all parts of the filter cell are dry and clean.
4. Check to see that the rubber gasket in the base cap is evenly placed.
5. Check the filtrate tube in the base cap to be certain it is free of obstruction.
6. Place the screen in the base cap with the wide rim up.
7. Place wet paper on the top of the screen.
8. Place the second rubber gasket on top of the filter paper.
9. Replace the cell body.
10. Turn the cell body clockwise until it securely fastens into the J slots.

Field Tests of Drilling Fluids

Standard API Filtration Test

Test Procedure (cont.)

11. Check to see that the rubber gasket is evenly fitted into the top cap.
12. Fill the filter cell to within 1 inch of the top with the drilling mud sample.
13. Check to see that the hole in the top cap is free of obstruction.
14. Place the top cap on the filter cell.
15. Place the cell body into the frame.
16. Tighten the T-screw securely.
17. Place a graduated cylinder under the filtrate tube and adjust the support to keep the cylinder under the filtrate tube.
18. Close the pressure-relief valve and the regulator valve until the pressure is 100 (�5) psi. Start timing immediately.
19. Allow the test to continue for 30 minutes.
20. Read and make note of the amount of filtrate in the graduated cylinder to the nearest 0.1 cc. Set the filtrate aside for use in conducting other tests.

Field Tests of Drilling Fluids

Standard API Filtration Test

21. Open the valve on the regulator by turning counterclockwise.
22. Open the pressure relief valve by moving it to the vertical position.
23. Wait until all pressure is released.
24. Remove the cell from the frame by loosening the T-screw.
25. Remove the top cap and pour the mud out.
26. Remove the bottom cap from the cell.
27. Turn the bottom cap upside down on a solid surface and remove the filter paper.
28. Gently rinse the filter paper and filter cake with water.
29. Measure the thickness of the filter cake to the nearest 1/32 in.
30. Inspect the filter cake for its physical properties such as softness/firmness and brittleness/flexibility.
31. Wash and dry all parts of the filter press.
32. Reassemble the filter press for storage. Do not put the filter paper and screen in the filter press when storing.

Field Tests of Drilling Fluids

Standard API Filtration Test

Record the results of the Standard API Filtration Test on the drilling mud report as follows:

Report the amount of filtrate in the graduated cylinder to the nearest 0.1 cc.

Report the cake thickness to the nearest 1/32 in., and check the box indicating "API."

Report the physical properties of the filter cake (soft or firm, brittle or flexible) The importance of filter cake quality cannot be overstated. A thin, firm cake is desirable.

Field Tests of Drilling Fluids

Standard API Filtration Test

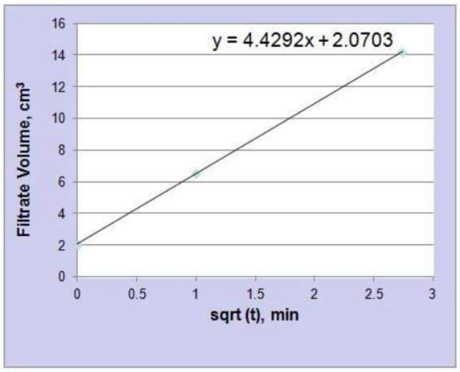
Example: Using the following data obtained using and HTHP filter press, determine the spurt loss and API water loss.

Time, min	Filtrate Volume, cm^3
1.0	6.5
7.5	14.2

Field Tests of Drilling Fluids

Standard API Filtration Test

Time, min	Filtrate Volume, cm^3
1.0	6.5
7.5	14.2



The spurt loss = 2.07 cm^3

The API water loss:

$$V_{30} = 4.43\sqrt{30} + 2.07 = 26.33\ cm^3$$

Field Tests of Drilling Fluids

Sand Content Analysis

By definition, solid particles larger than 74 microns (200 mesh) are classified as **API sand** [one micron (m) = 10^{-6}m]. These particles can be highly abrasive, and can cause excessive wear on pump parts, drill bits, and pipe connections. Excessive sand may also result in the deposition of a thick filter cake on the borehole wall, or it may settle in the hole around the tools when circulation is stopped.

The sand content set consists of a 200-mesh sieve, a funnel, and a glass measuring tube calibrated from 0 to 20% to directly read the percentage of sand by volume.

Field Tests of Drilling Fluids

Sand Content Analysis

Test Procedure

1. Pour the sample into the sand content tube until it fills up to the mark labeled "Mud to Here."
2. Add water to the mark labeled "Water to Here." Add oil instead of water when testing oil-base mud.
3. Cover the mouth of the tube and shake vigorously.
4. Pour this mixture through the screen.
5. Add more clear water (or oil, for oil-base mud) to the tube, shake, and pour it through the same screen.
6. Gently wash the sand retained on the screen with a stream of water (or oil, for oil-base mud) to remove all mud and shale particles.
7. Fit the funnel upside-down over the top of the screen.
8. Turn the tip of the funnel into the mouth of the washed tube.
9. Wash the sand back into the tube with water (or oil with oil-base mud) applied to the back of the screen.
10. Allow the sand to settle in the tube and read the volume percent of sand

Field Tests of Drilling Fluids

Sand Content Analysis

Reporting Procedures

Report the sand content as percent (%) by volume on the API Standard Drilling Mud Report. Take into account other coarse solids in the tube by observing their color, size, and shape. If their volume appears to be significant, subtract their estimated volume from the total volume.

Field Tests of Drilling Fluids

Oil, Water and Solids Content

Knowledge of a drilling mud's liquid and solids content is important in controlling its properties. This information often explains poor mud system performance and indicates whether the mud needs to be conditioned by adding water, treating it with a chemical thinner, or removing a particular contaminant. Also, proper control of the oil/water ratio and the water-in-oil emulsion in an oil-base mud depends upon a knowledge of the oil content. The equipment used to measure the oil, water, and solids content of the mud is included in the Oil and Water Retort Kit.

The test is a distillation of a mud sample that measures condensed oil and water collected from the retort.

Field Tests of Drilling Fluids

Oil, Water and Solids Content

Field Tests of Drilling Fluids

Oil, Water and Solids Content

Test Procedures

1.Lift the upper insulator lid.

2.Lift the retort assembly (upper retort chamber, lower mud chamber, and condenser) out of the insulator block.

3.Using the spatula as a screwdriver, loosen the lower mud chamber.

4.Remove the lower mud chamber from the retort assembly.

5.Using the corkscrew, remove the used steel wool from the upper chamber.

6.Using the spatula, clean the interior of the upper chamber. Clean the tube leading to the condenser with a pipe cleaner.

7.Remove the lid from the mud cup.

8.Using the spatula, clean the interior of the mud cup and lid.

9.Clear any obstructions from the vent hole in the lid.

10.Loosely pack the upper chamber with fine steel wool.

Field Tests of Drilling Fluids

Oil, Water and Solids Content

11. Apply a small amount of thread lubricant on the threads of the mud cup.
12. Fill the mud cup level full (10 ml), taking care to avoid creating air bubbles in the mud.
13. Place the lid securely on the mud chamber until excess mud comes through the vent hole.
14. Wipe excess mud off the lid.
15. Hold the retort assembly upright and screw the mud cup lid hand tight on the mud cup.
16. Replace the retort assembly in the insulator block.
17. Place a 10-ml graduated cylinder under the condenser with the discharge tube inserted into the cylinder.
18. Close the insulated lid.
19. Connect the electrical cord to the power supply.
20. Allow at least 30 minutes for the test.
21. Remove the graduated cylinder.
22. Read the volumes of oil and water collected in the cylinder.
23. Calculate the volume of solids as 10 ml minus the volumes of water and oil.

Field Tests of Drilling Fluids

Oil, Water and Solids Content

Reporting Results

- Volume percent of water
- Volume percent of oil
- Volume percent of solid

Field Tests of Drilling Fluids

Resistivity

The resistivity of water-base muds is measured and controlled to permit better evaluation of formation characteristics from electrical logs. The determination of resistivity involves the measurement of resistance to the flow of electrical current through a sample of known configuration. In the direct-reading resistivity meter, the resistance measurement is converted to resistivity in ohm meters.

Salt is used to lower the resistivity. Fresh water is the only means of raising resistivity.

Field Tests of Drilling Fluids

Resistivity

The following equipment and materials are required to conduct this test:

1. Mud, filtrate and filter cake

2. Direct reading resistivity meter for drilling fluids Resistivity Meter. *Courtesy of Fann Instrument Company*)

3. Calibrated resistivity cell

4. Thermometer, 32 to 220°F

Field Tests of Drilling Fluids

Resistivity

Test Procedure

1. Fill the clean, dry resistivity cell with freshly stirred mud or filtrate. Try to ensure no air bubbles are entrained. Fill the cell to the correct volume according to the manufacturer's procedure.

2. Connect the cell to the meter.

3. Measure the resistance in ohm- meters if using the direct reading meter. The value should be set to ohms if a "not direct meter" is being used.

4. Note the temperature of the measurement.

5. Clean the cell, rinse with deionized water and dry.

Field Tests of Drilling Fluids

Resistivity

Report Results:

1. Report the mud resistivity R_m or filtrate resistivity R_{mf} in ohm-meters to nearest 0.01 units.
2. Report the sample temperature in °F.
3. If the reading is in ohms, convert to ohm-meters by:
4. Resistance (ohm-meter) = R (ohms) x K (cell constant, m^2/m)

Field Tests of Drilling Fluids

pH

The control of many drilling fluid system properties is dependent on pH (the detection and treatment of contaminants such as cement and soluble carbonates). pH also affects the solubility of many thinners and divalent metal ions such as calcium and magnesium, and influences the dispersion or flocculation of clays.

The relative acidity or alkalinity of a liquid is conveniently expressed as pH. Defined as the negative logarithm (to the base 10) of the hydrogen-ion concentration, pH units decrease with increasing acidity by a factor of 10.

$pH = -\log[H^+]$

where $[H^+]$ is the hydrogen ion concentration in moles per liter. At room temperature, the ion product constant of water, K_w, has a value of 1×10^{-14} mol/L.

$K_w = [H^+]\,[OH^-] = 1.0 \times 10^{-14}$

For pure water, $[H^+] = [OH^-] = 1.0 \times 10^{-7}$ and hence, pH = 7.

Field Tests of Drilling Fluids

pH

Example: compute the amount of caustic required to raise the pH of water from 7 to 10.5. the molecular weight of caustic is 40.

Solution:

$$[OH^-] = \frac{1.0 \times 10^{-14}}{[H^+]} = \frac{1.0 \times 10^{-14}}{10^{-pH}} = 10^{pH-14}$$

$$\Delta[OH^-] = [OH^-]_{10.5} - [OH^-]_7 = 10^{10.5-14} - 10^{7-14} = 3.161 \times 10^{-4}\ mol/l$$

Moles of caustic in one liter

$N = C_M V = 3.161 \times 10^{-4}$ moles

The amount of caustic required for one liter

$m = n \times M = 3.161 \times 10^{-4} \times 40 = 0.0126$ g / liter

Field Tests of Drilling Fluids

Alkalinity

Alkalinity is a property which determines the amount of lime in mud. The mud is titrated to determine the total amount of lime, soluble and insoluble, in the system.

The phenolphthalein alkalinity refers to the amount of acid required to reduce the pH to 8.3, the phenolphthalein endpoint. The phenolphthalein alkalinity of the mud and mud filtrate is called the P_m and P_f.

Methyl orange alkalinity refers to the amount of acid required to reduce the pH to 4.3, the methyl orange endpoint. The methyl orange alkalinity of the mud and mud filtrate is called the M_m and M_f.

The API diagnostic tests include the determination of P_m, P_f, and M_f. all value are reported in cubic centimiters of 0.02N sulfuric acid per cubic centimeter of sample.

Field Tests of Drilling Fluids

Alkalinity

At pH = 8.3, the conversion of hydroxides to water and carbonates to bicarbonates is essentially complete.

$H^+ + OH^- = H_2O$

$H^+ + CO_3^{2-} = HCO_3^-$

As the pH is further reduced to 4.3, the acid then reacts with the bicarbonate ions to from carbon dioxide and water.

$HCO_3^- + H^+ = CO_2 + H_2O$

The free lime is given by: $0.26(P_m - f_w P_f)$. where f_w is the volume fraction of water in the mud and 0.26 is in lbm/bbl obtained by converting 0.02 N.

Field Tests of Drilling Fluids

Alkalinity

Example: A drilling mud is known to contain $Ca(OH)_2$. The alkalinity tests are conducted to determine the amount of undissolved lime in suspension in the mud. When 1 cm^3 of mud filtrate is titrated using 0.02 N H_2SO_4, 1.0 cm^3 of H_2SO_4 is required to reach the phenolphthalein endpoint and 1.1 cm^3 of H_2SO_4 is required to reach the methyl orange endpoint. When 1 cm^3 of water before titration so that any suspended lime can go into solution, 7.0 cm^3 of H_2SO_4 is required to reach the phenolphthalein endpoint. Compute the amount of free lime in suspension in the mud if the mud has a total solids content of 10%.

Field Tests of Drilling Fluids

Alkalinity

Example: A drilling mud is known to contain $Ca(OH)_2$. The alkalinity tests are conducted to determine the amount of undissolved lime in suspension in the mud. When 1 cm^3 of mud filtrate is titrated using 0.02 N H_2SO_4, 1.0 cm^3 of H_2SO_4 is required to reach the phenolphthalein endpoint and 1.1 cm^3 of H_2SO_4 is required to reach the methyl orange endpoint. When 1 cm^3 of mud is diluted with 50 cm^3 of water before titration so that any suspended lime can go into solution, 7.0 cm^3 of H_2SO_4 is required to reach the phenolphthalein endpoint. Compute the amount of free lime in suspension in the mud if the mud has a total solids content of 10%.

Solution: Since Pf and Mf have approximately the same value, an absence of any carbonates or bicarbonates is indicated. Thus, the alkalinity of the filtrate is mainly due to the presence of hydroxides. The free lime in lbm/bbl is given by

$0.26(P_m - f_w P_f) = 0.26(7.0 – 0.9 \times 1.0) = 1.59$ lbm/bbl.

Field Tests of Drilling Fluids

Alkalinity

The following test kits, often incorporated into a portable mud laboratory, can be used to test mud and filtrate alkalinity:

Chloride and Alkalinity Test Kit

Alkalinity and Water Hardness Test Kit

Chloride, Alkalinity, and Water Hardness Test Kit

Filtrate Analysis Kit

Filtrate Analysis and Pilot Testing Kit

Field Tests of Drilling Fluids

Alkalinity

The following equipment is necessary for alkalinity testing:

1. Phenolphthalein indicator solution
2. Sulfuric acid, H_{H2SO4} (0.02 N)
3. Methyl orange indicator solution
4. Distilled water
5. Polyethylene or porcelain titration dish, 140 ml
6. Pipettes (1 ml x 0.01 ml)
7. Pipettes (10 ml x 0.01 ml)
8. Polyethylene or glass stirring rod

Field Tests of Drilling Fluids

Alkalinity

Mud Alkalinity (P_m) Test Procedure

1. Measure 1 ml of mud into a titration dish and dilute to approximately 50 ml with distilled water. Stir well to disperse the mud.
2. Add 2 or 3 drops of phenolphthalein indicator solution.
3. Add 0.02 Normal sulfuric acid from a pipette, stirring continuously until the color first changes from red to the color of the mud.
4. P_m is taken as the milliliters of 0.02 N acid divided by the milliters of sample taken.

Reporting P_m

Report P_m on the API Standard Drilling Report as the ml of 0.02 N sulfuric acid required per ml of mud sample tested to reach the phenolphthalein end point.

Field Tests of Drilling Fluids

Alkalinity

Filtrate Alkalinity (P_f, M_f) Test Procedure

1. Measure 1 or more milliliters of filtrate, taken from the API Filtration Test) into a titration dish.
2. Add 2 or more drops of phenolphthalein indicator solution, which will turn the filtrate red.
3. Add 0.02 Normal (N/50) sulfuric acid from a pipette, stirring continuously until the color of the filtrate changes from red to the original color of the filtrate.

   NOTE: In some cases, the filtrate may be so dark that it is necessary to use a pH meter to determine this first end point. If the filtrate is so dark that the end point is masked, the end point is taken when the pH, as measured with the pH meter, drops to 8.3.
4. The volume in milliliters of 0.02 Normal (N/50) sulfuric acid needed to reach this end point, divided by the volume of filtrate in the sample is called the **P alkalinity of the filtrate**, or **P_f**.
5. *To the same sample*, add 2 or 3 drops of methyl orange indicator solution. Methyl purple (or bromo cresol green methyl red indicator) may be used on very dark filtrate samples.

Field Tests of Drilling Fluids

Alkalinity

6. Continue to add 0.02 Normal (N/50) sulfuric acid while stirring continuously until the sample turns from yellow to salmon pink
7. This second end point is called the **M alkalinity of the filtrat**e, or M_f. This is the total volume of acid in milliliters per volume of filtrate sample used to reach the M_f end point, *including* that volume used to reach the P_f end point.

Reporting P_f and M_f

Report P_f on the API Standard Drilling Mud Report as the ml of 0.02 N sulfuric acid per ml of filtrate required to reach the P end point. Report M_f as the ml of 0.02 N sulfuric acid required per ml of filtrate to reach the M end point, including that required to reach the P end point.

Field Tests of Drilling Fluids

Chloride Concentration

Salt can enter and contaminate the mud system when salt formations are drilled and when saline formation water enters the wellbore. The chloride concentration is determined by titration with silver nitrate solution. This causes the chloride to be removed from the solution as AgCl, a white precipitate.

$Ag^+ + Cl^- = AgCl$

The endpoint of the titration is detected using a potassium chromate indicator. The excess Ag^+ present after all Cl^- has been removed from solution reacts with the chromate to from Ag_2CrO_4, an orange-red precipitate. A 0.0282 N $AgNO_3$ concentration usually is used for the titration.

Field Tests of Drilling Fluids

Chloride Concentration

Example: One cm^3 of mud filtrate is titrated using 0.0828 N $AgNO_3$ and 9 cm^3 of $AgNO_3$ solution are required to reach the endpoint of the titration as indicated by the potassium chromate indicator. Compute the concentration of Cl^- present expressed in milligrams of Cl^- per liter. Also, assuming that only sodium chloride was present, compute the salinity of the filtrate in milligrams of NaCl per liter.

Field Tests of Drilling Fluids

Chloride Concentration

Example: One cm^3 of mud filtrate is titrated using 0.0282 N $AgNO_3$ and 9 cm^3 of $AgNO_3$ solution are required to reach the endpoint of the titration as indicated by the potassium chromate indicator. Compute the concentration of Cl^- present expressed in milligrams of Cl^- per liter. Also, assuming that only sodium chloride was present, compute the salinity of the filtrate in milligrams of NaCl per liter.

Solution: 0.0282 N $AgNO_3$ = 0.0282 Moles/liter $AgNO_3$

$n_{AgNO3} = C_M V = 0.0282 \times 9/1000 = 2.538 \times 10^{-4}$ moles $= n_{NaCl}$

Concentration of Cl^- : $C_M = n/V = 2.538 \times 10^{-4} / 1 cm^3 = 2.538 \times 10^{-4}$ moles/ml

Mass concentration: $m = n \times M = (2.538 \times 10^{-4} \times 1000)$ moles/L $\times 35.5 \times 1000 = 9000$ mg/L

Field Tests of Drilling Fluids

Chloride Concentration

The chloride content kit in the portable mud laboratory is used to conduct the chloride test.

- pipette, 1 ml;
- pipette, 5 ml;
- pipette, 10 ml;
- silver nitrate solution, 1 ml equivalent to .1 or 0.1 g Cl;
- distilled water;
- potassium chromate solution;
- polyethylene or porcelain titration dish;
- polyethylene or glass stirring rod.

Field Tests of Drilling Fluids

Chloride Concentration

Test Procedure

1. Pipette 1.0 ml of filtrate sample into a titration dish and dilute it to 40 to 50 ml with distilled water.

Add 4 or 5 drops of potassium chromate indicator solution.

2. While continuously stirring with a stirring rod, add standard silver nitrate solution slowly, drop by drop, until the sample turns from yellow to a definite red color (or to the first definite color change.)

   a. Use 0.1 silver nitrate solution if you expect a chloride concentration of 5000 ppm or less.

   b. Use 0.01 silver nitrate solution if you expect a chloride concentration of more than 5000 ppm.

The number of ml of standard silver nitrate solution used to reach the end point is multiplied by 10.0 when using the 0.1 silver nitrate solution, and by 1000 when using the 0.01 silver nitrate solution.

Reporting Results

Check the "chloride" box on the APT Standard Drilling Mud Report and report the chloride content of the sample as mg/l (ppm) chloride.