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**INSTRUCTIONS**  
**OFFSHORE TEST KIT - COMPLETE**  
*OFITE Part No. 161-00-C*



The OFI Offshore Test kit is a popular and complete portable “one man” test kit that features a lot of equipment in a small easily transportable package.. It is contained in a rugged stainless steel carrying case that has plenty of room for labware and reagents. The front side of the case serves as a work table when the case is opened up. As with all of our kits, the OFI Offshore Kit may be modified to meet special requirements.

***The following analysis may be performed with the standard OFI Offshore Test Kit:***

1. Alkalinity –  $P_fM_f$ – water based fluids
2. Alkalinity –  $P_fM_f$ – oil based fluids
3. Chloride – water based fluids
4. Chloride – oil based fluids
5. Hardness – Total as Calcium
6. Lime content – water based fluids
7. Lime content – oil based fluids
8. Ph Analysis – Paper
9. Retort Analysis – Oil Water & Solids content
10. Sand Content
11. Viscosity – Hand Crank Rheometer

## **ALKALINITY and LIME CONTENT INSTRUCTIONS**

### **Water Based Drilling Fluids**

Alkalinity is the acid neutralizing power of a substance. Alkalinity measurements in drilling fluid testing may be made on the whole mud (designated with a subscript  $m$ ) or on the filtrate (designated with a subscript  $f$ ). The data collected can also be used to estimate the concentrations of hydroxyl ( $\text{OH}^-$ ), carbonate ( $\text{CO}_3^{-2}$ ) and bicarbonate ( $\text{HCO}_3^-$ ) ions in the drilling fluid. Knowledge of the mud and filtrate alkalinity is important in many drilling operations. Mud additives, particularly some organic defloculants, require an alkaline environment in order to function properly. Alkalinity arising from hydroxyl ions is generally accepted as being beneficial while alkalinities resulting from carbonates or bicarbonates may be detrimental to mud performance.

The ions that are primarily responsible for *filtrate* alkalinity are the hydroxyl ( $\text{OH}^-$ ), carbonate ( $\text{CO}_3^{-2}$ ) and bicarbonate ( $\text{HCO}_3^-$ ) ions. The carbonates can change from one form to another by changing the pH of the solution. Other inorganic ions such as borate's, silicates, sulfides and phosphates may also contribute to the alkalinity. It is important to realize the following calculations are only estimates of the concentrations of the reported ionic species based on theoretical chemical equilibrium reactions. The composition of mud filtrates is often so complex that the interpretation of alkalinities may be misleading. Any particular alkalinity value represents all of the ions which will react with the acid within the pH range over which that particular value was tested. Anionic organic thinners and filtrate reducers contribute to a large portion of the  $M_f$  alkalinity value and may also mask the endpoint color change and render the test highly inaccurate in muds treated with organic thinners. For simple bentonite-based mud systems containing no organic thinners, the Phenolphthalein ( $P_f$ ) and the methyl orange ( $M_f$ ) alkalinities may be used as guidelines to determine the presence of carbonate/bicarbonate contamination and the treatment necessary to alleviate the problem. If organic thinners are present in large amounts, the conventional  $P_f/M_f$  test is suspect, and the  $P_1/P_2$  method should be used instead.

**Equipment - Water Based Drilling Fluids:**

- #147-16 Pocket pH Sensor (Optional)
- #153-26 Titration Dish, Polyethylene
- #153-28 Stirring Rod, Polyethylene
- #153-29 Syringe, glass tip, 2 ml
- #153-34 Pipette, Serological, 1 ml x 1/100 ml, glass
- #153-40 Pipette, Serological, 10 ml x 1/10 ml, glass

**Reagents:**

- #220-01 Phenolphthalein Indicator sol'n, 8 oz
- #230-08 Sulfuric Acid sol'n, N/50, 8 oz
- #240-02 Methyl Orange Indicator sol'n, 8 oz

**Procedure - Filtrate Alkalinity,  $P_f$ ,  $M_f$** 

1. Measure one or more milliliters of filtrate into the titration dish.
2. Add two or more drops of Phenolphthalein Indicator solution. If the solution turns pink, add N/50 Sulfuric Acid, drop by drop from the pipette, while stirring, until the pink color just disappears. If the filtrate is so colored that the end point cannot be seen, use a pH meter and titrate until the pH of the solution drops to pH 8.3, and this will be the end point.
3. Report the Phenolphthalein Alkalinity of the filtrate,  $P_f$ , as the number of milliliters of N/50 Sulfuric Acid required per milliliters of filtrate.
4. To the same sample which was titrated to the  $P_f$  endpoint, add two or three drops of Methyl Orange Indicator solution. Add the N/50 Sulfuric Acid drop by drop from the pipette while stirring until the color of the indicator changes from yellow to pink. The end point may also be taken when the pH of the sample drops to pH 4.3 as measured with a pH meter (more accurate).
5. Report the Methyl Orange Alkalinity of the filtrate,  $M_f$ , as the total milliliters of N/50 Sulfuric Acid per milliliters of filtrate required to reach the Methyl-Orange end-point. This also includes the amount of acid used to reach the Phenolphthalein,  $P_f$ , end-point.

**Calculation,  $P_f$ ,  $M_f$  (Estimation of Hydroxide ( $OH^-$ ), Carbonate ( $CO_3^{2-}$ ) & Bicarbonate ( $HCO_3^-$ ) ions)**

<u>Test Results</u>	<u>Calculation, Concentration mg/liter</u>	
$P_f = 0$	$M_f \times 1220 = \text{mg/L } HCO_3^-$	(Indicates Bicarbonate ion only)
$P_f = M_f$	$P_f \times 340 = \text{mg/L } OH^-$	(Indicates Hydroxide ion only)
$2P_f < M_f$	$2P_f \times 600 = \text{mg/L } CO_3^{2-}$	(Indicates Carbonate ion)
	$(M_f - 2P_f) \times 1220 = \text{mg/L } HCO_3^-$	(Indicates Bicarbonate ion)
$2P_f = M_f$	$M_f \times 600 = \text{mg/L } CO_3^{2-}$	(Indicates Carbonate ion only)
$2P_f > M_f$	$(2P_f - M_f) \times 340 = \text{mg/L } OH^-$	(Indicates Hydroxide ion)
	$(M_f - P_f) \times 1200 = \text{mg/L } CO_3^{2-}$	(Indicates Carbonate ion)

## Procedure - Whole Mud Alkalinity, $P_m$

1. Measure 1 ml of drilling mud into the titration dish and dilute with 25 to 50 ml of distilled water.
2. Add four or five drops of Phenolphthalein Indicator solution and while stirring, titrate with N/50 Sulfuric acid solution until the pink color just disappears. If the end point color change cannot be seen, it can be taken when the pH drops to pH 8.3 as measured on a pH meter. If cement contamination is suspected, the titration must be performed as rapidly as possible and the end-point is reported as the first disappearance of the pink color.
3. Report the Phenolphthalein alkalinity of the whole mud,  $P_m$ , as the number of milliliters of N/50 Sulfuric acid required per milliliter of mud.

## LIME CONTENT - Estimated

### Procedure:

1. Determine the  $P_f$  and  $P_m$  of the filtrate and whole mud as described in the Alkalinity test.
2. Determine the volume fraction of water  $F_w$ , using the percent of water from the liquid and solids as determined in a Retort analysis.

$$F_w = \frac{\% \text{ Water by Volume}}{100}$$

3. Report the Lime Content of the Fluid:

$$\text{Estimated Lime, lb/bbl} = 0.26 (P_m - F_w \times P_f)$$

$$\text{Estimated Lime, kg/m}^3 = 0.742 (P_m - F_w \times P_f)$$

## CHLORIDE – Water Based Fluids

This test measures the total soluble Chloride ion concentrations in the mud *Filtrate*. These Chlorides can come from Sodium Chloride, Calcium Chloride or Potassium Chloride. For the titration to work correctly, the pH of the filtrate needs to be slightly basic, around pH = 8.3, etc. Two chemical reactions take place simultaneously during the titration procedure.

1.  $\text{Ag}^+ + \text{Cl}^- \longrightarrow \text{AgCl}$
2.  $2\text{Ag}^+ + \text{CrO}_4^{2-} \longrightarrow \text{Ag}_2\text{CrO}_4$

The first reaction, the formation of Silver Chloride, accounts for the appearance of the white specs or milky appearance during the titration. The formation of Silver Chromate, which is red in color, will not start until all of the Chloride Ions are tied up as Silver Chloride. The Silver Nitrate will then react with the chromate from the Potassium Chromate Indicator to form Silver Chromate. So, for the above two reactions to occur, the filtrate needs to be weakly basic. (pH = 8.3). High pH will precipitate out Silver Oxide.

### EQUIPMENT:

- #153-26 Titration Dish, polyethylene
- #153-28 Stirring Rod, polyethylene
- #153-34 Pipette, 1 ml x 1/100 ml, glass
- #153-40 Pipette, 10 ml x 1/10 ml, glass

*Reagents:*

- #206-01 Deionized Water, 8 oz
- #215-00 \*Potassium Chromate Indicator sol'n, 2 oz (UN3082)
- #220-00 Phenolphthalein Indicator sol'n, 2 oz
- #230-08 Sulfuric Acid, 0.02N (N/50), 8 oz
- #265-02 Silver Nitrate sol'n, 0.001G, 0.0282N, 16 oz
- #265-06 Silver Nitrate sol'n, 0.01G, 0.282N, 8 oz
- #285-00 Calcium Carbonate, precipitated. 35 grams

**PROCEDURE - Water Based Fluids:**

1. Pipette one or more milliliters (cm<sup>3</sup>) of filtrate into the titration dish.
2. Add 2 - 3 drops of Phenolphthalein Indicator sol'n to the filtrate.
  - i. *If a pink color appears* - Titrate with N/50 Sulfuric acid until the color is discharged.
  - ii. *If the filtrate is deeply colored* - Add an additional 2 ml of N/50 Sulfuric Acid and stir.
  - iii. Then add 1 gram of Calcium Carbonate and stir.
3. Add 25 - 50 ml of distilled water. If any water other than distilled water is used, the chlorides in it must be accounted for by titration before adding the filtrate to it.
4. Add 5 - 10 drops of Potassium Chromate Indicator sol'n.
5. Add Silver Nitrate sol'n drop-by-drop from the pipette while stirring continuously with the stirring rod, until the color changes from yellow to orange-red and persists for 30 seconds. Record the number of milliliters (cm<sup>3</sup>) of Silver Nitrate sol'n required to reach the end point.
  - A. If the chloride ion concentration of the filtrate exceeds 10,000 milli grams (mg/l) per liter use the
  - B. gram chloride-ion per cubic centimeter (0.282N) strength solution.
 If over 10 milliliters (cm<sup>3</sup>) of Silver Nitrate is used, repeat the test with a smaller amount of filtrate.

**CALCULATIONS:**

$$\text{Chloride, mg/L} = \frac{*1000 \times \text{mls of Silver Nitrate titrated}}{\text{Filtrate Sample, mls}}$$

To Convert Units:

$$\text{Chloride, ppm} = \frac{\text{Chloride, mg/L}}{\text{Specific Gravity of Filtrate}}$$

$$\text{Salt (NaCl), mg/L} = (1.65) \text{ Chloride, mg/L}$$

Use 1000 as the multiplier for 0.0282N (.001gram) Chloride Ion solution, and 10,000 for the 0.282N (.01 gram) AgNO<sub>3</sub>

**REMARKS:**

1. Avoid contact with Silver Nitrate and wash immediately with water if Silver Nitrate gets on skin or clothing.
2. The end point of the reaction is when the Silver Chromate is first formed and it is reddish in color. When using the weak, or 0.001 gram sol'n, the end point is approached very gradually. Therefore the formation of the Silver Chromate can be seen by a color change from yellow to orange-red. If the strong (.01gram) solution is used the end point is reached much more rapidly and may go from yellow to red. As soon as the red color is seen, the titration procedure is complete.
3. White lumps of Silver Chloride form when titrating high concentrations of salt. This should not be taken for the end point of the titration.

## CHLORIDE - Oil Based Fluids

The whole mud chloride test procedure for oil muds is a titration procedure which measures the volume of a standard Silver Nitrate required to react with the Chloride ions to form insoluble Silver Chloride salts. The Chloride value reported for the whole mud may be assigned to the water phase of the solution up to the saturation point. The water soluble salt concentration indicates how effective an oil mud is in controlling shale through the "aqueous phase activity" concept. The water phase salinity value is also needed to adjust the retort value to obtain a corrected solids content for the oil mud. The test procedure uses the same sample as used in the whole mud Alkalinity test provided the sample is acidic ( $\text{pH} < 7$ ).

### Equipment - Oil Based Fluids:

#153-29-1	Syringe, glass tip, 5 ml
#153-51-1	Beaker, 400 ml, glass
#153-53	Magnetic Stirrer, with Stir Bars

### Reagents:

#206-02	Distilled Water, 16 oz
#215-02	Potassium Chromate sol'n, 8 oz (UN3082)
#220-01	Phenolphthalein Indicator sol'n, 8 oz
#230-10	Sulfuric Acid sol'n, N/10, 8 oz
#265-08	Silver Nitrate sol'n, 0.01g, 0.282N, 16 oz
#280-30	Arcosolv PNP, gal.

### Procedure – Oil Based Fluids

:

Perform the whole mud alkalinity test first as follows:

1. Add 100 ml of Arcosolv PNP solvent to the 400 ml beaker.
2. Fill the 5 ml syringe with at least 3 mls of whole mud and discharge 2 ml into the beaker. Swirl the mixture until it is homogenous.
3. Add 200 ml of deionized water.
4. Add 15 drops of Phenolphthalein Indicator solution.
5. While stirring with the magnetic stirrer, slowly titrate with N/10 Sulfuric Acid until the pink color just disappears. Continue stirring for one more minute, and if no pink color reappears, discontinue stirring. It may be necessary to stop the stirring to allow separation of the two phases in order to more clearly see the color in the aqueous phase.
6. Let the sample stand for 5 minutes and if no pink color reappears, the Alkalinity end point has been reached. If the pink color returns, titrate a second time with the Sulfuric Acid solution. If the pink color still returns titrate a third time, but if the color returns after this third titration, call this the end point.
7. After running the Alkalinity test make sure the mixture to be titrated for Chlorides is acidic (pH < 7) by adding 10 - 20 drops of N/10 Sulfuric Acid.
8. Add \*3.0 mls of Potassium Chromate Indicator solution.
9. While stirring with a Magnetic Stirrer, slowly titrate with 0.282N Silver Nitrate solution until a salmon pink color remains stable for at least one minute. It may be necessary to stop the stirring of the mixture and allow separation of the two phases to occur in order to more clearly see the color in the aqueous phase.
10. Note the total milliliters of 0.282N Silver Nitrate required to reach the end point to calculate the whole mud Chloride.

**Calculation:**

$$\text{Chloride, Whole Mud (Cl}_{om}\text{) Mg/l} = \frac{10,000 (\text{ml Silver Nitrate titrated})}{\text{ml of sample}}$$

\*Quantity has been revised since the last API issue - "R.P. 13B-2", Third Edition, Dated Feb. 1998.

## TOTAL HARDNESS as CALCIUM INSTRUCTIONS

The hardness of water or mud filtrates is due primarily to the presence of Calcium and Magnesium ions. When Hardness Titrating (EDTA) solution is added to the water, it combines with both Calcium and Magnesium, and the endpoint is determined with a suitable indicator. The total hardness of water is expressed as milligrams per liter Calcium. An endpoint that is obscured by dark components may be remedied by oxidizing with Sodium Hypochlorite.

### Equipment:

- #147-53 pH Strips, pH range 1 - 14, 100/box
- #153-26 Titration Dish, polyethylene
- #153-34 Pipette, 1 ml x 1/100 ml, glass
- #153-36 Pipette, 2 ml x 1/100 ml, glass
- #153-38 Pipette, 5 ml x 1/10 ml, glass
- #153-51 Beaker, 250 ml, glass
- #168-01 Hot Plate, with Thermostat, 115 volt (Optional)  
or
- #168-01-1 Hot Plate, with Thermostat, 230 volt (Optional)

### Reagents:

- #205-02 Indicator Sol'n (Calmagite®), Versenate Hardness, 2 oz
- #205-05 Buffer sol'n, Versenate Hardness (Ammonium), 8 oz (UN2672)
- #205-12 Titration sol'n, (EDTA), 0.01M, 400 Mg/L Ca<sup>+2</sup>, 16 oz
- #206-02 Deionized Water, 16 oz
- #230-25 Acetic Acid, Glacial, 8 oz (UN2789) (Optional)
- #261-00 Sodium Hypochlorite sol'n, 8 oz (UN1791) (Optional)
- #261-50 Masking Agent, 1:1:2 mixture by volume of  
Triethanolamine: tetraethylenepentamine : water, 16 oz  
(Optional)

### Procedure:

1. Measure at least 1.0 mLs of water or filtrate into a Titration Dish.  
*(If the filtrate is clear or is only lightly colored, omit steps 2 through 5.)*
2. Add 10 ml of Sodium Hypochlorite (Clorox®) and mix.
3. Add 1.0 ml of Glacial Acetic acid and mix.
4. Boil the sample for five minutes maintaining the same fluid volume by adding distilled water as required. Boiling is required to remove excess Chlorine. Verify the absence of Chlorine by immersing a strip of pH paper into the sample. If the paper is bleached white, continue boiling.
5. Cool the sample and wash the sides of the Beaker with deionized/distilled water.
6. Dilute the sample to 50 ml with deionized/distilled Water.
7. Add about 2 ml of Hardness Buffer sol'n and thoroughly mix.  
*Note: The presence of soluble Iron may interfere with the endpoint determination. If this is suspected a mixture of Triethanolamine: Tetraethylenepentamine : Water (1:1:2 by volume) has been found to be a suitable masking agent. One ml is used per titration.*
8. Add sufficient Hardness Indicator solution (2 to 6 drops) and mix. A wine-red color will develop if Calcium and/or magnesium is present.
9. While stirring, titrate with Hardness Titrating (EDTA) solution to the proper end point. Calcium Indicators produce a Red-to-Blue color change. The end point is taken as the point where additional Titrating solution produces no further Red-to-Blue color change. The Titrating solution will be used in the calculation.

### Calculation:

$$\text{Total Hardness as Calcium, mg/L} = \frac{400 (\text{EDTA Volume, ml}^3)}{\text{Volume Sample, ml}^3}$$

## pH PAPER:

1. Tear off and place a one inch strip of indicator paper on the surface of the mud.
2. Allow sufficient time for the paper to soak up liquid from the mud. This usually takes from a few seconds to a couple of minutes.
3. Match the color of the strip with the chart on the side of the dispenser to determine the pH.
4. Report the pH to the nearest 0.5 pH unit.

### *Remarks concerning pH paper testing:*

1. When the Chloride concentration is greater than about 10,000 mg/l pH paper may not give an accurate measurement.
2. Do not stick the pH paper or strips into the fluid sample.
3. The pH of mud filtrate may be taken and sometimes gives a faster color change, but the pH of the filtrate may differ from that of whole mud.

### *Ph Strips (Sticks):*

1. Lay one pH strip on the surface of the fluid with the colored indicator squares face down and in direct contact with the fluid.
2. Allow sufficient time for the indicator squares to soak up liquid from the mud. This usually takes from a few seconds to a couple of minutes.
3. Remove the pH strip from the mud and gently wash off any remaining mud from the strip.
4. While the color squares are still wet, match the pattern of the squares against the chart on the side of the dispenser.
5. Report the pH to the nearest 0.5 pH unit.

## RETORT ANALYSIS 10 ml Size - OFITE 165-00 Series

The retort provides a means for separating and measuring the volumes of water, oil and solids contained in a sample of drilling fluid. A known volume of sample is heated to vaporize the liquid components which are then condensed and

collected in a graduated cylinder. Liquid volumes are determined from reading the oil and water phases on the graduated cylinder. The total volume of solids, both suspended and dissolved, is obtained by noting the difference of the total sample volume versus the final liquid volume collected. Calculations are necessary to determine the volume of suspended solids since any dissolved solids will be retained in the retort. Relative volumes of low-gravity solids and weight materials may also be calculated.

### Equipment:

<i>Sample Cup:</i>	10 ml capacity
<i>Condenser:</i>	Sufficient mass to cool the water and oil vapors below their vaporization temperature prior to leaving the condenser chamber.
<i>Heating Element:</i>	Sufficient wattage to raise the temperature of the sample to above its vaporization point within API Specifications without causing the solids to boil over.
<i>Thermostat:</i>	Capable of limiting the temperature of the Retort to $930^{\circ}\text{F} \pm 70^{\circ}\text{F}$ ( $500 \pm 20^{\circ}\text{C}$ ) OFITE retorts are calibrated to heat a sample between $930^{\circ}$ and $1000^{\circ}\text{F}$ per API specifications. Any manual adjustments made to the thermostat are a safety hazard and will void the factory warrant
<i>Liquid Receiver:</i>	Graduated Cylinder or Tube, transparent and inert to oil, water or salt solutions and temperatures of up to $90^{\circ}\text{F}$ ( $32^{\circ}\text{C}$ ).
<i>Fine Steel Wool:</i>	No. 000 Steel Wool. Note: Liquid Steel Wool is not recommended.
<i>Grease:</i>	Never-Seez®. Used for a thread seal and lubricant at high temperatures.
<i>Pipe Cleaners:</i>	Cleaning Retort Chamber and Condenser passage.
<i>Spatula:</i>	Shaped to fit the inside dimensions of the sample cup.

The following guidelines should be followed to ensure safe operation of retorts.

1. Clean and dry the retort chamber and condenser, especially the inside of the mud sample cup, lid and the condenser passage (spout). Clean the sample cup threads with a wire brush. The spatula, corkscrew tip or a knife may be used to dislodge solids inside the sample cup. Pipe cleaners or a rigid tool should be used to scrape or drill out any residue out of the spout.

***Make sure the spout and the hole in the lid of the mud sample chamber is absolutely clear.***

2. The assembly should be cooled to  $<100^{\circ}\text{F}$  ( $37.8^{\circ}\text{C}$ ) from any previous usage.
3. The threads on the retort should be visually inspected before use for any sign of damage.
4. The steel wool should be changed out after every test to prevent solids from building up.
5. Retorts used offshore should be changed out every 6 months for examination and cleaning.

### Procedure:

1. Collect a representative sample of drilling fluid and pour it through a Marsh Funnel screen to remove any lost circulation material, large cuttings or debris.

2. Record the sample temperature. It should be within 10°F of the temperature at which mud density was determined.
3. If the sample contains gas or air bubbles, add 2 to 3 drops of a Defoaming Agent to about 300 mLs of mud. Stir slowly for 2 to 3 minutes to release any gasses entrained. Air or gas entrapment will result in erroneously high retort solids content due to the initial reduced liquid sample volume.
4. Pack a wad of no. 000 steel wool into the chamber to approximately 3/16 inch above the threads. As determined from experience, use only enough steel wool to prevent a boiling over of solids into the liquid receiver.
5. Using a clean syringe, fill the retort cup slowly with the non-aerated sample in order to avoid air entrapment. Lightly tap the side of the cup to expel any air and place the lid onto the cup. Rotate the lid to obtain a proper fit and be sure a small excess of fluid flows out the hole in the lid. Wipe any excess mud and clear any solids that may have accumulated in the hole in the lid.
6. Lubricate the threads on the sample cup with a light coat of Never-Seez<sup>®</sup>. This will prevent vapor loss through the threads and will also facilitate disassembly of the equipment at the end of the test.
7. Carefully hand tighten the Retort cup onto the Retort chamber and connect the assembly to the condenser. Hold the retort chamber upright and motionless while rotating the condenser onto the chamber. Place the chamber into the heating jacket and close the insulating lid.
8. Place a clean dry liquid receiver under the condenser discharge tube. The length of this receiver may require that it be angled out from the Retort or supported off the edge of the work table.
9. Turn on the Retort and observe the liquid exiting the Condenser. Continue heating for ten minutes beyond the time that no more condensate is being collected. If whole mud boils over into the receiver tube, the test must be rerun. Pack the Retort body with a larger amount of steel wool and rerun the test. Allow it to run a minimum of 45 minutes.
10. Remove the liquid receiver and allow it to cool. Read and record the volumes (or volume percentage) of 1. total liquid volume; 2. oil volume; and 3. water volume, after it has cooled to ambient temperature. If an emulsion interface is present between the oil and water phases, heating the interface may break the emulsion. One way to do this is to remove the retort assembly from the heating jacket by grasping the condenser. Carefully heat the receiver along the emulsion band by gently touching the receiver for short intervals with the hot Retort Chamber. Avoid boiling the liquid. After the emulsion interface is broken, allow the receiver to cool, and read the water volume at the lowest point of the meniscus.
11. Turn off the Retort and allow it to cool prior to cleaning. Do not use cold water to try to rapidly cool down the chamber.

### Calculations:

The measured volumes (mLs) of oil and water are converted into volume percents based on the volume of whole mud in the retort cup.

$$\text{Volume Percent (\% Oil)} = V_o = \frac{100 (\text{Oil volume collected, mLs})}{\text{Sample volume, mLs}}$$

$$\text{Volume Percent (\% Water)} = V_w = \frac{100 (\text{Water volume collected, mLs})}{\text{Sample volume, mLs}}$$

**Sample volume, mLs**

$$\text{Volume Percent (\%) Solids} = V_s = 100 - (V_o + V_w)$$

Note: The volume percent solids includes both suspended solids (weight material, etc.) and dissolved materials (for example salts). This volume percent will represent total suspended solids only if the mud is an untreated, freshwater mud.

To find the volume percent (%) of suspended solids and relate them to the relative volumes of low-gravity solids and weighting materials. In order to make these calculations, an accurate mud weight and Chloride concentration must be known.

$$V_{SS} = V_s - V_w \frac{\text{Chloride Concentration, mg/L}}{1,680,000 - 1.21 (C_s)}$$

Where:

$V_{SS}$  = Volume Percent (%) Suspended Solids

$C_s$  = Chloride Concentration, mg/L

Volume percent (%) Low-Gravity solids,  $V_{1g}$ , are calculated as follows:

$$V_{1g} = \frac{1}{P_b - P_{1g}} [100 P_f + (P_b - P_f)V_{SS} - 12 W_m - (P_f - P_o) V_o]$$

Where:

$V_{1g}$  = Volume percent (%) low-gravity solids.

$W_m$  = Mud Weight, pounds per gallon

$P_f$  = Density of filtrate, grams per cubic meter

$P_b$  = Density of weighting material, grams per cubic meter

$P_{1g}$  = Density of low gravity solids, grams per cubic meter (use 2.6 if unknown)

$P_o$  = Density of oil, grams per cubic meter (use 0.84 if unknown)

Volume percent (%) weighting material ( $V_b$ ) is calculated as follows:

$$V_b = V_{SS} - V_{1g}$$

Concentrations of low gravity solids, weighting material and suspended solids may be calculated as:

$$C_{1g} = 3.49 (P_{1g}) \times (V_{1g})$$

$$C_b = 3.49 (P_b) \times (V_b)$$

$$C_{SS} = C_{1g} + C_b$$

Where:

$C_{1g}$  = Low gravity concentration, pounds per barrel

$C_b$  = Weighting material concentration, pounds per barrel

$C_{SS}$  = Suspended solids concentration, pounds per barrel

## RHEOMETER, 2-SPEED, HAND CRANK OFITE PART No. 132-00

The OFI Rheometer is a direct-indicating manually operated rotational viscometer. The instrument is powered by the operator turning a crank which drives the spindle through a precision gear train. Fixed speeds of 300 and 600 rpm are selected by a shift lever. A knob on the hub of the speed change lever is used to determine gel strength. Fluid is contained in the annular space between two concentric cylinders. The outer cylinder or rotor sleeve is driven at a

constant rotational velocity or rpm. The inner cylinder, or Bob, is restrained by a torsion spring, and a dial indicates displacement of the Bob due to friction caused by the fluid. Instrument constants have been adjusted so that plastic viscosity and yield point are obtained by using readings from the rotor sleeve of 300 and 600 rpm.

### Procedure:

**300 RPM Setting:** Gear shift lever in the *all the way up* position and turn the crank with sufficient speed for slipping to be noticed.

**600 RPM Setting:** Gear shift lever in the *down* position and turn the crank with sufficient speed for slipping to be noticed.

**Stirring Setting:** Gear shift lever *all the way down* past the detent and rotate crank vigorously.

1. Place a recently agitated sample of fluid in a suitable container, leaving enough empty volume in the cup for the displacement of the Bob and Sleeve, which will displace approximately 100 mLs of fluid. Measurements in the field should be made with a minimum of delay from the time of sample retrieval and the place the sample was obtained should be stated on the Mud Report.
2. Immerse the rotor sleeve *exactly* to the scribed line and then tighten the leg lock nut to hold it in position.
3. Set the speed shift lever to the Stirring position (all the way down) and turn the crank for about 15 seconds. While stirring place a thermometer in the sample and record the temperature.
4. Set the lever in the detent at the 600 rpm setting (down) and continue cranking until the dial reading comes to a steady value. The time for this is dependent upon the mud characteristics. Record this dial reading for 600 rpm.
5. Switch the lever arm to 300 rpm (up) and crank until the dial reads a steady value. Record the reading for 300 rpm.

### ***Gel Strength:***

6. Again stir the sample by setting the speed shift lever to the Stirring position (all the way down) and turn the crank at high speed for about 10 seconds.
7. Allow the fluid to stand undisturbed for 10 seconds. Slowly and steadily turn the gel strength knob clockwise and note the maximum dial reading before the gel breaks. This reading will be recorded as the initial gel strength (10 second gel) in lbs/100 ft<sup>2</sup>.
8. Restir the fluid at high speed for 10 seconds and then allow the fluid to stand undisturbed for 10 minutes. Repeat the measurements in No. 7 above and report the maximum reading as 10 minute gel in lbs/100 ft<sup>2</sup>.

### Calculation:

$$\text{Plastic Viscosity, cP} = 600 \text{ rpm reading} - 300 \text{ rpm Reading}$$

$$\text{Yield Point, lb/100 ft}^2 = 300 \text{ rpm reading} - \text{Plastic Viscosity}$$

$$\text{Apparent Viscosity, cP} = 600 \text{ rpm reading} \div 2$$

### ***Field Check for Rheometer Speeds:***

For correct and consistent viscosity and yield point readings, it is essential that the Rheometer operate within 300 ± 6 rpm and 600 ± 12 rpm. Specifications for a new or repaired Rheometer are one half of these values. A method for checking the speeds of a Rheometer are described below. The procedure utilizes the stroboscopic effect a fluorescent light has on the equally spaced holes in the top of the rotor. When the Rheometer is turning exactly at 300 or 600 rpm, the holes will appear to stand still. If the actual speed of rotation is faster than 300 or 600 rpm, the holes will appear to

rotate clockwise, and if the actual rotation speed is slower than 300 or 600 rpm, the holes will appear to rotate counter clock-wise.

1. Place a fluorescent or neon light operating on 60 cycle current as close as possible to the Rheometer.
2. Lower the rotor sleeve into a sample of 10-W-20 motor oil to the scribed line and tighten the leg lock nut.
3. Crank the Rheometer at 300 rpms and time the number of seconds required for 12 holes to appear to rotate past. This time should be at least 10 seconds.
4. Repeat the procedure at the 600 rpm and the time should be at least 5 seconds for 12 holes to pass by.
5. If either of the above values are exceeded, the speed regulation of the instrument is in error and will require servicing by a trained and qualified technician. The Rheometer should be returned to;

**OFI Testing Equipment, Inc.**  
**1006 West 34th Street**  
**Houston, Tx. 77018**  
**Attn: Service**

**Be sure to include a return address, phone number, persons name and a brief description of the problem.**

#### Care of the Rheometer:

1. The Sleeve, Bob and Splash Guard should be washed and dried after each operation. The sleeve is removed by holding the spindle just above it and unscrewing the sleeve. The Bob and Splash Shield are removed by unscrewing the Bob.
2. Always set the instrument upright when cleaning to keep water out of the bearings.
3. When reassembling the Bob and Splash Shield, the flanged end of the Splash Shield goes on the shaft first.
4. If the Rheometer is returned for repair, or transported by vehicle, the Bob, Splash Shield and Hand Crank should always be removed prior to shipment to avoid further damage and expense.

## **SAND CONTENT DETERMINATION**

### **OFITE PART No. 167-00**

The sand content of drilling fluid is defined as anything larger than 74 microns in size and is measured by a sand content kit. The test may be performed on low solids muds as well as on weighted muds. It is important to know the sand content of drilling fluid as excessive sand results in the deposition of a thick filter cake on the wall of the hole, or may

settle back into the hole when circulation is stopped. High sand content also may cause excessive abrasion of pump parts and pipe connections and interferes with drilling tools and the setting of casing.

### Equipment:

<u>Part Number</u>	<u>Description</u>
167-10	Sieve, 200 mesh, 2.5 inch (63.5 millimeters) in diameter
167-20	Funnel, to fit sieve
167-30	Sand Content Tube, glass, graduated from 0 to 20%

### Test Procedure:

1. Fill the glass measuring tube with a freshly stirred sample of drilling fluid to the line marked "*mud to here.*" Add water to the next mark labeled "*water to here.*" Close the mouth of the tube with the thumb and shake vigorously.
2. Pour the mixture onto the clean wet sieve and discard the liquid that passes through the screen. Add more water to the tube, shake, and again pour through the sieve. Repeat this process until the tube is clean and the water passing through the screen is clear. Wash the sand retained on the screen to free it of any remaining mud and shale particles or anything else that will pass through the screen.
3. Place the funnel upside down over the top of the sieve. Without spilling any of the retained sand, slowly invert the assembly and insert the tip of the funnel into the mouth of the glass tube. Wash the sand from the screen into the tube with a fine spray of water through the back side of the screen. Be careful not to overflow the tube. Allow time for the sand to completely settle in the bottom of the tube.
4. Read the volume percent (%) of the sand from the graduations on the tube.

### Reporting:

Report the sand content of the drilling fluid in ***volume percent (%)***. Report the source of the mud sample, above the shaker, suction pit, etc. Coarse solids, other than sand such as loss circulation material or coarse barite will also be retained on the screen and the presence of these solids should be noted in the mud report.

### Remarks:

1. Do not force solids through the screen
2. Wash and dry the funnel, screen and tube after each use.
3. When washing the contents off the screen into the tube be careful not to rest the funnel directly on the tube. This could block the air flow and therefore retard the water from flowing into the tube. Hold the end of the funnel just inside the tube entrance without actually resting the funnel on the tube itself.