

Drilling and Completion Fluids

Egypt lab capabilities





GENERAL OVERVIEW

Cairo Support Laboratories is a facility located in Ein El Sokhna Road, Kattameya in Egypt, this facility supports the Drilling and Completion Fluids (DCF), High Pressure Pumping (PP), and Upstream Chemicals labs.

All three work collectively and hand in hand to provide, each in their own specialized fields, the best technical and operational support services in Egypt. This document herewith provides detailed information regarding the capabilities that the Drilling and Completion Fluids lab can offer to our customers in terms of services, tests, and specialized equipment.

Standard laboratory testing

The Baker Hughes Drilling and Completion Fluids laboratory in Egypt was established to deliver technical support for Baker Hughes drilling and completion fluids operations within the country. The lab conducts preliminary testing and offers direction for creating and applying Baker Hughes drilling fluid systems, including both water-based and oil-based formulations.

Test analyses performed:

- Water-based mud checks
- Oil-based mud checks
- Particle Size Distribution
- Static rheology
- Static filtration control
- Dynamic flow rheology
- Low shear rheology analyses
- Mud formula proposals
- Enhancement of mud properties
- Development of completion fluid formulas
- Water analyses
- Well remediation/MICRO-WASH™ analyses
- MICRO-CURE™/MICRO-PRIME™ analyses
- Permeability plugging tests
- Relative comparisons of effectiveness of similar products/ product evaluations and QA/QC testing

Testing equipment:

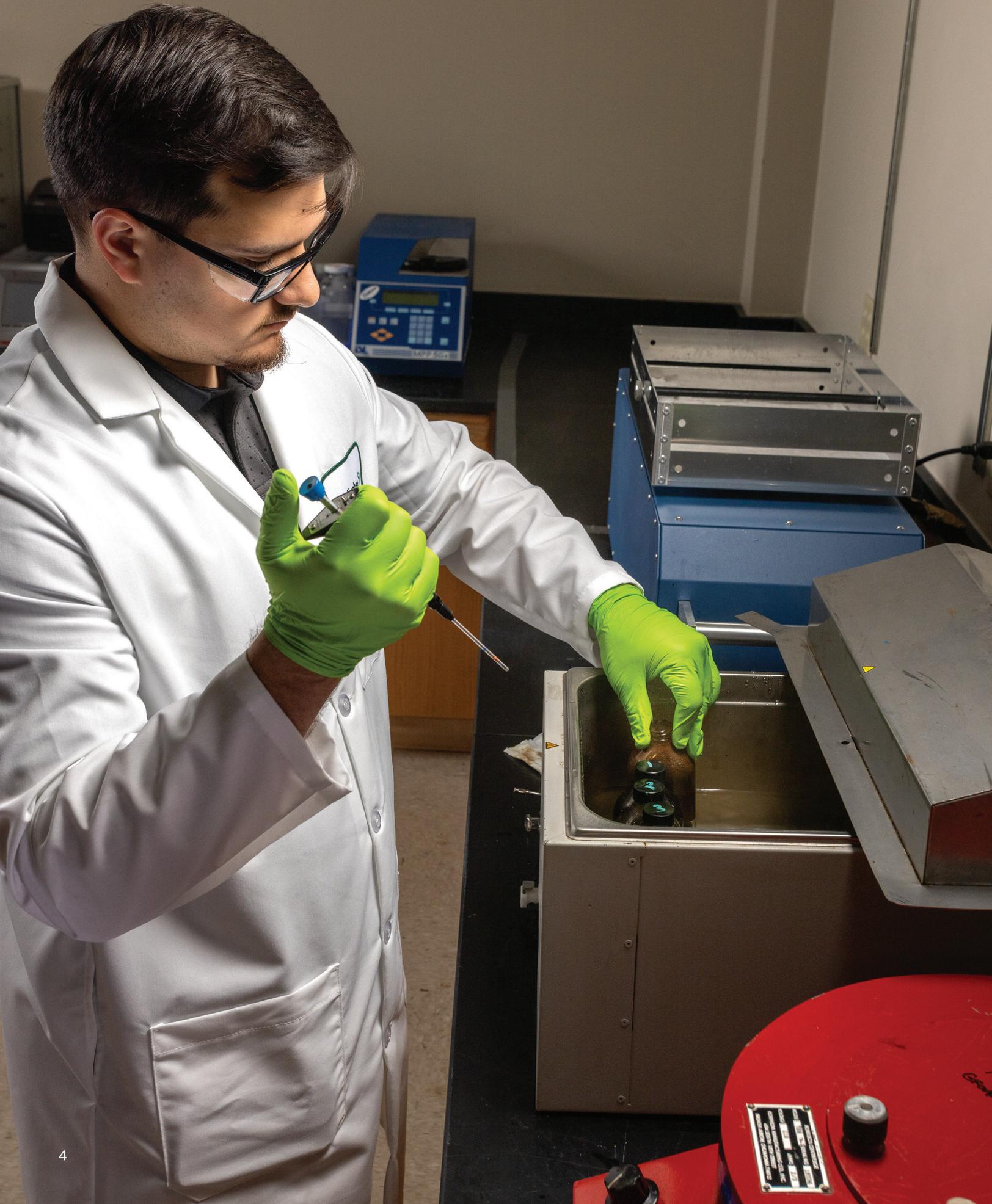
- Fann Model 35 V-G meter
- OFITE Model 900 viscometer
- Brookfield viscometer
- Particle size analyzer-Malvern Mastersizer 2000
- OFITE linear swell meter
- Bulk hardness tester
- Differential sticking tester
- Turbidity meter
- Silverson mixer
- Hamilton Beach® mixer
- pH meters
- Ro-tap sieves and agitator

- Permeability plugging tester with LCM evaluation capability
- Equipment to perform standard API mud checks
- Hot rolling ovens
- Static aging ovens
- OFITE lubricity meter
- Capillary Suction Timer (CST)
- Dissolved oxygen meter
- GGT kit
- Centrifuge
- Chiller

Project requests:

All project requests must be submitted to the laboratory along with a detailed and complete Technical Service Request (TSR) form. The form should provide comprehensive details and background information about the project or the mud samples to be analyzed. Supplying this information enables the laboratory team to determine the necessary tests and understand the expected outcomes.





Drilling Fluids equipment inventory

Equipment	Use
Aging roller ovens	Static and dynamic aging samples up to 1,100°F (593°C)
Analytical balance	Balances (0.0001 to 220 grams) for weighting products
Brookfield viscometer	Used to measure the viscosity of thixotropic fluids at ultra-high and ultra-low flow rates
Differential sticking teste	Differential sticking tendency of drill pipe
Electrical stability meter	ES measurements
Filter press	Full area, two-unit, model 12BL-2, manifold and cell assemble
Flash point apparatus	Used to determine the flash point temperature of fluid
FT-IR spectrometer	Used to determine chemical composition
Garret Gas Train	Determining sulfides and carbonates
Hot plate	Used to heat samples for chemical analysis
Hygrometer	Used to measure humidity levels
Laboratory centrifuge	Used to separate out solids
Malvern Mastersizer 2000 – PSD	Particle size measurement
Marsh funnel	Viscosity measurements
Methylene blue test	Used to identify and quantify reactive shale
Mud balances	Determining mud densities
OFITE 10 ml retort	High temperature mud stills for determining water, oil, and solids content; complete set with digital thermometer
OFITE 50 ml retort	High temperature mud stills for determining water, oil, and solids content; complete set with digital thermometer
OFITE linear swell meter	Shale inhibition
OFITE lubricity meter	Used to determine lubricity coefficient
OFITE Model 900 viscometer	Viscosity measurements
OFITE thermocup	Heating samples while measuring using viscometer; with 154 to 00, thermometer, 115V, 0 to 220°F

Equipment (cont'd)	Use
Particle plugging apparatus	Test sealing effectiveness of mud systems
pH meter	pH measurements
Pressurized mud balance	Pressurized mud balance for determining mud densities
Production screen tester	Used to evaluate the flow-back performance of fluids
Ro-tap sieve shaker	Used for sieves analysis
Sand content kit	Used to determine solid content (sand size)
Sieve set	Used for sieves analysis; all sizes
Silverson L4RT mixer	High shear mixing devices for preparing fluids; 110 V
Single API filter press	Used for API filtration at ambient temperature and 100 psi; with CO ₂ pressuring assembly and benchmount
Six-speed Fann viscometers	Viscosity measurements; with heating cups and digital temperature thermometers; Fann Model 35SA, 115 V
Slotted discs	For LCM evaluation
Three station Hamilton Beach® mixers	Low shear mixers for fluid preparation, with speed control to all three shafts; 220 V
Turbidity meter	Used to measure turbidity in NTU



Specialized equipment and techniques

Brine density and dilution

The density (specific gravity) of the undiluted brine as sample is required to calculate the results of the tests described below. The brine density may be measured on a mud balance or by means of a suitable hydrometer to obtain the density in gm/cc. This equipment is not included.



Brookfield DV2-LVT viscometer

The Brookfield DV2T viscometer measures fluid viscosity at given shear rates. The principal of operation of the DV2T is to drive a spindle (which is immersed in the test fluid) through a calibrated spring. The viscous drag of the fluid against the spindle is measured by the spring deflection. Spring deflection is measured with a rotary transducer. The measurement range of a DV2T (in centipoise or milliPascal•seconds) is determined by the rotational speed of the spindle, the size and shape of the spindle, the container the spindle is rotating in, and the full-scale torque of the calibrated spring. The measurement range of the device is from 1 to 6 m Cp with speeds 0.1 to 100 rpm.



Chiller

A chiller is an essential cooling system designed to remove heat from liquids.



Dynamic filtration unit

High pressure/high temperature (1,200 psi, 500°F) instrument utilizing a 2 to 4 darcy aloxite disk as a filter medium to better simulate filtrate loss and filter cake deposition under dynamic conditions. The dynamic high pressure high temperature (HP/HT) filter press measures filtration properties under varying dynamic downhole conditions. A motor-driven shaft fitted with propellers turns at varying speeds inside a standard 500 ml HP/HT cell. RPM settings from 1 to 1600 RPM impart laminar or turbulent flow to the fluid inside the cell. By varying the shaft length, the shear stress may be increased or decreased. The power is driven to the stirring shaft by a timing belt that is easily accessible for quick adjustment and removal. Other features include a variable-speed motor controlled through an SCR controller. RPM is indicated on a digital tachometer. The test procedure is the same as that in the conventional HP/HT filtration test. The only difference is the fluid circulates inside the cell while filtrate is being collected. Since the filter medium is conventional disk material, the results are fully comparable with those of other laboratories or for comparing historical trends.



Fann Model 75 automatic viscometer

The Model 75 automatic viscometer is a coaxial cylinder type that was developed to measure fluid rheological properties under high pressures and temperatures with a high degree of safety as was the previous Model 70. It was designed with oil well and geothermal drilling fluids in mind but has applications in many other fields. It features extensive safety interlocks and a single-board computer for automatic control of pressure, temperature and rotor speed, and test results. Specifications of the Model 75 allow operation to 500°F (260°C) and 20,000 PSIG (137,900 kPa). Its one-piece bench top design makes it suitable for use on a well site as well as in a laboratory. It uses a unique magnetic sensor to detect the motion of the jewel mounted torsion assembly in the test cell. The sensor system can be calibrated to \pm one degree (equivalent to one centipoise at 300 RPM). The Model 75 automatic viscometer can be operated in any of three configurations: as a standalone test instrument, an instrument under computer control, or as part of a fluids lab data collection network. Operation under computer or network control allows automatic execution of complex, user defined, test profiles of varying temperature, pressure and rotor speeds..



Flash point apparatus

The open cup flash point apparatus is a specialized device used to determine the flash point of flammable liquids. The flash point is the lowest temperature at which vapors of a sample ignite when exposed to an open flame under controlled conditions. The apparatus uses the Cleveland open-cup method: Heating the liquid in an open brass cup under controlled conditions, periodically applying a test flame, and recording the lowest temperature at which vapors briefly ignite. By continuing the test, it can also determine the fire point, when combustion sustains for at least five seconds.



FT-IR spectrometer

The FT-IR (Fourier Transform Infrared) spectrometer is a powerful analytical instrument used to identify and characterize chemical compounds by measuring their infrared absorption spectra. It works by passing infrared light through a sample and analyzing how different molecular bonds absorb specific wavelengths, producing a unique spectral fingerprint. This technology is widely applied in quality control, contamination analysis, and material verification for drilling fluids, and chemical additives. FT-IR is typically used when rapid, accurate identification of organic and inorganic components is required, ensuring compliance with specifications and supporting troubleshooting in the field or laboratory.



Garret Gas Train

The Garrett Gas Train is the most widely used portable instrument for the determination of soluble sulfides and carbonate concentrations in drilling fluid. Soluble sulfides include H_2S and the sulfide (S^{2-}) and bisulfide (HS^-) ions. Total soluble carbonates include CO_2 and the carbonate (CO_3) and bicarbonate (HCO_3) ions. Mud filtrate is acidified inside the gas train, converting all sulfides to H_2S or all carbonates to CO_2 , depending upon the test. The gas train separates the gas from the liquid and an inert carrier gas transports the gasses through the separate chambers. In chamber three, the gas stream is passed through a Dräger tube, which responds to H_2S or CO_2 by darkening along its length, with the stain length proportional to the amounts of concentrations in the filtrate. For qualitative H_2S analysis, lead acetate paper disks may be inserted to determine the presence or absence of sulfides. The Garrett Gas Train consists of a transparent train, pressure regulator assembly, CO_2 and N_2O cartridges, Dräger tubes for H_2S and carbonate detection, and a convenient carrying case.



Hydrometer kit

The hydrometer kit measures the true specific gravity of liquids in the range of 0.700 to 2.000 specific gravity. The kit consists of eight 265 mm/10.5-inch glass hydrometers and a thermometer range -30 to $120^{\circ}F$ in 1° divisions, all packed in a protective foam-lined carrying case. The hydrometer scale is standardized at $60^{\circ}F$. For maximum efficiency, special hydrometer cylinders are available in 250 ml and 500 ml sizes. Other specific gravity ranges and types of hydrometers are available upon request.



Dynamic linear swell meter

Drilling problems such as stuck pipe, tight hole, washout, and sloughing can be related to shale stability. Instrumentation used to determine if specific shales are likely to cause drilling and completion problems include the Capillary Suction Timer (CST) and the linear swell meter (LSM). The OFITE linear swell meter (LSM) is an instrument used to determine shale hydration or dehydration by measuring the increase or decrease in length over time of reconstituted or intact shale core. The LSM test is used with a capillary suction time (CST) test to determine the recommended mud system for drilling through a specific shale formation. First, a CST test is conducted to determine the correct inhibitor for the shale. Test results are graphed to show the percent of swelling versus swelling time in minutes. The LSM test demonstrates the inhibitive effects of these various fluids on shale swelling. Shale core samples for these tests are compacted (reconstituted) using the two-cell hydraulic compactor that complements the Linear Swell Meter. Pulverized shale is placed in a cylindrical mold, where compacting pressure is then applied and maintained while compaction occurs. Tests indicate that a constant pressure of 10,000 psig (68,940 kPa) applied for 1.5 hours results in satisfactory shale core plugs.



Lubricity meter

The lubricity meter measures the effectiveness of lubricants in stabilized drilling fluid. 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 the 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 hole. The device combination EP 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.



OFITE Model 900 low shear viscometer

The OFITE Model 900 automatic viscometer is a stand-alone field unit. It can perform standard API test sweeps of either mud or cement rheology. Standard speeds (rpms of 600, 300, 200, 100, 60, 30, 20, 10, 6, 3, 2 & 1) are provided as single button operations on the keypad. Specific shear rates can be achieved by entering the parameters on the numerical keyboard and pressing the "enter" button. The viscometer is capable of operating in the variable speed range 0.006 to 1000 rpms. The Model 900 is capable of operating in the field and is also capable of being connected to a computer for an automated operation which includes complete data acquisition using OFITE's ORCADA™ software.



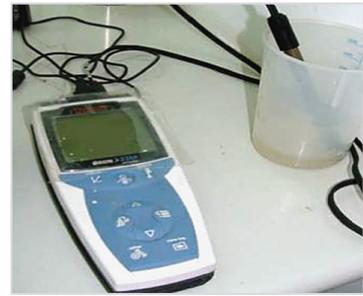
OFITE nitrate (NO₃) ion test kit

The OFITE nitrate ion test kit was specifically designed for reading the concentration of tracer nitrate ions in drilling fluids by people with extensive experience in oilfield research problems. The kit does not contain liquids, and the reagent mixtures are in individually sealed plastic ampules where moisture, air, heat, and cold have the least possible effect on them. Results are available in ppm nitrate rather than ppm nitrogen, which is not as readily useful in tracer work. Elapsed time for a test is 13 minutes, exclusive of any filtering. The range for a direct sample is 0 to 10 ppm, and diluting 1 to 5 gives a 50 ppm range with a maximum dilution of 1 to 20 yielding a 0 to 200 ppm range. This is a very accurate field test for nitrate ions.



pH meter

The ACORN series is the ultimate in portable direct reading pH and ion concentration measurement. It measures ion concentration (ppm), mV, pH, and temperature. However, the new generation of ORION (ORION 3 STAR) can also measure the aluminum ion concentration in the filtrate by consuming the fluoride ion in a standard solution.



Particle size analysis

The Malvern Mastersizer 2000 MU/SM laser diffraction particle size analyser measures particles sizes from 0.02 μm to 2,000 μm . This new instrument will help in the understanding of the role of finely divided particulate thixotropes in their application as sag avoiding additives. The laser technology particle size analyzer is used on a regular basis to carry out quality control tests on products such as barite, graded calcium carbonate and lost circulation materials. It can also be used to measure particle size distributions of field muds, including whole oil-based mud. This latter technique is useful for assessing likely treatment levels and monitoring the effectiveness of centrifugation.

The build-up of solids in drilling fluids is routinely monitored using the above instrumentation. Other techniques such as the automated sieve tester are used in conjunction with the above to characterize cored reservoir sands. When the type of solids has been differentiated by X-ray fluorescence and the data is combined with the particle size distribution information, a complete picture of the solids emerges.



Permeability plugging apparatus

The permeability plugging apparatus (PPA) is designed to provide accurate simulation and measurement of down-hole static filtration. This 4,000 psig rated PPA is ideal for predicting how a drilling fluid can form a permeable filter cake to seal off depleted/under pressure intervals. The PPA utilizes an HTHP heating jacket to simulate reservoir temperature. The fluid cell has pressure applied from the bottom of the cell and filtrate collected out the top. Pressure is transferred to the mud by a hydraulic hand pump through a small floating piston within the cell. The PPA employs a ceramic filter disc, which is available in varying porosities. The disc offers a more authentic representation of the formation. This test can be performed at conditions up to a pressure of 4,000 psig and temperature of 500°F/260°C.



Polymer test kit – clapper

This test determines the polymer concentration in mud filtrates. The test involves measurement of the rate of ammonia generation while the mud filtrate is heated in the presence of sodium hydroxide solution. The ammonia is removed from the reaction vessel with a slow air purge and detected with a Dräger® Tube. The approximate concentration of polymer is determined by measuring the time required for the Dräger Tube to turn blue. The procedure can be used to analyze all filtrates except those containing some types of lignosulfonates and polyacrylate filtration control additives.



Production screen tester

The production screen tester is a portable, rig site device that quickly evaluates whether completion or reservoir drill in fluids will flow back through the actual production screen without plugging, enabling real time decisions before running the completion assembly. By mounting a sample of the actual screen in a pressure cell—similar in operation to an API filter press—the tester passes the field fluid under controlled pressure (commonly via CO₂) and immediately reveals compatibility, helping prevent screen blockage, erosion, and costly remediation while optimizing fluid conditioning on site. It is used during well completions and fluid formulation checks to validate performance across wire wrapped, pre packed, and premium screens, reducing delays associated with shipping samples to a lab and safeguarding production integrity from the start. It Simulates flow-back by-passing completion fluid under pressure through a sample of the actual production screen. Also, it immediately indicates if the fluid will plug the screen during real operations, bypassing the need to wait for lab test results.



Roller oven

Is an effective aid in determining the effects temperature has on drilling fluid as it circulates through the wellbore. Aging the drilling fluid in pressurized containers effectively demonstrates the thermal effects on viscosity and how various additives behave at elevated temperatures. Aging is done under conditions that vary from static to dynamic and from ambient to highly elevated temperatures.



Sieve analysis device

With different sieves of different micron size that can be instilled with the bigger size at top and lower size at bottom, with the high and powerful motion generated by the device and after adjusting the motion time the particles of the material is separated at each sieve according to its size that can be weighted later and compared to the original weight of the sample to identify percentage of each size from total sample size.



Silverson laboratory mixer

The Silverson laboratory mixer is a high shearing instrument that is unsurpassed in speed, efficiency and product uniformity. The L4RT is the most popular Silverson mixer and is ideal for mixing, emulsifying, homogenizing, disintegrating, and dissolving - with an efficiency and flexibility unmatched by other machines. It includes a general-purpose mixing head, axial flow head and emulsifier screen.



Turbidity meter

The turbidity meter combines laboratory accuracy and reliability in an extremely compact, portable instrument for turbidity measurement. It is the ideal choice for regulatory monitoring, process water testing, and environmental water analysis in the field or laboratory. With a wide range of 0 to 1100 NTUs (Nephelometric Turbidity Units), a microprocessor enables full scale auto ranging. The direct digital readout has a resolution of 0.01 for the lowest range, with an accuracy of $\pm 2\%$ or 0.05 NTU, whichever is greater. A multi-detector optical configuration assures long term stability and minimizes stray light and color interferences. All readings are determined by the process of signal averaging over a 5-second period. This process minimizes fluctuations in readings attributed to large particles and enables rapid, highly repeatable measurements.



