OFITE®

DRILLING FLUIDS EQUIPMENT

For over 30 years OFI Testing Equipment (OFITE) has provided instruments and reagents for testing drilling fluids, well cements, completion fluids, and wastewater. In addition to these product lines we also offer a range of instruments for core analysis. From our manufacturing facility in Houston, TX we provide customers all over the world with quality products and exceptional service.

Our drilling fluids product line includes innovative designs such as the Model 900 Viscometer, which showcases our ability to develop new technology to meet customer and industry demands. We also offer Retorts, Aging Cells, Roller Ovens, Mud Balances, Filter Presses, and all other instruments required to evaluate drilling fluid properties according to API Recommended Practice 13B-1 and 13B-2.

As an independent manufacturer and supplier, OFITE has one priority, our customers.

Model 900 Automated Viscometer

The OFITE Model 900 Viscometer is a true Couette coaxial cylinder rotational viscometer, which employs a transducer to measure the induced angle of rotation of the bob by a fluid sample. For a fully automated Control/Data Acquisition System suitable for research applications, the Model 900 Viscometer may be connected to a computer via a serial (RS-232) port using OFITE's exclusive and field-proven Windows™- based ORCADA™ software.

Patent Number 6,766,028

Features

- Model 900 Viscometer is a true Couette coaxial cylinder rotational viscometer
- Run multiple units on one computer
- Push button calibration history and graphs available for improved analysis (with ORCADA software)
- Stepper motor technology insures accuracy of shear rates
- Single button operations on the keypad
- Routine repairs are easily performed
- Has the ability to operate accurately at extremely low shear rates (0.006 RPM)
- Not necessary to stop the motor between speed changes
- Optional KlikLock™ Bob (Patent Number 8,763,776) uses a magnetic coupling to make removal quick and easy.

Technical Specifications and Requirements

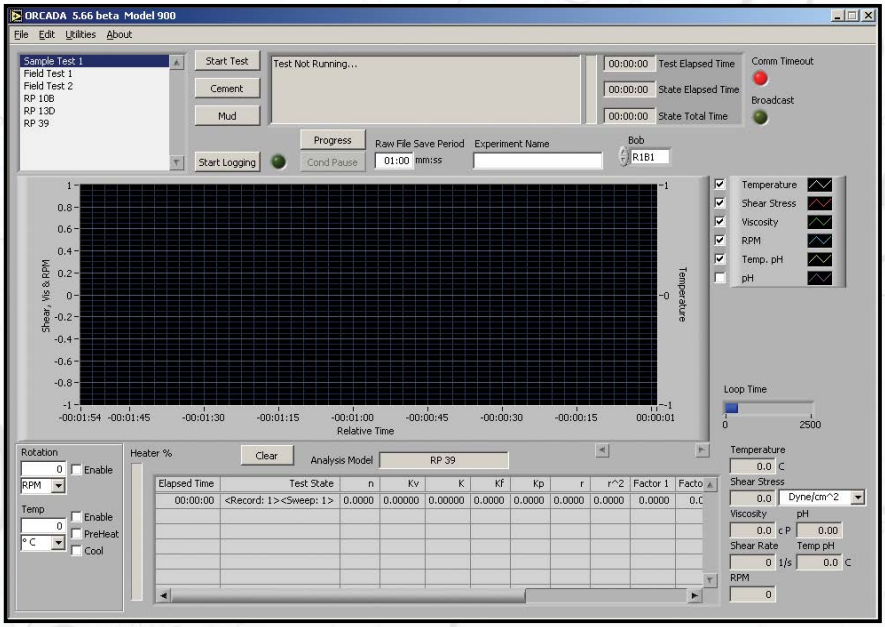
- #130-76-C Model 900 Viscometer, 115 Volt
- #130-76-1-C Model 900 Viscometer, 230 Volt

Specifications

- Instrument Geometry: True Couette Coaxial Cylinder
- Motor Speeds (RPM): 12 Fixed Speeds (600, 300, 200, 100, 60, 30, 20,10, 6, 3, 2, and 1); Variable speed range .006 - 1000
- Speed Accuracy (RPM): .001
- Shear Rate Range (sec^{-1}): .01 - 1,700
- Heat Cup: Stainless Steel, 150 Watts, Maximum Recommended Temp: 190°F (88°C)
- Power Requirements: 97 - 250 Volts AC, 200 Watts, 50/60 Hz
- Dimensions: 17.3" × 15" × 9.4" (44 × 38 × 24 cm)
- Weight: 18.9 lb (8.6 kg)
- Shipping Dimensions: 22" × 15" × 9.4" (56 × 38 × 24 cm)
- Shipping Weight: 35.3 lb (16 kg)
- Computer Requirements: DB-9 Serial Port, Windows 2000 or newer. Recommended screen resolution 1024 × 768 pixels

OFITE Data Acquisition Features

- Write programs based on time, temperature and shear rates
- Multiple calibration points: low and high shear rates
- Computer automatically stores data
- Multiple rheological programs available



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Introduction

The Model 900 Viscometer is a portable, yet fully automated system for measuring fluid viscosity. It is designed to be easy to use, easy to maintain and to provide consistent results. Its simplicity makes it ideally suited for field applications. Engineers will appreciate the push button calibration, its reliability, and the ability to perform standard American Petroleum Institute (API) recommended practices with one command. With the addition of a computer, it is able to perform a variety of more complex laboratory tests. Routine repairs, like bearing and torsion spring replacement, may be performed by field personnel with a minimum of training, without having to return the viscometer for repair. The optional *KlikLock™ bob uses a magnetic coupling to make removal quick and easy.

Description

The OFITE Model 900 Viscometer is a true Couette coaxial cylinder rotational viscometer, which employs a transducer to measure the induced angle of rotation of the bob by a fluid sample. The test fluid is contained in the annular space, or shear gap, between the rotor and the bob, which is attached to a shaft with a biasing spring. The viscous drag exerted by the fluid creates a torque on the bob, and is monitored by the transducer that measures the angular displacement of the bob. Using the angle of displacement of the bob, the processor calculates and transmits readable output of the sample characteristics in accordance with determined calculations based upon the shear rate and the bob displacement. Revolutionary improvements in stepper-motor technology by OFITE enables the Model 900 Viscometer to operate accurately at extremely low shear rates (0.01 1/s).

As a stand-alone field unit, the press of a single button (**MUD** or **CEM**) prompts the viscometer to perform standard API recommended practices for the technician's choice of Mud (Plastic Viscosity ["**PV**"] - Yield Point ["**YP**"]) or Cement rheologies. Standard speeds (600, 300, 200, etc.) are provided as single button operations on the keypad, or if another shear rate is desired, the parameters may be entered on the numbered keypad. Simply press **ENTER** after entering the desired shear rate and the viscometer performs the rest of the work. It is not necessary to stop the motor between speed changes.

For a fully automated Control/Data Acquisition System suitable for research applications, the Model 900 Viscometer may be connected to a computer via a serial (RS-232) port using OFITE's exclusive and field-proven Windows™-based ORCADA™ software.

*U.S. Patent Number 8,763,776

Components

#130-76-03	Thermocouple
#130-76-04	Main Bearing
#130-76-05	Retaining Ring
#130-76-08	Bob Shaft Wrench
#130-76-10	Universal Heat Cup (115 Volt Only)
#130-76-10-1	Universal Heat Cup (230 Volt Only)
#130-76-24	Bob Shaft Assembly (For Threaded Bobs)
#130-76-241	Bob Shaft Assembly (For KlikLock™ Bobs)
#130-76-51	Carrying Case
#130-79-19	USB to RS232 Cable
#132-56	Rotor, R1, 303 Stainless Steel
#132-57	Bearing Shield
#132-58	Bob, Threaded, B1, 303 Stainless Steel
#132-58-01	Bob, KlikLock™, B1, 316 Stainless Steel
#132-80	Certified Calibration Fluid, 100 cP, 10 oz
#134-05-2	Bob Shaft Bearing, Sealed
#134-10	Torsion Spring Assembly, F1.0
#135-02	External Retainer Ring for Bob Shaft
#152-37	AC Power Cord, 115 Volt
#152-38	AC Power Cord, 230 Volt

Optional:

#130-76-LSK	Low Shear Kit
#132-56-S	Rotor, R1, Slotted
#132-58-5	Bob, B1, Slotted
#134-05-2	Bob Shaft Bearing
#134-10-2	Torsion Spring Assembly, F0.2
#130-76-P	pH Meter
#132-56H	Rotor, R1, Hastelloy
#132-58-01H	Bob, Threaded, B1, C-276 Hastelloy
#132-58-01-HC	Bob, KlikLock™, B1, C-276 Hastelloy
#134-10-2	Torsion Spring Assembly, F0.2 (Green)
#134-10-3	Torsion Spring Assembly, F0.5 (Yellow)
#134-10	Torsion Spring Assembly, F1.0 (Blue)
#134-10-4	Torsion Spring Assembly, F2.0 (Red)
#134-10-5	Torsion Spring Assembly, F3.0 (Purple)
#134-10-6	Torsion Spring Assembly, F4.0 (White)
#154-04	Digital, Long-Stem Thermometer, NIST Traceable, 8" Stem, -58°F - 302°F (-50°C - 150°C)
#154-24	Thermometer, 32°F - 86°F (0°C - 30°C)

#130-76-C-SP	**Spare Parts Kit for #130-76-C**
#130-76-03	Thermocouple
#130-76-04	Main Bearing, Qty: 2
#130-76-05	Retaining Ring, Qty: 2
#132-80	Calibration Fluid, 100 cP, 16 oz
#132-81	Calibration Fluid, 50 cP, 16 oz
#134-05-2	Bob Shaft Bearing, Qty: 8
#135-02	External Retainer Ring, Qty: 2

Specifications

Instrument Geometry	True Couette Coaxial Cylinder
Motor Technology	Stepper
Motor Speeds (RPM)	12 Fixed Speeds (600, 300, 200, 100, 60, 30, 20, 10, 6, 3, 2, and 1); Variable speed range .006 - 1000
Speed Accuracy (RPM)	.001
Shear Rate Range (sec^{-1})	.01 - 1,700
Readout	Digital
Heat Cup	Stainless Steel, 150 Watts, Maximum Recommended Temp: 190°F (88°C)
Temperature Measurement	Type “J” Thermocouple
Automatic Tests	API Cementing and Mud Rheologies
Power Requirements	97 - 250 Volts AC, 200 Watts, 50/60 Hz
Weight (kg)	8.6
Dimensions (cm)	44 × 38 × 24
Shipping Weight (kg)	16
Shipping Dimensions (cm)	56 × 38 × 24
Computer Requirements	DB-9 Serial Port, Windows 2000 or newer. Recommended screen resolution 1024 × 768 pixels.

Rotor - Bob	**R1B1**	**R1B2**	**R1B3**	**R1B4**	**R1B5**
Rotor Radius, RR, (cm)	1.8415	1.8415	1.8415	1.8415	1.8415
Bob Radius, RB, (cm)	1.7245	1.2276	0.8622	0.8622	1.5987
Bob Height, L, (cm)	3.8	3.8	3.8	1.9	3.8
Shear Gap, (cm)	0.117	0.6139	0.9793	0.9793	0.2428
R Ratio, RB/RR	0.9365	0.666	0.468	0.468	0.8681
Shear Rate Constant k_R (sec^{-1} per RPM)	1.7023	0.377	0.2682	0.2682	0.8503
Shear Stress Constant for Effective Bob Surface k_S (cm^{-3})	0.01323	0.02610	0.05290	0.10600	0.01541
Overall Instrument Constant, K, with Standard F1.0 Spring, $\eta = KF\Theta/N$	300	2,672	7,620	15,200	349

Max. Shear Stress, SS_{MAX}, (Dyne / cm^2)	**Constant k_T**	**R1B1**	**R1B2**	**R1B3**	**R1B4**	**R1B5**
F 0.2 (Green)	77.2	330	651	1,320	2,644	384
F 0.5 (Yellow)	193	840	1,657	3,359	6,730	977
F 1.0 (Blue)	386	1,680	3,314	6,717	13,460	1,955
F 2.0 (Red)	772	3,360	6,629	13,435	26,921	3,910
F 3.0 (Purple)	1,158	5,040	9,943	20,152	40,381	5,865
F 4.0 (White)	1,544	6,720	13,257	26,870	53,841	7,819
F 5.0 (Black)	1,930	840	16,571	33,587	67,302	9,774
F 10.0 (Orange)	3,860	16,800	33,143	67,175	134,603	19,548

Shear Rate Range	R1B1	R1B2	R1B3	R1B4	R1B5
Shear Rate Constant, K_R, (sec^{-1} per RPM)	1.7023	0.3770	0.2682	0.2682	0.8503
Shear Rate, (sec^{-1} or 1/s) 1 RPM	1.70	0.38	0.27	0.27	0.85
2 RPM	3.40	0.75	0.54	0.54	1.70
3 RPM	5.11	1.13	0.80	0.80	2.56
6 RPM	10.21	2.26	1.61	1.61	5.11
10 RPM	17.02	3.77	2.68	2.68	8.51
20 RPM	34.05	7.54	5.36	5.36	17.03
30 RPM	51.07	11.31	8.05	8.05	25.54
60 RPM	102.14	22.62	16.09	16.09	51.07
100 RPM	170.23	37.70	26.82	26.82	85.12
200 RPM	340.46	75.40	53.64	53.64	170.23
300 RPM	510.69	113.10	80.46	80.46	255.35
600 RPM	1,021.38	226.20	160.92	160.92	510.69
1,000 RPM	1,702.30	377.00	268.20	268.20	851.15

Viscosity Ranges<a> (cP)	R1B1	R1B2	R1B3	R1B4	R1B5
Minimum Viscosity<b> @600 RPM	0.5<c>	4.5	12.7	25	1.2
Maximum Viscosity<d> @0.01 RPM	10,000,000	89,000,000	255,000,000	500,000,000	23,000,000

<a> Computed for standard Torsion Spring (F 1.0). For other torsion 160.92springs, multiply by F factor
<b> Lower viscosities can be measured by the Model 900, however one must take into account the effect of bearing drag, Taylor vortices, zero offset, etc. when looking at the expected accuracy of the reading
<c> For practical purposes the minimum viscosity is limited to 0.5 cP due to Taylor Vortices
<d> Maximum viscosity is based on Maximum Shear Stress and Minimum shear rate (RPM). However, due to practical and physical limitations, it may be difficult to take these measurements.

Viscosity Conversions
To convert from units on left side to units on top, multiply by factor @ intercept.

	Centipoise (cP)	Poise (P)	g/(cm*s)	$(mN*s)m^2$	mPa*s	$\frac{(lb*s)}{100\ ft^2}$
Centipoise (cP)	1	0.01	0.01	1	1	0.002088
Poise (P)	100	1	100	100	100	0.2088
g/(cm*s)	100	1	100	100	100	0.2088
$(mN*s)m^2$	1	0.01	0.01	1	1	0.002088
mPa*s	1	0.01	0.01	1	1	0.002088
$\frac{(lb*s)}{100\ ft^2}$	478.93	4.789	4.789	478.93	478.93	1

Shear Stress Conversions To convert from units on left side to units on top, multiply by factor @ intercept.					
	Dyne/cm^2	Pa	lb/100ft^2	lb/ft^2	DR
Dyne/cm^2	1	0.1	0.2084	0.002084	0.1957
Pa	10	1	2.084	0.02084	1.957
lb/100ft^2	4.788	0.4788	1	0.01	0.939
lb/ft^2	478.8	47.88	100	1	93.9
DR	5.107	0.5107	1.065	0.01065	1

What Bob & Spring Should I Use?

There is often confusion or misunderstanding about what a viscometer can actually measure. For example, a viscometer with an R1B1 F1 combination can measure water fairly well at 100 RPM and higher, but at 3 RPM, the readings would be shaky at best. While on the other hand, a linear fluid with a viscosity of 15000, could not get past 6 RPM with the same combination.

To estimate which spring might be best, use the formula below to calculate a Minimum Spring factor, where one establishes the maximum RPM the fluid is going to be tested at, as well as what the expected “Apparent Viscosity” of the fluid at that RPM. If the Factor comes out as .87, then an F 1.0 spring should be used. If it comes out as .16, then an F 0.2 spring would be best. To cover all ranges, it may be necessary to use more than one spring.

Always run the TransCal procedure (steps 10 - 14 on page 51) after changing the bob or spring.

$$\text{Minimum Spring Factor (F)} = \frac{\text{RPM(max)} * \text{AV(max)}}{\text{BOB(F)}*90000}$$

Bob (F)	
R1B1	1.0
R1B2	8.9
R1B3	25.4
R1B4	50.7
R1B5	2.4