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Model 900 Viscometer

130-76-C (115 Volt)

130-76-1-C (230 Volt)

ORCADA 5.76 Model 900 Software

Instruction Manual

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Ver. 5.10

Patent No. 6,776,028 - OFI Testing Equipment, Inc.

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Intro

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.

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.

Components

#130-76-03	Thermocouple
#130-76-04	Main Bearing; Qty: 2
#130-76-05	Retaining Ring
#130-76-06	Drive Belt
#130-76-07	Drive Gear
#130-76-09	1.5 mm Allen Key
#130-76-10	Universal Heat Cup (115-Volt Only)
#130-76-10-1	Universal Heat Cup (230-Volt Only)
#130-76-11	Terminal; Qty: 8
#130-76-12	Header; Package of 19
#130-76-14	Standoff; Qty: 4
#130-76-15	Nylon Washer; Qty: 4
#130-76-16	Nylon Washer; Qty: 4
#130-76-17	Nylon Washer; $\frac{5}{8}$ " ID
#130-76-23	Gear
#130-76-24	Bob Shaft Assembly
#130-76-28	Motor
#130-76-34	Splash Guard
#130-76-35	Keypad
#130-76-36	Motor Spacer; $\frac{1}{8}$ "; Neoprene; 70 Durometer
#130-76-37	Transducer
#130-76-38	Control Card
#130-76-40	Back Panel
#130-76-41	Cover
#130-76-42	Display
#130-76-43	SSR
#130-76-44	Thermocouple Jack
#130-76-45	Sensor Plate
#130-76-46	Display Cable
#130-76-48	Power Supply
#130-76-51	Carrying Case
#130-79-15	Serial Cable; OB9; M/F
#132-56	Rotor, R1, 303 Stainless Steel
#132-58	B1 Bob; 303 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; Qty: 2
#135-19	Socket Set Screw; Nylon Tip for Spring Bushing; Qty: 2
#135-19	Socket Set Screw; Nylon Tip for Spring Bushing; Qty: 3
#135-19-1	Socket Set Screw; 8-32 × 3/16; Nylon Tip; Qty: 2
#142-63	Locking Screw
#152-37	AC Power Cord; 3-Conductor (115-Volt Only)
#152-38	AC Power Cord; 3-Conductor; International (230-Volt Only)
#171-44	Rubber Foot; $\frac{3}{4}$ "; Qty: 4

Optional:

- #130-76-P pH Meter
- #132-58-1 B2 Bob; 303 Stainless Steel
- #132-58-2 B3 Bob; 303 Stainless Steel
- #132-58-3 B4 Bob; 303 Stainless Steel
- #132-58-4 B5 Bob; 303 Stainless Steel
- #132-58H B1 Bob; Hastelloy
- #134-10-2 Torsion Spring Assembly; F0.2
- #134-10-3 Torsion Spring Assembly; F0.5
- #134-10-4 Torsion Spring Assembly; F2.0
- #134-10-5 Torsion Spring Assembly; F3.0
- #134-10-6 Torsion Spring Assembly; F4.0
- #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 for #130-76-C

#130-76-1-C-SP Spare Parts for #130-76-1-C

- #130-76-03 Thermocouple
- #130-76-04 Main Bearing; Qty: 4
- #130-76-05 Retaining Ring; Qty: 2
- #132-80 Calibration Fluid; 100 cP; 16 oz.; Qty: 2
- #132-81 Calibration Fluid; 50 cP; 16 oz.
- #134-05-2 Bob Shaft Bearing; Qty: 6
- #134-10 Torsion Spring Assembly F 1.0
- #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 XP. Recommended screen resolution 1024 × 768 pixels.

Range of Measurement for Model 900

Rotor - Bob	R1B1	R1B2	R1B3	R1B4
Rotor Radius, RR, (cm)	1.8415	1.8415	1.8415	1.8415
Bob Radius, RB, (cm)	1.7245	1.2276	0.8622	0.8622
Bob Height, L, (cm)	3.8	3.8	3.8	1.9
Shear Gap, (cm)	0.117	0.6139	0.9793	0.9793
R Ratio, RB/RR	0.9365	0.666	0.468	0.468

Max. Shear Stress, SS_{MAX}, (Dyne / cm²)	R1B1	R1B2	R1B3	R1B4
F 0.2	330	651	1320	2644
F 0.5	840	1657	3359	6730
F 1.0	1680	3314	6717	13460
F 2.0	3360	6629	13435	26921
F 3.0	5040	9943	20152	40381
F 4.0	6720	13257	26870	53841
F 5.0	8400	16571	33587	67302
F 10.0	16800	33143	67175	134603

Shear Rate Range	R1B1	R1B2	R1B3	R1B4
Shear Rate Constant, K_R , (sec^{-1} per RPM)	1.7023	0.3770	0.2682	0.2682
Shear Rate, (sec^{-1} or 1/s)				
1 RPM	1.70	0.38	0.27	0.27
2 RPM	3.40	0.75	0.54	0.54
3 RPM	5.11	1.13	0.80	0.80
6 RPM	10.21	2.26	1.61	1.61
10 RPM	17.02	3.77	2.68	2.68
20 RPM	34.05	7.54	5.36	5.36
30 RPM	51.07	11.31	8.05	8.05
60 RPM	102.14	22.62	16.09	16.09
100 RPM	170.23	37.70	26.82	26.82
200 RPM	340.46	75.40	53.64	53.64
300 RPM	510.69	113.10	80.46	80.46
600 RPM	1021.38	226.20	160.92	160.92
1,000 RPM	1702.30	377.00	268.20	268.20

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

<a> Computed for standard Torsion Spring (F 1.0). For other torsion springs, multiply by F factor
 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	$\frac{(\text{lb*s})}{100 \text{ ft}^2}$
Centipoise (cP)	1	0.01	0.01	1	1	0.002088
Poise (P)	100	1	1	100	100	0.2088
g/(cm*s)	100	1	1	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
$\frac{(\text{lb*s})}{100 \text{ ft}^2}$	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 a 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 would be at that RPM. If the Factor comes out as .87, then a F 1.0 spring should be used. If it comes out as .16, then a F 0.2 spring would be best. To cover all ranges, it may be necessary to use more than one 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

Safety

In order to comply with the requirements of safety standard EN 61010, the viscometer has a separable cord and plug, without a locking device, to mate with a socket outlet in the building. If the user substitutes another cord, the cord should not exceed 3 meters (9'10") in length.

Any interruption of the protective earth conductor inside or outside the instrument, or disconnection of the protective earth terminal is likely to make the instrument dangerous under some fault conditions. Intentional interruption is prohibited.

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment might be impaired. Whenever it is likely that protection has been impaired, the instrument should be made inoperative, and secured against accidental operation. OFITE Technical Service should be contacted for advice.

Any service performed by removing the viscometer cover should only be performed by a knowledgeable operator.

There are no user-serviceable components inside the heat cup cover. The Heat Cup should only be serviced by a factory-authorized technician.

Setup



1. Connect the instrument to a power source. This viscometer will operate equally well at 115 Volts or 230 Volts, 50 or 60 Hz.

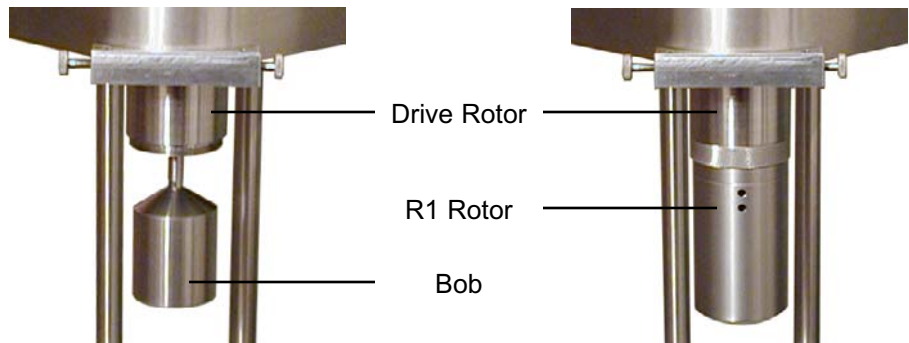
Always plug the Model 900 into a surge suppressor instead of directly into an electrical outlet. The internal electrical components can be damaged by voltage spikes.

2. To control the temperature, plug the thermocouple into the left side of the housing cover and place the thermocouple into the thermocouple well of the thermocup. Also plug the power cord of the thermocup into the back of the Model 900.

3. With the instrument turned **OFF**, place the splash guard onto the bob shaft with the short tube end up towards the bearings.



The Model 900 must be turned off each time the bob is installed or removed.



4. Screw on the appropriate bob with tapered end up towards splash guard.
5. Using the bobshaft wrench provided, locate the wrench flats on the shaft and place the wrench here for tightening the bob in place.



Do not tighten against the “stop pin” of the instrument!



Bob Shaft Wrench



Splash Guard

6. Position the rotor over the bob and move it upwards to join the rotor. The threads assure the rotor will attach evenly and uniformly each and every time.



7. The On-Off switch is located on the back panel, just above the power cable connection. Turn the unit **ON** and follow the display instructions, or press **CLEAR/STOP**.

8. Refer to the “Thermocouple Calibration” section on page 45.

It is recommended that a calibration procedure be run due to the possibility of mishandling during shipment of the Model 900. Refer to the “Calibration - Standalone” section on page 20 for instructions on calibrating the unit manually. Refer to the “Calibration - With Computer” section on page 24 for instructions on calibrating the unit with the ORCADA™ Software.

9. Place a properly prepared sample of test fluid (if an R1B1 bob is being used, approximately 165 - 170 mL) in the sample cup and immerse the rotor exactly to the scribed line on the rotor by raising the platform. Tighten the lock nut on the platform.

10. If you are using the optional pH Meter, refer to the “**pH Meter for Model 900**” instruction manual for detailed information about setting up and using the pH Meter with the Model 900.

When operating under computer control, the keypad on the Model 900 unit is disabled and the unit is controlled from the PC. However, the type of bob being used for the test must be entered in **SETUP** (refer to step 5 on page 20 for details) before connecting the unit to the PC.

Software Start

The OFITE Model 900 Viscometer can be operated from a PC using the ORCADATM 5.75 Model 900 software. When operating under computer control, the keypad on the Model 900 is disabled and all operation is controlled from the PC.

The computer must be equipped with a DB-9 serial port. If your computer does not have a DB-9 serial port, it is recommended that you purchase a USB to Serial adapter by a third party vendor.

The computer must be running Windows® 2000 or Windows® XP. For optimum viewing, it is recommended that your computer's display be set to 1024 x 768 pixel resolution.

1. Double-click the "ORCADATA" icon on the desktop.
2. The first time you run the software, you will be asked to select a hardware configuration. Select the the appropriate device and click "OK". You will now see the Main Screen.
3. The Windows XP firewall may try to block the ORCADATA software from communicating with the viscometer. If the firewall shows the following alert, select "Unblock".



Windows XP Firewall Alert

Main Screen



Note

“Start Test” - This button starts a test in Auto Mode. Once a test is started, this button becomes the “Abort Test” button. Click here to stop the test.

“Cement” - This button performs the same function as the “CEM” button on the unit’s keypad. Refer to page 22 for more information.

“Mud” - This button performs the same function as the “MUD” button on the unit’s keypad. Refer to page 21 for more information.

The “Mud” and “Cement” buttons perform standard tests based on API specifications. These tests ignore the “Dead Time” and “DAQ Time” settings on the Options screen. Temperature control, which is disabled during custom Auto-Mode tests, is available during a “Mud” or “Cement” test.

“Progress” - This button opens the Test Progress window, which shows all of the steps of the current test and highlights the one currently in process.

Record	Heat Time	Heat RPM	Temp	Cond. Time	Cond. RPM	#Steps	Delta Time	Gal Time 1	RPM 1	RPM 2						
1	0	120		0	1			00:00:10	600	300						
2	0	120	00:00:10	600	1			00:00:10								
3	0	120	00:00:10	600	1			00:10:00								

“Status” - This box at the top of the screen shows the current status of the test.

“Comm Timeout” - This light will be off when the PC is successfully communicating with the viscometer. If communication is interrupted for any reason, the light will shine red to indicate a problem.

“Start Logging” - This button is available in manual mode only. Click here to begin recording test data. The light next to this button will shine green while logging is in progress.

“Cond Pause” - This button will pause a test during the conditioning phase and put the software into Manual Mode. While the test is paused, the motor and heat controls can be controlled in the same manner as in a standard Manual Mode test.

To resume the test, click the “Cond Pause” button again. You will be asked if you want to “Continue” the test with the remaining conditioning time or if you want to “Override” the remaining time and extend the effective conditioning time. If you choose to “Continue”, the time remaining in the conditioning cycle will appear as though the test was never paused. If you choose to “Override”, the time remaining in the conditioning cycle will resume at the point where the test was paused.

For example, assume a test has a conditioning time of 10 minutes and the test is paused at the 5 minute mark for 1 minute. If the test is unpaused using the “Continue” option, the time remaining in the conditioning cycle will be 4 minutes. However, if the test is unpaused using the “Override” option, the time remaining in the conditioning cycle will be five minutes, making the effective total conditioning time 11 minutes.



“Raw File Save Period” - This field determines how often data is recorded during a test.

“Experiment Name” - This field will be used to identify the experiment later. This field is required before starting a test in Auto Mode or starting logging in Manual Mode.

“Bob” - Select the type of bob currently being used in the unit. An incorrect value in this field will adversely affect your test results.

“Key” - The checkboxes next to the graph key enable and disable graphing of the indicated values. For example, to exclude RPM from the graph, uncheck the “RPM” box. You can also customize the appearance of the lines on the graph by clicking on the line example on the right side of the key.

“Manual Mode Controls” - The manual mode controls, in the bottom left-hand corner of the screen, adjust the rotor speed and the temperature while the unit is operating in manual mode.

“Rotation” - This field determines the rotational speed. The drop-down box beneath the field sets the units to either RPM or 1/s.

“Enable” - Place a check in this box to engage the motor. Uncheck the box to stop the motor.

“Temp” - This field determines the test temperature. The drop-down list beneath the field sets the units to either °F or °C.

“Enable” - Place a check in this box to enable temperature control. If the value in the “Temp” field is higher than the sample temperature, the heaters will engage to heat the sample.

“PreHeat” - This field is not used on the Model 900.

“Cool” - This field is not used on the Model 900.

“Clear” - This button removes all data from the graph.

“Analysis Model” - This field, below the graph, displays the current Analysis Model being used in the test. This variable is set in the Test Builder (refer to page 28 for more information).

“Analysis Data” - This chart shows the calculated values based on the Analysis Model being used for the test. This data will not display until after the analysis sweep is completed.

“Temperature”, “Shear Stress”, “Viscosity”, “Shear Rate”, “RPM” - These fields display the current value for these variables. They are display only. The drop-down box next to the “Shear Stress” field changes the units of the Shear Stress variable. The units can be set to: Dyne/cm², lb/100ft², Pa., Dial Reading, lb/ft²

Calibration

Standalone

The calibration procedure is easily performed by pressing the **CAL** button and following the instructions as you are prompted on the unit's display screen. Calibrations should be routinely performed prior to rheological testing and are necessary after changing out bearings or the torsion spring.

For the most accurate calibration results, calibrate the thermocouple before performing the following procedure. Refer to page 45 for instructions.

If you use a computer with the Model 900, you must unplug the connection before beginning the procedure.

1. **“Check P is 15,000 - 25,000. Adjust then Enter. P=XXXXX”**

A number for **“P”** (Position of the Transducer) will be initially displayed on the screen. If this number falls outside the given range, the torsion spring will need to be manually adjusted so the **“P”** falls within the parameters.

- a. Remove the stainless housing cover.
- b. Loosen the two 5/64" allen set screws on the side of the torsion spring housing (see picture on page 44).
- c. Position the housing-cover so the display can be read, and gradually rotate the Zero Calibration Knob in very small increments until the number displayed falls within the given range for **“P”**.
- d. Carefully lower the housing straight down onto the unit chassis.
- e. Re-tighten set screws.

Press **ENTER**.

2. **“Max vis. for 300 RPM is 300.0 cP”**



*Recommended Viscosities for
Calibration at 300 RPMs
for various Torsion Springs (R1, B1):*

Torsion Spring, F0.2 = 60 cP
Torsion Spring, F0.5 = 150 cP
Torsion Spring, F1.0 = 300 cP
Torsion Spring, F2.0 = 600 cP
Torsion Spring, F3.0 = 900 cP

3. Add approximately 170 mL calibration fluid into the clean and dry stainless steel sample cup. Place the sample cup with calibration fluid onto the platform. Loosen the lock nut on the platform with the stainless steel arm until the fluid level reaches the scribed line on the rotor. Tighten the lock nut on the platform.
4. Allow a couple of minutes for the temperature of the calibration fluid to equalize.
5. Find the calibration sheet attached to the calibration fluid you are using. Record the viscosity at the temperature being read on the unit.
6. Enter the actual viscosity (listed on the calibration sheet) of the calibration fluid (must be ≤ 300 cP if the standard B1 Bob, R1 Rotor and F1 Torsion Spring are used) using the left side of the keypad. Press **ENTER**.
7. The machine will perform the calibration internally in a series of sweeps, and return to the main screen.
8. Turn the unit **OFF**.
9. Loosen the lock nut on the platform while holding the bottom of the platform with your other hand. Slowly lower the platform with the sample cup and calibration fluid. Allow the stainless steel cup to remain beneath the bob and rotor to allow residual calibration fluid to drain.
10. Pour the calibration fluid from the sample cup back into the 16 oz. (500 mL) container.



Note

Used calibration fluid can contaminate new fluid. Before mixing the used with the new, inspect the used fluid for contamination. Discard any fluid that is cloudy or contains suspended solids.

11. Remove the rotor. Wipe any residual calibration fluid off the rotor and the bob with either a paper towel or a soft cloth. Make sure the wrench is in place prior to wiping off the bob. Wipe the sample cup dry with a paper towel.

Calibration

With Computer

Before the Model 900 unit can be calibrated using the ORCADA™ Software, the Calibration Mode must be set to “ORCADA Software”. Refer to the “Software - Options” section on page 26 for more information.

From the main screen choose, “Calibrate Shear Stress” from the “Utilities” menu.

1. Select a calibration fluid from the “Cal Fluid Batch” drop-down list. If the list is empty, click the “Fluid Manager” button to add new fluid batches. Refer to page 19 for more information.

If the “Temp Out of Range” light shines red, the current sample temperature is out of the specified range for the calibration fluid. The sample will have to be heated or cooled to be within the acceptable range before calibration.

Do not attempt a calibration if the sample is not within the appropriate temperature range.



2. Choose a set of calibration rates from the “Rate Set” drop-down list.

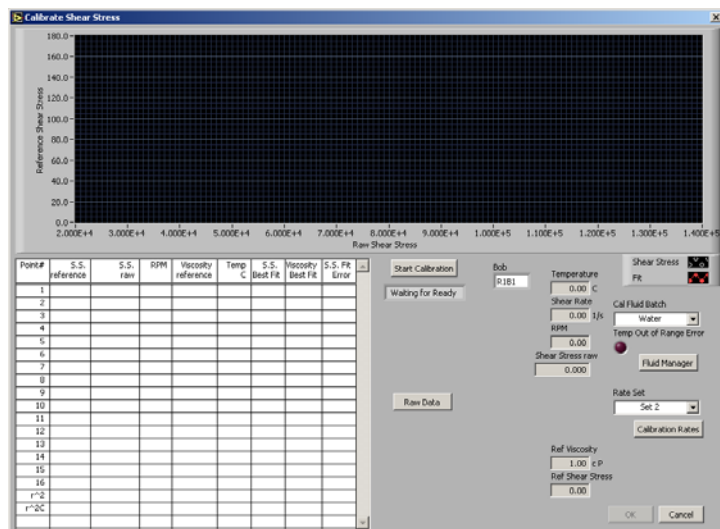
To create or edit a rate set, click the “Calibration Rates” button. To create a new set, click the “New” button and enter a name and the rotational speeds. To edit a set, select it in the “Rate Set” list, then change the rotational speeds as necessary.



Rate Sets

3. Click the “Start Calibration” button to begin the calibration.

Once the calibration has started, the software will begin filling in the chart and plotting the results on the graph.



4. As the calibration proceeds, the software will begin to display the collected data in the chart. At the end of the calibration, the software will calculate the “ r^2 ” value, which measures the accuracy of the calibration. If this value is less than 0.9990, recalibrate the unit. If this value is still low, change the lower bearing (see page 40 for instructions) and try the calibration again. If the unit still does not calibrate, it will require servicing by an OFITE technician.

“**S.S. Reference**” - the ideal shear stress as calculated by the software

“**S.S. Raw**” - the actual signal coming from the unit

“**RPM**” - rotational speed

“**Viscosity Reference**” - the ideal viscosity of the sample as calculated by the software

“**Temp**” - the temperature of the sample at the time viscosity was measured

“**S.S. Best Fit**” - shear stress value demonstrated by the viscometer

“**Viscosity Best Fit**” - viscosity value demonstrated by the viscometer

“**S.S. Fit Error**” - deviation of actual shear stress from “S.S. Best Fit”

“ **r^2** ” - This is a measure of the accuracy of the calibration. It will be calculated at the end of the calibration cycle. If this value does not read greater than 0.9990 after multiple calibration tests, the unit will require servicing or new bearings.

“ **r^2C** ” - This value is not used on the Model 900 and should be ignored.

“**Temperature**” - the temperature of the sample

“**Shear Rate**” - rotational speed (1/s)

“**RPM**” - rotational speed (RPM)

“**Shear Stress Raw**” - the actual signal coming from the unit

“**Ref Viscosity**” - the ideal viscosity of the sample as calculated by the software

“**Ref Shear Stress**” - the ideal shear stress as calculated by the software

Calibration

Fluid Manager

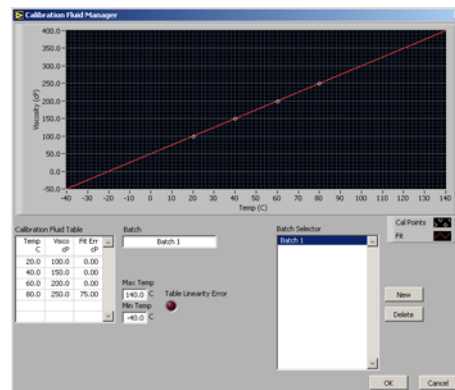
Before calibrating the unit, you must input the specifications of the calibration fluid that you are using. This will give the software the information it needs to perform the calibration accurately.

Click the “Fluid Manager” button on the Calibration screen to add a new calibration fluid batch.

1. Click “New” to add a new batch. You can also edit an existing batch by selecting it in the “Batch Selector” list.
2. In the “Batch” field, type a name for the batch. OFITE recommends using the lot number and viscosity from the Certification Chart that was provided with the fluid.
3. In the “Calibration Fluid Table”, enter at least two Temperature/Viscosity pairs from the Certification Chart. Only two pairs are required.

The “Table Linearity Error” light will shine red if the values in the “Calibration Fluid Table” do not create a straight line. If this occurs, check the values and re-enter them.

4. Once you have entered all the batches, click “OK” to close the Fluid Manager and return to the Calibration screen.



Operation

Standalone

When operating in stand-alone mode, the keypunch panel on the top of the viscometer is used. Following are descriptions of the buttons:

1. **Individually numbered buttons on left side - 0 (zero) through 9 (nine)**

Used to set RPMs or 1/s. Accurate to two decimal places (0.01 RPM). After entering the desired shear rate, follow by pressing the **ENTER** key.

2. **Numbered buttons on right side - 600, 300, 200, 100, 60, 30, 20, 10, 6, 3, 2 and 1**

These are shear rates typically used in oilfield rheology, and provide a quick and convenient means of changing the rotor speeds. The RPM speed may be quickly and directly changed by pressing the numbered pads. No programming or any other entry is necessary.

3. **CLEAR / STOP**

Used to end a test sequence, or to re-enter.

4. **NEXT**

Used for sequencing functions.

5. **SET UP**

Used to program the machine. The unit prompts you to enter a value for each parameter, or you can simply press **NEXT** to accept the defaults. Descriptions of the parameters in the order they appear on the display follow below:

a. **“Temperature”:**

“Current”: Set point target temperature for machine to ramp to.

“New”: New target temperature.

Press **ENTER** and then **NEXT**.

b. **“Bob #”:** 1 is standard

“New (1 - 5)”: Use if another bob (B1, B2, B3, etc.) is used.

Press **ENTER** and then **NEXT**.

c. **“SS Units”:** Changes the shear stress measuring units that are displayed. Enter selection number or leave alone if unchanged.

1 = Dynes/cm² 2 = Pa (Pascal) 5 = lb/ft²
3 = lb/100ft² 4 = D.R. (*Dial Reading)

Press **ENTER** and then **NEXT**.

**Used to calculate an association with a mechanical viscometer.*

Patent No. 6,776,028 - OFI Testing Equipment, Inc.

a. Press **MUD**. The following steps will be performed. At each interval, the viscometer stabilizes and then records a reading. If you prefer not to wait for the 10 minute Gel test, you may hit **NEXT** to cancel that particular operation, while still obtaining readings on everything else that was measured.

- 1) Mixing Speed
- 2) 600 RPM for 15 seconds
- 3) 600 RPM for 10 seconds
- 4) 10 second Gel (Wait 10 seconds)
- 5) Mix for 10 seconds
- 6) 10 minute Gel (Wait 10 minutes)

b. After the completion of the test, the following is displayed:

- 1) **"PV"** =
- 2) **"YP"** =
- 3) **"10 Sec Gel"** =
- 4) **"10 Min Gel"** =

8. CEM

By pressing this button once, the viscometer will automatically measure, calculate and display shear stress dial readings as per API Recommended practice 10. This automation enables the technician to simultaneously perform other tasks. It also assures increased accuracy and reproducibility, as each test is conducted in the same manner and for the same time periods.

a. Press **CEM**. The viscometer will automatically begin ramping up to 300 RPM and back down, taking readings at specific intervals along the way. At each interval, the viscometer maintains the RPM speed for 10 seconds for stabilization and then records a reading. If you prefer not to wait for the 10 minute Gel test, you may hit **NEXT** to cancel that particular operation, while still obtaining readings on everything else that was measured. The RPM intervals at which data is gathered include:

- 1) 3 RPM
- 2) 6 RPM
- 3) 30 RPM
- 4) 60 RPM
- 5) 100 RPM
- 6) 200 RPM
- 7) 300 RPM
- 8) 200 RPM
- 9) 100 RPM
- 10) 60 RPM
- 11) 30 RPM

- 12) 6 RPM
- 13) 3 RPM
- 14) 10 second Gel (Wait 10 seconds)
- 15) 10 minute Gel (Wait 10 minutes)

b. After the completion of the test, results are displayed as follows. Clicking **NEXT** allows you to proceed to the next set of readings.

- 1) “**Up Readings**” for all the test speeds
- 2) “**Down Readings**” for all the test speeds
- 3) “**Avg Readings**” for all the test speeds
- 4) “**Gels & Temp**”
 1. **10 Sec** =
 2. **10 Min** =
 3. **Temp** =

9. In addition to the pre-installed programs (MUD and CEM), the OFITE Model 900 contains 8 slots for custom programs created with the ORCADA™ Software. Refer to page 36 for instructions on creating custom programs. To access these custom programs:

a. Press the **SET UP** key twice.

At this point you can press the **ENTER** key to recall the results of the last test run.

b. Press the **SET UP** key again to select a new test to run.

c. Select a test by pressing the numeric key corresponding to the test you wish to run. The test will start immediately.

d. When the test is complete, the unit will beep.

e. Press the **NEXT** key to page through the test results.

f. Press the **CLEAR/STOP** key to return to the main menu.

Operation

With Computer

The ORCADA™ software has two modes for running tests: **Auto** and **Manual**. By default, the software is in **Manual** mode when first opened.

To begin a test in **Manual** mode:

1. Add approximately 170 mL of test fluid to the clean and dry stainless steel sample cup.
2. Enter the raw file save period (in MM:SS, where MM is the two digit number of minutes and SS is the two digit number of seconds) and select the shear stress units from the drop-down menu.
3. Enter a temperature in the “Temp” field and choose Celsius or Fahrenheit.
4. Select the “Enable” checkbox next to the “Rotation” field to start the motor.

Once the motor is started, the display fields on the right-hand side of the screen will begin displaying test data.

5. Select the “Enable” checkbox next to the “Temp” field to start the heater.

The “Preheat” and “Cool” options are used for pressurized viscometers only.

6. Enter a name in the “Experiment Name” field and click the “Start Logging” button.
7. Enter a comment in the resulting dialog box. Comments are optional, but can be used later to identify the test results.

To begin a test in **Auto** mode:



Note



Note

1. Add approximately 170 mL of test fluid to the clean and dry stainless steel sample cup.
2. Enter the raw file save period (in MM:SS) and select the shear stress units from the drop-down menu.
3. Highlight a test to run from the list in the upper left-hand corner of the Main Screen. Refer to page 28 for instructions on creating custom tests.
4. Enter a name in the “Experiment Name” field.
5. Click the “Start Test” button.
6. Enter a comment in the resulting dialog box. Comments are optional, but can be used later to identify the test results.



Caution: The Model 900 Viscometer thermocouple must be immersed in the fluid before enabling the temperature or heating a sample in the heat cup.

Software

Options

To access the Options screen, choose “Options” from the “Edit” menu.

“**900 Calibration Mode**” - Place the slider on “ORCADATA Software” to enable the calibration screen. Place the slider on “Onboard” to calibrate the unit using the onboard controls.

“**Spring Constant**” - Enter the type of spring being used in the unit.

“**Scientific Instruments pH Com Port**” - This field specifies which Com port the external pH Meter is connected to.

“**Enable pH**” - Check this box if you are using an external pH Meter. This will enable the “pH” and “Temp pH” fields in the process variable area of the Main Screen. It will also make “pH” an option on the key to the graph.

“**RPM DAQ Settings**” - “RPM High”, “RPM Med” and “RPM Low”, “Dead Time”, “DAQ Time”. These fields are used to determine the amount of time needed for the sample to stabilize at a given rate. The fields are also used to determine the amount of time data is averaged before being saved. For example, if RPM High is set to 60, Dead Time is set to 15 and DAQ Time is set to 20, any rate of 60 RPM or greater during a sweep would stabilize for 15 seconds then begin averaging data for 20 seconds before saving the data.

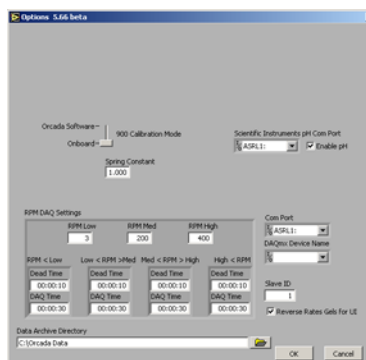
“**Com Port**” - This field specifies which Com port the viscometer is connected to.

“**DAQmx Device Name**” - If multiple DAQ cards are installed on the PC, choose the card you wish the unit to use.

“**Slave ID**” - If multiple units are being monitored through the ORCADATA™ Software, each one must be identified by a unique “Slave ID”.

“**Reverse Rates Gel UI**” - If “Hysteresis” is selected on the “Test Builder” screen (see page 28), this option will perform a gel test after both the forward and backward portions of the sweep.

“**Data Archive Directory**” - This field specifies the directory to store archived data.



Software

Save Rate Settings

By default, the ORCADATA™ Software saves data to file based on a set time interval. This time interval can be changed by editing the “Raw File Save Period” field on the main screen. However, the “Save Rate Settings” feature provides more control over data save points. The software will monitor each selected variable and record a data point to the file when that variable changes by the amount specified.

1. Select “Save Rate Settings” from the “Edit” menu.
2. Place a check mark next to each variable you wish to monitor.
3. In the field after the variable name, enter the variance required to initiate a save point.

For example, if you want the software to record a data point when the temperature increases or decreases more than 5°, place a check next to “Temperature” and enter 5 in the field next to it.

4. Click “OK” to save the settings and return to the main screen.

“Elapsed Time” - seconds since the start of the test

“RPM” - rotational speed (RPM)

“Shear Rate” - rotational speed (1/s)

“RPM SP” - rotational speed setpoint

“Temperature” - measured sample temperature

“Temperature pH” - temperature reading from the external pH meter

“Temp SP” - temperature setpoint

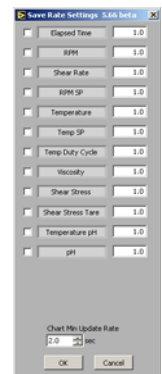
“Temp Duty Cycle” - the frequency (in seconds) the heaters engage to increase the temperature

“Viscosity” - measured viscosity (cP)

“Shear Stress” - measured shear stress

“Shear Stress Tare” - change in measured shear stress

“pH” - pH reading from the external pH meter



Software

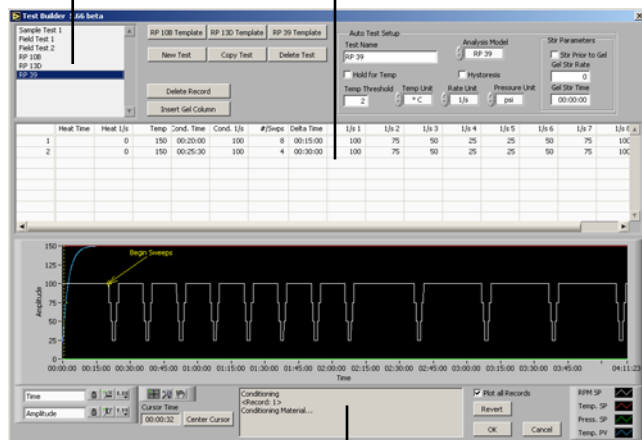
Test Builder

The Test Builder is designed to help you build custom tests for use in **Auto** mode. To access the test builder, go to the Main Screen and choose “Test Builder” from the “Edit” menu.

1. To create a new test, click the “New Test” button. To create a new test based on one of the “RP 10B”, “RP 13D”, or “RP 39” analysis models, click the appropriate button at the top of the screen to open a template. To edit an existing test, select the test from the list in the upper left-hand corner of the screen.
2. Enter a name in the “Test Name” field.
3. Choose an Analysis Model.
 - a. “**RP 39**” - Power Law Model - records the Power Law calculations (n and k)
 - b. “**RP 13D**” - Bingham Plastic Analysis Models - records plastic viscosity (PV) and yield point (YP)
 - c. “**RP 10B**” - Power Law and Bingham Plastic Models combined
4. Input the values for your test into the fields in Record 1.
 - a. “**Heat Time**” - the time it will take the unit to heat the sample to the temperature setpoint. If this field is left blank, the unit will heat the sample as fast as possible.
 - b. “**Heat RPM**” - the rotational speed during the heating period
 - c. “**Temp**” - the temperature setpoint. Enter any letter in this field to indicate “Ambient”.

Available Tests

Records



Test Detail

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- d. **“Cond. Time”** - the time period to condition the sample
 - e. **“Cond. RPM”** - the rotational speed during conditioning
 - f. **“#/Swps”** - the number of sweeps to perform after conditioning. A sweep is a set of rotational speeds separated by time interval. Between sweeps, the rotor returns to the Cond. RPM. At the end of each sweep, the unit calculates the Analysis Model values.
 - g. **“Delta Time”** - the time interval between sweeps
 - h. **“Gel Time 1”** - During a gel time interval, the rotor comes to a complete stop and waits. At the end of the interval, the rotational speed is increased to 3 RPM until the gel breaks and a gel strength value is recorded. Click the “Insert Gel Column” button to add a gel time to the record.
 - i. **“RPM 1, 2, 3, etc.”** - The RPM fields set the speed of each step of the sweep.
5. Repeat step 4 in the following record fields until you have completed building your test.
 6. Click the “OK” button to save the test and return to the main screen.

“Hold for Temp” - Click this checkbox to tell the unit to wait until the sample has reached the temperature setpoint before proceeding to the next step. If this box is unchecked, the test will proceed while the sample is heating.

“Temp Threshold” - This field specifies an acceptable variance on the temperature. For example, if the temperature setpoint is 150° and the “Temp Threshold” is set to 5°, the unit will consider the setpoint reached when the temperature is between 145° and 155°.

“Temp Unit” - set temperature units to either °F or °C

“Rate Unit” - set the rate units to either RPM or 1/s

“Pressure Unit” - The field is not used on the Model 900.

“Hystoresis” - If this box is checked, each sweep will be performed forward and backwards.

“Stir Parameters” - These parameters only apply if the test includes a gel time.

“Stir Prior to Gel” - Check this box to stir the sample before calculating gel strength.

“Gel Stir Rate” - This is the rate the sample will be stirred prior to calculating gel strength.

“Gel Stir Time” - This is the time interval the sample will be stirred.

“Plot All Records” - If this box is checked, all records will be plotted on the graph. If it is not checked, only the currently highlighted record will be plotted.

The graph below the records provides a visual representation of the current test. Each line represents one aspect of the test: RPM Setpoint, Temperature Setpoint, and Temperature PV. Refer to the key to the right of the graph for details.

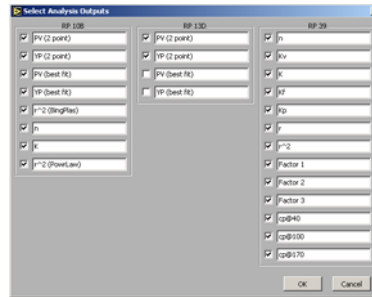
The graph features a cursor, a vertical yellow line, that can be used to view more detailed information about the different phases of the test. The “Center Cursor” button moves the cursor to the center of the graph. Click and drag the cursor across the graph to see more detailed information. Refer to the “Test Detail” field below the graph for more information.

Software

Select Analysis Outputs

After building a test in the Test Builder, the chart at the bottom of the Main Screen will show the various data points being calculated by the viscometer based on the chosen Analysis Model. This chart, however, is customizable. You can choose which data points are displayed on the chart and which are not.

From the “Edit” menu, choose “Select Analysis Outputs”. By default, all data points are selected and will appear on the chart. To remove a data point from the chart, simply uncheck the box next to it.

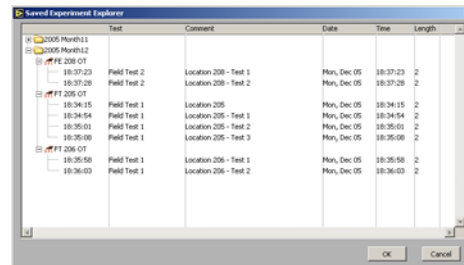


Software

Saved Test Data

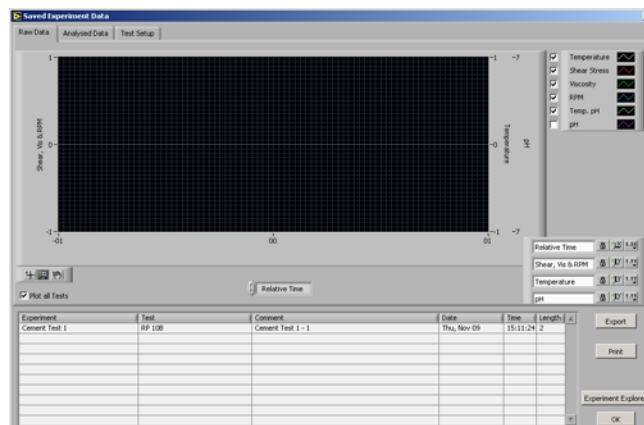
To review test data from past tests:

1. Select “Saved Test Data” from the “File” menu.
2. The saved test data is grouped by month. Select the folder for the year and month of the data you are looking for and click the small + sign next to it. This will show you all of the data for tests run that month, including any comments you added.
3. Select the test you are looking for and click the “OK” button. Multiple tests can be selected by holding down the CTRL key and selecting each test.



Saved Experiment Explorer

4. On the “Raw Data” tab you will see the graph of the test results. The “Analysed Data” tab shows the results of the calculations based on the Analysis Model. The “Test Setup” tab shows the parameters of the test.



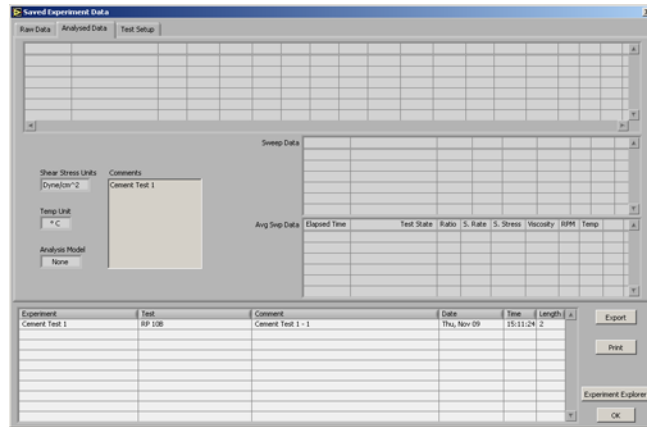
Raw Data

“Export” - Click this button if you wish to export the test data to a file. You will be asked to select a filename and destination and then click “OK”. The resulting file can then be opened in Microsoft® Excel for further analysis.

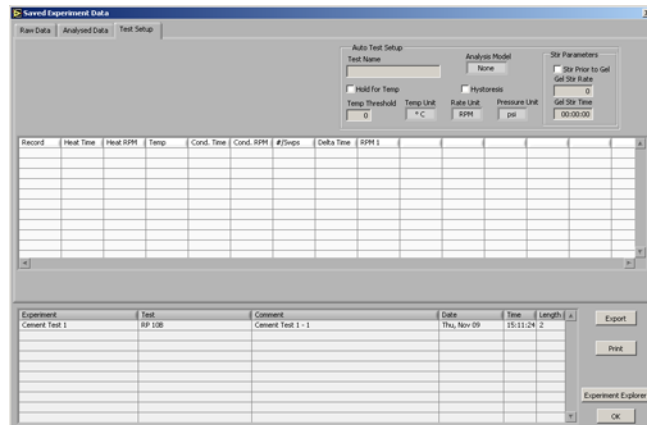
“Print” - Click this button to print the results to the default printer.

“Experiment Explorer” - Click this button to choose another set of test data to review.

“OK” - Click this button to return to the main screen.



Analysed Data



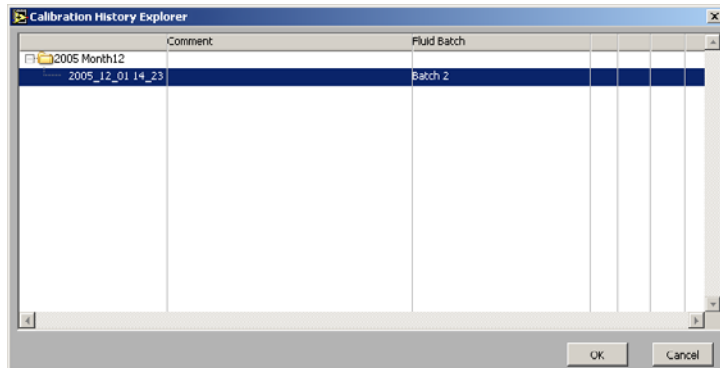
Test Setup

Software

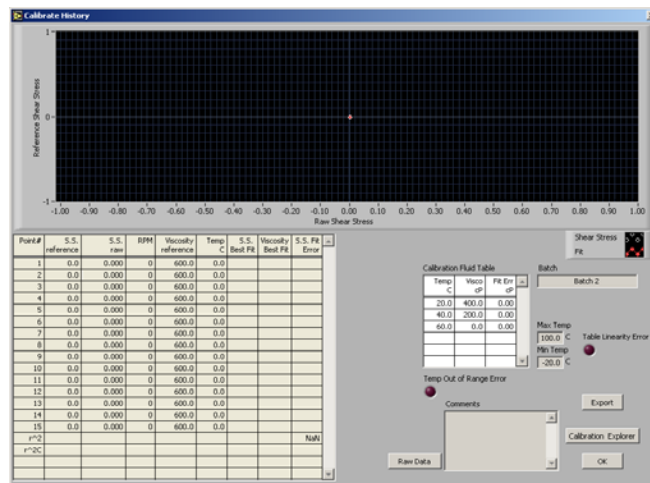
Calibration History

On the Calibration History Screen, you can retrieve the data from all past calibration tests.

1. Begin on the Main Screen. Select “Calibration History” from the “Utilities” menu.
2. The calibration tests are grouped by month. Select the folder for the year and month of the calibration test you are looking for and click the small + sign next to it. This will show you all of the calibration tests run that month, including the fluid batch and any comments you added after the test.
3. Select the test you wish to view and click the “OK” button.
4. You can now see the graph, chart, and fluid batch details.
5. Click the “Export” button if you wish to export the calibration results to a file. You will be asked to select a filename and destination and then click “OK”.
6. When you are finished reviewing the calibration history, click the “OK” button to return to the main screen.



Calibration History Explorer



Calibration History

Software

Import/Export

The Import/Export feature of the ORCADATA™ Software makes it possible to transfer a test from one PC to another.

1. Begin on the Main Screen. Choose “Export” from the “File” menu.
2. Select the tests you wish to export. Hold down the CTRL key to select multiple tests.
3. Click the “Export” button. You will be asked to choose a destination and filename and then click “OK”.
4. Copy this file to the destination PC.

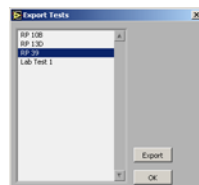
The file must be placed in the correct folder for it to be available for import. To find this folder, first navigate to the folder specified in the “Data Archive Directory” field in the Options screen (see page 26 for details). From there go to the “ORCADATA” folder and then the “Tests Import Export” folder.

5. On the destination PC, choose “Import” from the “File” menu.
6. Choose the tests you wish to import. Hold down the CTRL key to select multiple tests.

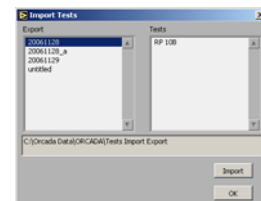
The “Export” field lists all of the files that are available for import. Once you have selected one, the “Tests” field shows which individual tests can be imported from that file.

Below the “Export” and “Tests” fields is a display-only field that shows the folder being scanned for exported tests. Make sure the tests you want to import have been placed in that folder.

7. Click the “Import” button. The new tests will appear in the list in the upper left-hand corner of the Main Screen.



Export



Import

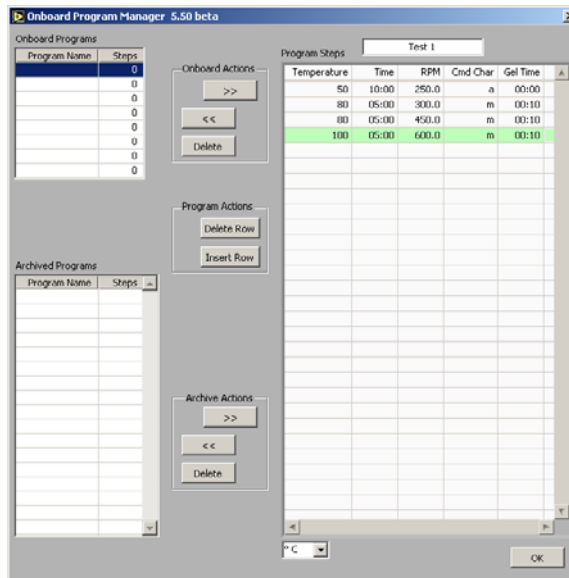
Software

Onboard Program
Manager

From the Onboard Functions screen, you can create custom test programs to be uploaded to the Model 900 unit. These programs can then be run from the onboard control panel, without requiring the ORCADA™ software.

1. Begin on the Main Screen. On the “Utilities” menu, choose, “900 Onboard Functions” then “Onboard Program Builder”. When the screen opens, the unit will transfer the programs stored in the unit’s memory to the PC. These will be displayed in the “Onboard Programs” list in the upper left-hand corner of the screen.
2. If you are editing an existing onboard program, select the program name from the “Onboard Programs” box and click the “>>” button. This will copy the steps of the selected program into the “Program Steps” box where they can be edited.
3. At the bottom of the screen, select the desired temperature units (°F/°C).
4. Enter the required information in the “Program Steps” box. To insert or delete a row, click the corresponding “Program Actions” button.
 - a. **“Temperature”** - temperature setpoint
 - b. **“Time”** - time to heat the sample (mm:ss)
 - c. **“RPM”** - rotational speed
 - d. **“CMD Char”** -
 - i. **“a”** - This option calculates the average shear stress over the conditioning period.
 - ii. **“m”** - This option performs a mudsweep when both the “Temperature” and “Time” conditions are met. During the mudsweep, the rotor is turn at 300 RPM for 15 seconds, then 600 RPM for 15 seconds, then the software calculates plastic viscosity (PV) and yield point (YP).
 - e. **“Gel Time”** - time to let the sample stand before calculating gel strength (mm:ss)
5. When you have finished entering all of the test steps, select a slot on the “Onboard Programs” box and click the “<<” button. This will copy the steps from the “Program Steps” box to the Model 900 unit. Each slot in the “Onboard Programs” box corresponds to a program number on the Model 900. The first slot will be #1 on the unit, the second slot will be #2, etc.

If the slot you choose is already storing a program, that program will be overwritten by the new one.



6. Programs can be archived to disk for backup and easy access. The “Archived Programs” box displays all archived programs. These programs are accessed and modified the same as the onboard programs.

Onboard Actions:

>> - This button copies the steps of the selected onboard program into the “Program Steps” box.

<< - This button copies the steps from the “Program Steps” box into the selected onboard program. The selected program will be overwritten and the new program will be copied to the Model 900 unit.

Delete - This button deletes the selected onboard program.

Archive Actions:

>> - This button copies the steps of the selected archived program into the “Program Steps” box.

<< - This button copies the steps from the “Program Steps” box into the selected archived program. The selected program will be overwritten.

Delete - This button deletes the selected archive program.

Program Actions:

“Delete Row” - deletes the selected row in the “Program Steps” box

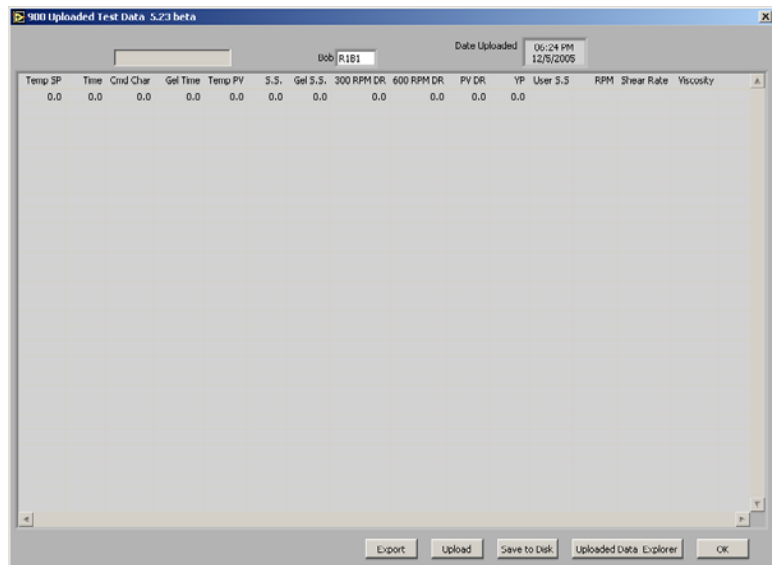
“Insert Row” - inserts a new row above and identical to the selected row

Software

Upload Test Data

1. To transfer the results of the last test from the Model 900 unit to the PC, click “Utilities”, then “900 Onboard Functions”, then “Upload Test Data”.
2. Click the “Upload” button to initiate the transfer and display the data on the screen. Each line shows one step of the test.
 - a. “**Temp SP**” - temperature setpoint
 - b. “**Time**” - elapsed time (in minutes) for the step
 - c. “**Cmd Char**” - command character
 - d. “**Gel Time**” - gel time set point
 - e. “**Temp PV**” - temperature process variable. This is the actual temperature of the sample
 - f. “**S.S.**” - shear stress
 - g. “**Gel S.S.**” - gel shear stress
 - h. “**300 RPM DR**” - If the “Cmd Char” is “m”, this will show the 300 RPM dial reading.
 - i. “**600 RPM DR**” - If the “Cmd Char” is “m”, this will show the 600 RPM dial reading.
 - j. “**PV DR**” - If the “Cmd Char” is “m”, this will show the plastic viscosity dial reading.
 - k. “**YP**” - If the “Cmd Char” is “m”, this will show the yield point dial reading.
 - l. “**User S.S.**” - If the “Cmd Char” is “a”, this will read the average shear stress.
 - m. “**RPM**” - rotational speed (RPM)
 - n. “**Shear Rate**” - rotational speed (1/s)
 - o. “**Viscosity**” - average viscosity
3. Click the “Export” button to export the data to a disk file.
4. Click the “Save To Disk” button to save the data to the “Upload Data Explorer” to be viewed later.
5. Click the “Upload Data Explorer” to access previously saved data sets.

- a. Locate the folder for the date of the saved data.
 - b. Click the small + sign next to the folder.
 - c. Select the data set you wish to view and click “OK”.
 - d. The data set will appear on the screen.
6. Press the “OK” button to close the “Upload Test Data” and return to the main screen.



Disassembly



Maintenance



This procedure should be performed immediately after **every** test and calibration.

1. Turn the unit off.
2. Remove the R1 rotor from the drive rotor.
3. Place bobshaft wrench on the flats located just above the bob. Remove bob.

Do not try to remove the bob without the wrench. Doing so can cause severe internal damage.

4. Once the bob is removed, remove splash guard and wipe down the bobshaft. Clean all removed parts with water and or appropriate solvent.

The Model 900 utilizes a stepper motor / timing chain, drive and a non-contact rotational transducer detection system, which is extremely accurate and sensitive enough to detect micro-divisions of 1/262,000th of a revolution. This viscometer utilizes an absolute minimum of moving parts, and there are no gears to jam up or get worn down like more conventional units. The bob shaft bearings are isolated from the rotation of the rotor, which ensures no induced drag on the bob shaft due to rotation. This results in more sensitive and accurate readings, particularly at low shear rates, and the life of the bearings is prolonged. When replacement is warranted however, the bearings and the torsion spring may be easily changed. This is a major advantage over previous viscometers.

It is important to remove the bob from the bob shaft during viscometer transport to prevent bending or damaging the bob shaft assembly.

Tools Required:

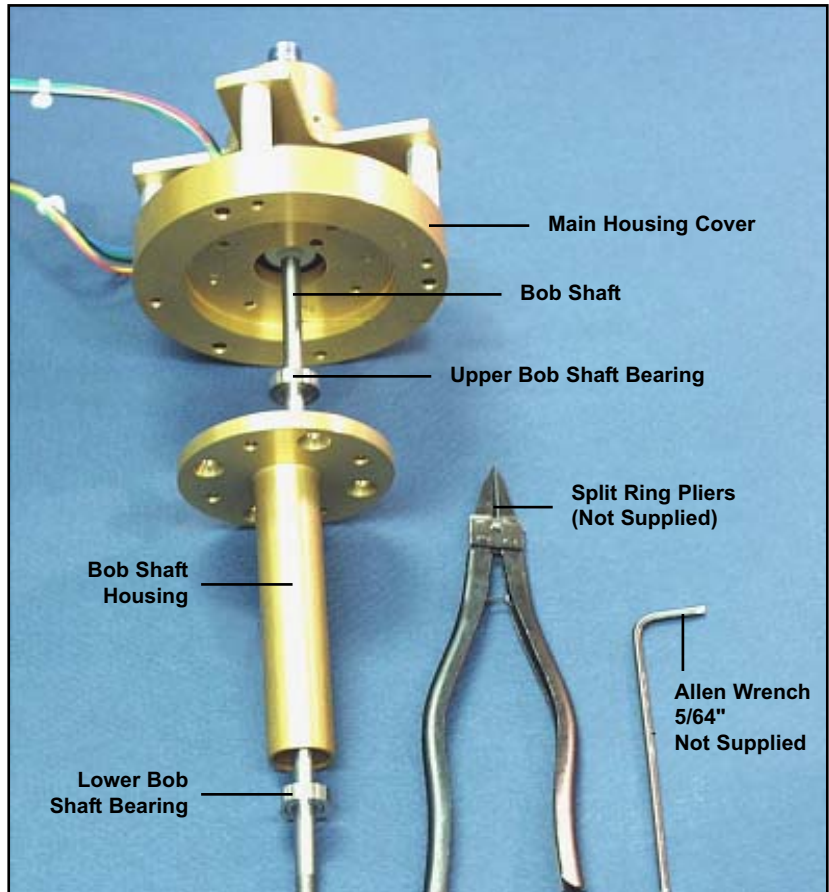
Allen Wrench, 1/16"
Allen Wrench, 5/64"
Allen Wrench, (1.5 mm provided)
Split Ring Pliers, small
Bob Shaft Wrench (provided)

Bob Shaft Bearing Replacement:

1. Unplug all electrical wires and the thermocouple wire from the housing. Ensure bob and rotor have been removed. Remove the five screws along the base of the outer housing cover, and gently lift off the cover.

Warning: Risk of electrical shock.

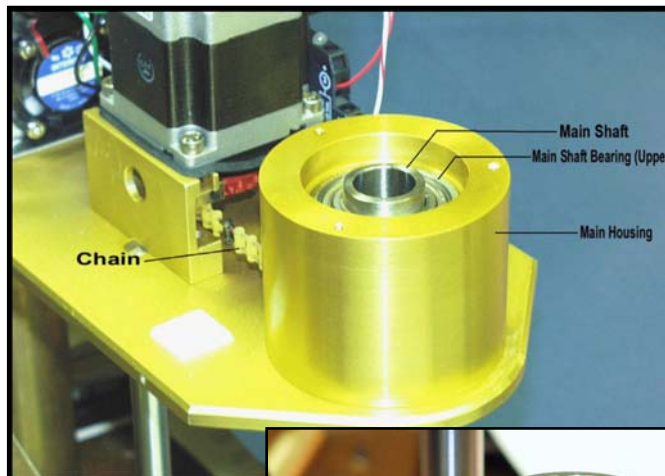
2. Unplug the torque transducer cable from the inner housing cover.
3. Remove the main housing cover by unscrewing the three Allen screws.
4. Carefully lift the entire assembly out of the main housing.



5. Using the split ring pliers, carefully remove the two split rings from the lower bob shaft bearing.
6. Remove the four Allen screws from the underside of the main housing cover.
7. Gently slide the bob shaft housing down the bob shaft, to access the upper bob shaft bearing. Unlike the lower bearing, this one readily comes off of the shaft, with no retainer ring holding it in place.
8. Replace the upper bearing first and re-attach the bob shaft housing to the main housing cover with the four Allen set screws.
9. Slide the lower bearing into place and secure with new retainer rings.
10. Replace main housing cover onto the main housing with the three screws. Be sure the serial number is facing forward on the transducer.
11. Re-attach the torque transducer cable to card.
12. Replace the outer housing cover. Take care that no cables are pinched between the cover and the frame.

Main Shaft Bearing Replacement:

1. Unplug all electrical wires and the thermocouple wire from the housing. Remove the Allen screws along the base of the outer housing cover, and gently lift off the cover.
2. Unplug the torque transducer cable from the inner housing cover.
3. Remove the main housing cover by unscrewing the three 5/64" Allen set screws.
4. Carefully lift the entire bob shaft assembly out of the main housing.
5. Loosen the motor with the appropriate Allen wrench. The four screws are located around the base of the motor.



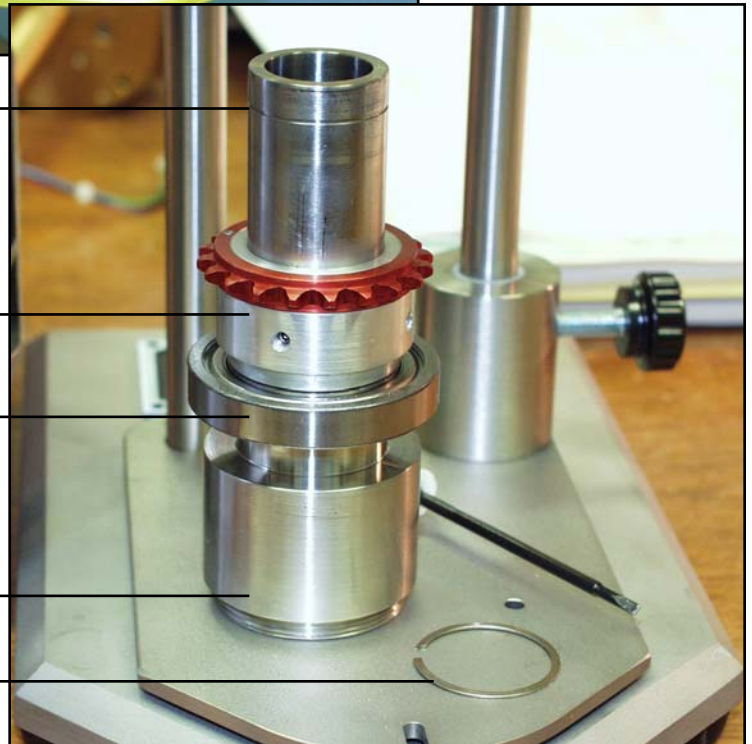
Split Ring
Groove

Gear
(#130-76-23)

Lower Main
Bearing
(#130-76-04)

Rotor Tube
(#130-76-22)

Split Ring
(#130-76-05)



6. Gently slide the motor forward to loosen the chain, freeing it from the sprocket.
7. Remove the split ring from on top of the main shaft bearing. A small flat head screwdriver may be used for removal.
8. Slide the main shaft assembly down out of the main housing body. The upper bearing will stay inside the housing, but it can be easily removed and replaced by lifting it up out of its recess.
9. To replace the lower main shaft bearing, loosen the two Allen set screws on the side of the sprocket. The sprocket and the bearing may then be removed from the main shaft.
10. Replace the lower bearing and sprocket, tighten the Allen screws, and replace the assembly inside the main housing. Make sure the belt fits around the teeth in the sprocket.
11. Replace the split ring on top of the main shaft bearing. It is easier to replace the split ring if upward pressure is applied to the main shaft assembly from below.
12. Again make sure the belt fits around the sprocket teeth, and then push the motor toward the back of the viscometer. This will tighten the belt. Turn the main shaft by hand to make sure the belt and main shaft assembly are turning freely. Tighten down motor.
13. Re-attach the main housing cover and re-calibrate.



Tip

Torsion Spring Replacement:

1. Unplug all electrical wires and the thermocouple wire from the housing. Remove the Allen screws along the base of the outer housing cover, and gently lift off the cover.
2. Using the Allen wrench, loosen the recessed set screw in the side of the Zero Calibration Knob.
3. Using the metric Allen wrench (provided) carefully loosen the Allen set screw in the transducer clamp located on top of the transducer.

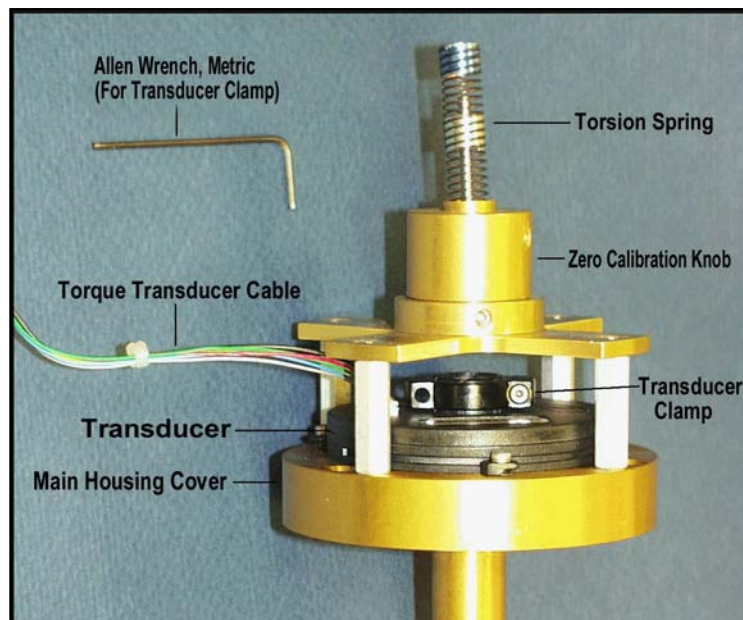
It is very important that no downward pressure is applied to the transducer spring clamp at this time.

4. The torsion spring can now be removed from the top.



Important

5. The replacement spring must be carefully placed inside the transducer clamp so that it seats all the way down. The bottom lock collet should be enclosed and the upper collet should be inside the spring clamp of the zero calibration knob.
6. Carefully tighten the spring clamp set screw on the transducer with the metric Allen wrench.
7. Tighten the 1/16" recessed Allen set screw on the side of the Zero Calibration Knob.
8. Loosen the two 5/64" Allen set screws that hold the Zero Calibration Knob in place.
9. Turn on the Viscometer, and press the calibration button on the lid of the housing. Adjust (turn) the Zero Calibration Knob until the "P" number falls with the given range (between 15,000 and 25,000).
10. Tighten the two 5/64" Allen screws on the side of the Zero Calibration Knob.
11. Replace the outer housing cover.
12. Re-calibrate.



Appendix

Thermocouple Calibration

In order to calibrate the thermocouple properly, the temperature units on the viscometer must be set to Celsius. If the unit is set to Fahrenheit, change it to Celsius before calibrating:

1. Press **SET UP**
2. Press **NEXT** 6 times. The displays should now read "Temperature Units:"
3. Enter **1**
4. Press **ENTER**, then **CLEAR/STOP** to return to the main screen.

To calibrate the thermocouple, compare the temperature reading of the thermocouple to that of an NIST traceable thermometer. Then set the temperature offset on the Model 900.

1. Press **SET UP**.
2. Press **600** 3 times.
3. Press **NEXT** 11 times. The display should now read "TC Offset".
4. Enter **0**
5. Press **ENTER**, then **CLEAR/STOP** to return to the main screen.
6. Record the temperature readings of both the NIST traceable thermometer and the Model 900 Viscometer.

Example: NIST traceable thermometer reading: 21.0°C
 Model 900 Viscometer: 23.2°C
 Temperature Differential: -2.2°C

7. Repeat steps 1 through 3 above to return to the thermocouple offset screen.
8. Enter **2.2**. The extra "." specifies a negative value.
9. Press **ENTER**, then **CLEAR/STOP** to return to the main screen.
10. The unit should display the same temperature ($\pm 0.2^\circ\text{C}$) as the NIST traceable thermometer.

Appendix

Grounding

Proper grounding protects the equipment operator from the risk of electric shock. The electrical cord provided with this equipment has an equipment-grounding conductor and a grounding plug. Observe the following guidelines at all times:

- Always connect the plug to a matching outlet that is properly installed and grounded.
- If an extension cord is necessary, make sure it has three prongs and is compatible with the electrical cord provided with the equipment.
- Do not modify the electrical cord provided with the equipment. If it is not compatible with any available outlets, have a compatible outlet installed by a qualified electrician.
- If the equipment-grounding conductor (solid green or green and yellow) is improperly connected, the operator will be at risk of electrical shock. Never connect it to a live terminal.
- Local codes may require a Ground Fault Interrupt Circuit (GFIC).
- Repair or replace a damaged or worn cord immediately.
- When in doubt, consult a qualified electrician.

Appendix

Technical Support

For support, contact the OFITE Technical Services Department:

Phone: 713-880-9885
877-837-8683

Fax: 713-880-9886

Email: TechService@ofite.com

Mailing Address:

11302 Steeplecrest Dr.
Houston, Texas 77065