Model 422 (Single Cell) & Model 422CC (Dual Cell) Auto Consistometer

Instruction Manual

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fann®
Fann Instrument Company

Model 422 & Model 422CC Automatic Consistometer Instruction Manual

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Table of Contents

List of Tables and Figures

1 Introduction

Cements are a critical element in the drilling, completion, work over, and abandonment of wells. For each application, cement slurry is designed with specific properties and is given additives that provide predictable slurry density, volume, viscosity, compressive strength, fluid loss, gas migration, and thickening time. Slurry thickening time, or the time a slurry remains pumpable in a well, is one of the most critical properties in designing cement slurry. A predictable thickening time is desired, while maintaining the other specific properties of the cement slurry. The thickening time can be measured in a laboratory by testing a sample of the cement slurry in a pressurized consistometer. The elapsed time between initial application of pressure and temperature on the slurry sample and occurrence of a predetermined value of consistency (usually 100 Bearden Units, Bc) is the thickening time for the sample at the particular specification test schedule.

The Model 422 (single cell) and 422CC (dual cell) automatic pressurized consistometers are able to test cement slurries at temperatures up to 400°F/204°C and 22,000 psig/151 MPa. The consistometer slurry cup assembly 02-0030 uses a rotating, cylindrical slurry cup and a stationary paddle assembly enclosed in a pressure vessel. Pressure is applied to the vessel using mineral oil and an air driven hydraulic pump. A tubular heater surrounding the slurry cup supplies heat to the pressure chamber. A centerline thermocouple is provided for determining the temperature of the cement slurry.

The slurry cup is rotated through the use of an electric motor and a magnetic drive unit. The rotational speed of the slurry cup is variable between 25 and 250 rpm to allow the user to study slurries at speeds other than the API prescribed speed of 150 rpm.

The consistency of the cement slurry is measured through a potentiometer mechanism commonly referred to as a ‘pot mech’. The potentiometer is coupled with a torsion spring to resist the rotating force of the paddle. The rotational force is proportional to the consistency of the cement slurry and is measured through the potentiometer resistor as the spring deflects under load. The consistency is displayed on the plot generated by the data acquisition system. The consistency values are recorded in Bearded Units of consistency (Bc).

The consistometer is equipped with two devices for post-test cooling of the instrument. The first is an external-cooling coil attached to the pressure vessel. After completion of the test, cooling water may be circulated through this coil to cool the pressure vessel. The instrument is also equipped with an oil reservoir cooling coil to independently cool the oil after a test.

Fann pressurized consistometers are equipped with a state-of-the- art control and data acquisition system that provides unparalleled ease of use for the operator. The parameters of interest may be displayed in either English or SI units. Temperature control and data acquisition is programmed through the use of a 22” touch screen

monitor. A plot showing temperature, pressure and consistency may be plotted on any compatible ink jet printer. The data and plots may also be transferred electronically to a network or USB drive for use on a separate computer.

1.1 Document Conventions

The following icons are used as necessary in this instruction manual.

NOTE. Notes emphasize additional information that may be useful to the reader.

CAUTION. Describes a situation or practice that requires operator awareness or action in order to avoid undesirable consequences.

MANDATORY ACTION. Gives directions that, if not observed, could result in loss of data or in damage to equipment.

WARNING! Describes an unsafe condition or practice that if not corrected, could result in personal injury or threat to health.

ELECTRICITY WARNING! Alerts the operator that there is risk of electric shock.

HOT SURFACE! Alerts the operator that there is a hot surface and that there is risk of getting burned if the surface is touched.

EXPLOSION RISK! Alerts the operator that there is risk of explosion.

2 Safety

Safe laboratory practices and procedures should be observed while operating and maintaining the Model 422 & 422CC. Follow the instructions provided to avoid personal injuries or damage to the equipment.

Always wear appropriate personal protective equipment (PPE) when operating or maintaining the Consistometer.

2.1 Safe Pressurization

This Consistometer has pressurized air, water, and hydraulic lines that present a hazard if not depressurized before maintenance or disassembly.

The hydraulic diaphragm pump and the pressure relief valve require compressed air. Before working on any of these devices or connected air lines, shut off the compressed air supply to the machine, and carefully relieve air pressure from the machine.

2.2 Safe Heating

Before opening the pressure chamber, use the cooling system to lower the temperature to at least 120°F (49°C). The machine uses domestic water as coolant. Shut off the domestic water supply before servicing.

NEVER operate the heater on an empty chamber. The heater element will quickly overheat and fail. To prevent smoke and possible fire, always fill the chamber and pressurize before heating.

2.3 Safe Electrical Operation

Disconnect the power cable before attempting any electrical or mechanical maintenance. Be aware that after the power switch is turned off, the electrical terminals inside the panel will remain electrically energized.

Refer to the electrical schematic before performing any maintenance or troubleshooting.

Always disconnect the power cable before attempting any repair.

3 Specifications

Table 3-1 Model 422 and Model 422CC Specifications

Category	Specification
Electrical	
Input Voltage	230 VAC (±10%)
Input Power	5500W (single), 10000W (dual)
Current	25A (single), 50A (dual)
Input Frequency	50-60Hz
Mechanical	
Height (single)	66 in. (157 cm)
Height (dual)	61 in (155 cm)
Width (single)	24 in. (61 cm)
Width (dual)	48 in. (122 cm)
Depth (single)	24 in (61 cm)
Depth (dual)	30 in. (76 cm)
Weight (single)	850 lbs. (386 kg)
Weight (dual)	1600 lb. (726 kg)
Environmental	
Operating Temperature	(32º to 105º F) 0-40º C
Operating Humidity	0-95% noncondensing
Heater	
Heater Power	5000W (per pressure vessel)
Heater Type	Internal cast rod member
Heater Control	Solid state relay
Drive Unit	
Drive Motor	1/8 Hp (93W), 180 VDC
Drive Speed	25-250 rpm (variable)
Air/Water Connections	
Water In/out	¼ MNPT (2)
Air Input	¼ MNPT (1) maximum 120psi

4 Installation

The instrument's center of gravity is located near the front of the instrument due to the weight of the pressure vessel. Be very careful when rolling or transporting the instrument that it does not tip over toward the front.

It is ideal to leave room behind the instrument so that qualified personnel may have service access. If this is not possible, try to make the unit easy to disconnect and move for service.

Once the instrument has been moved to its desired location, air, water, and electrical connections can be made. The air inlet, water inlet, and water drain connections are each ¼ inch female NPT connections and are located on the lower right rear of the instrument. A number of ¼ inch male NPT to 8mm tube fittings are included for international locations. The air and water inlet connections may be made with either metal or plastic tubing. It is recommended that the water drain lines be made from metal, since this line may carry very hot water and steam from time to time. Electrical connections are made using the twist lock receptacle on the rear of the instrument. A 30 amp female plug is included with each consistometer.

Please observe the following precautions when making the wiring connections.

- A qualified installer should do the wiring in accordance with local electrical codes.
- The instrument should be securely connected to a separate earth ground. The ground wire must be larger in diameter than the supply conductors. An 8-gauge minimum ground wire is recommended for a dual consistometer and a 10-gauge minimum ground wire is recommended for a single consistometer.

- An 8BC or larger fire extinguisher to fight electrical and oil fires should be placed within 50 feet of the consistometer.

Certain components are supported during shipment with wooden blocks, foam padding, plastic ties, etc. to prevent damage. Open the front doors and remove all the packing materials that would interfere with the operation of the instrument before powering the instrument. Some components such as touch screen LCD monitor and computer control modules are removed from the instrument prior to shipment and may be in a separate container to prevent damage. These devices must be reinstalled and reconnected before operating the instrument. Before operating the instrument, it is a good idea to check the bottom of the consistometer for loose screws or bolts that may have loosened and/or fallen out during shipment. This is particularly true for overseas shipments.

Locate the box containing the monitor, reticulating arm and computer and remove them from their shipping containers. Secure the arm and monitor to the consistometer by sliding the arm mount onto the rear side of the cabinet mounting panel as shown in Figure 4-1.

Connect the power cord from the monitor to the A/C outlet on the back of the instrument. Failure to do so can cause the instrument to malfunction. Alternately, the touchscreen may be powered using a DC power adapter.

Plugging the touchscreen and printer into a different outlet creates an undesirable ground loop to occur. This creates an unstable electrical system.

The control box should be connected to the instrument by connecting the 5-pin power cord to the back of the instrument frame as well as the supplied USB cable. The instrument will not operate without this USB cable connected from the computer to the machine.

It is strongly recommended that a 230V uninterruptable power supply (UPS) be installed on the instrument. This will condition the power signal and prevent loss of power to the computer. There are two power connectors on the back of the electrical box. A UPS may be connected between these power connectors to maintain consistometer computer operation during short power outages or interruptions. If a UPS is not used, a jumper cord must be connected between these two connectors or the unit will not power on. An appropriate jumper cord is included with the consistometer accessories.

A printer is included with the instrument and may be connected to the computer control box. Connect the USB connector on the printer cable to any USB input on

the control box. The printer must also be connected to the A/C power outlet on the back of the instrument. Failure to connect the power adapter to the A/C power outlet on the back of the instrument can cause the instrument to malfunction. A USB flash drive may also be connected to the control box in lieu of a printer. Test data may be uploaded to the USB drive and then transferred to a computer for archival storage. It is considered a best practice to keep a keyboard connected to the computer as it will be necessary to input programming features, save data files, etc.

Before attempting to operate the instrument, it is recommended that operators read the remainder of the manual to become familiar with the consistometer operation.

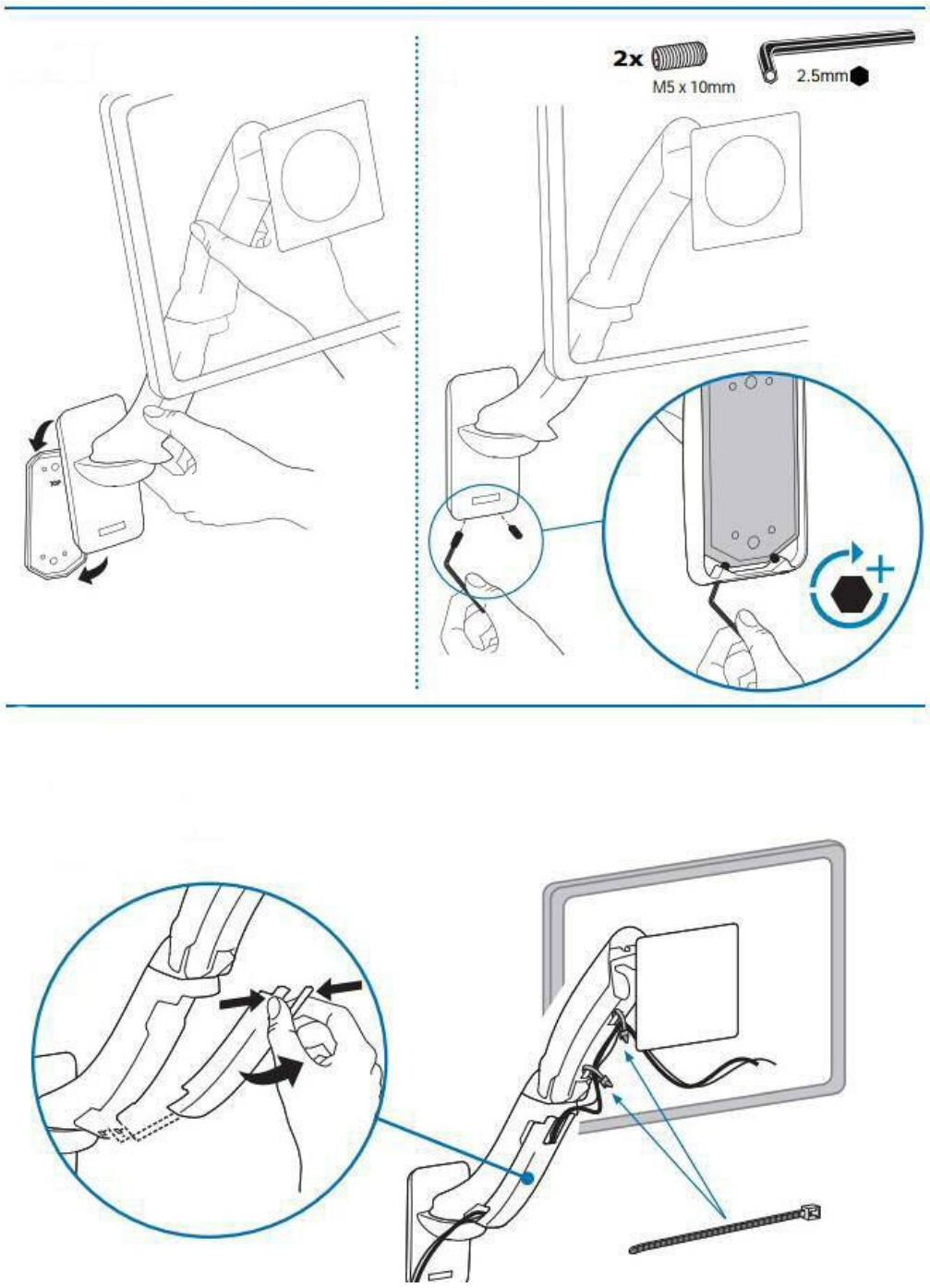


Figure 4-1 Installing the monitor mount

5 Using the Touchscreen Software

Touch screens were created to provide users with an easy to use interface. This allows the user to input and view data without a keyboard or mouse. The touch surface is able to detect contact and send position information back to the processor. Using the touch screen has the same result of using a mouse to point and click. One mouse click is accomplished by one touch of the screen. A double- click is achieved with two quick touches. With this standard method of input, no special software is required to utilize the screen.

A finger or stylus is most often used on the touch-screen. Experimentation will quickly show which objects will activate the screen and which will not.

It is important to note the touch surface does NOT use pressure to detect input. A light touch is all that is needed.

Sharp instruments (such as pencils, pens, screwdrivers, etc.) should not be used as they may damage the touch surface.

The purpose of the touch screen is to provide the user with a single interface to the instrument. All instrument operations are accessed and controlled through the touch screen. This consistometer is a leap forward in designed because it is the first time that mechanical control has been eliminated from the point of view of the operating technician. Filling and draining the pressure vessel with oil, heating and cooling, pressurizing and depressurizing, and rotational speed are all fully automated. Our unique testing and test data screens offer detailed control over test parameters and the way the plot looks including color designations and job properties. Alternately, test data can be exported raw and utilized however one wishes. Each instrument is complete and requires no additional software or hardware to function.

5.1 One Key Recovery for the Computer

If the computer has a severe virus attack, operating system crash, hard disk failure or corrupted programs and software then the user may take simple steps to restore the system to its original factory condition.

- Pressing F3 during the 10 second boot sequence brings up access to the recovery menu.
- Select option 1 for a factory restore. Original application programs and configurations will be restored.
- Alternately, a newer backup point can be created. For example if CementLab software has been updated to a newer version, performed new calibrations, and have installed any new programs then a new backup point would restore these. Selecting option 2 creates a new backup.

5.2 Software Upgrades

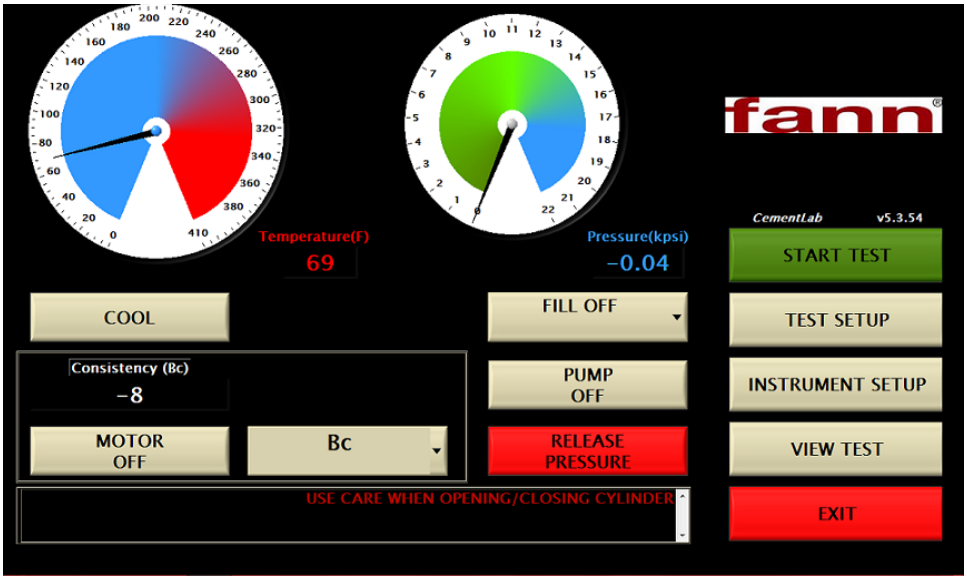
From time to time, Fann makes software upgrades available that provide increased functionality or problem fixes. Generally, the only file that needs to be upgraded is CementLab.exe. It is located in the c:\Program Files\Fann folder. If it is necessary to install an updated CementLab.exe file, it may be copied from the USB memory stick. It may also be copied over a network if the instrument is connected to one. To copy the file from a memory stick, put the new file on the memory stick, rename the old CementLab.exe file to “Old.exe” and copy the new file into the proper folder using Windows Explorer, which is accessible from the start menu or My Computer icon. The memory stick will generally be the D: drive. Should the new CementLab.exe program not work properly, simply delete it and restore Old.exe to the original. However, system upgrades are only recommended with the expressed permission of a Fann engineer.

5.3 Using the USB Port and Printer

The instrument is equipped with a Universal Serial Bus (USB) port on the front panel that allows the use of a USB memory stick for mobile storage. The memory stick is a flash disk that can be connected to the USB port on the instrument control box and used as an external hard drive. Simply insert the memory stick into the USB port and the memory stick will become the D: drive. Software upgrades may be installed using the memory stick and tests may be archived to the memory stick and transferred to a PC for permanent storage. A color inkjet printer is pre-installed at the factory and is shipped with a new instrument. The printer is a useful tool for providing immediate printed results directly from the instrument. A 115/230V power adapter and a USB data cable are provided to connect the printer. The printer

power adapter must be connected to the back of the instrument to prevent instrument malfunction. See section 4 for installation information.

5.4 Software Main Menu



The main menu is starting point for the instrument. From here users may start new tests, set up test parameters, setup instrument parameters, or view an old test. Also located on the main menu is the reading for current temperature, consistency, and pressure. On the right side of the screen, the version software that is currently installed on the instrument is displayed. In the screenshot above, the version is 5.3.53.

- The cooling button is located on the main screen and is operated by selecting it to turn it on. Select again to turn off. The cooling button is connected to a solenoid valve which is connected to the cooling input located on the back of the instrument. Typically, water is used at house pressure and temperature. However, circulating chiller can also be connected. If cooling is turned on when start test is activated, the cooling will remain on and heating will not ensue. Turn cooling off if starting a normal test is desired.

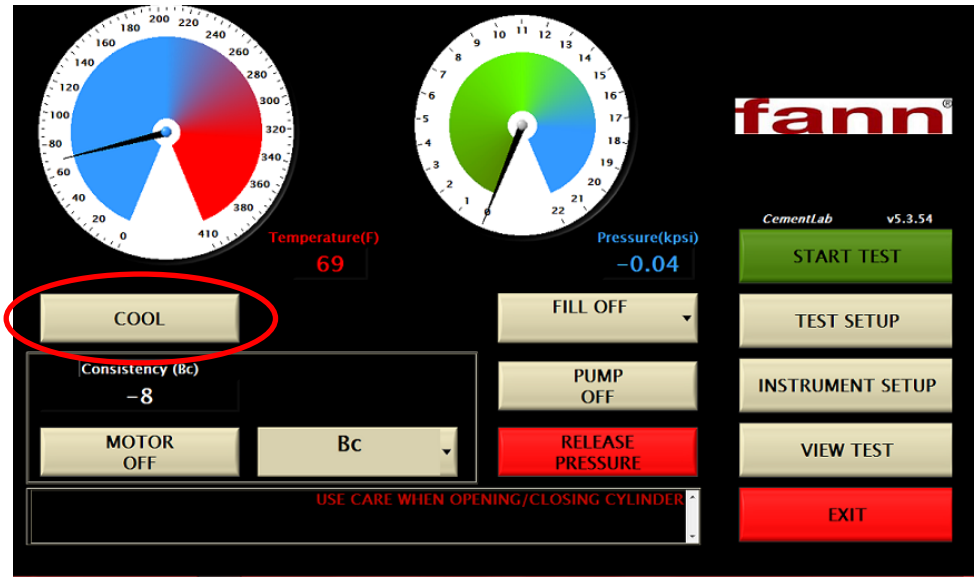
- The motor switch is located on the main screen and is operated by selecting it to turn it on. Select again to turn off. The motor speed is set to turn at 150 rpm.

- The fill button is located on the main screen. This button operates several functions in one. As shown below, the fill button shows fill off, fill on, run test, and drain cylinder. The fill off position neither allows oil or air into the cylinder. The fill on position allows oil to flow from the reservoir into the

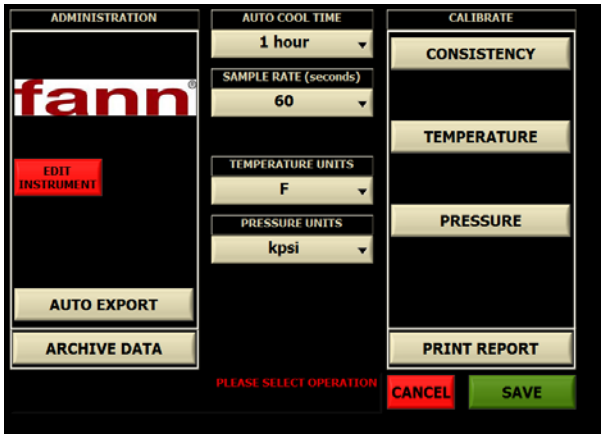
cylinder. The run test position performs the same function as fill on but gives the user the understanding that the cylinder is ready for pump pressure application. The drain cylinder position will open the pressure release valve thereby releasing any high pressure and start the flow of oil back to the reservoir.

- The pump button located on the main screen is operated by pressing and holding it to turn on and releasing to turn off. This button operates the high pressure pump connected to the cylinder.

- The release pressure button is operated by pressing and holding to open and releasing to close. The button is connected to the high pressure release valve.

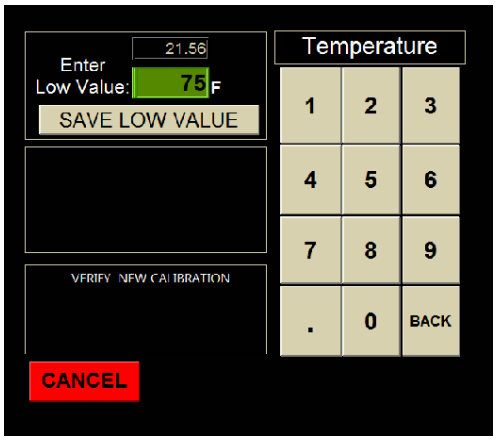


5.5 Instrument Setup



The instrument setup button takes the user to the instrument setup screen shown above. From this screen the user may perform a variety of operations and change options.

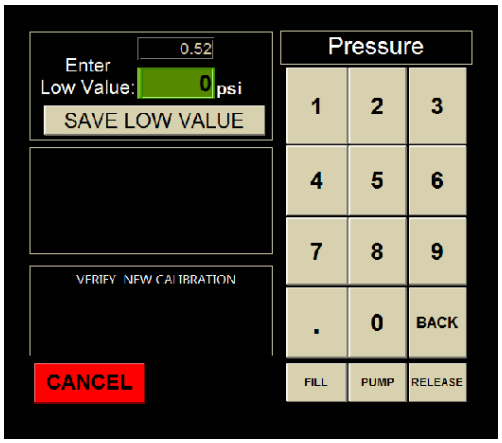
5.5.1 Calibrating Temperature



Temperature calibration must be performed by a qualified individual that has a certified temperature calibration device. When the screen above appears, connect a J type temperature calibrator to the thermocouple connector input on the instrument. Enter a lower-limit temperature value on the calibrator. Touch the Enter Low Value parameter box shown above and then enter the correct temperature value for the low data point using the touchpad at the right. The raw value is the voltage signal read directly from the I/O hardware and it should change as the calibration signal changes.

When the low data point has been entered, press the SAVE LOW VALUE button. The user can now enter the high data point on the calibrator and then again on the touchscreen as before. The raw value should be different for the low and high data points or there will be a computation error. After the high data point has been established, press the SAVE HIGH VALUE button. We recommend using a low value of room temperature and a high value of 400°F or near maximum operating temperature. The user can now vary the calibration signal and see how the calibrated signal compares with that of the calibration device in the VERIFY NEW CALIBRATION box. If the signals compare favorably, press the SAVE button to save the calibration. The calibration values will be stored in a configuration file and take effect upon saving and exiting the Instrument Setup menu.

5.5.2 Calibrating Pressure



Pressure calibration must be performed by a qualified individual that has a certified pressure calibration device. When the screen as shown above appears, connect the pressure calibrator to the top of the pressure vessel using a 9/16-18 high pressure nut. Enter a lower-limit pressure value on the calibrator. Touch the Enter Low Value parameter box shown above and then enter the correct pressure value for the low data point using the touchpad at the right. The raw value is the voltage signal read directly from the I/O hardware and it should change as the calibration signal changes. When the low data point has been entered, press the SAVE LOW VALUE button. The user can now enter the high data point on the calibrator and then again on the touchscreen as before. The raw value should be different for the low and high data points or there will be a computation error. After the high data point has been established, press the SAVE HIGH VALUE button. We recommend using a low value of house air pressure and a high value of 20,000psi or near maximum operating pressure. The user can now vary the calibration signal and see how the calibrated signal compares with that of the calibration device in the VERIFY NEW CALIBRATION box. If the signals compare favorably, press the SAVE button to save the calibration. The calibration values will be stored in a configuration file and take effect upon saving and exiting the Instrument Setup menu.

5.5.3 Calibrating Consistency

Consistency should be calibrated by using the consistency calibrator kit. Kit includes calibrator base, weight set and hanger, wedge with cord, and 3 clip wiring harness. This device applies a known torque to the potentiometer mechanism spring, allowing the readout to be observed on the screen. Calibration of the potentiometer mechanism is described in the example below. It is recommended that consistency be calibrated at minimum once a month.

1. Connect the calibrator base near the front edge of the consistometer using the two holes, nuts and bolts.

2. Install the potentiometer mechanism to be calibrated on the holder. Insert the wedge into the open slot nearest the potentiometer ground spring.

3. Wind the cord around the potentiometer mechanism frame and over the pulley. Place the hanger weight hook in the loop on the end of the cord.

4. Install the alligator clips to the potentiometer mechanism springs matching the wire colors to the contact pin wire colors.

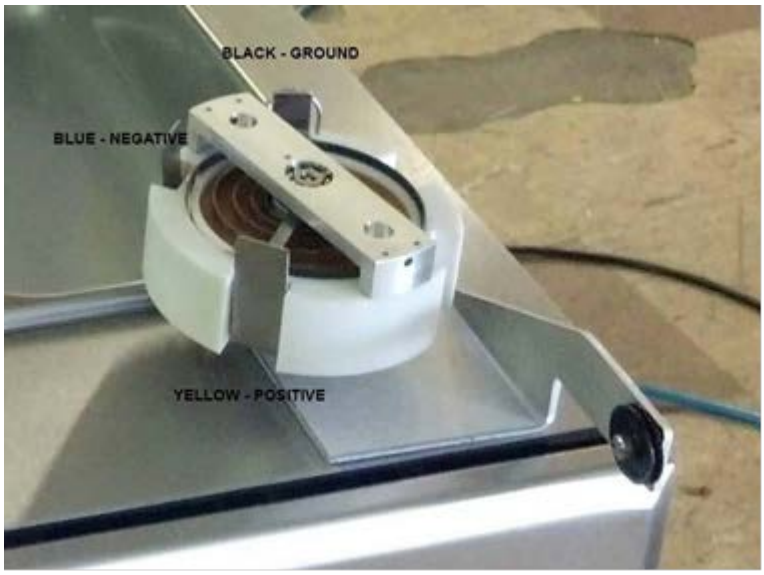
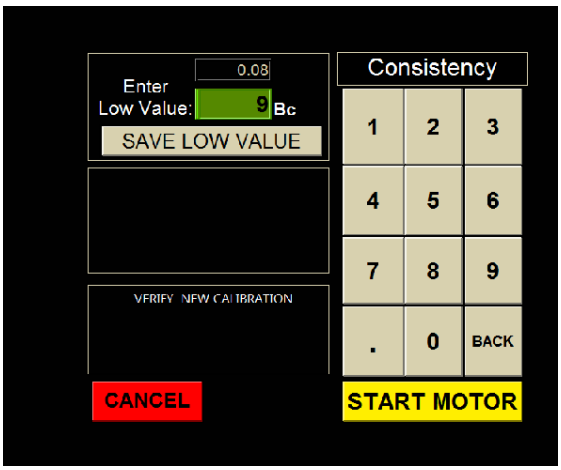


Figure 5-1 Alligator clips attached to potentiometer mechanism springs

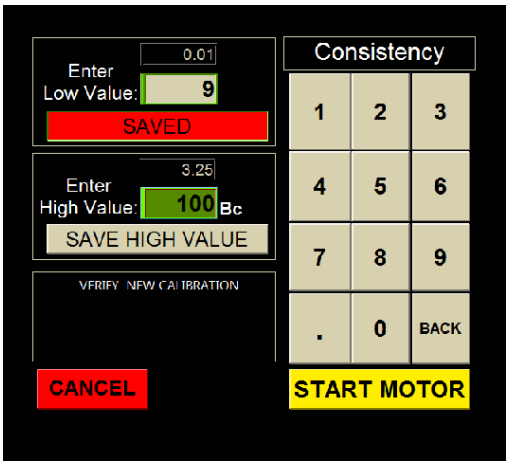
5. Insert the calibrator plug into the CALIBRATOR socket on the deck of the instrument.

6. Within instrument setup, select CALIBRATE - CONSISTENCY.

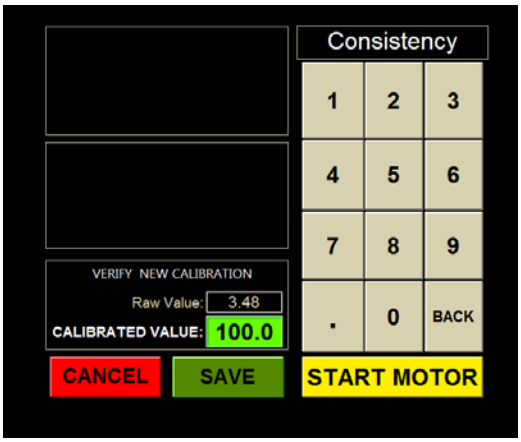
7. The weight of the hanger on the string is 50g. This is an equivalent of 9 Bc. On the touchscreen in the box labeled LOW DATA POINT input 9 on the touchpad. Select SAVE LOW VALUE. See below screenshot. It may be necessary to tap the calibrator base to loosen any wound tension on the spring while in this screen.



8. Place 400g of weights on the weight hanger. This is the equivalent of 100 Bearden Units of Consistency (Bc). On the touchscreen in the box labeled HIGH DATA POINT input 100 on the touchpad. Select SAVE HIGH VALUE. It may be necessary to tap the calibrator base to loosen any wound tension in the spring while in this screen.



9. By removing weight from the hanger it is possible to verify the CALIBRATED VALUE as shown below. If the values are correct, calibration is complete. If the values are incorrect, repeat steps making adjustments to potentiometer mechanism as required. Refer to Table 5-1 for weight to Bc conversions for pot-mech.



By applying additional weights between 0 and 400g and plotting consistency display as a function of applied weight, the linearity of the potentiometer mechanism may be assessed.

Table 5-1 Consistency as a Function of Weight vs. Torque*

WEIGHT (g)	CONSISTENCY (Bc)
0	-4
50	9
100	22
150	35
200	48
250	61
300	74
350	87
400	100

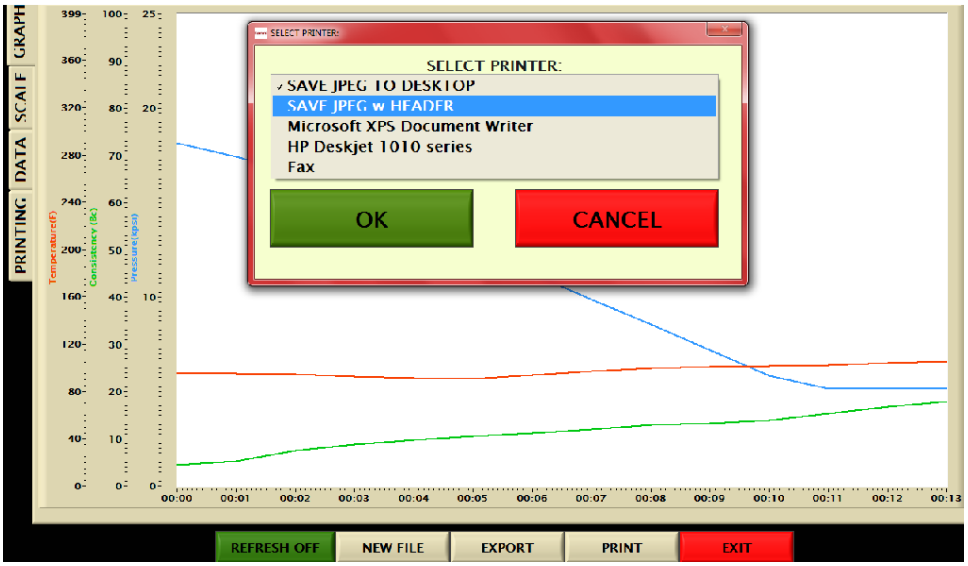
* Based on the equation from API Specification 10A and Recommended Practice RP10B-2

$T = 78.2 + 20.02 \times Bc$

Where: T = Torque, expressed in gram centimeters (g cm)
Bc = slurry consistency, expressed in Bearden units

5.5.4 Print Report

A copy of the calibration time and date for temperature, pressure, and consistency may be exported to an attached printer or saved as a jpg file. An example is shown below:



5.5.5 Auto Cool Time

After a test is completed and auto cooling has been selected, the cooling valve automatically opens and begins to cool the cylinder and oil reservoir. It is possible to select how long a period of cooling is active. Selections include between 1-24 hours and always on. If a test is started while cooling is still activated, the test will not heat even if it is programmed to heat. In other words, cooling must be deactivated if a test is to be started, even if it is still in automatic mode.

5.5.6 Sample Rate

This button allows the user to select a sampling rate for taking data. Rate is given in number of seconds between samples. To save data space and achieve acceptable test resolution, a sample rate of 30 or 60 seconds is recommended. For increased resolution lower the sample rate.

5.5.7 Temperature and Pressure Units

These buttons allow the user to select English or SI.

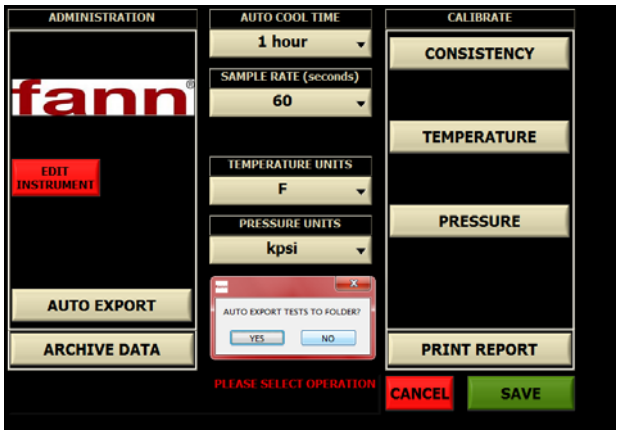
5.5.8 Archive Data

This button allows the user to transfer copies of all the test files stored in the consistometer to another location. The tests may be saved to the USB memory stick or to a local/network folder. Note that the program will ask for the storage location

and the user may browse to any available drive or folder as shown below. Selecting ‘current folder’ accomplishes the destination selection. Once the files are copied from the consistometer to another location, the files remain on the consistometer and will still be accessible from the instrument. To permanently delete these files, the user must go to their stored location and delete them manually. The default location for Fann test files is C:/Fann/Tests. This folder also stores the actual test parameters so any test deleted cannot be run again without reprogramming TEST SETUP.

5.5.9 Auto Export

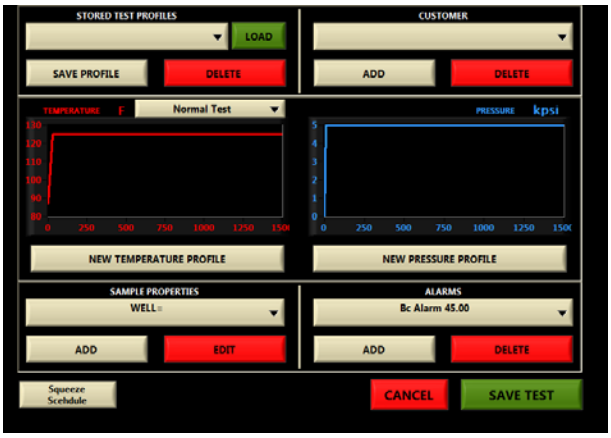
This button allows users to store test files in a completely different folder automatically. If YES is selected, the user is prompted to select a destination folder to store test files. If NO is selected, test files are stored in their default Tests folder location. If yes is selected and tests are being stored in another location, no copies are kept anywhere else. If the user desires to change back to default, they must select NO as shown following.



The “Edit Instrument” button should only be used when instructed to by Fann and is password protected. This application performs changes the config.ini file.

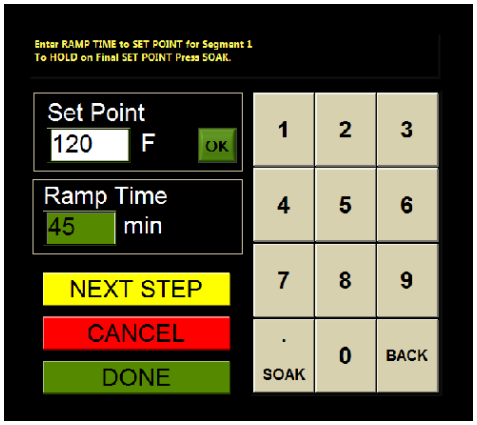
6 Test Setup

From this menu the user can enter or reset a temperature and pressure ramp and soak schedule. The user can also configure the hesitation squeeze schedule, input sample properties, input time or consistency alarms, and input customer data.



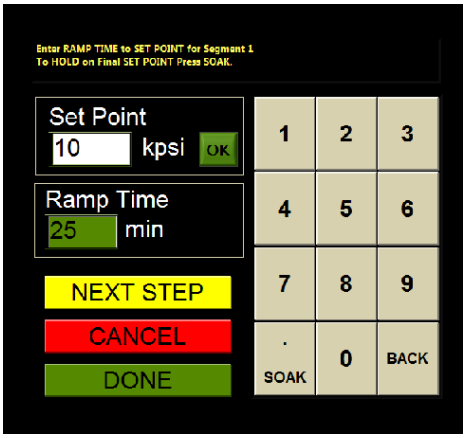
6.1 Temperature Control

Temperature is automatically controlled by programing a temperature ramp into the software. To create a new temperature profile either select that button or just above select the graph with the red temperature line. The program temperature screen is shown below. Enter desired set point values by touching the SET POINT parameter box and entering the values on the keypad. Time to set point is selected by touching the TIME parameter box and entering a time in minutes on the touch pad. The final segment should always be a SOAK segment where the temperature equals the final test temperature and the time equals SOAK. This guarantees the instrument will maintain final temperature for the remainder of a test. After a profile has been entered, press the SAVE button. At this point a graph of the desired temperature ramp is displayed for confirmation. Press: ACCEPT to save ramp or CANCEL to exit without saving as shown following.



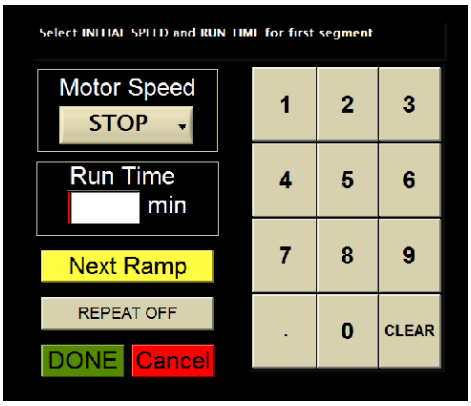
6.2 Pressure Control

Pressure is automatically controlled by programming a pressure ramp into the software. To create a new pressure profile either select that button or just above select the graph with the blue pressure line. The program pressure screen is shown below. Enter desired set point values by touching the SET POINT parameter box and entering the values on the keypad. Time to set point is selected by touching the TIME parameter box and entering a time in minutes on the touch pad. The final segment should always be a SOAK segment where the pressure equals the final test pressure and the time equals SOAK. This guarantees the instrument will maintain final temperature for the remainder of a test. After a profile has been entered, press the SAVE button. At this point a graph of the desired temperature ramp is displayed for confirmation. Press accept or cancel to return to the programming screens. An example of confirmation is shown below:



6.3 Hesitation Squeeze (Squeeze Schedule)

On units equipped with the hesitation squeeze option it may be accessed using the button labeled Hesitation Squeeze. Pressing this button will bring up the screen shown below.



This allows a very random schedule to be programmed using user selected timing intervals.

Select Motor Speed = Bc, select the empty box under Run Time and enter the hesitation start time in minutes using the touch pad a right. The Start Time is the elapsed time from the beginning of the test to the first hesitation squeeze start.

Select Next Ramp to enter first stop. The screen will re-initialize - select STOP for motor speed and enter desired amount of time for STOP segment in Run Time box. Selecting Next Ramp again to enter run time after first STOP segment. If repeating the schedule for the remainder of the test is desired, simply select AUTO REPEAT after 3 segments have been entered (Bc-STOP-Bc). An infinite number of sequences can be input. Select SAVE to save or Cancel to exit without new schedule. A preview of the schedule will be displayed for approval.

6.4 Sample Properties

Test printouts contain information cells which can be edited by the user. Sample properties such as well, district, cement, density, weight, water, etc. can be chosen as suitable information. An example of these sample properties is shown below. Properties can be added and deleted here. The value for these properties will be selected after a test is complete. Select view test and select the test file to be chosen. Then select the PRINTING tab on the left hand side and sample properties can be seen and values edited accordingly.

6.5 Alarms

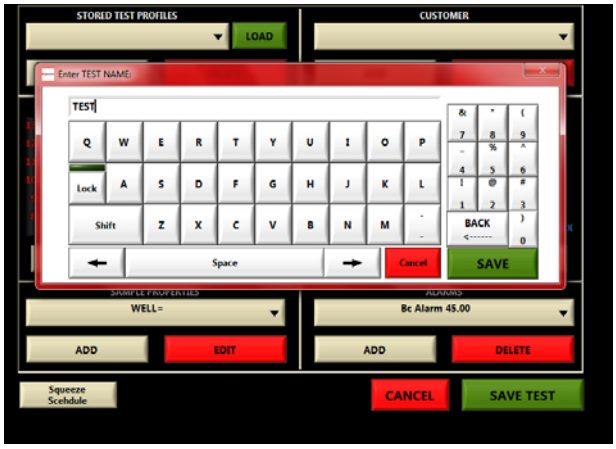
Consistency and time alarms can be added to and deleted from a test setup. These alarms produce audible alerts are displayed in the test printout. An example of programmed alarms is shown following. Factory defaults contain Bc alarms only.

6.6 Customer Data

The customer button allows the user to input a customer name for the test being performed. It is no different than a sample property and can be added and deleted from the test setup.

6.7 Save Test

Once the user has finished selecting temperature and pressure ramp profiles the last step is to push SAVE TEST. A pop-up appears and requires the user to select a test name. This will be the test file name and will be stored in the tests folder located on the C drive. An example is shown below. Choose a descriptive test name and select save. Once this action has been performed, the software is ready and programmed for that specific test. The next action would be to start test. Refer to the start test section. If a test setup is not performed prior to starting a test, the previous test file will continue to be written to. It is not automatic for the machine to know to start a new test file without user input.

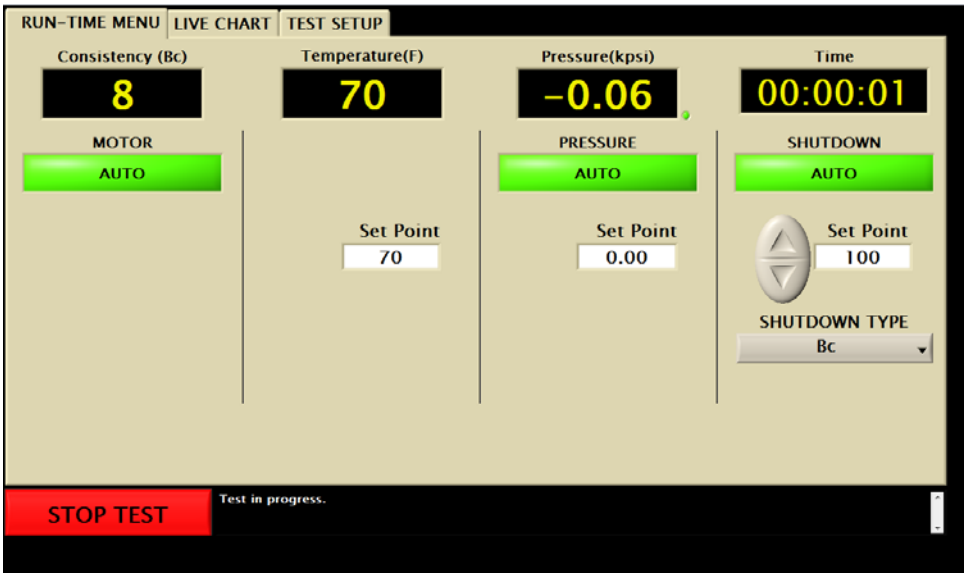


7 Start Test

Once the instrument is properly configured and a test has been entered in the TEST SETUP section. Testing can begin by selecting the START TEST button from the main menu.

7.1 Live Testing Screen

Once a test has begun, a real-time display of current values will be presented. The user may view a live chart at any time by pressing the LIVE CHART tab button located at the top of the screen. Printing can be done at any time by selecting the ADVANCED CHART & PRINTING OPTIONS button (Please note that a printer must be connected to the instrument before trying to print.). This button will also enable the user to view detailed test information and streaming numerical data. The user can also create custom header and footer segments of the printed plot. Pressing the EXIT button returns the user to the RUN TIME MENU shown below.



The instrument is equipped with an automatic consistency shutdown and alarm. Use the up/down arrows to select the consistency value at which the alarm should occur. If the Auto Shutdown feature is ON, the instrument will automatically stop the test when the indicated alarm value is reached. In addition to stopping the test, automatic shutdown will also turn the heater and motor off and the cooling water on. Note that the Auto Shutdown Alarm is in addition to the alarm values entered in TEST SETUP that are printed with each plot. In addition to the automatic consistency shutdown there is a timed shutdown. It is necessary to select the number of hours from the drop- down box that is required for a timed shutdown.

7.2 Stopping a Test

To stop the current test, the user must press the STOP TEST button on the RUN-TIME MENU screen. Once the test has been stopped, no further data will be logged and no further temperature or pressure control will be provided. The software will save the current test in a file on the instrument's local hard disk. The default location is C:/Fann/Tests. If auto-shutdown is enabled, the test will be stopped when the Consistency Alarm value has been reached. This action has the same effect as the user pressing the STOP TEST button; however it also turns the motor and heater off and the cooling water on.

Note that there is a 5-10 second delay from the time a consistency alarm is triggered until automatic shutdown occurs. This is to prevent noise or spikes in the consistency signal from triggering automatic shutdown prematurely.

8 View Test

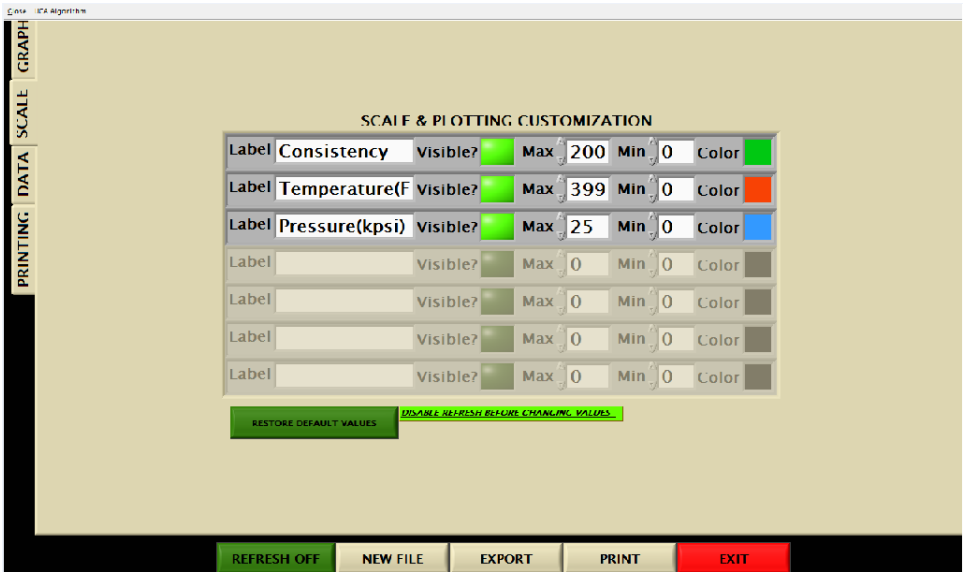
The view test button allows the user to access previously completed test data. The data may be viewed either graphically or in spread sheet format, customized, scaled, printed, and exported. The print button will open a dialog box giving the user the option to select a printer or jpeg file option. The export button gives the user to option to output a txt file to a destination folder.

8.1 Graph Tab

The left y-axis displays Gel (if option is installed on the instrument), Consistency, Temperature, and Pressure. Each Curve is given a specific scale, color and units. The x-axis is given in minutes.

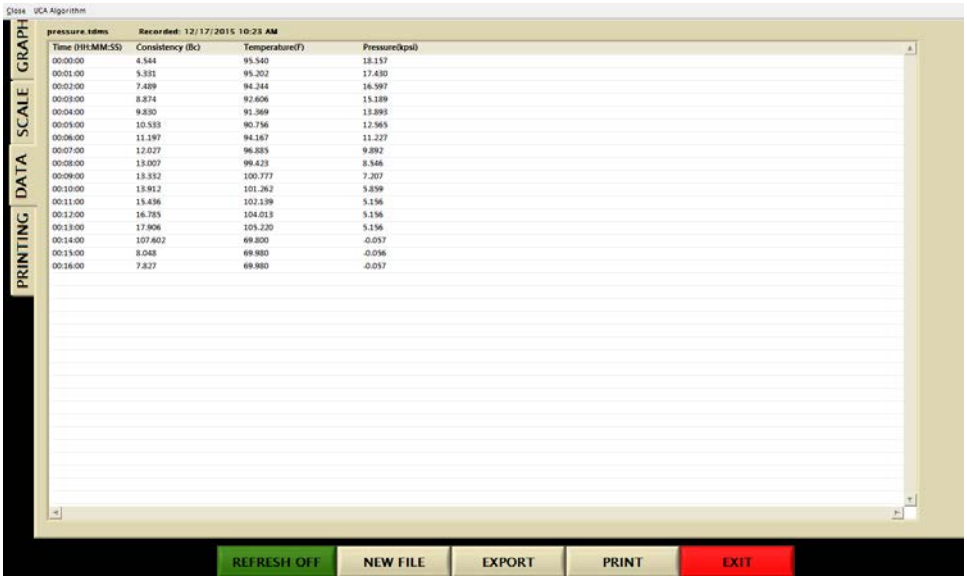
8.2 Scale Tab

The scale and plot customization tab allows the user to turn on or off the display of each curve by pressing the green “Visible?” button. The maximum and minimum scalar may also be edited using the Max and Min boxes. The color of the curve may also be edited using the Color box.



8.3 Data Tab

The data tab displays the test file name and date recorded at the top of the screen. The data tab also displays all data for each sample point including time (HH:MM:SS), consistency (Bc), Gel (lb/100ft^2) (if option is equipped on the instrument), Temperature (units optional), and Pressure (units optional). Depending on the sample time selected the time stamp will be congruent.



8.4 Printing Tab

The printing tab allows the user to change specific test data that is outputted to the test print out. A company logo may be inserted into the print out header by selecting the logo box. Pixel size must be 192x96 before the picture can successfully be inserted. Values for well, district, cement, density, water, etc. may be entered to further populate the test print out and further provide information to customers.

9 Pneumatic, Cooling, and Electronic Controls

9.1 Pneumatic Controls

The pneumatic controls consist of the pressure release, drain cylinder, and pump air regulators. The components in this section are used to release pressure and drain oil from the pressure vessel and to power the air driven hydraulic pump that applies pressure to the sample.

If the pump air pressire drops off significantly when the pump is operating, an air line may be blocked or the compressor may be insufficient to deliver the volume of air required.

The pump air pressure regulator is located on the back side of the motor mount bracket and is used to control the air pressure to the air driven hydraulic pump. Higher hydraulic pressures require higher air pressures. To adjust the pressure of the air supplied to the pump, pull the knob on the regulator out to unlock it. Turn the regulator knob clockwise to increase the pressure and counterclockwise to decrease the pressure. The pump air pressure gauge shows the pressure of the air delivered to the pump. When the adjustment is finished, push the knob in to lock it in place if desired. The air pressure is factory set at a default value of around 120psig.

The pressure release air pressure regulator is located on the underside of the instrument deck and is used to control the air pressure to the pressure release air-operated valve (AOV). Smaller cylinder release pressures require higher air pressure. To adjust the pressure of the air supplied to the air-operated valve, pull the knob on the regulator out to unlock it. Turn the regulator knob clockwise to increase the pressure and counterclockwise to decrease the pressure. The pressure release AOV air pressure gauge shows the pressure of the air delivered to the air-operated valve. When the adjustment is finished, push the knob in to lock it in place if desired. The air pressure is factory set at a default value between 35-40psig.

The drain cylinder air pressure regulator is located on the underside of the instrument deck and is used to control the air pressure to the drain cylinder AOV. The drain cylinder air regulator is set at 40psig and does not usually require any adjustment as long as the AOV is cycling on and off when the drain cylinder button is pushed. However, adjustment is the same as it is for the pressure release air pressure regulator as detailed above.

9.2 Cooling Controls

The cooling controls are most often used to cool the cylinder and oil reservoir upon completion of a test. Water is most often the choice of cooling fluid but a chiller may also be employed to provide further cooling capacity. The cooling controls consist of a cooling button located on the main screen. The pressurized consistometer is equipped with internal cooling coils in the oil reservoir for quick cooling of the hydraulic oil and faster turnaround between tests. The cooling button also allows cooling fluid to flow through the cooling jacket surrounding the pressure vessel. The cooling button may be turned on manually at the completion of a test to cool the pressure vessel. Alternatively, an automatic cooling procedure can be used to cool the cylinder as described in the section 7. The reservoir and pressure vessel cooling are simultaneously operated.

9.3 Electronic Controls

The main power switch is located behind the touchscreen stand towards the rear of the instrument. This push-button switch contains a red colored LED that illuminates when depressed and electrical current is flowing. To power off the instrument, first shut down the Windows operating system properly and then depress the power switch to the off position. The red LED will then power off.

The electrical box is located at the rear of the instrument along the top. There is a panel cover for this box which may be removed to access most of the electrical components. Move the touch screen stand forward to allow removal of the top panel cover. Always use caution when accessing the electrical box. It may be necessary to properly shutdown the instrument and remove power before accessing the electrical components.

The instrument is equipped with a current monitoring relay which monitors the amount of current being supplied to the instrument. There is an initial start-up delay and a trip delay. The monitor is set to cut off power to the instrument if it senses more than 25 amps for more than 30 seconds. This safety device prevents a run-away heating situation that may be caused by a short or other dangerous current situation. If the current monitoring relay has been tripped, it is necessary to unplug the main power cord from the back of the instrument and then plug it back in to reset.

The motor speed control knob and speed control board are located inside the electrical box. The motor speed is default set at 150 rpm at the factory. To increase the motor speed, turn the knob clockwise. To decrease the speed, turn the knob counterclockwise.

There is a manual pressure release button switch located on the instrument. It is labeled MANUAL PRESSURE RELEASE. The button switch is for manual override purposes in case the computer becomes unresponsive to commands and

the need to evacuate chamber pressure becomes necessary. If this switch is depressed, the instrument will immediately release all pressure within the pressure vessel. Another use for the manual pressure release switch is to evacuate any residual pressure left over from a test. When the instrument has finished the “drain cylinder” procedure, there is sometimes residual air pressure from the air inlet pushing the oil back into the reservoir. Usually, this residual pressure is vented when carefully and slowly loosening the thermocouple nut on top of the pressure vessel plug.

10 Operation

10.1 Example of Running a Thickening Time Test

The steps listed below are for experienced users who are familiar with consistometer operation.

A light coating of grease on the threads is important to prevent cement from filling the threads.

Do not pound the lid closed with a sledgehammer. It is recommended that the lid be loosened a few degrees to allow easy removal after a test is finished.

1. Turn the instrument on. Depress the red LED POWER switch to the ON position.
2. Once the Windows operating system has fully loaded double click the CementLab windows icon on the home screen.
3. Once CementLab has loaded press Test Setup and program a temperature and pressure ramp as described in the Test Setup section.
4. Mix the slurry and fill the slurry cup.
5. Prior to placing the slurry cup and potentiometer mechanism (pot mech) into the pressure vessel, place the pot mech onto the assembled slurry cup and fit the drive disc and bar using the supplied hex key and drive bar set screw.
6. Place the slurry cup then the potentiometer mechanism (pot mech) into the pressure vessel using the supplied slurry cup and potentiometer bails. Engage the slurry cup to the cup table. The motor may be turned on now using the motor button. Engage the pot mech onto the drive shaft bar making sure the top pot mech bearing is aligned with the paddle shaft.
7. Verify the instrument is reading consistency. If not, there is a problem with slurry cup and potentiometer alignment. Locate the problem and adjust.

8. Close the lid on the pressure vessel. Insert the thermocouple, but do not tighten thermocouple fitting.

9. Press the FILL button and fill the pressure vessel with oil. With a paper towel and the supplied 5/8” wrench, wait for all the air to escape the thermocouple hole and oil to begin seeping out. Once oil is seen, fully tighten the thermocouple fitting.

10. Turn off cooling if active. Verify the instrument is reading consistency and press Start Test.

10.2 Example of Stopping a Thickening Time Test

The steps listed below are for experienced users who are familiar with consistometer operation.

1. There is a selection available for automatic or manual shutdown. In automatic shutdown, the type of shutdown may be chosen. Automatic shutdown is achieved by either selecting a maximum consistency or elapsed time value in the live testing screen or waiting for that value to be reached. It takes 60 seconds after the value has been reached for the control software to perform shutdown. To manually stop a test, press Stop Test.

2. If manually shut down and the temperature is above ambient, press Cool in the main screen. If automatic shutdown has been activated cooling will activate automatically.

3. Turn the pump off by pressing the Pump On/Off button.

4. Select Drain Cylinder from the drop down box and wait for the pressure to be released from the pressure vessel.

5. Wait for the cylinder to cool enough to touch and then slowly loosen the thermocouple using a shop towel to prevent any residual pressure spray from going everywhere.

6. Take care to observe the temperature of the various components as they will be hot after a test. When the cylinder is cool enough to touch, remove the top plug from the pressure vessel.

7. Using the supplied slurry cup and potentiometer bails remove the potentiometer and slurry cup. Take care to drain any leftover oil from the tops back into the cell.

8. Disassemble the slurry cup and remove the slurry before it sets and becomes too hard.

9. Slurry cups are tapered, with the large end at the top. This makes it easier to press the cement plug out of the slurry cup. Press the cement plug out from bottom to top. Take care to not bend the paddle shaft.

10. Clean all surfaces and threads using a mild detergent. Be very careful not to damage the threads or sealing surfaces of components as this may make reassembly difficult.

11. Flat diaphragms are generally thrown away after every test depending on the maximum temperature reached during a test.

12. Check the potentiometer for proper operation. Lightly re-grease threads.

11 Maintenance and Basic Servicing

Regular maintenance and basic servicing procedures are described in this section. If more extensive maintenance or service of the instrument is required, please contact Fann Instrument Company.

11.1 Pressure Vessel and Hydraulic System Maintenance

The metal o-ring, the pressure vessel o-ring seat, and the bottom of the seal shaft are the keys to reliable pressure sealing. If these components are free from debris and scratches/dents, reliable sealing will be easily achieved.

1. Inspect the pressure vessel's o-ring and the seat below it after each test and wipe it free of cement particles and other debris. Do not use sharp objects, such as screwdrivers, when removing the o-ring as it will likely bend or scratch the o-ring, ruining it. Should the seat below the o-ring or the seal shaft become pitted or scratched from cement particles that have migrated into the seal, lapping of the seat and seal shaft may be required.

2. The cylinder plug threads have been coated with a friction reducing PTFE coating by the factory to help prevent thread seizing and galling. However, it is still recommended to apply a molybdenum disulfide anti-seize compound to the threads periodically.

If the transfer of the oil from the pressure vessel to the reservoir is slow, the filter should be cleaned or replaced.

3. The high-pressure filter is located just to the right of the pressure vessel. This filter protects the air operated valves and capillary tubes from cement particle damage and/or blockage. It also prevents cement particles from being carried into the oil reservoir. This filter must be disassembled and the filter element cleaned or replaced periodically.

4. The mineral oil in the reservoir should be drained and replaced when it becomes dirty. The low-pressure oil filter element should also be replaced periodically. The oil reservoir is equipped with drain valve on the bottom and a filling plug at the top. To thoroughly clean the reservoir, the entire unit may be taken out of the instrument and the bottom removed. Mineral oil may be conveniently added by pouring oil into the pressure cylinder and

transferring it to the oil reservoir. The mineral oil supplied with the instrument has an open cup flash point of approximately 188 °C/370°F.

5. The magnetic drive should be flushed with clean solvent periodically and whenever cement spills into the cylinder or particles contaminate the drive. If cement enters the magnetic drive, it will cause the bearings to wear quickly. If the worn bearings are not replaced, it may cause the inner magnetic drive shaft to wear out prematurely. Worn bearings may also cause excessive slurry cup run-out.

11.2 Potentiometer Mechanism Maintenance

1. Check upper and lower bearings for smooth, friction free operation. If bearing operation is not smooth, clean or replace the bearings. If the bearings do not operate smoothly, it may cause thickening times to increase.

2. Check for broken wires in the potentiometer resistor. The resistance should measure between 80 and 100 Ohms. The surface of the resistor that is in contact with the wiper may be burnished with a smooth, round rod (such as a screwdriver blade) to reduce noise in the consistency signal if necessary.

3. Periodically check that the wiper is making contact with the potentiometer resistor throughout its entire length of travel. The wiper arm should make a nice friction sound with the resistor.

4. Check to make sure the two brass contact strips are located as shown in Figure 11-1. They should be placed towards the ends of the resistor. The ground wire should make contact with ground contact spring and fed through the small hole and into the body making contact with the spring retainer. The potentiometer slider should rest right at the beginning of the resistor winding. Make adjustments to the pointer location using the triangular patterned screws on the underside of the pot mech. The stop arm should rest against the only cap screw on the underside of the potentiometer.

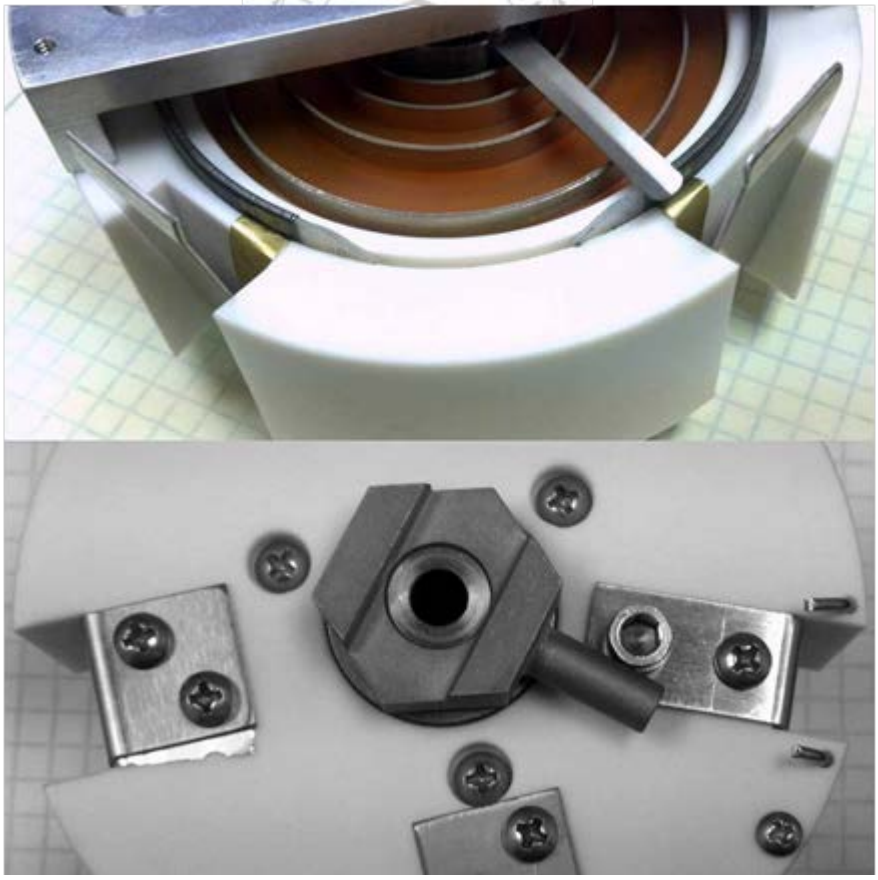


Figure 11-1 Potentiometer Mechanism Maintenance, step 4

11.3 Slurry Cup Maintenance

1. Check the slurry cup after every test to be certain the threads are not contaminated with cement. Lubricate the threads with grease prior to the start of every test.

2. It is recommended that hardened cement slugs be pressed out, rather than pounded out with a hammer. Pressing tends to cause less damage. When pressing the slug out, be careful not to damage the paddle shaft point or the paddle itself. If the slug is not pressed out straight, it may cause the cup sleeve to become oval and prevent the threaded closures from threading into the sleeve.

3. If so equipped, periodically disassembly the diaphragm hub and clean any cement from the Teflon o-rings. Replace the o-rings if they are badly worn.

4. Check the rubber diaphragm for signs of brittleness or cracking. Replace if necessary.

5. Check the point on the bottom of the paddle shaft. Replace it if it is worn to the point that the paddle rubs on the bottom of the slurry cup. Check to see that the paddle shaft is not excessively worn where the shaft extends through the diaphragm hub. Replace if wear is excessive.

6. Check the slurry cup seal plug for wear. Replace it if it is worn to the point that the paddle rubs on the bottom of the slurry cup.

11.4 Replacing the Low Pressure Filter

To minimize the mess, place a bucket or cup under the filter housing to catch any oil that might spill.

1. Make certain the fill button is not active and that the unit is not trying to pump oil. Instrument must be in stand-by with nothing active.

2. Locate the automotive style low-pressure oil filter housing near the front door of the instrument

3. Unscrew the filter.

4. Replace the filter element with a new element.

5. Check for leaks.

11.5 Potentiometer Mechanism Resistor Replacement

1. Remove shaft bearing retainer and potentiometer slider.

2. Remove old resistor from mounting frame, being careful not to damage slot.

3. Position new resistor over the slot in the mounting frame with the straight side down. The connecting strip must be installed under the resistor in the groove in the mounting frame. The length of resistor extending past the connecting strip should be approximately even on both ends.

4. Seat the resistor securely in the slot in the mounting frame. Use care to avoid damage to the resistor. The top surface of resistor must be level with the top of the mounting frame.

5. Use a smooth, round rod (such as the round shank of a screwdriver) to rub top surface of resistor, burnishing resistance wire lightly so potentiometer slider will slide smoothly with minimal noise.

6. Rotate potentiometer slider by hand. Assure that slider makes contact with the resistor during its entire range of motion. If necessary, adjust slider by bending it up or down.

7. Replace shaft bearing retainer and check the potentiometer mechanism with a calibrating device.

11.6 Potentiometer Mechanism Spring Replacement

1. Remove shaft bearing retainer and potentiometer slider.

2. Remove old spring.

The spring should wind tighter when the slider is moved in the counter- clockwise direction.

3. Install new spring.

4. Replace potentiometer slider.

5. Loosen the three spring adjuster clamp screws on underside of the frame, but do not remove the screws.

6. Rotate the spring adjuster until the potentiometer slider lines up with the front contact strip. Tighten adjuster clamp screws.

7. Rotate potentiometer slider by hand. Assure that slider makes contact with the resistor during its entire range of motion. If necessary, adjust slider by bending it up or down.

8. Replace shaft bearing retainer and check the potentiometer mechanism with a calibrating device.

12 Warranty and Returns

12.1 Warranty

Fann Instrument Company warrants only title to the equipment, products and materials supplied and that the same are free from defects in workmanship and materials for one year from date of delivery. THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED OF MERCHANTABILITY, FITNESS OR OTHERWISE BEYOND THOSE STATED IN THE IMMEDIATELY PRECEDING SENTENCE. Fann's sole liability and Customer's exclusive remedy in any cause of action (whether in contract, tort, breach of warranty or otherwise) arising out of the sale, lease or use of any equipment, products or materials is expressly limited to the replacement of such on their return to Fann or, at Fann's option, to the allowance to Customer of credit for the cost of such items. In no event shall Fann be liable for special, incidental, indirect, consequential or punitive damages. Notwithstanding any specification or description in its catalogs, literature or brochures of materials used in the manufacture of its products, Fann reserves the right to substitute other materials without notice. Fann does not warrant in any way equipment, products, and material not manufactured by Fann, and such will be sold only with the warranties, if any, that are given by the manufacturer thereof. Fann will only pass through to Customer the warranty granted to it by the manufacturer of such items.

12.2 Returns

For your protection, items being returned must be carefully packed to prevent damage in shipment and insured against possible damage or loss. Fann will not be responsible for damage resulting from careless or insufficient packing. Before returning items for any reason, authorization must be obtained from Fann Instrument Company. When applying for authorization, please include information regarding the reason the items are to be returned.

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