Dependable Products From People You Trust

Dual-Cell Ultrasonic Cement Analyzer

Part No. 120-52

Instruction Manual

Updated 6/1/2009
Ver. 1.07

OFI Testing Equipment, Inc.
P.O. Box 925918 Houston, Texas 77292-5918 U.S.A.
Tele: 713.880.9885 or 877.837.8683 Fax: 713.880.9886 www.ofite.com

Table of Contents

Intro

By measuring the change in velocity of an acoustic signal, the Ultrasonic Cement Analyzer provides a continuous non-destructive method of determining compressive strength as a function of time.

Description

The cement slurry to be tested is placed in an autoclave unit with temperature and pressure adjusted to simulate downhole conditions. An acoustic signal is then transmitted through the cement sample. As the strength of the cement increases over time, the acoustic signal travels faster through the sample.

A computer running customized Windows® software measures the transit times of the signal over time and interpolates the compressive strength values. This data is available in real time onscreen and is also stored in an Excel® spreadsheet for easy graphical viewing and printing.

The dual-cell UCA consists of two single-cell UCA units in a single enclosure. Both units share electrical power; air, water, and drain plumbing; and PC to UCA connectivity. All other systems (heating, pressurization, etc.) are completely separate.

Features

- Cement samples are not destroyed
- Additional autoclaves are available
- Programmable temperature control (up to 400°F or 204.4°C)
- Regulator and back pressure regulator provide extensive pressure control (up to 16,000 PSI or 110,400 kPa)
- Data is available instantly onscreen and is automatically converted to Excel® spreadsheet format

Specifications

- Size: 15" × 40" × 18" (38 × 122 × 45.8 cm)
- Weight: 170 lbs (78 kg)
- Air Supply - 100 PSI (690 kPa) Recommended; 150 PSI (1,035 kPa) Maximum; ¼" NPT Connector
- Water Supply - standard tap water; ¼" NPT Connector
- 120V/220 V, 50/60 Hz Power

Components

Packing List:

#120-00-001	Sonalert; Qty: 2
#120-25-059	Contactor; Qty: 2
#120-50-TR	Transducer; Set of 2; Qty: 2
#120-50-001	Circuit Board
#120-51-001	Temperature Controller, Eurotherm Model 2408 P4; Qty: 2
#120-104	Rupture Disk; 17,500 PSI (121 MPa); Qty: 2
#120-910-061	Union Elbow; ¼" Tube; Qty: 4
#123-011	O-ring for Test Cell; Qty: 4
#123-023	Low-Temperature Acoustic Couplant; 250°F (121.1°C)
#123-024	High-Temperature Acoustic Couplant; 600°F (315.5°C)
#130-75-71	17" Monitor
#130-75-74	Desktop Computer
#130-76-11	Terminal; Qty: 14
#130-77-025	Leveling Leg; Qty: 4
#130-77-054	⅛" Male Elbow; Qty: 6
#130-78-045	Male Connector; ¼" Tube OD × ¼"; Qty: 7
#130-78-046	Stainless Steel Swagelok Tube Fitting; Male Connector; ¼" Tube OD × ⅜" Male NPT; Qty: 2
#130-79-14	Printer
#130-79-14-1	USB 2.0 Cable; A/B; 10'
#130-79-15	Serial Cable; OB9; M/F
#130-79-26	3-Pin Female Connector; Qty: 4
#130-79-27	3-Pin Male Connector; Qty: 4
#150-80-074	Quick-Connect Stem
#152-38	AC Power Cord; 3-Conductor; International (Continental European); Qty: 3
#171-48-3	Plug Receptacle; Qty: 2
#172-24	Solid State Relay; 240V-25A

Optional:

#120-52-SP	**Spare Parts for #120-52:**
#122-004	Thermocouple Assembly; Qty: 2
#122-010	Heater Assembly; Qty: 2
#122-053	Rupture Disk 22,500 PSI (155 MPa); Qty: 4
#122-073	2-Amp Fuse; 5 mm × 20 mm; Qty: 8
#122-077	10-Amp Fuse; 5 mm × 20 mm; Qty: 8
#123-011	Test Cell O-ring; Qty: 160
#123-023	Low-Temperature Acoustic Couplant; 250°F (121.1°C); Qty: 6
#123-024	High-Temperature Acoustic Couplant; 600°F (315.5°C); Qty: 4

Setup
UCA

1. Begin by making sure all switches are off and all pressure knobs are turned completely counter-clockwise.

2. Connect the **AIR**, **WATER**, and **DRAIN** connectors on the back of the unit to their appropriate source and plug in the power cord.

3. Turn the “Main” switch on.

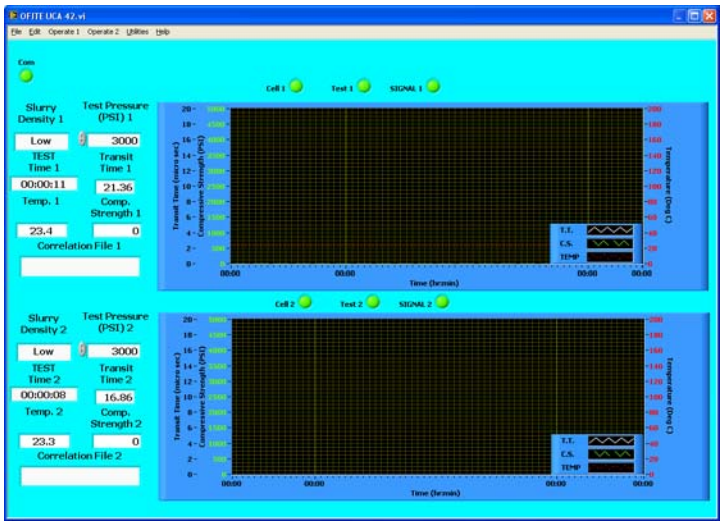
Setup
Software

Before you begin your test, you must prepare the PC to record the data.

1. Connect the PC to the unit with the serial cable (supplied) and turn the PC on.

2. Open the “OFITE UCA” software by double-clicking the icon on the desktop.

3. In the upper left-hand corner of the screen you will see a colored light labeled **“Com”**. If the light is green, the PC and the UCA unit are communicating. If the light is red, there is a communication problem. Make sure the serial cable is properly connected and that the correct COM port is selected in the “Options” screen (see page 6 for details).



Above each graph is a light labeled **“Cell 1”** or **“Cell 2”**. If this light is green, it indicates that everything is operating normally. If the light is red, there has been a fatal error in the test and the UCA unit will have to be restarted before the test can continue.

The light labeled **“Test 1”** or **“Test 2”** is green when a test is running. It is yellow when a test is stopped.

The light labeled **“Signal 1”** or **“Signal 2”** turns green when you select “Start Test” or “Start Transmission” from the “Operate” menu.

The **"Correlation File"** field shows the file name of the custom correlation file being used (if any). See page 20 for information on custom correlation files.

4. From the "Edit" menu, click "Options":

"COM Port" - Select the COM port the PC is connected to. The default is set to 1 and should not be changed unless the PC hardware changes.

"Slurry Density" - Select the density of the slurry you are testing. If your slurry does not fit one of the preset profiles, create a custom blend (see page 20).

"Data File Directory" - This field sets the default location for saved test data.

"Temp Units" - Select either "Deg C" or "Deg F".

"Comp. Strength Units" - Choose either "PSI" or "MPa".

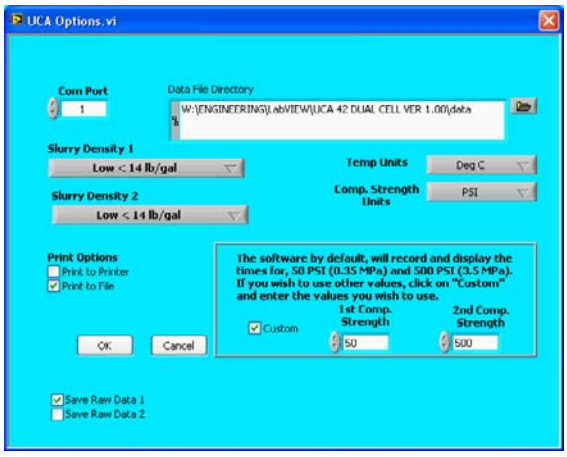
"Print to Printer" - When this option is selected, the print function will print to the default printer.

"Print to File" - When this option is selected, the print function will create a file on the PC.

The "Print to Printer" and "Print to File" options can be used simultaneously.

"Save Raw Data" - When this option is selected, the software stores all of the raw data received from the UCA unit. This option should only be used for troubleshooting. If everything is working properly, leave this option unchecked.

"Custom" - By default, the UCA software records and displays the elapsed time when the compressive strength reaches 50 and 500 PSI. To record the time at different compressive strengths, check the **"Custom"** box and enter the new values.



Note

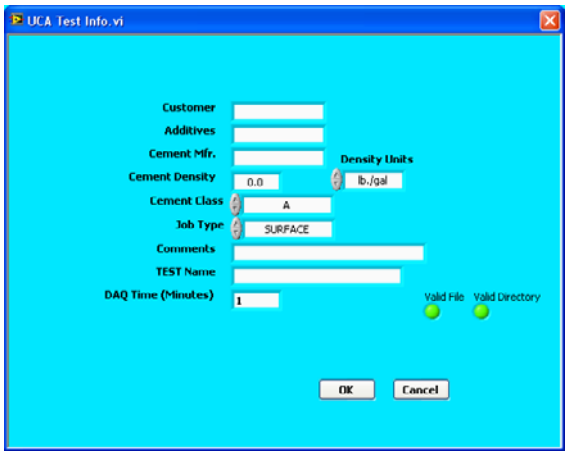
5. Enter the pressure setting of your project in the “Test Pressure” field on the main screen.

   This field does not affect the test. The text in this field will only be used in the data report created later and is display only.

Note

6. Now click “Load Test” from the “Operate” menu. Here you can enter the details of the test you about to perform ahead of time.

   Loading the test simply prepares the software to begin recording the data from the UCA unit. The information you enter here will display in the header of the data file. It will not affect the test.



7. If you wish to view the results from a previous test, select “Reprint Chart” from the “Utilities” menu. Find the file you would like to view and then click OK. This will display the chart and give you the option to print the chart to the default printer.

8. During a test, if you need to remove the cell from the UCA unit, you can do so without stopping your test. Choose “Stop Transmission” from the “Operate” menu. This will stop the transducers from transmitting the signal through the test cell. The test will continue running while transmission is stopped. When you are finished with the cell, return it to the UCA unit and click “Start Transmission” from the “Operate” menu.

Important

Be sure to stop transmission any time you handle the test cell after a test has started. Failure to do so can result in electric shock if the transducers activate while you are touching the cell.

Operation

Temperature Controller

The controller allows you to program a temperature profile for your test. This profile will be divided into at least two segments. Each segment controls a portion of the test and determines the temperature, time, and behavior of the test cell during a specified time period.

The four buttons along the bottom of the display provide access to the temperature profiles. Begin by pressing the “PAGE” button three times. The display will read "Prog List". Now, press the “SCROLL” key repeatedly until the setting you wish to change is shown on the display. Then press either arrow key until the appropriate value is displayed. Once you've chosen a value, press the “SCROLL” key again to select a new setting.
The first group of settings should read as follows:

Setting	Value
Prg1	1
Hb	OFF
Hb.u	0.0
Rmp.u	min
Dwl.u	min
Cyc.n	1

Important

These settings will be the same for every test. Do not change them.

1. Begin by defining the first segment of the test.
    a. Press the “SCROLL” key repeatedly until “Seg” appears on the display.
    b. Press either arrow key repeatedly until “1” appears on the display. You are now editing segment 1.

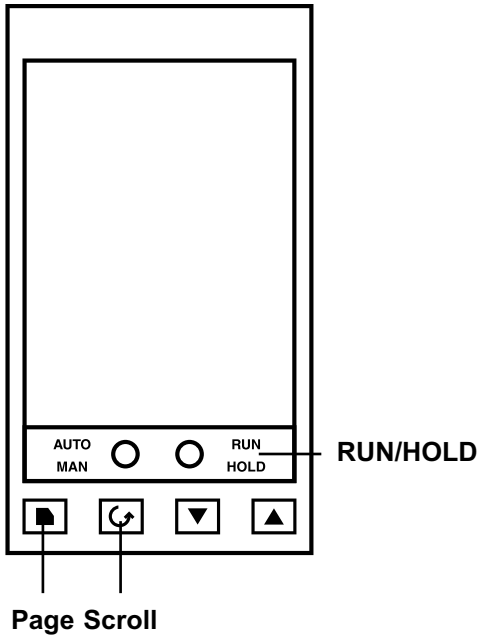
2. The first setting is “Type”.
    a. Press the “SCROLL” key until the word “Type” appears on the display.
    b. The available options are “rmp.r”, “rmp.t”, or “dwell”. Press either arrow key until the appropriate value appears on the display.

    Rmp.r programs the controller to steadily increase the temperature by a specified rate (degrees per minute). If you choose this value, your next option will be “Tgt”, which is your target temperature and then “Rate” which is the rate you want the temperature to increase.

    Rmp.t increases the temperature over a specified time interval (minutes). If you choose this value, your next option will be “Tgt” (target temperature) and then “Dur” (duration in minutes).

    Dwell holds the temperature at its current setting for the duration specified.

Temperature Controller



3. Now define the second segment.
    a. Press the “SCROLL” key until “Seg” appears on the display.
    b. Press either arrow key until “2” appears on the display. You are now editing segment 2.

4. Continue this process with each segment in the test.

5. When you reach the last segment, set the “Type” to “end”. The next setting will be “End.t”.

    If you choose “**sop**”, the heat will be turned off and the test ended.

    If you choose “**dwell**”, the heat will be held at the current temperature indefinitely.

Example 1:

Heat the sample at 2.5° per minute and stop at 150°. Hold at 150° for 180 minutes and then stop the heat.

Setting	Value	Description
Prg	1	
Hb	OFF	
Hb.u	0.0	
Rmp.u	min	
Dwl.u	min	
Cyc.n	1	

Seg	1	Segment 1
Type	rmp.r	Increase temperature at a specified rate
Tgt	150	Heat to 150°
Rate	2.5	Increase temperature at 2.5° per minute
Seg	2	Segment 2
Type	dwell	Hold on the current temperature
Dur	180	Hold for 180 minutes
Seg	3	Segment 3
Type	end	This is the last segment
End.t	sop	Stop the heat

Example 2:

Heat the sample to 200° over a period of 90 minutes. Then increase the temperature to 300° at a rate of 3° per minute. Hold that temperature until the unit is turned off.

Setting	**Value**	**Description**
Prg	1	
Hb	OFF	
Hb.u	0.0	
Rmp.u	min	
Dwl.u	min	
Cyc.n	1	
Seg	1	Segment 1
Type	rmp.t	Increase temperature for a specified time
Tgt	200	Heat to 200°
Dur	90	Increase temperature for 90 minutes
Seg	2	Segment 2
Type	rmp.r	Increase temperature at a specified rate
Tgt	300	Heat to 300°
Rate	3	Increase temperature at 3° per minute
Seg	3	Segment 3
Type	end	This is the last segment
End.t	dwell	Hold at the current temperature indefinitely

Operation

Alarms

The Ultrasonic Cement Analyzer is designed to protect itself from a heating malfunction. If the temperature of the unit reaches a critical level, the internal alarm automatically turns off the heat and the pump. Two switches on the front control panel determine how the operator is notified of an alarm.

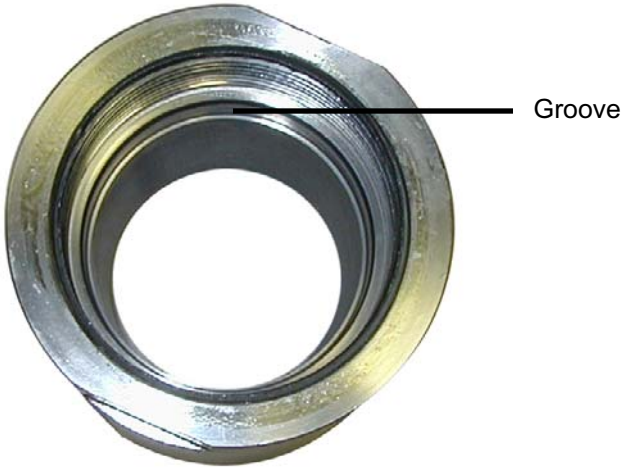
If the **"Sonalert"** switch is turned on, an audible alarm will sound. If the red **"Alarm"** switch is turned on, a light behind the switch will blink. These two alarms can be activated independent of each other.

If both alarm switches are off, an alarm condition can still be triggered. However, there will be no warning to indicate the alarm. It is highly recommended that at least one alarm notification is turned on at all times.

Operation

Preparing the Test Cell

1. With both cell caps removed, examine the inside of the test cell from both ends. Below each set of threads is a small groove. The end with the smaller groove is the bottom of the test cell.



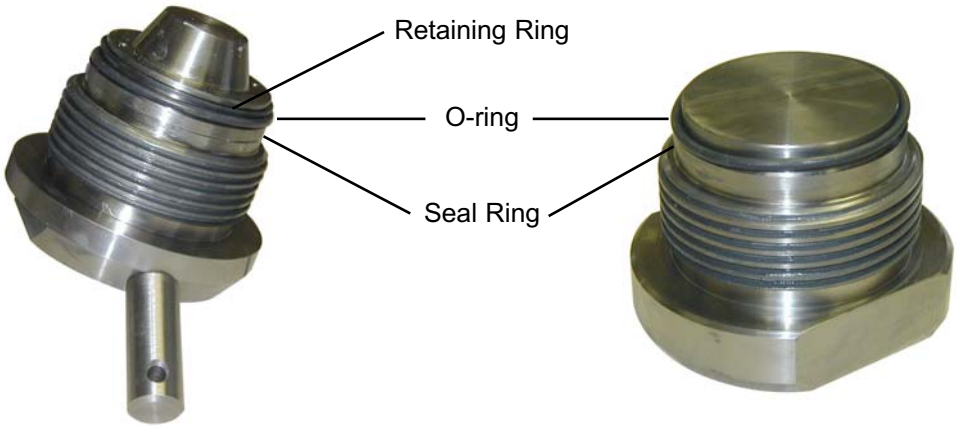
2. Apply high temperature grease to the metal seal ring and place it onto the bottom cell cap with the larger portion pointing down.

3. Apply high-temperature grease to a cell cap o-ring and place it around the cell cap on top of the seal ring. Wipe off any excess grease from the inside surface of the cell cap.


Metal Seal Ring
(Cross Section)

4. Apply a very thin layer of grease to the inside surface of the cell cap and the test cell.

5. Carefully screw the bottom cell cap onto the test cell. The cell cap should turn smoothly in the test cell threads. If you encounter resistance, stop turning and unscrew the cap slightly. Then continue turning until the cap is completely tightened.



Top Cell Cap

Bottom Cell Cap

6. Once the cap is completely tightened, unscrew it one quarter turn. This will facilitate disassembly later.

7. Turn the test cell over and begin filling it with the cement slurry. Place the fill gauge against the inside of the test cell. Fill the cell until the cement barely touches the bottom of the measuring tool.

Important

It is important that you begin the test no more than five minutes after adding the cement slurry to the test cell.

Fill Gauge (#120-50-018)

8. Prepare the top cell cap just as you did the bottom cell cap. Remember to apply high temperature grease to the seal ring, o-ring, and inside surface.

9. Place the metal retaining ring on the cell cap in the dedicated groove just above the o-ring.

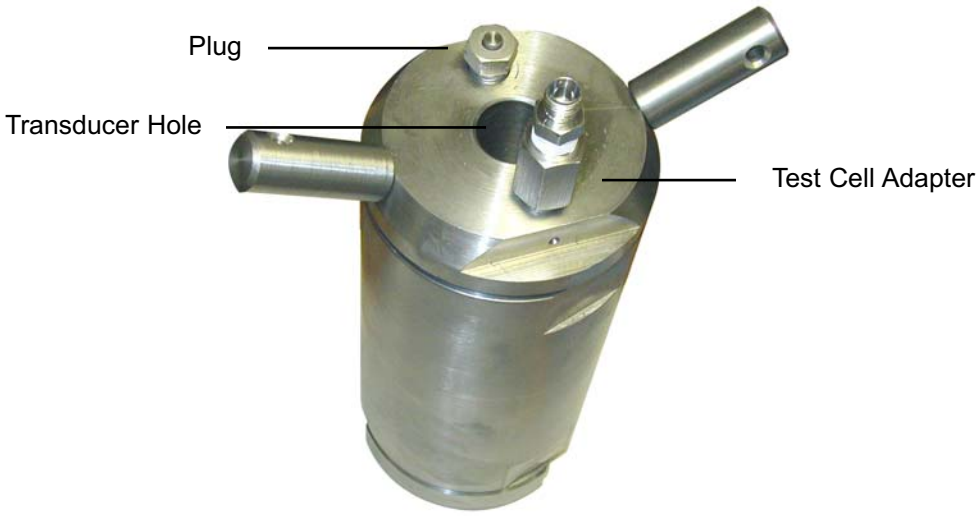
10. Carefully screw the top cell cap into the test cell, just as you did with the bottom cell cap.

11. Make sure the transducers and the transducer holes in the cell caps are clean and free of debris. If they are not, they can be cleaned with a rag or paper towel. You can also use alcohol if further cleaning is necessary.

12. Apply a thin coat of an ultrasonic couplant to the two transducers and place them into the holes.

Note

Two types of ultrasonic couplant are provided to you. The low-temperature gel should be used for temperatures up to 260°F (126.7°C). The high-temperature gel is suitable for higher temperatures. Carefully read the label before using either of these gels.



Operation

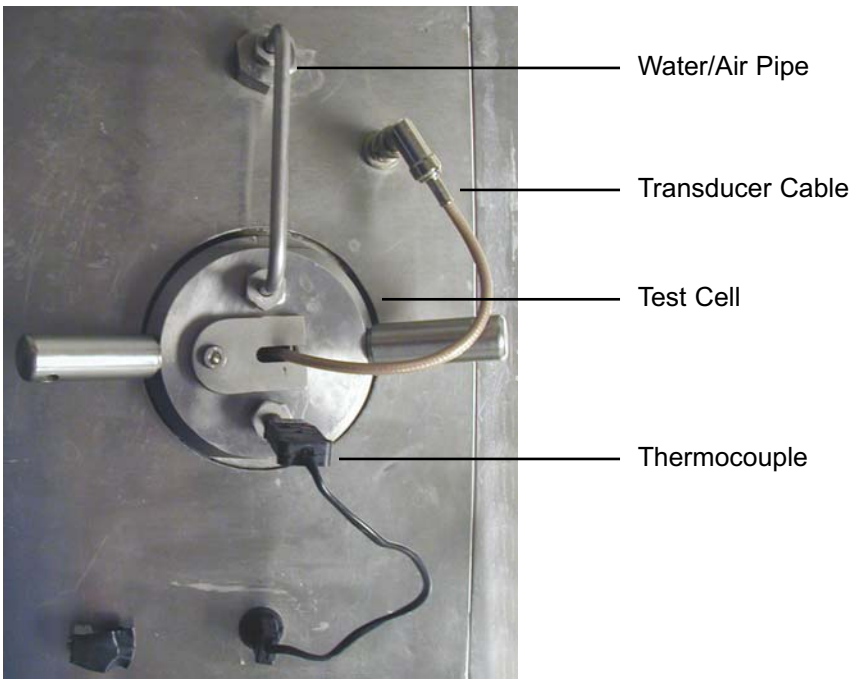
Performing the Test

1. Carefully place the cell into the heating jacket. Make sure the bottom transducer is inside the hole in the cell cap before lowering the cell.

2. Connect the water/air pipe to the test cell.

3. Attach the thermocouple to the test cell and hand tighten.

4. Connect the transducer cable to the unit using the supplied attachment.



5. Make sure the pressure valves are closed by turning them completely counter-clockwise.

6. Turn the “Water Supply” valve on. This valve controls the water supply to both cells.

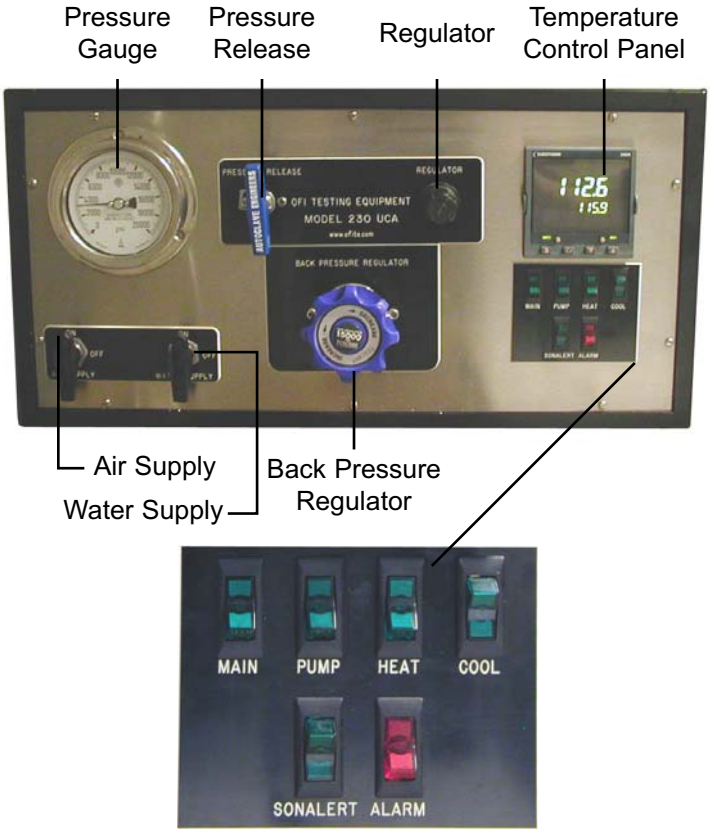
7. Have a 5/8" wrench handy and turn the “Fill Cell” valve on. When water starts coming out of the top cell cap, tighten the thermocouple. This will allow any air inside the test cell to escape before the test begins.

8. Open the air valve and turn on the pump.

9. Turn the regulator clockwise to increase the pressure within the test cell. If the pressure does not build, turn the back pressure regulator clockwise. Allow the pressure to build slightly higher than necessary for your test. Then, turn the back pressure regulator counter-clockwise slowly to lower the pressure.

The regulator allows pressure to enter the test cell. If the pressure falls too low, the regulator engages to bring it back up. Turning the regulator clockwise increases the amount of pressure allowed into the test cell. The back pressure regulator allows pressure to leave the test cell. If the pressure builds up too much (due to thermal expansion), the back pressure regulator bleeds off the excess. Turning the back pressure regulator counter-clockwise increases the amount of pressure allowed to leave the test cell.

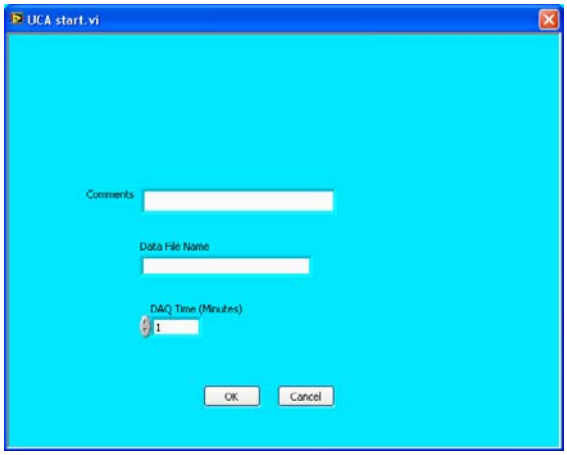
Correctly setting the regulator and back pressure regulator is a trial and error process. Always start with the back pressure regulator closed (clockwise) and use the regulator to increase the pressure higher than you need. Then, slowly open the back pressure regulator (counter-clockwise) until the pressure drops to the desired level.



10. Turn on the heat.

11. Push and hold the “RUN/HOLD” button on the temperature controller until you see the word “RUN” on the display.

12. Once all the fields are complete and the test cell is in the unit and ready, click “Start Test” on the “Operate” menu in the UCA software. Enter a value in the “DAQ Time” field (at least one minute) to set the interval in which data is saved to the file. Fill in the rest of the fields and click OK.



After 30 seconds, the “Elapsed Time”, “Temperature”, “Transit Time”, and “Compressive Strength” fields will begin to display readings.

“Elapsed Time” - Time since the test began (HR:MIN)

“Temperature” - Temperature within the test cell. (°F or °C, depending on the settings in the Options screen)

“Transit Time” - Time required for the sound wave to travel through the sample (Milliseconds)

Important

Solid particles and air bubbles within the cement slurry can adversely affect the results of your test. The first Transit Time reading should be at least 10ms. If it is less than 10ms, wait a few minutes to see if the problem corrects itself. When you see a Transit Time greater than 10ms, restart the test by clicking the “Stop Test” button and then clicking the “Start Test” button again. If the problem does not self-correct, you will need to remix your slurry and start the test again. To avoid this problem, carefully follow the mixing procedure in API Specification 10.

“Compressive Strength” - Calculated compressive strength of the sample (PSI or MPa)

Operation

Removing the Test Cell

1. When the test is complete, click “End Test” on the “Operate” menu. The data file will be automatically saved in the folder specified on the “Options” screen.

2. Push the “Run/Hold” button on the controller and hold it until both lights are off.

3. Turn the heat off.

4. Turn the “Cool” switch on and allow the test cell to cool completely.

5. When the cell has cooled, turn the “Pump” and the “Cool” switches off.

6. Turn off both the water and air valves.

7. Open the pressure release by turning the valve counter-clockwise.

8. Remove the thermocouple, pipe, and transducer from the test cell.

9. Remove the test cell from the heating jacket.

10. Remove both cell caps and pour off any excess water.

Tip

The cell caps may be too tight to remove by hand. To remove the top cell cap, place the test cell in a vise. Use the grooves on the test cell cylinder to anchor the vise. To remove the bottom cell cap, place the cell back in the vise. This time use the grooves on the cell cap. Then use a strap wrench to turn the cell and remove it from the cell cap.

To remove top cap

To remove bottom cap

If the test cell will not turn, remove it from the vise and pound on the bottom cell cap with a hammer to loosen the cement inside. Then return the cell to the vise and try again.

11. With the bottom cell cap off, remove the o-ring and seal ring from inside the cell.

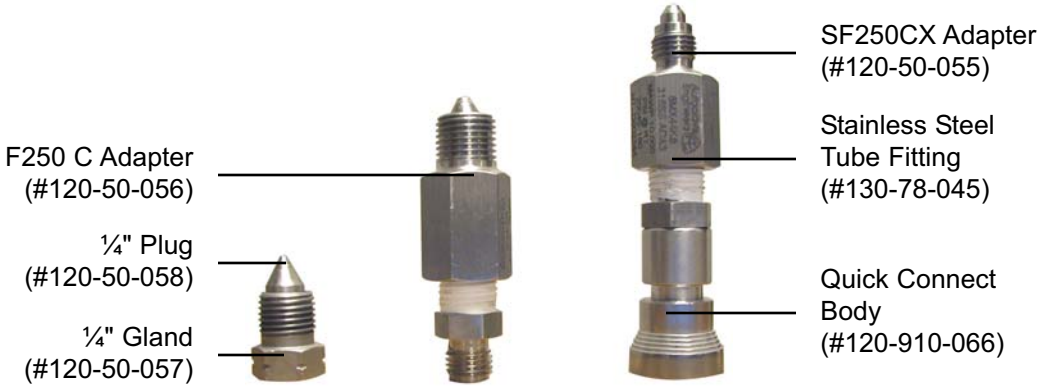
12. Screw the top cell cap back onto the top of the test cell.

13. Screw the plug into one of the holes in the cell cap.

14. Screw the test cell adapter into the other hole in the cell cap.

Note

The holes in the top of the cell cap are interchangeable.



15. Screw the adapter into the appropriate hole on the top of the unit casing.

16. Attach the air hose to the two fittings. The fitting on the unit uses a quick-connect, while the fitting on the test cell requires manual tightening.

17. Plug the thermocouple into the unit. The unit will not function if the thermocouple is not plugged in.

18. Close the pressure release by turning the valve clockwise. Then open the water and air valves.

19. Turn on the pump.

Tip

If the pressure does not begin building, close the back pressure regulator by turning the valve clockwise.

Important

20. When you hear the block of cement pop out of the test cell, turn off the pump and close the water and air valves.

    The cement block may be propelled out of the test cell with great force, causing serious injury and damage. Be sure to always point the test cell away from people or equipment.

21. Open the pressure release by turning the valve counter-clockwise.

22. Disconnect the air hose and remove all of the fittings.

23. Remove the cell cap and thoroughly clean the test cell.

Maintenance

1. After every test, completely disassemble the test cell and thoroughly clean all surfaces, including the metal seal ring and the metal retaining ring, with soap and water. Any cement left on the test cell will harden and could damage the equipment.

2. Before every test, inspect the o-rings, seal rings, and retaining ring for damage or wear. O-rings should not be cracked, split, or brittle. The seal rings and retaining ring should not be bent or dented. Replace any damaged pieces before beginning a new test.

3. Ensure that the transducer holes in both cell caps are clean and free of debris. Also, be sure to clean the bottom surface of the transducers. This will help ensure a strong signal with minimal interference during a test.

Appendix

Custom Blend Setup

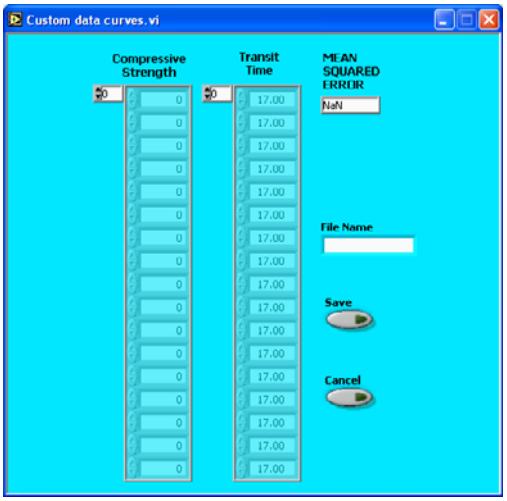
If the slurry being tested does not fit the profile of the preset densities, you will need to create a “Custom Blend” profile.

1. On the “Utilities” menu, select “Custom Blend Entry”.

2. Enter a filename in the “File Name” field.

3. Enter the compressive strength (PSI) and corresponding transit times (milliseconds). You must enter at least 7 sets of data.

4. Click the “Save” button to save the profile.



Appendix

Calibration

To calibrate the test cell, choose “Calibrate Cell” from the “Utilities” menu. There are two calibration options:

“Water” - Fill the test cell with distilled water and place it in the unit as described in the “Preparing the Test Cell” section on page 11.

“Steel” - Place the 3.5" steel calibration block inside the test cell. It will be necessary to unscrew the top and bottom caps as much as possible without removing them. This will allow sufficient space for the calibration block. Once the block is in the cell and the caps are secure, place it in the unit as described in the “Preparing the Test Cell” section on page 11.

The **“TT Micro SEC/in”** field will show you the raw transit time. The **“CAL OLD”** field shows the current offset value determined from the last calibration. The **“CAL NEW”** field shows the new offset value. Click the “Continue” button to save the new offset value.