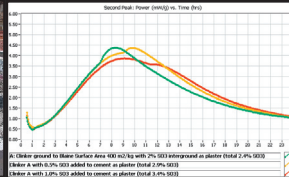
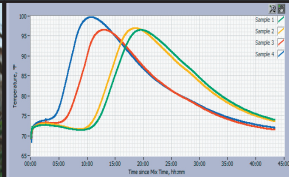
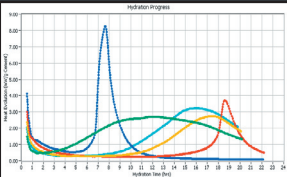


calmetrix

F-CAL 4000/8000

USER MANUAL



CALMETRIX INC.
F-CAL 4000 AND F-CAL 8000 FIELD CALORIMETER
FOR CONCRETE AND CEMENT

USER MANUAL

IMPORTANT SAFETY RULES



- Caution: Always hold the lid with one hand when loading or unloading calorimeter or lock lid in place to prevent it from falling and pinching fingers.

DISCLAIMER

Calmetrix does not assume any liability as related, but not limited to, the accuracy, relevance or interpretation of results while using F-Cal.

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A. BEFORE YOU START USING THE EQUIPMENT

What is in your box?

1. F-Cal equipment
2. USB Cable to connect the F-Cal to your computer's USB port
3. Instruction Manual
4. CalCommander installation CD

CalCommander Software Installation.

1. Insert the CalCommander CD in your CD/DVD drive and follow the on-screen installation instructions
2. Restart your Computer
3. Click on the CalCommander Icon on your Desktop to open CalCommander
4. Connect the F-Cal to your computer using the USB cable that is provided with the equipment. When connecting your F-Cal for the first time your Windows Operating System will automatically install the necessary drivers. Once the installation is finished, your F-Cal serial number will appear on the top of the screen in the F-Cal Logger module.

NOTE: Your P-Cal includes one license for the following software modules:

- F/P-Cal Logger to operate the equipment
- F/P-Cal Reports to retrieve past results and create reports
- F/P-Cal Set to infer thermal indicators of setting times
- P-Cal Strength to calibrate and predict strength for a given mix design

For specific questions about licensing and registration, please email register@calmetrix.com or call (617) 203-2090.

B. GENERAL USE

F-Cal measures the temperature from up to four 4"x8" cylinders (F-Cal 4000) or eight 3"x6" cylinders (F-Cal 8000). The equipment can be used with cement paste, mortar or real concrete (including coarse aggregates). Please refer to Section F in this manual for recommendations of use with paste and mortar samples. The temperature curve provides a "fingerprint" of the chemical reactions in the sample, that can be analyzed to infer specific reactions during early stages of hydration, usually 24 to 36 hours after batching/mixing.

C. HANDLING INSTRUCTIONS

Concrete cylinders must be clean on the outside before inserting them into the calorimeter. Cement or admixtures on the outside will cause vial to get stuck in the calorimeter, with expensive and time-consuming repair as a result. We recommend that all cylinders be capped to avoid accidental spillage.

AVOID lifting or transporting the F-Cal with samples inside, as equipment might be damaged. If you have to move or transport the unit during a test with samples loaded inside the unit, make sure to keep the lid in the same position (fully open or closed) during the entire duration of the test, for consistency in thermal insulation.

D. OPERATING THE EQUIPMENT – CALCOMMANDER SOFTWARE

Connect the F-Cal to your computer using the USB cable (provided). Open the CalCommander software. You will see the Welcome Screen.



Click on the F-Cal Logger tab on top.

Familiarize yourself with the main window of the F-Cal Logger software module:

Plot area

Command area

Mix Configuration area

Mix Configuration area:

This part of the screen is used to capture all mix and sample related data.

(a) Note that the number of tabs corresponds to the total number of channels connected. With one F-Cal 8000, or with two F-Cal 4000 units connected in parallel, eight tabs will appear.

Enter the Mix data for each sample on the corresponding tab. This data will be stored along with the sample test data and will appear when you visualize curves in the F-Cal Reports module.

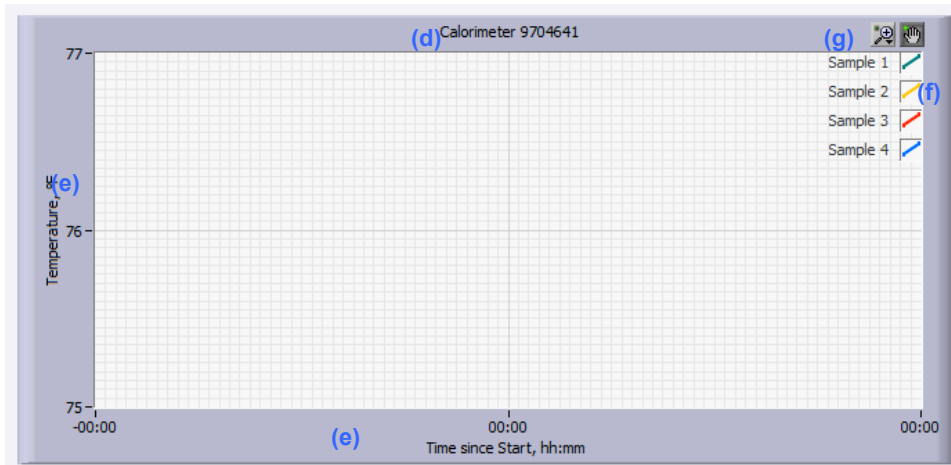
(b) Disable a given sensor, e.g. if no sample is contained in the corresponding cylinder slot by unchecking the “Sensor Enabled” box.

(c) Make sure you enter the mixing time (when the water hits the cement) in the “Mix Date/Time” field. This time will be used as the point of origin so as to make side-by-side comparisons of curves from tests performed at different times.

The screenshot displays a software interface for configuring mix data. It features four tabs labeled 'Sample 1', 'Sample 2', 'Sample 3', and 'Sample 4'. The 'Sample 1' tab is active and contains the following fields:

- Mix ID: [Text Input]
- Water / Cement Ratio: [Text Input] 0.00
- Cement Source / ID: [Text Input]
- Cement Content: [Text Input] 0.00
- Units: [Dropdown Menu] lbs / cy
- SCM 1: Type [Dropdown Menu] None, Percent [Text Input] 0.00, Source [Text Input]
- SCM 2: Type [Dropdown Menu] None, Percent [Text Input] 0.00, Source [Text Input]
- SCM 3: Type [Dropdown Menu] None, Percent [Text Input] 0.00, Source [Text Input]
- Admix 1: Name [Text Input], Dose [Text Input] 0.00, Units [Dropdown Menu] oz / cwt
- Admix 2: Name [Text Input], Dose [Text Input] 0.00, Units [Dropdown Menu] oz / cwt
- Admix 3: Name [Text Input], Dose [Text Input] 0.00, Units [Dropdown Menu] oz / cwt
- Workability: Type [Dropdown Menu] slump, Measure [Text Input] 0.00, Units [Dropdown Menu] inches, Unit Weight [Text Input] 0, Units [Dropdown Menu] lbs / cft
- Mix Date / Time: [Text Input] May 04, 2010 22:59
- Mix Temperature: [Text Input] 32.0
- % Air: [Text Input] 0.0
- Sensor Enabled: [Checked Checkbox]

Plot area.



(d) The serial number of equipment currently connected is displayed on top of the chart area. Several serial numbers will appear if more than one F-Cal unit is connected.

(e) Right-click on the x or y-axis to change scaling from Automatic to Manual. In Manual mode, you can adjust the min and max using the cursor.

(f) Click on a graph legend/color on the right of the screen to change the appearance (color, line type, etc.)

(g) Click on the Zoom and Motion tools on top (f) to zoom in/out or move the graph.

Command area.

This area is used to operate the F-Cal's logging functions

Temperature, °F			
Sample 1	Sample 2	Sample 3	Sample 4
76.33	75.42	75.51	76.03

Logging (Green light) Log Conflict (Red light)
Low Battery (Red light) Bad Sensor Contact (Red light)

Battery, V
3.03

Copy Configuration from Current Tab
Paste Configuration to Current Tab
Read Configuration from Logger
Update Configuration File

Start Logging
Stop Logging
Read Data from Logger

Report Title
[Input Field]

Save Log Data to File
Create Mini PDF Report
Print Mini Report
Save Graph

Displays current temperature as measured. To change units from °F to °C, click on the SETTINGS tab on top, select the Measurement Units field. Click on « Accept new options » on the bottom of the SETTINGS tab to validate your changes.

The Logging light turns green when your F-Cal is logging data.

Log Conflict lights up when more than one F-Cal is connected to your computer and the software is unable to determine proper start times for each logger.

Low Battery will light up when the battery needs to be replaced. Refer to Section H – Troubleshooting.

Bad Sensor Contact indicates a bad connection between the sensor and the logger located within your F-Cal equipment. Refer to Section H in this User Manual to troubleshoot bad connections.

Copy Configuration from any Mix Configuration Data tab, and Paste it in another tab. This is useful when testing several mixes that have similar configuration data.

When disconnecting your F-Cal, your configuration data will not appear automatically upon reconnection. Click on "Read Configuration from Logger" to display Configuration data.

Click on "Update Configuration Data" to save changes made to the Configuration Data after logging has started.

Click on "Start Logging" to begin logging temperatures. All sensors in your F-Cal will start logging. Note: it is not necessary to keep your computer connected after logging has been activated. All data will be stored in the F-Cal's internal memory. Reconnect your computer at a later time to retrieve data.

"Stop Logging" at the end of your test. After "Stop Logging" has been selected, you cannot continue logging data on your current test. Data will be saved automatically in your default Logs folder.

"Read Data from Logger" to update the graph at any time during testing.

Create or Print PDF reports, or Save the current graph as an image file.

E. OPERATING YOUR UNIT FOR THE FIRST TIME

Calibration and Connections.

Your F-Cal uses thermistors for temperature measurements, and does not require calibration.

To verify that internal connections have not been compromised during shipping, a test run should be conducted by loading the unit with cylinders of hot water. With all cells loaded with water at the same temperature, start logging. After thirty minutes, the temperature reading on all sensors should stabilize and temperatures from one cell to another should be within 2°F or less.

Check for error signals – LOW BATTERY or BAD SENSOR CONTACT - on the upper right hand side of the F-Cal Logger screen. Refer to Section H Troubleshooting to address any issues.

F. SAMPLE PREPARATION AND RECOMMENDED TEST PROCEDURE

1. Ensure that the mixing procedure is sufficient to disperse binder properly.
2. If the water/cement (w/c) ratio is pre-defined, perform a pre-test mix with blank cement paste or mortar (no admixtures) and another pre-test with the highest desired dosage of admixtures. Adjust w/c ratio if necessary.
3. If the water demand of the cement – admixture combination to be tested is unknown, perform a pre-test to determine required water to binder ratio (binder includes cement and any supplementary material used as a cement replacement)

Mortar, concrete or paste

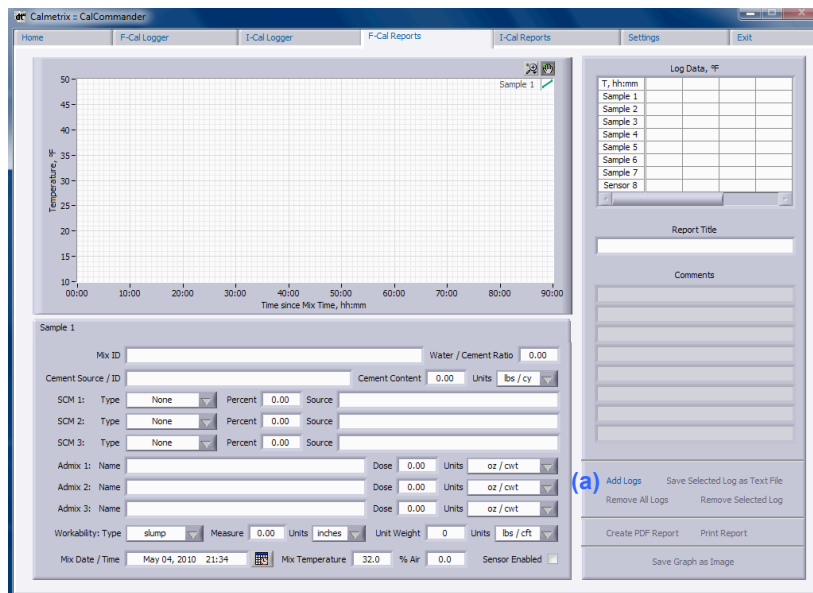
Note that the outlined procedure covers testing of mortar, concrete or paste.

Preparation

4. We recommend you start logging data in all channels of your F-Cal at least one hour before inserting the first sample. This allows the unit to reach a stable baseline temperature.
5. Pre-dilute admixtures to ensure accurate weighing or use high accuracy micro-pipettes for accurate volumetric dosing.
6. Use the same mixing sequences and times as far as possible within a test series
7. Prepare mortar according to standard or prepare concrete or sample concrete directly from production (in batch plant mixer or ready mix truck). Be sure to enter mix data in the Mix Configuration area of the P-Cal Logger tab for future reference.
8. When using cement paste, we recommend sample sizes of 1.25kg (approx. $\frac{1}{3}$ volume of a 4"x8" -100 mm x200 mm- cylinder)
9. When using mortar, we recommend sample sizes of 2kg (approx. $\frac{1}{2}$ volume of a 4"x8" cylinder)

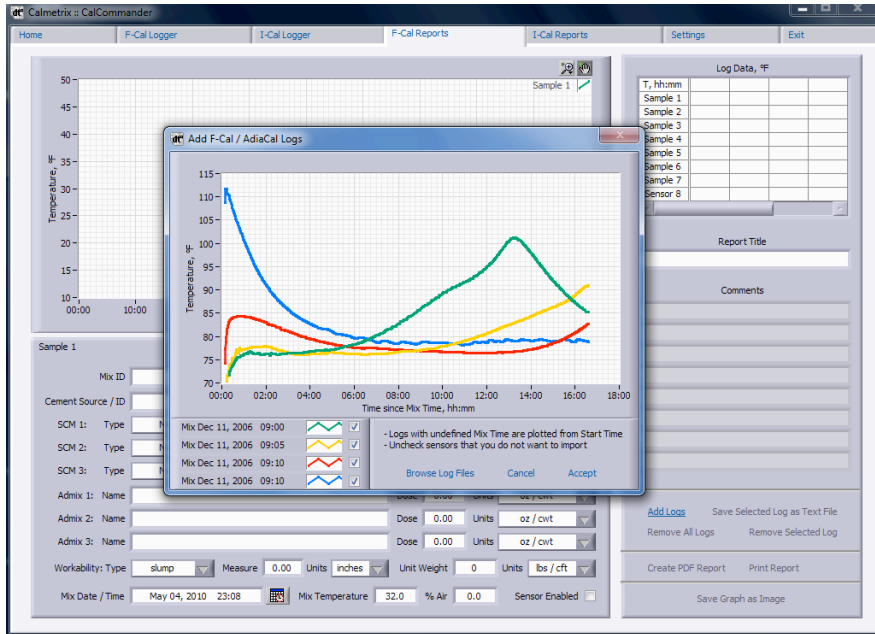
G. VISUALIZING RESULTS – F-CAL REPORT GENERATOR

With CalCommander open on your computer, click on the F-Cal Reports Tab on top. A new window will appear, as in the picture below.



(a) - Add Plot – select C:\Users\Public\Documents\Calmetrix\CalCommander\Logs (default storage of completed log files) or any other location where you store completed log files. Select the log file you would like to display

A new window will appear.

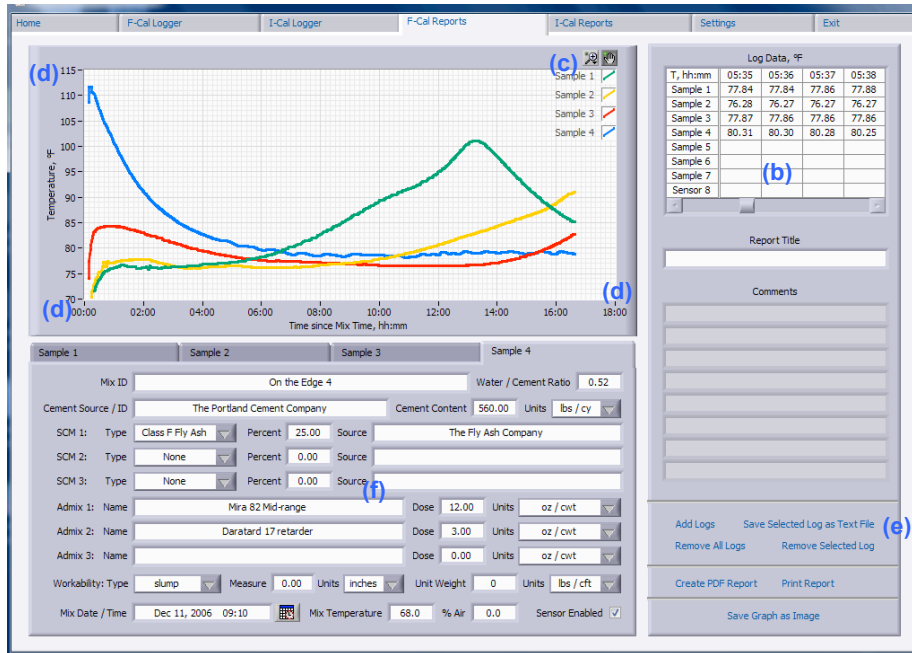


Uncheck the box for the files you would not like to import.

Repeat the steps above to add more files from other log files. You can add up to 8 files on any Report Generator graph.

Click Accept and the files you selected will appear in the Report Generator window.

The F-Cal Report Generator can read F-Cal files or Grace AdiaCal™ files.



(b) - Actual log data is displayed in this area. Temperatures are measured and logged every minute.

(c) - Use Graphing tools to Zoom In/Out, click on the legend to change colors or style of graphs.

(d) - Click on the min/max values on the x or y-axis to change the min and max to modify the range and scale.

(e) - "Save Selected Log as Text File" saves the information, including all temperature values from the currently selected Sample tab in a .txt file. Data from .txt files can easily be copied and pasted in an application such as Microsoft Excel for spreadsheet calculations on plotted data.

Note that data displayed in the Mix data section (f) can be edited for PDF reports ("create PDF Reports"), Prints ("Print Report"), or when saving data as a text file.

H. ESTIMATING SETTING TIMES FROM CALORIMETRY CURVES – F-CAL SET

F/P-Cal Set can help you predict initial and final setting times within close approximation by applying the “Fractions Method” and generate Thermal Indicators of Set (TIS). This method is based on the assumption that for a given mix design there is a correlation between the heat evolution and setting times. Initial set is reached when the temperature level in a sample placed in the P-Cal reaches a certain fraction of the peak. Each mix has its very own fraction values corresponding to initial and final set. Once the fraction values are determined for a given mix design, they can be used to predict setting times when the same mix is used again in the future.

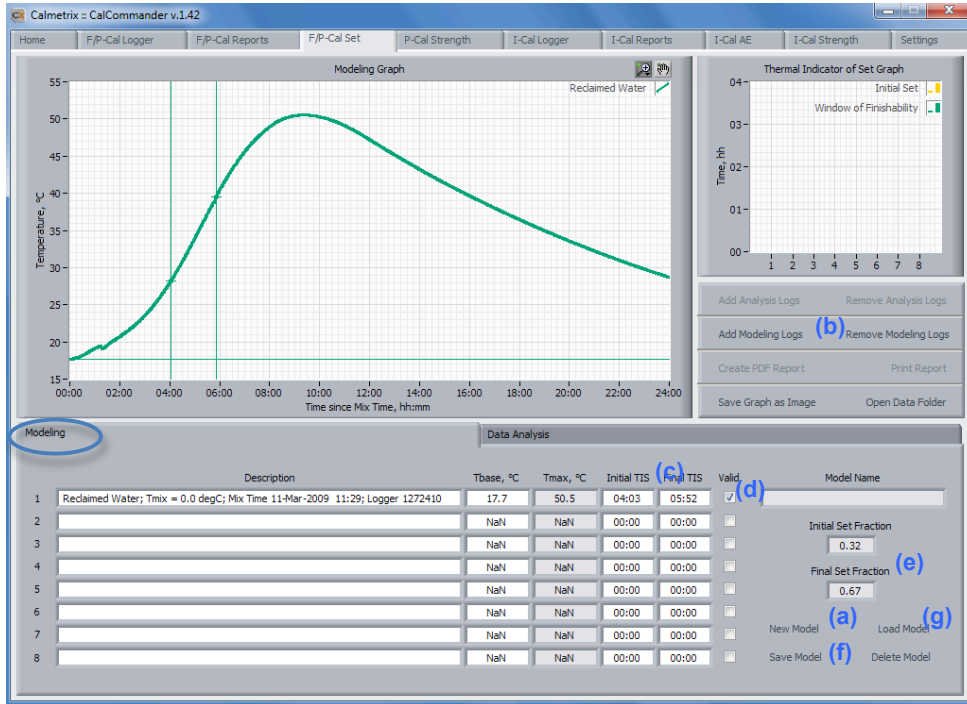
How to use the F-Cal Set module.

To be able to predict setting times for a given mix design, you will first have to create a model which establishes the relationship between the temperature curve and initial and final set, as measured by a standard method, for example ASTM C403.

First, build a model

To build a new Model for a given mixture, proceed as follows:

1. Go to F/P-Cal Set and select the “Modeling” tab. Click on New Model (a)
2. Click on “Add Modeling Log” (b). A new window will pop up, letting you browse to the file containing the calorimetry curve for the mix for which you would like to build a model. You can load up to 8 curves for the same mix.
3. Select one or several curves for this mix and click on “Accept”. The selected curve(s) will appear on the screen, as shown below.
4. For each curve, enter the measured Initial Setting time in the Initial TIS field and the Final Setting time in the Final TIS field (c). These values should be measured using the standard you normally use to determine setting times, e.g. ASTM C403. Now select the curves that you want to use to build your Fractions Model for this mix by checking or un-checking the “Valid” box (d). The average fraction values of all “Valid” mixes will display in the Initial Set Fraction and Final Set Fraction fields to the right (e).
5. Save your model by clicking on “Save” (f). You will be asked to provide a name for your model. Once saved, your model will be stored in the Calibration folder and can later be selected when predicting setting times for the same mix design using the Data Analysis tab.

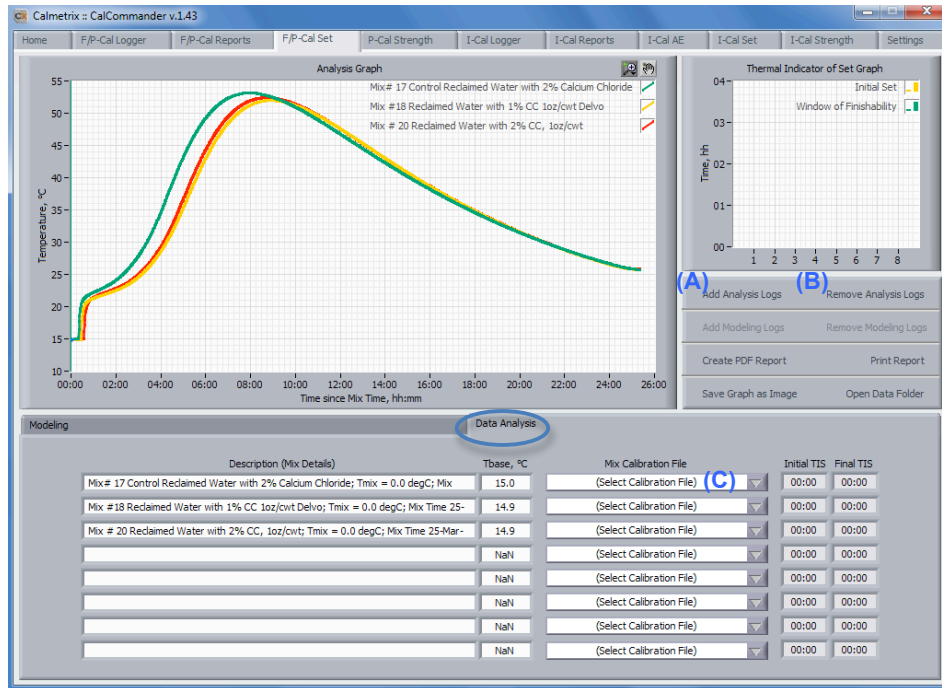


6. You can later open and edit an existing model by clicking on Load Model (g)

Now you're ready to use the setting time prediction tool

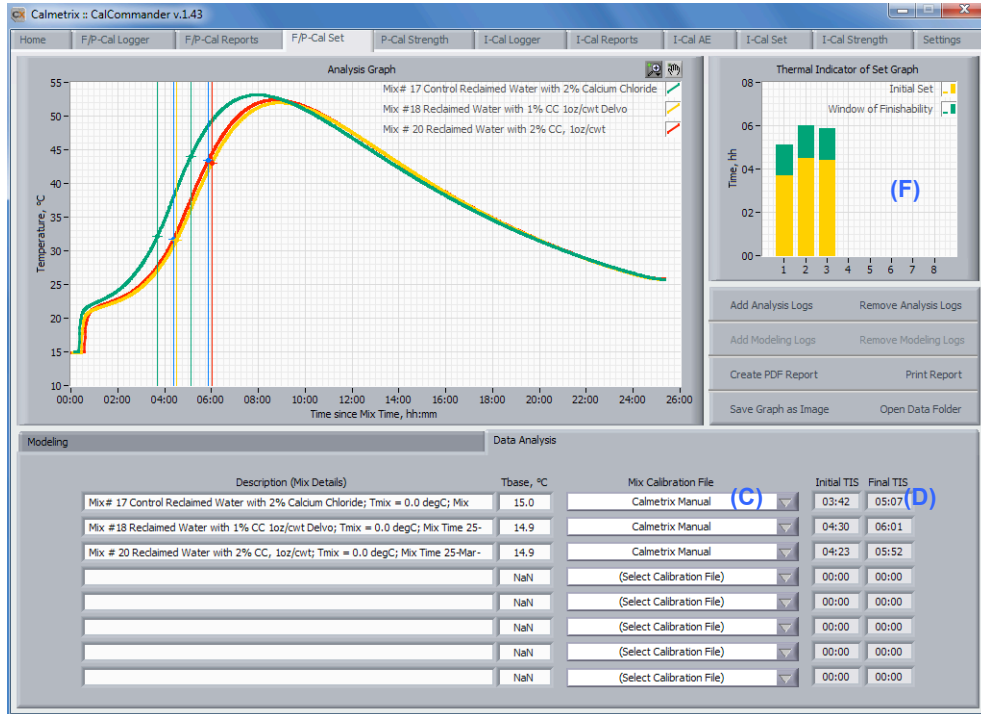
Once a model has been established for a given mixture, it can be used to predict early and late times of set of the same mixture by using only a calorimetry curve. To use the prediction tool, proceed as follows:

1. Click on the "Data Analysis" tab.
2. Click on "Add Analysis Logs" (A) to select the calorimetry data for which you would like to make a setting time prediction and click OK. You can add up to 8 calorimetry curves.



3. You can remove one or several logs by clicking on Remove Analysis Logs (B).
4. Once you have loaded all curves you would like to analyze, select the calibration field to use for each by clicking on the drop-down menu in (C).

- The software will calculate and display the Thermal Indicators of Set (D).



- The upper right hand side graph (F) displays the calculated initial set, final set and the Finishability time window.

The following are useful papers as a resource for data interpretation and examples of uses for your F-Cal field calorimeter and Calorimetry in general.

1. Sandberg, P., and Liberman, S., "Monitoring and Evaluation of Cement Hydration by Semi-Adiabatic Field Calorimetry," *Concrete Heat Development: Monitoring, Prediction, and Management*, ACI SP-241-2, Atlanta, GA, April, 2007, pp. 13-24.
2. Riding, K.A., Poole J.L., Juenger, M.C.G., Schindler, A.K., and Folliard K.J., "Calorimetry Performed On-Site: Methods and Uses", ACI SP-241.
3. Poole, J.L., "Hydration Study of Cementitious Materials Using Semi-Adiabatic Calorimetry," PhD Dissertation, The University of Texas at Austin, Austin, TX, 2007.
4. Wang, K., Ge, Z., Grove, J., Ruiz, M., Rasmussen, R., and Ferragut, T., "Developing a Simple and Rapid Test for Monitoring the Heat Evolution of Concrete Mixtures for Both Laboratory and Field Applications", National Concrete Pavement Technology Center, Ames, IA, January 2007, 58 pp.
5. Cost, V. T., and Gardiner, A., "Practical Concrete Mixture Evaluation via Semi-Adiabatic Calorimetry," *2009 Concrete Technology Forum – Focus on Performance Prediction*, Cincinnati, OH, May, 2009, 21 pp.
6. Cost, T., "Thermal Measurements of Hydration Concrete Mixtures: A Useful Quality Control Tool for Concrete Producers", NRMCA Publication 2PE004

I. TROUBLESHOOTING

Most common problems can be identified on the F-Cal Logger module screen of your CalCommander software.

If the “Log Conflict” light is lit: CalCommander can handle up to 8 channels at any time, either one F-Cal 8000 or two F-Cal 4000 in parallel. If more than one F-Cal equipment is connected at any time, a log conflict may occur if logging started at different times on the equipment that is connected. To resolve the conflict, leave only one F-Cal connected while entering data in CalCommander. Remember that once you started logging, you can disconnect the equipment. Your F-Cal will keep logging temperatures on all channels until you reconnect it and press “Stop Logging”. This enables you to work with several F-Cals in parallel, and to connect them to your computer only when you want to work on mix data.

If the “Low Battery” light is lit: You will have to change the battery as soon as possible. The logger requires one 3-Volt CR-2032 lithium battery. Press Stop logging when possible. You will not be able to continue the current test run after you changed the battery. Disconnect the equipment from your company and withdraw all samples from the channels. Carefully lift the inner insulation out of the outer case. Locate the logger(s) (a small rectangular box) on the side of the insulating foam block. Unplug all sensor cables from the logger. Be careful to note the sequence of the sensors so that you can reconnect them to the right ports after you finish replacing the battery. Remove the logger, then unscrew the logger case. Lift the circuit board and carefully push the battery out with a small blunt instrument, or pull it out with your fingernail. Insert a new battery, positive side facing up. Carefully realign the logger case and re-fasten the screws. Reconnect the four temperature sensors making sure each one is connected to the proper port. Place the insulating foam block back into the outer case.

If “Bad Sensor Contact” is lit: Stop logging, withdraw samples and proceed to lift out the insulating foam block as described in the “Low Battery” section above. Locate the logger and ensure that all four sensor connectors are pushed in all the way. If the problem persists, call Calmetrix Customer Support at (617) 203-2090 or email support@calmetrix.com.

If erratic values appear in any of the temperature readings: Insert sample cylinders filled with water at equal temperatures in all channels and start logging. Start logging and wait for 30 minutes. Check that all temperature readings are within a 2°F (1°C) range. If any sensor indicates a temperature out of that range, proceed as with the “Bad Sensor Contact” section above. If the problem persists, contact Calmetrix customer support.

ENJOY YOUR F-CAL 4000/8000 EQUIPMENT

Questions? - Find us at:

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