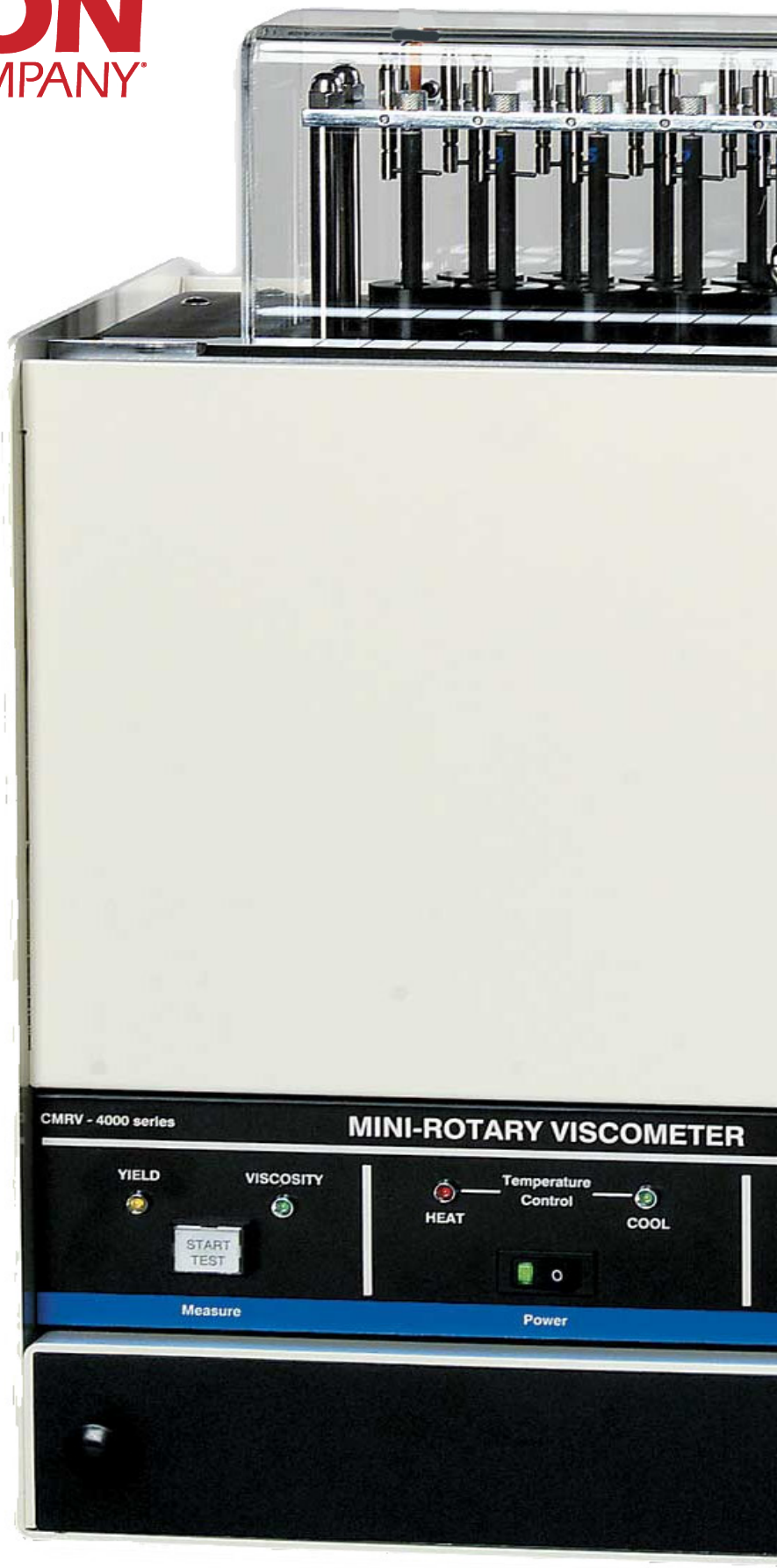
CANNON INSTRUMENT COMPANY

Mini-Rotary Viscometer CMRV-4500

Instruction & Operation Manual



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CHAPTER 1

INTRODUCTION

Purpose of the manual

This manual has been written to provide the information necessary for proper installation, operation, and maintenance of the ***CANNON®*** Mini-Rotary Viscometer (CMRV-4500).

Instrument utility

The ***CANNON®*** Mini-Rotary Viscometer is used to measure the apparent viscosity and yield stress of engine oils and drive line lubricants within the temperature range of -10˚C to -40˚C using ASTM test methods D 4684, D 3829, D6821 and D 6896. ASTM test method D 4684 is required by the Society of Automotive Engineers (SAE) Engine Oil Viscosity Classification SAE J300.

NOTE

*The CMRV-4500 capabilities have been tailored to the requirements of the current ASTM methods cited above. For this reason, the instrument may not be suitable for some general-purpose viscometry applications. Consult with **CANNON®** Customer Service before testing with materials and/or methodology at significant variance with ASTM D 4684, ASTM D 3829 or ASTM D 6821.*

Improvements

The CMRV-4500 is a state-of-the-art system offering many superior features including:

CMRV-4500 with pulley-wheel assembly

- *New Method compatibility*

The CMRV-4500 is fully compatible with ASTM D 6821, the new Drive Line Lubricants test method. The CMRV-4500 is fully compatible with ASTM D 6896, a new method for testing used diesel oils.

- *Improved insulation for temperature control*

The CMRV-4500 instrument features a redesigned housing and accessory rotor caps to enhance insulating characteristics and precision.

- *Software library of temperature profiles (cooling profiles)*

Predefined cooling profiles that comply with methods ASTM D 3829, ASTM D 4684, ASTM D 6821 and ASTM D 6896 are supplied with the CMRV software. The user may also create custom cooling profiles with the Profile Designer.

- *VISCPRO® software with Profile Designer*

The VISCPRO® software for Windows® XP® features a Profile Designer for creating unique cooling profiles.

- *Networking capability for multiple instruments*

The VISCPRO® software can control/monitor up to four CMRV instruments with one computer via RS-485 serial connections. See APPENDIX D for more information.

Instrument overview

The ***CANNON®*** Mini-Rotary Viscometer is designed for precision control of temperature over time, enabling accurate yield stress and viscosity measurement of oil samples in conformance with ASTM D 3829, ASTM D 4684, ASTM D 6821 and ASTM D 6896 test methods.

Test procedure

Oil samples placed in the CMRV-4500 viscometric cells are heated and cooled at a predetermined rate according to a user-specified cooling profile. The cooling profile parameters are downloaded to the CMRV-4500 onboard memory via a serial interface with the host computer. The CMRV-4500 then uses this profile to control the rate of temperature change, independent of the host computer.

All three methods specify that the samples be initially heated to ensure that all components of the sample are released into solution. The samples are then slowly cooled to the test temperature using the user-selected temperature profile and maintained at test temperature for a specified soak period. Following the soak period, apparent viscosity (and yield stress if applicable) for each sample is determined by applying a constant torque to, and measuring the rotational speed of, a cylindrical rotor which has been immersed in the sample.

The time required for completion of the ASTM D 3829 test cycle is approximately 19 hours. The time required for completion of the ASTM D 4684 (TP-1, two-day) test is 45½ to 53½ hours. The time required for completion of the ASTM D 6821 test cycle is approximately 18 hours. The time required for completion of the ASTM D 6986 test cycle is approximately 43½ to 53½ hours.

NOTE *See Chapter 10 for additional information on the ASTM procedures.*

Instrument specifications

CMRV 4500 SERIES SPECIFICATIONS		
Instrument Model	**Model 4500**	
Dimensions	317 mm wide × 260 mm deep × 489 mm high (12.5 × 10.25 × 19.25")	
Weight	18.6 kg (41 lbs)	
Shipping Weight	27 kg (60 lbs)	
Operational temperature	80°C to -40°C	
Operating Conditions	15°C-30°C, 10%-90% RH non-condensing; Installation category II Pollution degree 2	
Fuse Rating	M 5A 250V; 1¼" × ¼"	
Compliance	EMC directive (89/336/EEC); Low voltage directive (73/23/EEC) HI-POT (1900 VDC, 60 sec.)	
Catalog Number/ Electrical Requirements	**9728-R21 (Model 4500)**	**9728-R22 (Model 4500)**
	CMRV Block Assembly 100V AC ± 10% 50/60 Hz, 400 watts	**CMRV Block Assembly** 115V AC ± 10% 50/60 Hz, 400 watts
	9728-R23 (Model 4500F)	**(All Models)**
	CMRV Block Assembly 230V AC ± 10% 50/60 Hz, 400 watts	**CMRV Air/Water Heat Exchanger** 100V AC ± 10% (P52.6551) 115V AC ± 10% (P52.6542) 230V AC ± 10% (P52.6543) 50/60 Hz, 1100 watts
	Use only the approved power cord supplied with your unit.	

Safety warnings

Please observe the following safety procedures and notices for proper operation of your CMRV-4500 unit:

- Make sure that your unit is operated only by qualified personnel
- Make sure that you read and understand all operating instructions and safety precautions listed in this manual before installing or operating your unit. If you have questions regarding instrument operation or documentation, contact ***CANNON***® Instrument Company.
- Deviation from the installation, operation or maintenance procedures described in this manual may result in a hazardous situation and may void the manufacturer's warranty.
- Transport the unit with care. Sudden jolts or drops may cause damage to components.
- Observe all warning labels.
- Never remove warning labels.
- Never operate damaged or leaking equipment.
- Always turn off the unit and disconnect the mains cable from the power source before performing service or maintenance procedures, or before moving the unit.
- Always remove sample from the cells before moving the unit.
- Never operate the equipment with damaged mains power cables.

- Refer all service and repairs to qualified personnel.

General Caution

In addition to the warnings previously listed, additional cautions are posted throughout the manual. These warnings may be designated by an appropriate symbol inside an equilateral triangle. General cautions are indicated with an exclamation point (see diagram, left). Read and follow these important instructions. Failure to observe these instructions can result in permanent damage to the unit, significant property damage, and personal injury.

Hot Surface Caution

Hot surface cautions (see diagram, left) may be attached on or near hot surfaces of the CMRV-4500. Avoid touching these surfaces when running profiles at temperatures above 50°C.

Protective Conductor

The Protective Conductor Terminal symbol is used to indicate required ground connections for your instrument electrical supply.

WARNING

When supplying power to this instrument, connect the protective ground (earth) terminals of the instrument to the protective conductor of the (supplied) line (MAINS) power cord. The main plug for the power cord should only be inserted in a socket outlet (receptacle) provided with a protective ground (earth) contact. Do not use an extension cord (power cable) without a protective conductor (grounding).

~ MAINS

AC Power Input Symbol

The ~MAINS symbol indicates instructions or connections for the AC power supply. The AC Power input must match the electrical specifications listed on the label on the rear panel of the instrument. The supplied AC Mains power cord must be attached to the connector labelled ~MAINS. This connection serves as a means of disconnect and should be readily accessible.

(**O**)

Supply OFF Symbol

The (**O**) symbol indicates the OFF position for the electrical switches for your unit (AC Mains or accessories).

CHAPTER 2 UNPACKING AND ASSEMBLY

Unpacking the CMRV-4500

CAUTION *Some CMRV components, including the Air/Water Heat Exchanger, are quite heavy. To avoid injury, obtain necessary assistance when lifting and moving shipping cartons and heavier unpacked components.*

- Remove all components from the shipping container(s).
- Remove any and all packing materials (styrofoam, etc.) from the components.
- Verify reception of shipped materials by comparing equipment items with packing/parts list(s). Report missing items to ***CANNON***® Instrument Company immediately.
- Inspect each component for signs for damage. Report damages to the shipper and to the ***CANNON***® Instrument Company immediately.

Damaged items

Retain all packing materials until the instrument is connected and functioning properly. If any component(s) must be returned to ***CANNON***® Instrument Company, the damaged item(s) should be repackaged in the original shipping container. Refer to Chapter 19 of this manual for instructions on returning defective equipment. Customers outside the United States should contact the local ***CANNON***® agent for procedures on returning products to ***CANNON***® .

System components

Before beginning assembly, please verify that all components listed on the packing slip are present, including:

- CMRV-4500 chassis/controller
- Air/Water Heat Exchanger
- Main power cord
- Pulley-wheel assembly
- 9 Matched rotors
- 9 Rings and threads
- RS-232 interface cable
- Small uncalibrated thermometer (0°C to +105°C)
- Large calibrated ASTM thermometer (-46°C to +30°C)
- 3k-ohm temperature probe
- CD-ROM with VISCPRO® software for Windows® XP®

- Set of weights:
  One 150-gram weight • One hook-cage • Nine additional weights
- 1 Bottle of N105B with test sample and data sheet
- Tubing and tube clamps
- Plexiglas® Top Cover
- Instruction & Operation Manual
- 9 Rotor bearing pins
- 10 Rotor locking pins

User-Supplied Equipment

∿ MAINS

The user must supply an electrical power source matching the electrical requirements indicated on the rear panel of the CMRV-4500 model.

Computer

An IBM-compatible computer with the Windows® XP® operating system (see computer specifications sheet included with your instrument) and printer are also required.

Cleaning supplies

The following items are required for regular cleaning of the viscometer cells between tests:

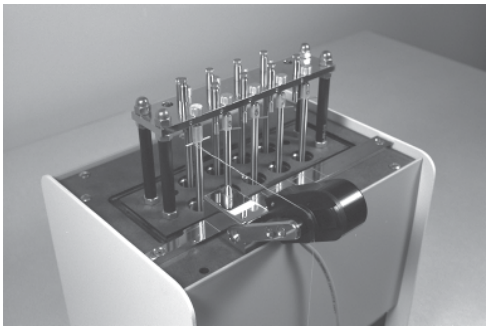
- oil solvent
- acetone
- suitable solvent-resistant container for placing/cleaning rotors
- vacuum source with trap for solvent and oil
- flexible tube, about 150 mm long and 3-5 mm in diameter, connected to the vacuum trap
- two plastic squeeze bottles, each with an extension long enough to direct oil solvent and acetone directly into the viscometer cells

CHAPTER 3

CMRV-4500 APPARATUS DESCRIPTION

CMRV-4500 unit/accessories

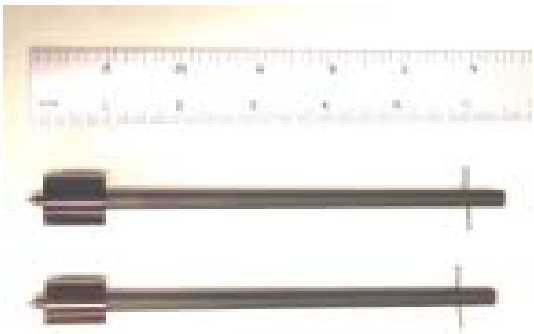
The CMRV-4500 unit contains an aluminum block with a heater for warming the block. Nine viscometric cells are closely fitted into nine holes in the block (see photo). There are also two thermometer wells in the block.



CMRV-4 unit with rotors inserted and thread wound on pulley-wheel

Lower rotor bearing

Each viscometric cell consists of an aluminum block aperture with a rotor resting in a stainless steel cup at the base. The rotor is attached to a rotor shaft with a pivot point at the bottom. The pivot point fits a mating conical depression at the bottom of the stainless steel cup; this mechanism serves as the lower bearing. The standard rotor composition is hardened stainless steel. The drive line rotor composition is Delrin® (NOTE: The drive line rotors/pins/weights must be purchased separately from CANNON®.)



Rotor for oil testing (top) and drive line lubricant testing

Upper rotor bearing

The upper bearing consists of a brass insert at the top of the rotor shaft with a 1.2 mm hole on the shaft axis. A cylindrical rotor pin is inserted through the upper bearing plate about one or two millimeters into the hole on the shaft axis.

Upper bearing assembly with rotor and rotor locking pin in place

Rotor crossbar

The rotor crossbar is used to hold the loop at the end of the thread. It also serves as an indicator for (optional) manual timing of rotor rotation.

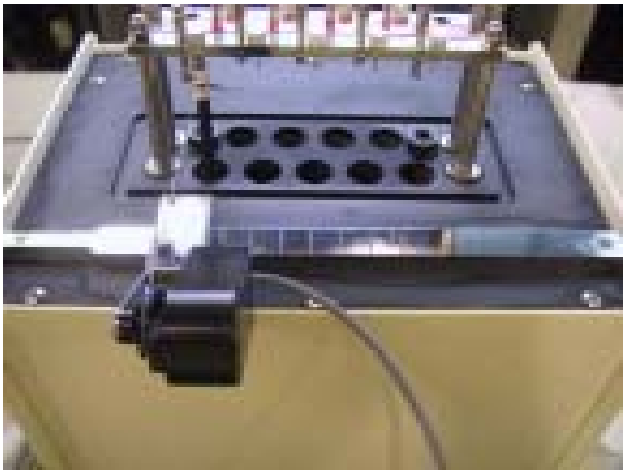
String on rotor and pulley-wheel assembly

Rotor locking pins

The rotor locking pins are used to prevent unwanted rotor rotation. When the locking pin is lowered over the rotor crossbar (see photo), rotation is prevented. When the pins are in the raised (detent) position, the rotors are free to rotate.

Pulley-wheel assembly

The pulley-wheel assembly consists of a V-channel timing wheel with a digital-optical sensor permitting precise measurement of the wheel rotation. The pulley-wheel base is designed to be fitted to the CMRV-4500 slide track adjacent to the viscometric cells. The probe cable is connected to the jack on the front of the CMRV-4500 housing.



Slide track with pulley-wheel assembly

Winding thread

The thread used for CMRV-4500 testing is a single, nonelastic strand of 70 cm (28") winding thread of silk, cotton, or similar material (Coats North America or comparable brand, 0.1 mm radius) with a loop on one end. One end is wound around the CMRV-4500 rotor. The other end of the thread is tied to a small rigid plastic ring from which the test weight may be suspended.

Slide track

The pulley-wheel assembly is designed to interlock with the pulley-wheel slide track and move laterally so it can be aligned with the scored marks on the track opposite each of the nine rotor shafts.

Hook-weights

Hook-weights are hung on the plastic ring at the free end of the thread to apply the required force to the rotor during yield stress and viscosity measurements. Nine disk weights, one hook-cage, and one larger hook-weight are provided. Weights vary depending on the ASTM Method used for testing.

Hook-weights

Temperature probe

CMRV-4500 block temperature is detected by a 3k-ohm temperature probe, which must be seated securely in the thermistor aperture at the rear of the CMRV housing and plugged into the electronic chassis.

Thermometers

The CMRV-4500 unit is shipped from ***CANNON***® with two thermometers to be used to check the temperature of the block.

- The long thermometer used for the probe and cell calibrations is a PRINCO mercury-thallium calibrated thermometer with a range of -46°C to +30°C in .2°C increments and an accuracy of ± 0.01°C below 20°C.

NOTE *If a thermometer is removed from the CMRV-4500 when the unit is cooling, plug the thermometer aperture in the Plexiglas® cover to prevent ice formation around the rotors.*

- The shorter, high-temperature uncalibrated thermometer has a range of 0°C to 105°C in 1°C increments with an accuracy of ± 1°C.

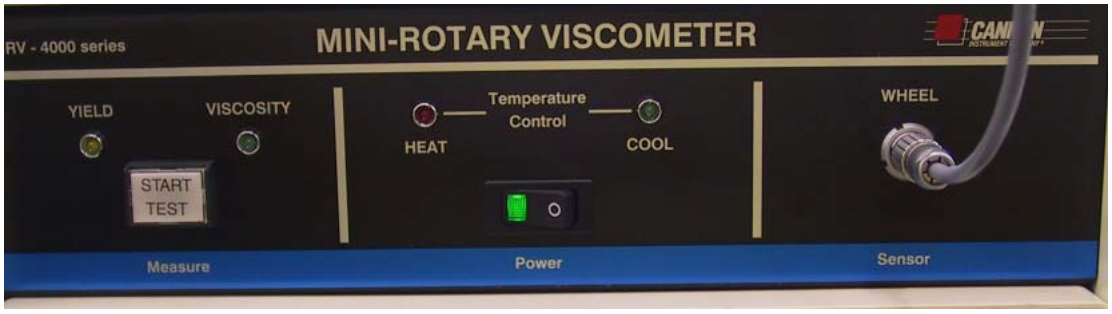
Air/Water Heat Exchanger

CMRV-4500 cooling is accomplished with internal thermoelectric cells and an external Air/Water Heat Exchanger circulating a mixture of water and antifreeze to remove heat from the thermoelectric modules.

Air/Water Heat Exchanger
(see chapter 4 for Setup diagram)

The Air/Water Heat Exchanger contains the electronics necessary to monitor the coolant flow rate and regulate the action of the circulating pump during the running of ASTM-specified temperature profiles. The Heat Exchanger also supplies DC power for the operation of the CMRV thermoelectric modules.

Front panel operations



CMRV front panel

Control features

CMRV front panel control features are simple and functional. The central switch on the front panel is the power switch for the unit. The light-emitting diodes (LEDs) above the switch indicate function of the heating and cooling systems. The Sensor connection on the right side of the panel mates with the cable from the pulleywheel optical sensor. The Start Test button on the left side of the panel is used to initiate CMRV-controlled testing and calibration routines. The Yield and Viscosity LEDs light during yield stress or viscosity testing.

For additional details on front panel operation, refer to the calibration and testing chapters of this manual.

SETUP

The instructions in this chapter are for setting up a single CMRV-4500 with the Air/Water Heat Exchanger. For additional information on multi-unit configurations, see APPENDIX D.

CAUTION *Do not apply power to the CMRV-4500 or Heat Exchanger until all connections are secure.*

Physical placement

CAUTION *Some CMRV components, including the Air/Water Heat Exchanger, are quite heavy. To avoid injury, obtain necessary assistance when lifting and moving these components.*

Control unit placement

Place the CMRV-4500 on a stable laboratory bench or table top within 10 mm of the front edge. This will allow the weight suspended from the pulley-wheel assembly to clear the edge of the table during viscosity and yield stress tests. Allow 30.5 cm (12") of clearance to the back and sides of the unit.

A/W Heat Exchanger

Place the Air/Water Heat Exchanger below the table top on which the CMRV-4500 is placed. The unit may be located within the parameters permitted by the length of the hoses and cables shipped with the unit.

CAUTION *Do not obstruct the front or rear cooling vents on the Air/Water Heat Exchanger.*

Thermometer placement

When in use, the large thermometer (-46°C to +30°C) is placed in the thermometer well on the left side of the CMRV-4500 unit (seen from the front).

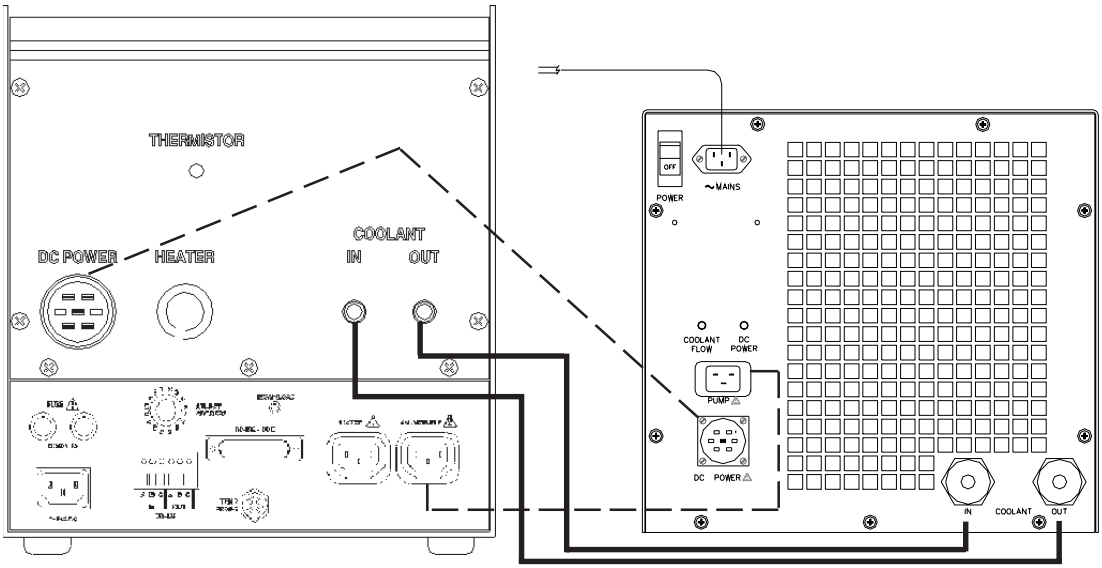
When in use, the small thermometer (0°C to 105°C) is placed in the thermometer well on the right side of the CMRV-4500 unit (as seen from the front).

NOTE *If the mercury column in a thermometer has separated during shipment, read the instructions included in APPENDIX C. These instructions offer several methods for joining separated mercury columns.*

Tubing connections

There are two tubing connections on the rear of the CMRV-4500 housing (see diagram, next page). The fitting on the left is the coolant INLET (for introducing coolant to the CMRV-4500) and the fitting on the right of the rear panel is the coolant OUTLET (for returning coolant to the Ex

changer). Clamp the open ends of both hoses to these fittings, then secure the hoses to the appropriate bulkhead fittings on the Air/Water Heat Exchanger using the bulkhead inserts provided with the tubing (see Figure). The fittings will snap into place. To release and remove the tubing from the Air/Water Heat Exchanger, push down on the button on the bulkhead fittings to release the connector locking clips.



CMRV-4500 tubing (solid lines) and electrical (dotted lines) controller/AWHE connections

Filling the Air/Water Heat Exchanger

Obtain a supply of quality automotive antifreeze (ethylene glycol) and mix it with water in a ratio of 30 percent antifreeze to 70 percent water. Do not mix antifreeze types in the Air-Water Heat Exchanger.

After you have secured the Exchanger tubing connections (see previous section) pour this antifreeze/water mixture into the reservoir opening on the top of the Air/Water Heat Exchanger until it is full (approximately 4 liters).

CAUTION *Ethylene glycol is a toxic substance. Use proper safety precautions when handling. Follow appropriate MSDS instructions.*

NOTE *Depending on the amount of fluid displacement in the coolant lines, it may be necessary to add additional antifreeze/water mixture to the*

Exchanger when the unit commences operation. You will be able to observe the liquid circulating inside the reservoir from the opening at the top of the Exchanger during normal operation. If air bubbles are consistently visible in the coolant lines, add additional mixture until the Exchanger is full.

CAUTION *The water-antifreeze mix should be replaced annually for reliable performance and to prevent corrosion of internal components (see* Flushing and draining the Air/Water Heat Exchanger*, this chapter).*

Electrical / serial connections

A/W Heat Exchanger

Plug the male end of the DC power cable into the DC POWER OUT fitting on the rear panel of the Air/Water Heat Exchanger and turn the locking clip clockwise to secure the connection. Attach the other end of the cable to the receptacle labelled DC POWER at the back of the CMRV-4500 unit (see figure, previous page). This connection provides power to the thermoelectric cooling modules.

Insert the power cable for the Air/Water Heat Exchanger into the receptacle on the Exchanger rear panel. Secure the power cable in place by tightening the Phillips screw on the cable clamp.

Make sure the Air/Water Heat Exchanger power switch is in the *OFF* position; then insert the power line cord from the Exchanger into an appropriate power source for your unit.

Before providing mains power to the unit, check the label on the rear panel of the Exchanger to verify that the electrical specifications for the unit match those of the power supply.

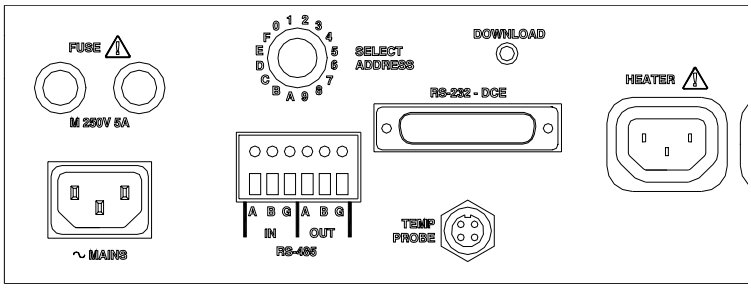


Figure 11: CMRV rear panel

Attach the M-F three-prong connector cable from the Exchanger PUMP outlet to the PUMP receptacle on the CMRV-4500 controller (see figures on pages 12-13). This power connection permits CMRV-4500 control of pump operation.

Thermistor

Insert the Lemo® plug from the temperature probe into the jack marked TEMP PROBE on rear of the CMRV controller (see *Figure 11*). Insert the probe tip as far as it will go into the hole marked THERMISTOR on the rear of the CMRV-4500 chassis.

Heater

Insert the heater plug from the upper section of the CMRV-4500 housing into the HEATER receptacle on the rear panel of the CMRV controller.

CMRV-4500 power cord

Make sure the CMRV-4500 power switch is in the *OFF* position. Then insert the power line cord from the rear panel of the CMRV controller into an appropriate power source for your unit

Before providing mains power to the unit, check the label on the rear panel of the Exchanger to verify that the electrical specifications for the unit match those of the power supply. Use only the supplied, approved appliance cords for the CMRV.

Serial connections

To connect a single CMRV-4500 instrument to the host computer, connect the computer cable to the RS-232, DB-25-pin socket at the rear of the CMRV-4500 controller and secure the cable connection with the two small screws on the ears of the plug. Attach the other end of the cable to the RS-232 port at the rear of your computer.

NOTES

COM 2 and COM 4 use the same IRQ settings on most computers, meaning that they cannot be used simultaneously. The COM 1 and COM 3 ports have the same problem. Do not try to use a device on COM 4 if you are using COM 2 for the CMRV instrument.

Some display adaptors (in particular, S3, 8514A and ATI mach 8) have an address conflict with COM 4 ports. If this is the case, you may need to use another COM port or replace your current display adaptor.

RS-485 serial connections

To install multiple CMRV units using RS-485 serial cable connections, see the multi-unit configuration instructions in APPENDIX D.

Pulley-wheel installation

To install the pulley-wheel assembly atop the CMRV:

1. Remove the left screw from the front of the upper panel (see photo). This will provide clearance to install the assembly on the slide track.

Removing screw to install pulley wheel

CAUTION *Use care in handling the pulley-wheel assembly to avoid damage to the wheel or the movement sensor.*

2. Install the pulley-wheel assembly by sliding it onto the left end of the slide track with the pulley-wheel facing out (see photo).

CAUTION *Make sure that the assembly is seated securely on the track.*

Pulley-wheel assembly mounted on slide track

3. Replace the left front screw. This will prevent the assembly from sliding off the track.
4. Plug the free end of the pulley-wheel sensor wire into the jack labelled WHEEL on the front of the CMRV-4500 controller.

NOTE *To disconnect the sensor, pull it out by the knurled portion of the plug.*

Installation notes

Download button

The CMRV-4500 is capable of receiving firmware updates from the computer via the DOWNLOAD button on the rear of the electronic chassis. Should such an update be required, ***CANNON***® will provide detailed instructions regarding the download procedure for updating the firmware.

NOTE *If the* DOWNLOAD *button is pressed inadvertently, switch off the CMRV-4500 power for at least four seconds, then restore power to the unit.*

Setting the CMRV instrument address

Address selection knob

When installing/connecting a new CMRV instrument, you must set the instrument address using the SELECT ADDRESS dial on the rear of the CMRV controller. This dial offers 16 settings (0-9, A-F).

Procedure

To set the address, rotate the dial (see photo) to a setting not currently in use by other CMRV instruments.

CAUTION *The MRVW software will not function correctly unless each networked CMRV instrument is set to a different address (see APPENDIX D for multi-unit configuration).*

Cleaning the instrument housing

CAUTION *Before cleaning the CMRV housing, turn off the instrument and unplug the power cord. Do not clean the instrument unless the cell temperature is within 10°C of ambient.*

Periodically clean the outside of the unit with a damp cloth moistened with water and/or a mild detergent solution.

Flushing and draining the Air/Water Heat Exchanger

The water-antifreeze mixture should be replaced annually for reliable performance and to prevent corrosion of internal components. Do not mix antifreeze types in the Air-Water Heat Exchanger.

To flush fluid from the Exchanger and CMRV-4500, obtain replacement antifreeze, a funnel, a drain bucket and a supply of warm water. Then complete the following procedures:

Flushing fluid from the Exchanger

Removing the Exchanger tubing connection

1. Turn off the Heat Exchanger power switch to remove power from the Exchanger.
2. Detach the quick-connect fitting securing the tubing from the CMRV-4500 to the IN connection on the Exchanger (see photo) by pushing down on the release button while pulling the hose connection out. Place the tube end in the drain bucket and pull the hose off of the ribbed section of the fitting. Fluid will begin draining from the CMRV-4500 and Exchanger.
3. Open the lid of the Exchanger reservoir and place the funnel in the opening.
4. Turn on the Exchanger power switch to engage the Exchanger circulating pump. Fluid from the Exchanger and CMRV-4500 will flow into the drain bucket.
5. Immediately begin adding warm water to the Exchanger reservoir through the funnel and continue as it is pumped out into the drain bucket until the water exiting the drain hose into the drain bucket flows clear.
6. Stop adding water to the reservoir and immediately turn off the Heat Exchanger power switch.

CAUTION *Do NOT permit the Exchanger pump to operate without fluid in the system. Doing so will damage the pump.*

7. Replace the connector on the Exchanger hose, and reattach the connector to the fitting on the Exchanger (see photo).

Draining fluid from the Exchanger

After the antifreeze mixture has been flushed from the Air/Water Heat Exchanger per the preceding procedure, drain the system as follows:

1. Make certain that the Heat Exchanger power is OFF, then remove the external housing from the Air/Water Heat Exchanger by removing the six screws securing the housing to the sides of the frame (three screws on each side of the unit) and the six screws on the top and sides of the rear panel.
2. Locate the twin stopcocks at the top and bottom of the radiator (see photo, next page). Attach a drain hose to the bottom stopcock and place the opposite end of the hose in a drain bucket.
3. Open the top and bottom stopcocks by turning them parallel to the nozzle and permit water to drain from the radiator. Then close the stopcocks and remove the drain hose from the bottom stopcock.

NOTE *A small amount of water/antifreeze mixture may remain in the tubing leading from the external connector to the reservoir. If desired, this fluid may be drained by pulling the hose off of the ribbed section of the quick-connect fitting previously installed. Reattach the tubing before completing the remainder of this procedure.*

Heat Exchanger with housing removed and stopcocks highlighted

4. Replace the external housing on the Air/Water Heat Exchanger and secure it with the six screws previously removed. If necessary, reseat the gasket around the reservoir opening with a small screwdriver.
5. Add water-antifreeze mixture to the Exchanger per the earlier instructions in this chapter to complete the water-antifreeze flush and drain procedure.

FHP MOTOR

NOTES

For rountine maintenance and improved bearing life expectancy, a few drops of non detergent "twenty weight" oil can be added every 12 months.

Fans should be cleared of dust/other material on a regular basis.

CHAPTER 5

VISCPRO® INSTALLATION

VISCPRO® for Windows® XP®

VISCPRO® is a powerful new software product providing a generic instrument interface for controlling and operating your ***CANNON***® instrument(s) via computer. VISCPRO® also includes reporting/analysis modules for processing and displaying sample data.

Installing VISCPRO® software

To install the VISCPRO® software, follow the instructions below in the sequence presented. Make certain that you complete the sections on checking instrument settings and calibration data. If you encounter difficulties at any stage in the installation process, call ***CANNON***® service at 814-353-8000.

Computer requirements

IBM-compatible computer with pentium processor and Windows® XP® installed and operating normally • SVGA compatible display • 32 MB RAM • 200 MB hard disk space • CD-ROM drive • serial port

Windows® XP® installation

1. Turn on your computer. Wait for the Windows® software to load.
2. From the Windows® Start Bar click Settings/Control Panel. Insert the first VISCPRO® installation CD-ROM into the disk drive.
3. Double-click the Add/Remove Programs icon and follow the Windows prompts to complete the installation procedure. The executable file for VISCPRO® software installation is SETUP.EXE.

Installation actions

The installation program will:

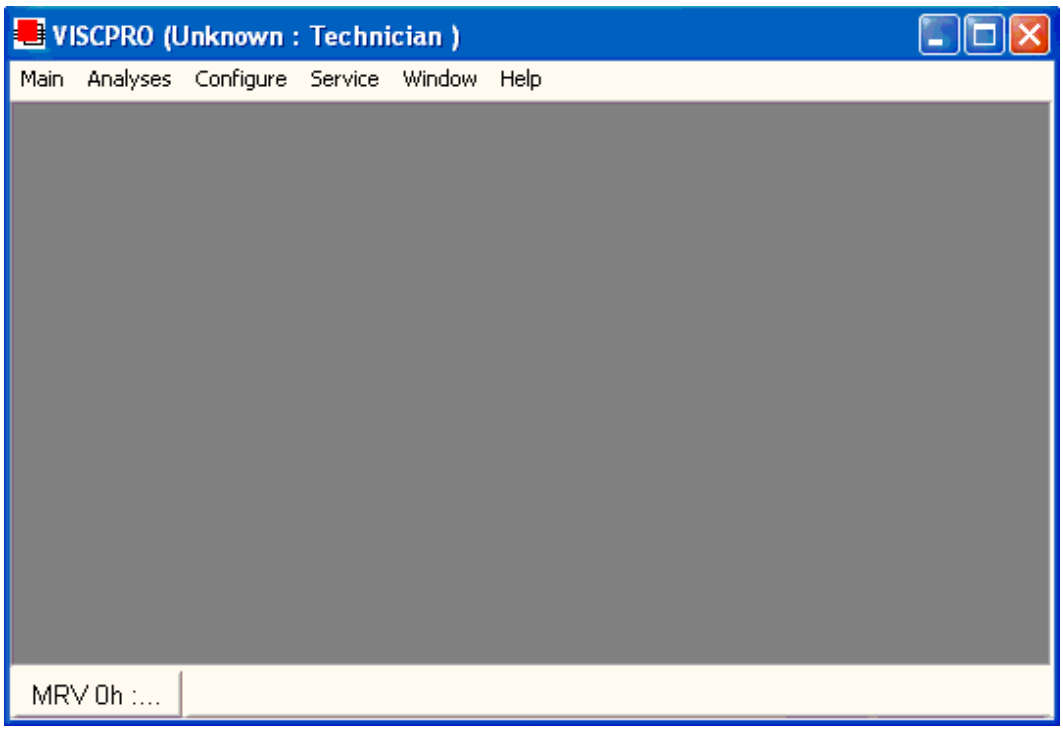
- create a directory for your data files. The default directory is C:\Program Files\Cannon Instrument\VISCPRO).
- write SETUP information to the Windows® registry.
- copy the software executable file and other necessary files to the directory you specify.
- update other files in your Windows® directories to versions fully compatible with the current VISCPRO® software.
- place a shortcut icon for the VISCPRO® executable file on your Windows® desktop.

Running the software

Loading software

Make certain that your CMRV instrument is properly connected to your computer and the CMRV power switch is ON. Then start the VISCPRO® software by double-clicking the VISCPRO® icon on your Windows® desktop. Or click Start/Programs/VISCPRO/VISCPRO.EXE).

Right now, your computer monitor should look like this:

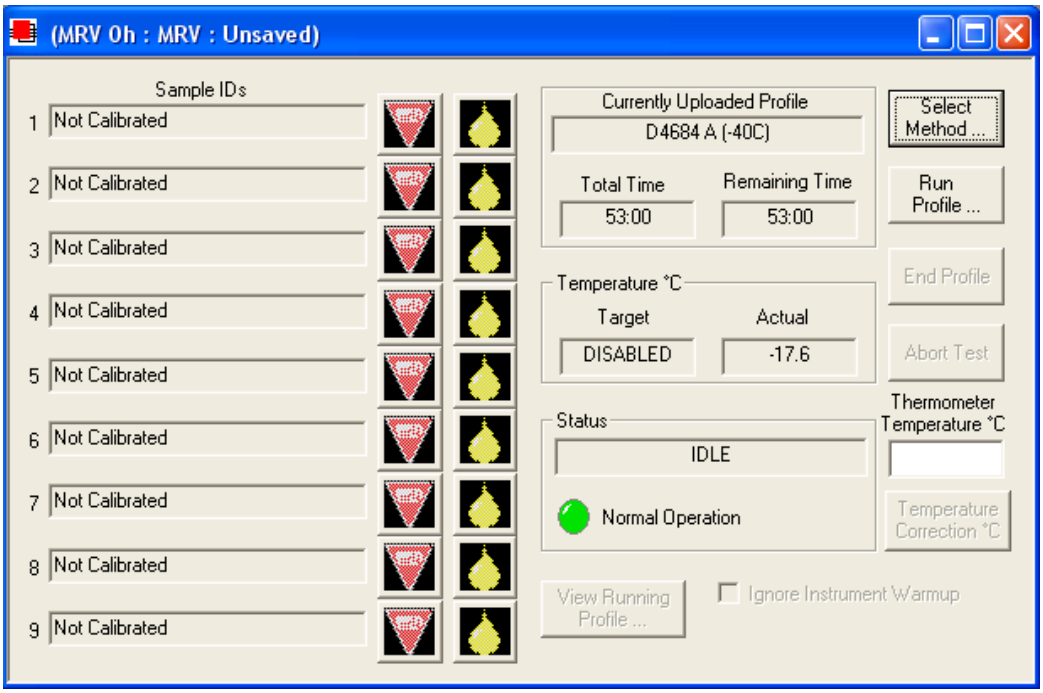


The VISCPRO® primary display

The VISCPRO® primary display window is framed on the top by the VISCPRO® title bar and menu bar, and on the bottom by the VISCPRO® status bar.

Displaying the Instrument View window

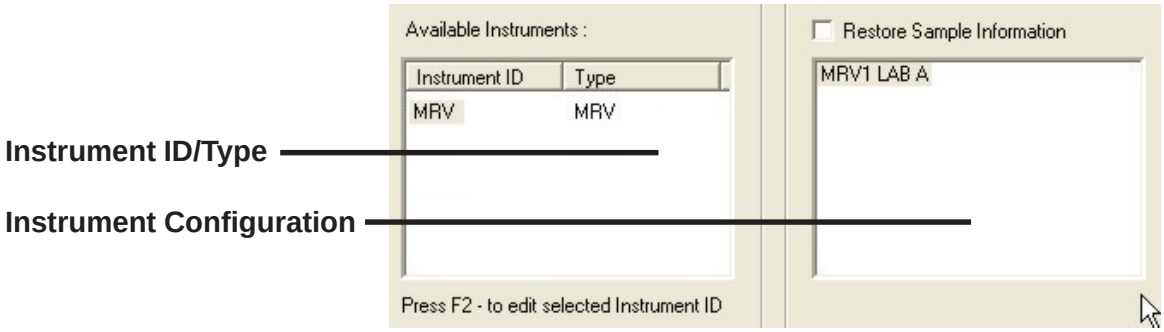
The application window can be configured to display child windows, such as the Instrument View window, which describes your ***CANNON®*** instrument and provides controls for running tests:



The Instrument View window

NOTE

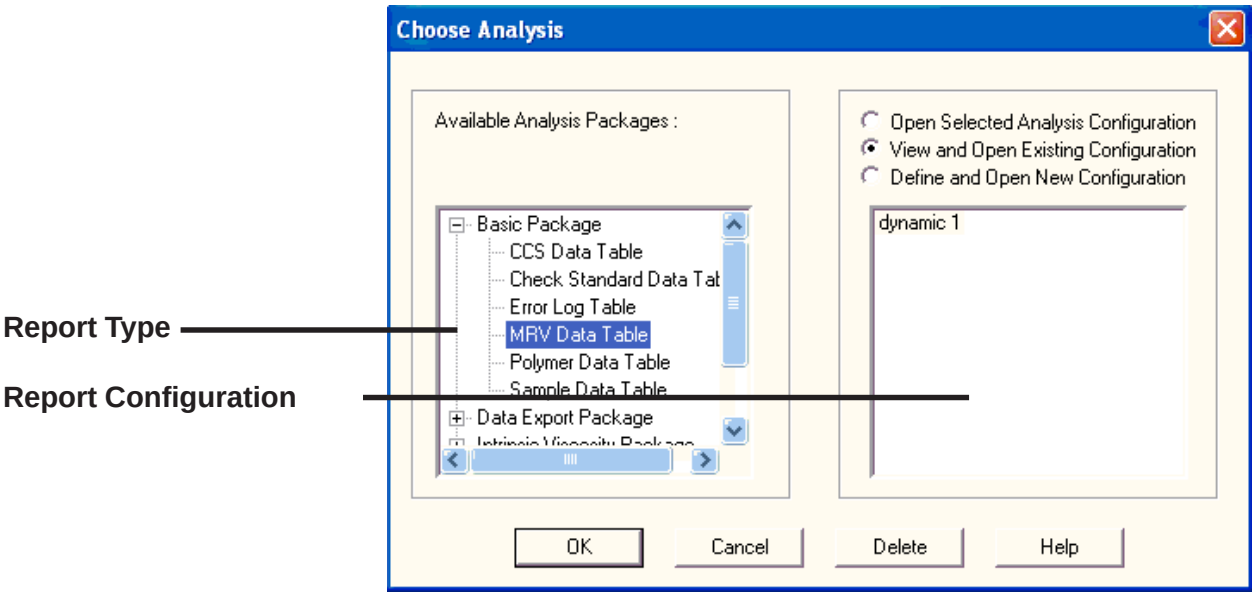
To display the Instrument View window, click View Instrument *from the Main menu. The View Instrument window will appear. Then click the* ***MRV*** *instrument ID to display the list of available configurations. For now, select the default configuration and click* OK.



If the Available Instruments *list box is blank, your instrument(s) may not be on-line. Check cable connections and make certain the instrument power switch is ON.*

Viewing report data

After you have completed CMRV calibration and testing (see next chapters), you will be able to display a report window with CMRV-4500 test results. To access the database and display test data, click Analyses/ View Analysis. Then select MRV Data Table from the list of available analyses:



The Choose Analysis window

Choose the desired report configuration from the list of available configurations and then click OK to open the Analysis Configuration window. Then select report configuration options (see Chapter 13 for more information) and click OK to generate the analysis from existing sample data. If the report window is blank, you may have to change the Date Filter options to include the desired range of samples from the database.

Archive data.MRV Data Table

Sample ID	Test Date	Test Time	Cell Num	Yield Stress(Pa)	Viscosity(mPa·s)	Temp Data File
MRV Test 1	4/5/2002	19:45:25	1	N/A	31137	99565548.TTD
MRV Test 2	4/5/2002	19:47:25	2	N/A	31657	99565548.TTD
MRV Test 3	4/5/2002	19:49:25	3	N/A	31284	99565548.TTD
MRV Test 4	4/5/2002	19:52:25	4	N/A	31114	99565548.TTD
MRV Test 5	4/5/2002	19:54:25	5	35 < Y <= 105	N/A	99565548.TTD
test 1	3/18/2003	14:07:48	1	35 < Y <= 35	N/A	101302520.ttd
test 1	3/18/2003	14:09:18	1	N/A	3717	101302520.ttd
test2	3/18/2003	14:11:57	2	35 < Y <= 35	N/A	101302520.ttd
test2	3/18/2003	14:12:22	2	N/A	3773	101302520.ttd
test3	3/18/2003	14:14:33	3	35 < Y <= 35	N/A	101302520.ttd
test3	3/18/2003	14:15:09	3	N/A	7831	101302520.ttd
test4	3/18/2003	14:16:04	4	35 < Y <= 35	N/A	101302520.ttd
test4	3/18/2003	14:16:28	4	N/A	3777	101302520.ttd

Idle

The Sample Analysis Table window

Checking Configuration data

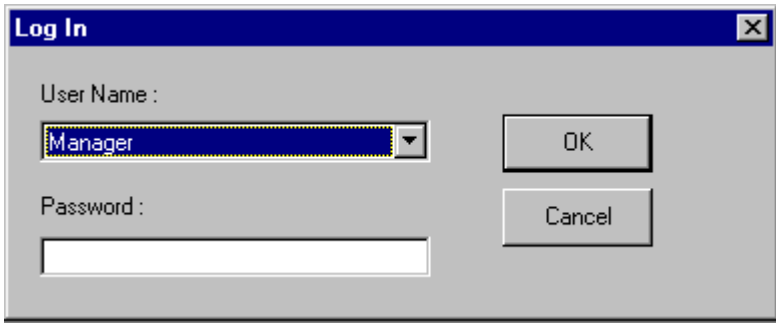
Follow the procedures in the next several sections of this chapter to select and verify the instrument and calibration settings to ensure that they conform to the actual characteristics of your ***CANNON***® instrument.

Configuration protection

To check the configuration settings for your instrument(s), you must log in to the security system as a manager. The software is installed with a default Manager account. This account has no password, allowing any operator access to manager-level software functions as long as the password is not activated/changed. If you would like to engage the full-release security options, see *Security Options*, this chapter, for instructions.

Logging in

1. Use your mouse to click Main from the VISCPRO® menu bar.
2. Click Log In from the Main menu options.
3. Click on the (arrow) on the right side of the User Name: list box to display the list of registered users.
4. Click Manager. Do NOT enter a password!

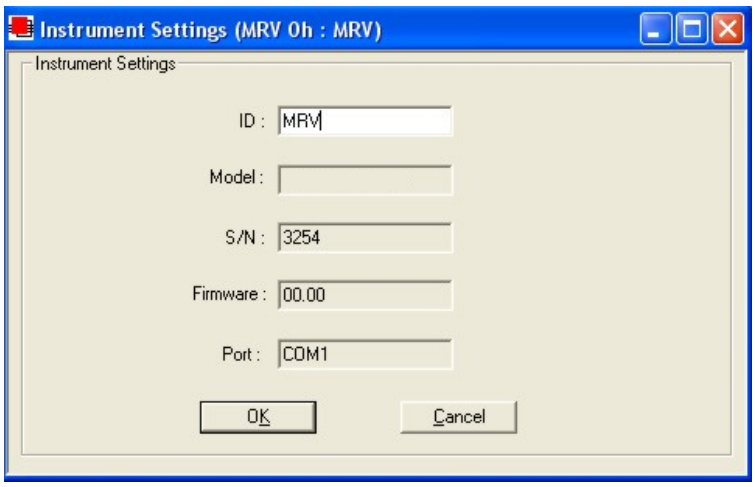


5. Click OK. The Log In window will close automatically and you will be logged in as management personnel.

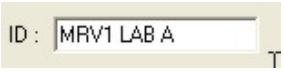
Checking Instrument Settings

1. Use your mouse to click (select) Configure from the VISCPRO® menu bar.
2. Select your instrument from the list of available instruments (there may be only one instrument in the list).
3. Select Instrument Settings from the list of configuration options. The Instrument Settings window will appear.

You will use the Instrument Settings window (see graphic following) to describe and control MRV instrument operational features. These settings affect the instrument as a whole. Check the instrument settings for your instrument per the instructions, and make any necessary changes:



The Instrument Settings window



4. Use the ID field to input instrument identification information using up to 30 alphanumeric characters.

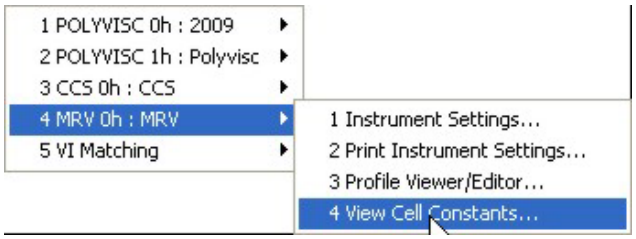
   The remaining fields in the Instrument Settings window are non-editable (information is obtained via serial communication with the CMRV instrument). The Model: field will indicate the model of your instrument. The S/N: field indicates the serial number from the label on the rear service panel. The Firmware: field indicates the version for the current instrument firmware. The Port: field indicates the current communications port for the RS-232 cable connecting your computer to the CMRV-4500 instrument.

5. When you have entered all settings, click OK.

Checking initial calibration

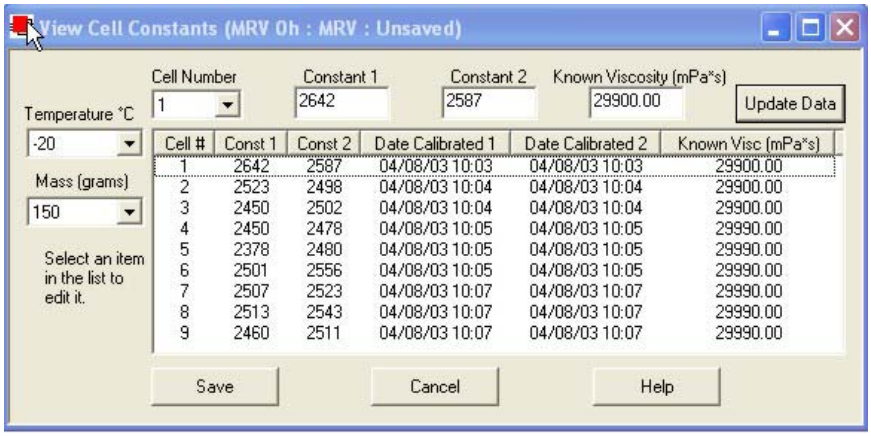
After you have completed the CMRV instrument calibration for temperature and cell constants (see following chapters), follow the procedure below to verify the initial calibration settings.

1. From the VISCPRO primary window, click Configure/MRV/View Cell Constants. The View Cell Constants window will open.



2. Ensure that Calibration data, including constants and viscosity, is available for each cell. Then click OK to close the View Cell Constants window.

NOTE *Some fields/options are security-protected, and may not be viewable.*



The View Cell Constants window

3. Click Configuration/Print Instrument Settings to open the Windows® Print window. Select the desired printer and click OK to print current calibration settings.

NOTE *CANNON recommends printing calibration settings each time the calibration values change.*

Setting multiple CMRV instrument addresses

When installing/connecting multiple CMRV instruments, ensure that the instrument address for each instrument is different. See APPENDIX D for more information on multi-unit configuration.

Security options

The VISCPRO® application offers a level-based security system with a log in procedure. This system ensures that available software functions are appropriate for the user's needs.

Following initial installation of the software, security options may be accessed and changed from the VISCPRO® Main menu by individuals who have the manager password (initially blank).

Each user can be assigned a security level, which is used to determine permitted operations. Three security levels are defined by the software: *Technician* (least privileged), *Manager* (intermediate privilege), and *Service* (maximum privilege–reserved for ***CANNON***® Instrument Company service personnel).

Users log in when using the software by typing their name and (optional) password in the Log In window. Different security levels offer different instrument use options. Technicians are permitted to access operational

features required for testing samples and performing other routine operations. Managers may access advanced configuration and reporting options. The Service level permits access to all instrument and security parameters.

Initial security setup

The VISCPRO® software installation creates a security account for one manager with a blank password. After VISCPRO® installation, a password should be assigned for the manager using the Change Password menu option from Main. Managers may add or change accounts for technician status personnel.

Log In...

Use the Log In feature to identify the CMRV operator and/or access security functions.

NOTE

Once an operator is logged in, that operator's name is associated with any sample data obtained during that VISCPRO session. The operator name may be included in analyses.

Procedure

1. Click Log In from Main.
2. Select the desired name from the drop-down list box.
3. Type the desired password in the Password field for the individual selected.
4. Click OK.

Change Password...

Use the Change Password feature to change the current user password.

Procedure

1. Log in to the VISCPRO® software using the Log In command from Main.
2. Select Change Password from the Main menu options.
3. Type in the new password in the Password field.
4. Retype the password in the Confirm Your New Password field.
5. Click OK to save the new password and close the Change Password window.

Update User Information...

Use the Update User Information feature to update the security list of authorized technicians and managers. User information can only be updated by an individual logged in with a higher security clearance than the user for which information is to be altered. Manager status is necessary to change Technician information. Service status is necessary to change Manager information. To obtain Service status, it is necessary to select user CANNON Instrument Company from the Log In window and to type in the current ***CANNON***® password. For the current password (updated daily), call ***CANNON***® at (814) 353-8000.

Procedure

1. Click Log In from Main.
2. Select your Manager or Service level user name from the User Name list box. Input the correct password in the appropriate field.
3. Click OK.
4. Click Update User Information from Main.
5. Select the desired user from the User Name list box.

NOTE *To delete a user, just click* Remove User *after selecting the user name. The account will be immediately and permanently removed.*

6. Enter and verify the desired password, and select user security status using the appropriate list boxes.
7. Retype the password in the Confirm Password field.
8. Click Add or Update User to save your changes.
9. Click Done to exit the Change User List window.

Log Out

To use the Log Out feature, click Log Out from Main. The current user will be logged out of the security list of authorized technicians and managers. The software will automatically reset to the lowest security level. Any ongoing test operations will continue.

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CHAPTER 6

PREPARING FOR CMRV TESTING/CALIBRATION

The procedures in this chapter should be followed when preparing for CMRV-4500 testing or calibration.

NOTE *In the event that the protocols of your ASTM test method differ from any of the procedures outlined in this manual, the ASTM method should take precedence.*

A/W Heat Exchanger

To prepare for operation of the CMRV-4500 unit, turn on the POWER switch on the upper rear panel of the Air/Water Heat Exchanger.

Checking thermometers

The ice point of the CMRV-4500 thermometers should be checked periodically at 76 mm immersion, which corresponds to the depth of immersion in the CMRV-4500 aluminum block.

Small deviations in the ice point (less than 0.4°C) should be noted and added to (or subtracted from) calibration readings at all other temperatures (See section on temperature calibration). If corrections larger than 0.4°C are needed, there may be a problem with the thermometer. Examine the thermometer for a bubble of gas in the lower reservoir, a bubble of mercury in the upper reservoir, or a break in the mercury column. For information on joining separated mercury columns see APPENDIX C.

Cleaning cycle

Clean the rotors and all nine viscometric cells as described in the following procedure.

CAUTION *When handling the rotors, be careful not to damage the rotor tips. Damage to the tips will cause erroneous test results and may damage the cells.*

CAUTION *When operating the CMRV, make sure that the rotor and cell numbers coincide (use the #1 rotor in cell #1, the #2 rotor in cell #2, and so on). Failure to do so may diminish test accuracy and void the cell calibration constants.*

Cleaning procedure

1. Remove the Plexiglas® cover from the CMRV-4500 and place it away from the cleaning solvents.

CAUTION! *Exposure to acetone liquid or acetone vapor may damage the cover.*

2. Turn on the CMRV-4500 (the green power indicator on the switch will light and the left panel lights will flash once).

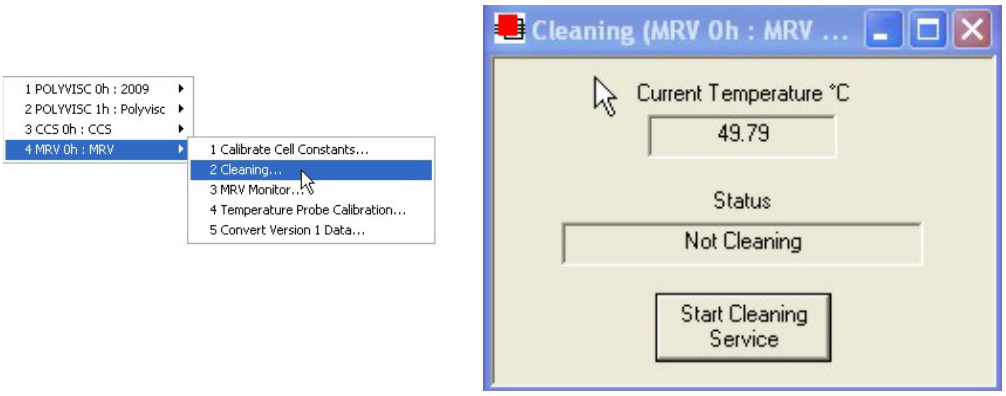
NOTE *The CMRV cleaning procedure may be initiated from a "cold" CMRV; however, a calibration or profile should not be initiated until the instrument has completed a warmup period of approximately 45 minutes. If the warm-up period is less than 45 minutes, the instrument may not control temperature within acceptable tolerance parameters.*

3. Assemble the necessary cleaning supplies:

- oil solvent
- acetone (optional during low humidity)
- suitable solvent-resistant container for placing/cleaning rotors
- vacuum w/trap for solvent and oil
- flexible tube, about 150 mm long and 3-5 mm in diameter, connected to the vacuum trap
- two plastic squeeze bottles, each with an extension long enough to be able to direct oil solvent and acetone directly into the cup of the viscometer cells

4. Start the VISCPRO® software.

5. Click Service/MRV and select the Cleaning ... option to open the Cleaning Service window. The window displays the current CMRV block temperature for the selected instrument, as measured by the temperature probe. The window also indicates the current instrument status.



The Cleaning Service window

6. Click Start Cleaning Service. to initiate the cleaning cycle. The instrument will be heated to 50°C for convenient cleaning.

7. Remove the threads from the rotors and set the threads aside.

NOTE ***CANNON®** recommends hanging the threads on individual hooks during cleaning. Hanging a paper clip on each loop reduces the chance of curling.*

8. Wait for the CMRV-4500 to reach the cleaning temperature.

NOTE *When the CMRV-4500 cleaning cycle is activated, the internal heater raises the viscometer block temperature 2-3°C per minute to approximately 50°C. Precise temperature control is not necessary for cleaning.*

9. When the CMRV-4500 has reached cleaning temperature remove the rotors and wipe excess oil from them. Gently place the rotors into a solvent-resistant container, such as a 500-ml glass beaker.

CAUTION *Be careful not to damage the rotor tips when handling the rotors.*

10. Use a vacuum to remove oil from the viscometric cells.
11. Thoroughly rinse the inside surfaces of each cell at least twice with oil solvent using a squeeze bottle with a length of plastic tubing attached to the nozzle (see photo). Direct the stream from the spray bottle in such a way that the liquid swirls around the inside walls of the cell.

Solvent cleaning of CMRV test cells

WARNING *Your solvent may be a hazardous substance. Use in accordance with procedures recommended by your Material Safety Data Sheet (MSDS). Avoid contact with skin and eyes. Avoid inhaling vapors. Use only in a well-ventilated area.*

12. Use vacuum to remove the solvent from the cells after each rinse.
13. Repeat steps 11-12 using acetone in place of solvent.

WARNING *Acetone is a hazardous substance. Use in accordance with procedures recommended by your Material Safety Data Sheet (MSDS). Avoid contact with skin and eyes. Avoid inhaling vapors. Use only in a well-ventilated area.*

14. After the final rinse, allow the acetone to evaporate from the viscometric cell until the surfaces are completely dry.

Cleaning rotors

15. Thoroughly rinse each rotor individually with oil solvent, then with acetone. Properly dispose of waste liquid after cleaning.
16. After the final acetone rinse, place the rotors in a clean, dry area until the remaining solvent on rotor surfaces has evaporated.

17. When you have finished cleaning the viscometer cells and rotors, click Stop Cleaning Cycle. Then click ☒ to exit the Cleaning ... window.

NOTE *After the cleaning cycle, you should permit the cells and rotors to dry for 15 minutes before introducing oil sample into the viscometric cells.*

Inserting rotors

The viscometric cells are numbered from left to right when looking at the viscometer from the pulley-wheel side, with cells 1, 3, 5, 7, and 9 in the front row and cells 2, 4, 6, and 8 in the back row. Each rotor is identified by the number at the top of its shaft.

1. Rotors are normally stored in the integral storage drawer. When you are ready to begin a temperature profile, inject the sample and gently place each of the nine numbered rotors into their corresponding viscometric cells.

⚠ **CAUTION** *Do NOT drop the rotors into position or you may damage the rotor tips.*

Inserting rotor pins

2. Align the rotor beneath the corresponding hole in the upper bearing plate.

NOTE *The upper bearing support should have approximately 1 to 2 mm (1/32 to 1/16 inch) clearance above the top of the rotor shaft. If the rotor tip is not seated properly, there will not be enough clearance between the top of the rotor shaft and the upper bearing plate to permit orientation of the rotor under the bearing plate.*

3. Insert the pin through the plate and into the center bearing hole at the top of the rotor shafts.

NOTE *The pins, when inserted through the upper bearing plate, should extend approximately 3 mm (1/8 inch) below the plate.*

Checking rotors

4. Make sure that the rotor locking pins are in the raised (detent) position. Rotate each of the rotors to ensure that it spins freely and without signs of binding at either bearing.
5. Remove the rotors from the viscometric cells.
6. If necessary, install the pulley-wheel assembly on the slide track. See Chapter 4 for details.

Sensor connection

7. Make sure that the free end of the sensor wire from the pulley-wheel assembly is plugged into the receptacle marked WHEEL on the CMRV-4500 front panel.

You are now ready to perform the CMRV-4500 calibration procedure or run a test sample using the applicable test methods or a custom profile. See the appropriate chapter for further instructions.

CHAPTER 7

CALIBRATING THE CMRV TEMPERATURE PROBE

The CMRV temperature probe must be calibrated before performing the initial cell calibration or running temperature profiles. A complete **calibration session** involves setting temperature offsets in the VISCPRO software for key temperature checkpoints beginning at 80°C, then 50°C, then other temperatures at 5-degree increments from 0 to -40°C. The calibration process ensures that temperature probe readings are correctly interpreted by the CMRV hardware and software. This ensures accurate temperature control throughout the temperature profile.

There is a 10-minute equilibration time at each calibration temperature. The entire calibration procedure requires at least 3 hours and requires operator input at each temperature plateau. Thereafter, the probe should be calibrated at the user's discretion, particularly when viscosity data is suspect, the instrument exhibits poor repeatability, or the probe temperature on the display does not correspond with the calibrated thermometer reading.

Both the CMRV *probe* calibration and *cell* calibration procedures should be completed shortly after initial installation of the CMRV software. Probe calibration must precede cell calibration to ensure accurate temperature control during the cell calibration process. Periodic probe calibration will enhance the accuracy of test results.

Probe calibration procedure

1. After preparing the CMRV instrument (see Chapter 6), place 10 ml ± 0.1 ml of any clean generic oil sample into each of the viscometric cells being calibrated. Carefully place the rotors into their corresponding viscometric cells and secure each rotor in position with the rotor pin.

Checking temperature probe

2. Make sure that the thermistor probe sheath is securely seated in the cylindrical opening on the rear of the CMRV housing.

3. Using the VISCPRO® software, click Service/MRV/Temperature Probe Calibration. The Temperature Probe Calibration window will open.

NOTE

In preparation for the heating phase of the calibration procedure, remove the calibrated -46°C to +30°C thermometer from the CMRV block to prevent separation of the mercury column. Reinsert the calibrated thermometer when CMRV block temperature is within its range.

4. Select the desired temperature for calibration by clicking on the thermometer graphic or selecting the temperature from the drop-down box. Then click the Calibrate button to begin the calibration

NOTE *In each calibration session, the **initial** probe calibration must be performed at 80°C (see procedure below) before calibrating at other temperatures. When prompted by the VISCPRO software: "Do you want to zero the offset at 80°C before calibrating?", click YES the first time in the session that you attempt to calibrate at 80°C. Thereafter, click NO unless you would like to start the calibration over from the default offset value.*

The CMRV unit will begin heating or cooling to the desired temperature. When it reaches temperature, a 10-minute timer will start. This delay allows the CMRV temperature to stabilize at the calibration temperature. Note that more time may be required for stabilization at 80°C, 50°C and 0°C. After the timed delay, the Thermometer Temperature °C field will become active, enabling data entry.

5. After the instrument reaches the probe calibration temperature and completes the temperature stabilization period, type the actual temperature from the reference thermometer in the Thermometer Temperature °C field. Then click the Accept button to store the temperature calibration offset to the current instrument configuration.
6. Click the Calibrate button again to reset the timer and check the calibration for that temperature. If the reference temperature varies from the displayed temperature, repeat steps 5 & 6.

NOTE *Make certain to use the "-" key when entering a temperature below 0°.*

7. Repeat steps 4 through 6 for each desired calibration temperature. Then click ☒ to exit the Temperature Probe Calibration window.

NOTES *Make certain to SAVE the instrument following a successful calibration (File/Save Instrument). You should also print an archive copy of calibration data (click Configure/MRV/Print Instrument Settings). A partial calibration session may enable you to run some profiles as long as the coldest calibration offset is 5° lower than the lowest profile temperature.*

Manual restoration of voltage and offset data

If the VISCPRO database is corrupted, or if temperature calibration data is lost for any other reason, voltage and temperature offset values may be manually restored without recalibrating the instrument. Existing data can be viewed by clicking Service/MRV/Temperature Probe Calibration. When the user is logged into VISCPRO as a Manager, the Temperature Probe Calibration window displays additional security-protected controls for manual adjustment/restoration of voltage and offset values obtained during the probe calibration.

To manually adjust temperature offsets or voltage reference values, log into the VISCPRO software as a Manager. Then open the probe calibration window (Service/MRV/Temperature Probe Calibration). The Reference Supply Voltages and offset fields will now be editable. Use your printed copy of the most current instrument settings to determine appropriate values and input the values in the indicated fields. Click OK when the values have been entered correctly. Then click the Accept Manually Entered Offsets and Voltages button.

CHAPTER 8

CALIBRATING THE CMRV CELLS

Initial calibration

To ensure the accuracy of sample data, the CMRV-4500 cell calibration procedure must be completed after initial installation of the software. First complete the temperature probe calibration (see previous chapter) and instrument preparation (Chapter 6). Then follow the procedure in this chapter to calibrate the CMRV cells.

Frequency

After the initial calibration, ***CANNON***® recommends that the cells be calibrated every 4-8 weeks at the discretion of the user. Note that some ASTM methods may require multiple calibrations prior to sample testing. These ASTM profiles will not appear in the drop-down list until all calibration(s) required by the method is/are performed.

Calibration theory

Each of the nine viscometric cells must be calibrated to determine the relationship between viscosity, angular velocity of the rotor, and the applied mass.

The general calibration constant is determined from the following equation:

$$C' = \frac{r\eta}{(M-m)t'}$$

where C' = general calibration constant, millipascals (mPa)
r = number of full revolutions
η = known viscosity of calibration oil at the calibration temperature in centipoise (cP)
(1 centipoise = 1 millipascal second (mPa·s (cP))
M = applied mass, grams (g)
m = mechanical friction of bearings, grams (g)
t' = time for r revolutions in seconds (s)

When this test is run according to the applicable ASTM procedures, m is negligible relative to M, r = 3, and M = 150. Thus, for convenience, the calibration equation can be simplified as follows:

$$c = \frac{\eta}{t_{3r}}$$

where C = calibration constant for a specific cell for 3 revolutions at a mass of 150 g (mPa)

η = viscosity of the calibration standard (cP)
t_{3r} = time for 3 revolutions of the rotor (sec)

Cell calibration procedure

Calibration standards

CANNON® viscosity standard **N105B** is recommended for calibration at -20°C and -25°C. This calibration is required for running ASTM profiles included with the software. At -20°C, N105B has a nominal viscosity of 30,000 cP (mPa·s). At -25°C, N105B has a nominal viscosity of 56,600 cP (mPa·s).

It is also possible to calibrate the CMRV cells at -25°C using viscosity standard **N400B** with a nominal viscosity of 60,000 cP (mPa·s).

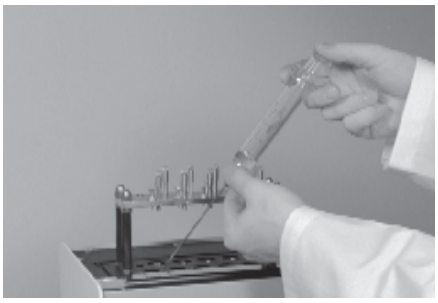
CANNON® Instrument Company can furnish viscosity standards for a variety of temperatures and viscosities. The CMRV-4500 can be calibrated over the viscosity range of 1 to 99,999 cP (mPa·s).

After you have prepared the CMRV-4500 for the calibration run (see Chapter 6) follow the procedure below to calibrate the CMRV.

Preparing the cells

Introducing sample

1. Place 10 ml of the calibration standard into each of the nine cells (see photo).
2. Carefully place the rotors in their corresponding viscometric cells, making sure that the rotor tip at the bottom of the shaft slides into the recess at the bottom of the cup. Do *NOT* drop the rotors into place.

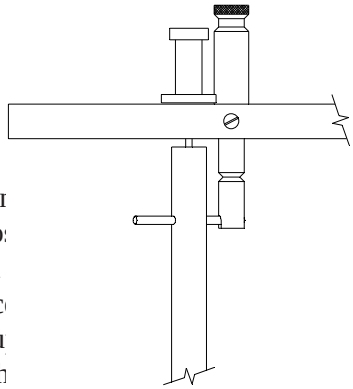


Injecting standard into CMRV test cells

3. Secure each rotor in position with a rotor pin, and make sure that the rotor locking pin is in the raised position.

Winding rotors

4. To wind the rotors in preparation for the cell calibration, slide the pulley-wheel assembly along the track until the pulley is aligned with the rotor to be wound. Use the engraved lines on the slide bar as a guide to determine the proper position of the left side of the pulley-wheel block.
5. Place the loop of a thread over the left end of the crossbar at the top of the rotor shaft.
6. Pass the free end of the thread (the end with the plastic ring) over the pulley-wheel and allow it to hang freely in front of the viscometer. While holding the rotor motionless, hook a light weight, such as a large paper clip, on the plastic ring to apply slight tension to the thread.
7. Guiding the thread with your finger, turn the rotor clockwise to wind the thread *above* the crossbar until the knot in the loop has been



wound around the rotor shaft. Then pass the thread below the crossbar and continue turning the rotor clockwise (as viewed from above) to wind 20 closely spaced turn thread around the shaft *below* the cro *without* overlapping the turns. About (8 inches) of thread will remain. Plac remaining length of thread over the u bearing support plate so it hangs to th the viscometer and secure the rotor in place by lowering the rotor locking pin over the rotor crossbar (see figure and photo). You may need to turn the rotor slightly to align the crossbar with the locking pin.

Wound rotor with cell caps in place

8. Repeat steps 4-7 for each of the remaining rotors/ cells.

Plexiglas® cover placement

9. Place the Plexiglas® cover in position over the top of the viscometric cells. The small hole which allows the -46 to 30°C thermometer to extend through the cover should be on the left when viewed from the front of the viscometer.

10. CMRV users following the ASTM D 4684 or ASTM D 3829 methodology should connect a flexible 3/16"-OD tube from their dry gas supply and regulator to the dry gas purge in the Plexiglas® cover. The tubing may be removed, along with the cover, prior to viscosity/yield stress testing.

11. Whatever the methodology, the purge should continue throughout the temperature profile using dry gas at a flow rate between 20 and 30 milliliters per minute.

CMRV with side-mounted dry gas purge

NOTES

To reduce the chance of separating the mercury column during the heating phase of the temperature profile, you may wish to initially remove the calibrated thermometer from the CMRV unit. Store the thermometer in a vertical position. You may replace the calibrated thermometer when the CMRV has cooled to 30°C or lower. If the thermometer is not in place during CMRV-4500 cooling, you should seal the thermometer well in the block and the thermometer hole in the Plexiglas® cover with stoppers, particularly when the humidity of the ambient air is high. This will help prevent frost buildup on the surface of the block and enhance temperature control.

Be sure the thread is properly wound around each rotor and the Plexiglas® cover is in place on top of the CMRV-4500 before proceeding with the test.

Cell calibration test procedure

Cell calibration

Use the VISCPRO® software to input calibration information as follows:

1. Load the VISCPRO software and make certain that the MRV instrument is listed on a button bar at the bottom of the Primary Window. If it is not, click Poll for Instruments from the Main menu to establish computer contact with the CMRV unit.
2. Click Service/Calibrate Cell Constants. The Calibration Parameters window will open.
3. Click the Temperature field and select the desired calibration temperature from the drop-down options.
4. Click the Mass field and select the correct value for the test mass.
5. Click the Known Viscosity field and input the known viscosity of the standard at the calibration temperature in centipoise (mPa·s).
6. Click the Calibrate ... button to open the Calibrate Cell Constants window. The CMRV-4500 will cool to the desired calibration temperature and maintain the temperature for one hour. When the instrument has completed the calibration profile, the Status field in the Calibrate Cell Constants window will indicate Ready to Calibrate.

Running a calibration test

7. Remove the Plexiglas® cover and align the pulley-wheel with the cell to be calibrated.
8. Place the thread from this cell over the pulley-wheel. Hook the calibration weight specified by the Method to the end of the thread (see photo).
9. From the Calibrate window, click the desired cell number for calibration.
10. Press the blinking Start Test button on the CMRV controller.
11. Raise the locking pin quickly and smoothly. The weight will apply torque to the rotor. The computer will record the time for three complete revolutions.
12. Permit the wheel to make at least three complete revolutions (the viscosity LED will go out). Then catch and remove the 150-gram weight before the thread is completely unwound. Do not permit the thread to completely unwind.

NOTE *After the rotor revolution time has been recorded, the program will calculate the calibration constant for that cell.*

13. At the conclusion of the test, the VISCPRO® software will display the newly-calculated calibration constants.

NOTE *If the new constants vary from the previous cell constants by more than 4 percent, an error will be generated. It is generally advisable to recalibrate the cell in this instance.*

NOTE *To view previously-stored calibration constants, click Configure/MRV/ View Cell Constants.*

14. Repeat the above calibration routine for the remaining cells.

Limiting calibration time

It is recommended that you perform the cell calibration immediately following the one-hour sample soak time. Although ***CANNON***® viscosity standards N105B and N400B have been dewaxed to a very low temperature, the standard should not be allowed to soak at -20°C for more than two hours. The small amount of wax which may be in the oil could cause an error in calibration.

NOTE *If any cell has a calibration constant more than 10 percent higher or lower than the average for the other cells, the fault may be excessive friction in the upper bearing, improper seating of the lower bearing, or a damaged rotor tip. Examine the rotor for damage and, if necessary, replace the rotor and recalibrate the cell.*

Saving calibration data

15. At the conclusion of the calibration, review the displayed data in the Calibrate Cell Constants window. If the data is not acceptable, recalibrate as necessary.

16. When acceptable values have been obtained, click Abort Temperature Control. Then click Save Data to save the new calibration constants. Do not omit this step or new calibration data will be lost.
17. Close the Calibrate Cell Constants window and then click Main/Save Instrument. The Save Instrument window will appear.
18. In the Save As box, input a name for the new instrument configuration (which includes the newly-calculated calibration constants). Then click OK to save the configuration.

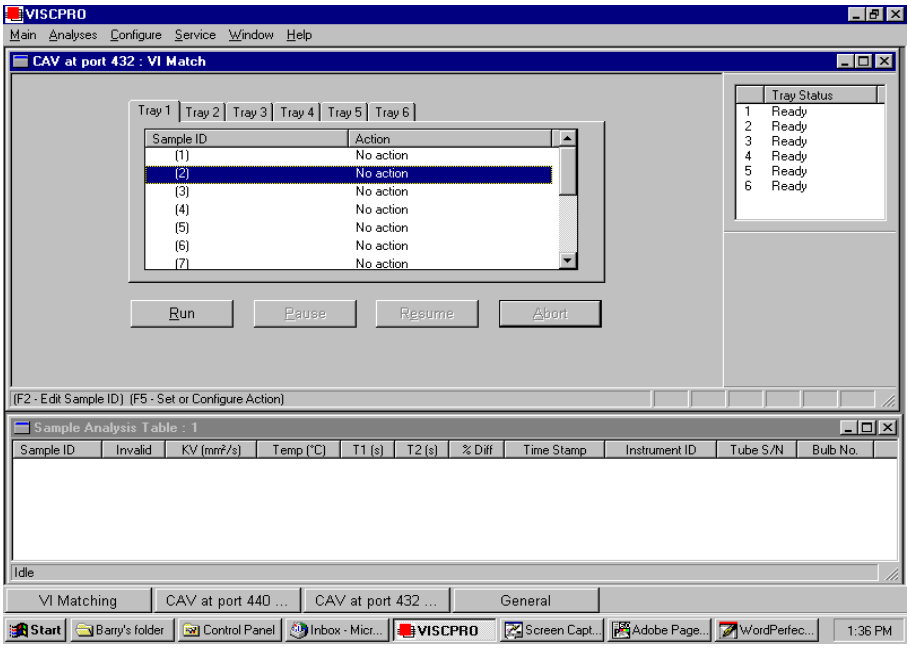
Printing calibration data

CANNON Instrument Company recommends generating a hard copy record of calibration data after each calibration session. To print the current calibration constants, click Configure/Print Instrument Settings.

CHAPTER 9 USING THE CMRV SOFTWARE

VISCPRO® generic instrument interface

Your software for Windows® 95/NT® is comprised of a generic instrument interface (VISCPRO®) and a collection of instrument/analysis-specific modules. This chapter of the manual will explain the software options for the VISCPRO® program and other modules commonly bundled with the instrument software. Additional software modules, customized software, and any documentation for add-on software options, are provided separately.



VISCPRO® primary display with menu options

HELP system

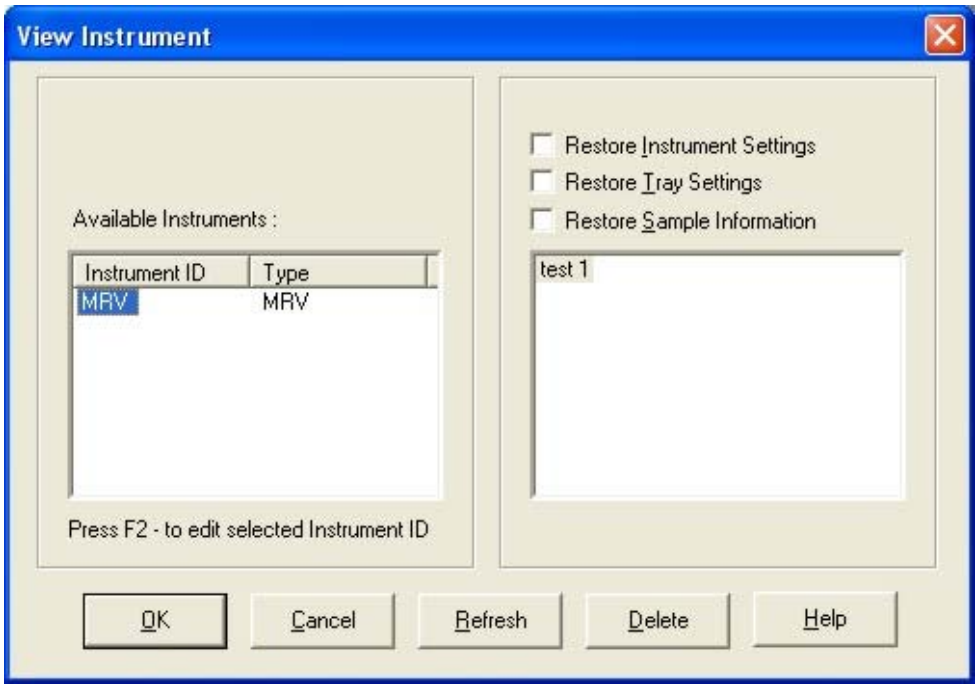
Your software supports a complete HELP system. To access HELP for the software, click the HELP option from the VISCPRO® primary display. For context-sensitive HELP support for your interface, press F1 or click on the HELP buttons provided.

NOTE *Because the VISCPRO® software is security-protected, some documented menu options may not be visible to technician-operators.*

Main options

View Instrument...

The View Instrument option opens the View Instrument window which permits you to view existing instruments and configurations. You may also select and restore elements from saved configurations for on-line instruments.



The View Instrument window

The View Instrument window is comprised of:

- Two list boxes (Available Instruments and Saved Configurations)
- Restore ... check boxes (the Restore Instrument Settings and Restore Service Settings options are password-protected managerial/service functions)
- Five button options (OK, Cancel, Refresh (screen refresh), Delete and Help).

Available Instruments: The Available Instruments list box in the View Instrument window displays a list of all on-line instruments for configuration. To view and/or select saved configuration options for an on-line instrument, you must first click on the desired instrument from the list of available instruments.

NOTE *To access the Instrument View window to enter sample information for the selected instrument WITHOUT restoring a saved configuration, click on the desired instrument, then click* OK *without checking any of the* Restore *options. The last-used configuration for that instrument will be retrieved.*

Saved Configurations: The Saved Configurations list box (located directly under the Restore . . . check boxes) allows you to make changes to the current configuration for any networked ***CANNON***® instrument by restoring any or all elements (Instrument, Tray or Sample) of a saved configuration. To restore saved configuration settings, select the instrument from the Available Instruments window and then click on the desired configuration from the list of saved configurations. Then click on the desired Restore ... options (see below) and click OK.

NOTE *If you wish to permanently delete a saved Configuration, highlight it and click the DELETE button or press the* Delete *key. Click Yes at the Confirm Delete prompt to immediately and permanently delete the configuration.*

Restore ... : The Restore check boxes allow you to restore Instrument, Tray or Sample information from the saved configuration for the selected instrument.

Click the Restore Instrument Settings check box if you want to restore all Instrument Settings for the highlighted saved configuration (see *Instrument Settings* section in this chapter). Instrument settings apply to the instrument as a whole.

Click the Restore Tray Settings check box if you want to restore all tray settings for the highlighted saved configuration. Tray Settings are common to other CANNON instruments but are not applicable to the CMRV instrument.

Click the Restore Sample Information check box if you want to restore all sample ID information for the highlighted saved configuration. Sample information includes individual sample IDs and actions.

View Instrument window button options:

OK	Opens the Instrument View window for the selected instrument and restores any selected configuration settings.
Cancel	Closes the View Instrument window.
Refresh	Updates the Available Instruments list box to include instruments which may have come on-line since the software was loaded.
Delete	Permanently and immediately deletes the highlighted instrument configuration (functions only when a configuration is selected).
Help	Accesses context-sensitive help.

Save Instrument...

The Save Instrument option opens the Save Instrument window. The Save Instrument window permits you to save all current instrument information for any selected instrument, including Instrument Settings, Tray Settings and Sample settings, to the database. Once saved, the instrument information may be restored at any time using the Restore options from the View Instrument window.

To use the Save Instrument window, select the desired instrument by clicking on the instrument name in the Available Instruments list box. Then enter a name for the configuration in the Save As: field.

NOTE

If you wish, you may choose to overwrite an existing configuration with current settings by clicking on the name of the existing configuration in the Configuration list box. The Configuration name will be transferred to the Save As: *field.*

Click OK to store the new configuration. To exit the Save Instrument window without saving the configuration, click Cancel.

Poll for Instruments

The Poll for Instruments option queries the hardware interface to establish communications with ***CANNON***® instruments attached to the host computer.

Use the Poll for Instruments option to establish a computer connection with instruments which may have come "on line" after the software has been in operation. When the connection has been verified by the controlling software via the hardware interface, the instrument name will be added to the status bar at the bottom of the VISCPRO® window.

Security options

The VISCPRO® application offers a level-based security system with a log in procedure. This system ensures that available software functions are appropriate for the security level of the user.

Initial security settings will be completed during CMRV installation. Following installation, security options may be accessed and changed from the VISCPRO® Main menu by individuals who have the manager password.

Each user can be assigned a security level, which is used to determine permitted operations. Three security levels are defined by the software: *Technician* (least privileged), *Manager* (intermediate privilege), and *Service* (maximum privilege–reserved for ***CANNON***® Instrument Company service personnel).

Users log in when using the software by typing their name and (optional) password using the Log In window. Different security levels offer different CMRV use options. Technicians are permitted to access operational features required for testing samples and performing other routine

operations. Managers may access advanced configuration and reporting options. The Service level permits access to all instrument and security parameters.

Initial security setup

The VISCPRO® software installation creates a security account for one manager with a blank password. After VISCPRO® installation, a password should be assigned for the manager using the Change Password menu option from Main. Managers may add or change accounts for technician status personnel.

Log In...

Use the Log In feature to identify the CMRV operator and/or access security functions.

NOTE

Once an operator is logged in, that operator's name is associated with any sample data obtained during that VISCPRO session. The operator name may be included in analyses.

Procedure

1. Click Log In from Main.
2. Select the desired name from the drop-down list box.
3. Type the desired password in the Password field for the individual selected.
4. Click OK.

Change Password...

Use the Change Password feature to change the current user password.

Procedure

1. Log in to the VISCPRO® software using the Log In command from Main.
2. Select Change Password from the Main menu options.
3. Type in the new password in the Password field.
4. Retype the password in the Confirm Your New Password field.
5. Click OK to save the new password and close the Change Password window.

Update User Information...

Use the Update User Information feature to update the security list of authorized technicians and managers. User information can only be updated by an individual logged in with a higher security clearance than the user for which information is to be altered. Manager status is necessary to change Technician information. Service status is necessary to change Manager information. To obtain Service status, it is necessary to select user CANNON Instrument Company from the Log In window and to type in the current ***CANNON***® password. For the current password (updated daily), call ***CANNON***® at (814) 353-8000.

Procedure

1. Click Log In from Main.

2. Select your Manager or Service level user name from the User Name list box. Input the correct password in the appropriate field.
3. Click OK.
4. Click Update User Information from Main.
5. Select the desired user from the User Name list box.

NOTE *To delete a user, just click* Remove User *after selecting the user name. The account will be immediately and permanently removed.*

6. Enter and verify the desired password, and select user security status using the appropriate list boxes.
7. Retype the password in the Confirm Password field.
8. Click Add or Update User to save your changes.
9. Click Done to exit the Change User List window.

Log Out

To use the Log Out feature, click Log Out from Main. The current user will be logged out of the security list of authorized CAV technicians and managers. The software will automatically reset to the lowest security level. Any ongoing test operations will continue.

Print/Print setup options

Print... Ctrl+P

Select this standard Windows® print option to access the Windows® print window. Then select print options for the currently-active analysis/report (see *Analysis options*).

Print Setup...

Select this standard Windows® print option to access the print setup window. Check your printer driver documentation for additional information on print setup options.

Exit

Select the Exit option to exit the instrument software. Or you may click ☒ on the application title bar.

Analyses options

Data obtained from all instruments during sample testing is stored in the central VISCPRO® database. To view data, you must create an analysis configuration requesting the desired sample information in the desired format. Analysis configurations can be saved and later restored. The analysis configuration options provide powerful tools for reporting sample information. Refer to Chapter 13 of the manual for general information on using the analysis options. For specific information regarding the individual analysis packages shipped with your software (e.g., *Data Table*, *Data Export*), consult the manual chapter for that particular analysis.

Each analysis generates a report based on instrument data in the VISCPRO® database. The following analyses are shipped with the software:

Analysis types

- Error Data Export, MRV Data Export analyses—configures data for output to a file, parallel port, or serial port.
- Error Log Table—lists error messages and related data.
- MRV Data Table—displays test information.

Analyses menu options

The following VISCPRO® menu options are used to create and manage analyses:

- View Analysis—opens the Choose Analysis window. See View Analysis, below, for more details.
- Report Title—opens the Designate Report Title window. Permits data entry of up to three lines of text for the report title.
- Configure Analysis—Accesses Configuration options. For information on configuring analyses, consult Chapter 13 and the manual chapter corresponding to the particular analysis.
- Save Configuration—Opens the Save Configuration window. Type the desired file name in the Save As: field and click OK to save the configuration.

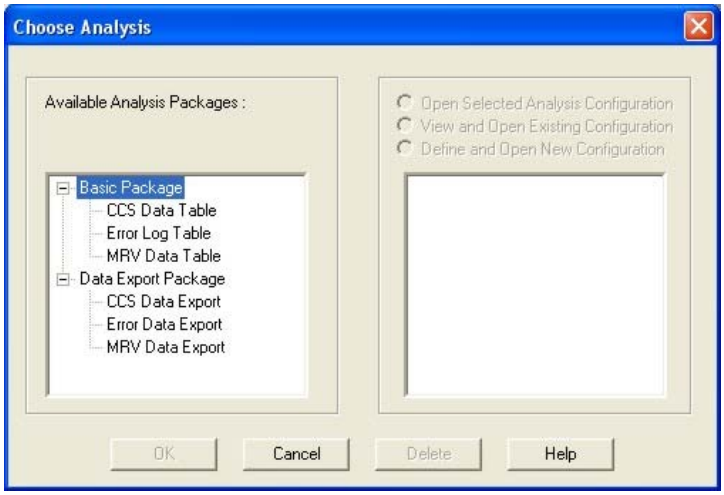
NOTE *The* Configure Analysis *and* Save Analysis *options are only available from the Analyses menu when an analysis window is open.*

View Analysis ...

Select View Analysis to select an analysis from a list of available analyses or define a new analysis.

To display an analysis, click the View Analysis option from the Analyses menu. The Choose Analysis window will appear. The Choose Analysis window provides a list of available analyses in a list box on the left side of the window. The analyses are organized into similar groups using a directory tree structure.

The Choose Analysis window



NOTE *"Unopened" report directories identified with the ⊞ symbol contain one or more analysis packages. Click on the ⊞ to reveal or conceal the list.*

Select the desired analysis from the directory tree. After an analysis has been selected, you can configure the analysis to display the information you want from the central VISCPRO® database. The Choose Analysis window provides three options for doing this:

Click the appropriate radio button . Then select the desired saved configuration (if any) and click OK:

- Select Open Selected Analysis Configuration if you wish to create and display the selected analysis using the saved configuration highlighted in the list box on the right side of the Choose Analysis window.
- Select View and Open Existing Configuration if you wish to open the configuration window for the analysis configuration highlighted in the list box on the right side of the Choose Analysis window.
- Select Define and Open New Configuration to open the configuration window using default settings for the selected analysis.

NOTE

For more information on defining and using configurations, see Chapter 13.

Window options

The Window menu provides options for scaling and arranging multiple windows/icons for screen display. In VISCPRO® you can also save and restore a specific window configuration.

Arrange Icons

Select this standard Windows® display option to arrange any minimized analysis/report or instrument windows at the bottom of the primary application window.

Tile

Select this Windows® display option to resize and regroup all open windows to view multiple on-screen reports/instruments. You may select *horizontal* or *vertical* tiling for more convenient viewing of data.

Cascade

Select this standard Windows® display option to resize and regroup all open windows in an overlapping format which provides more space for the active window.

Save Window Layout

Select this security-protected Manager-level function to save the current VISCPRO® screen configuration, including any currently-open analyses and Instrument View windows. To restore the saved configuration to the VISCPRO® display, click Restore Window Layout (see below).

Restore Window Layout

This function restores the saved VISCPRO® screen configuration. Any currently-open analysis windows will be closed before the saved configuration is loaded. Also note that currently-open Instrument View windows may be obscured by the restored configuration. To view these obscured

windows, click Window from the VISCPRO® primary display and select the desired instrument view. Restoring a saved window configuration does not affect current CMRV sample testing operations.

CMRV module menu options

In addition to the VISCPRO® menu functions, unique software application modules for each type of ***CANNON***® instrument generate additional interface options. The modules determine the characteristics, function and appearance of VISCPRO® software menus and windows. The CMRV software module generates menu choices from the VISCPRO® primary display. These menu choices (under the Configure and Service headings) access important CMRV configuration and operation options.

Configure options

The Configure menu provides the user with a powerful tool for description of CMRV instrument capabilities, and for customizing CMRV test procedures. Once configuration settings have been determined for optimum performance, the settings can be saved and restored using the Main menu Save Instrument and View Instrument functions.

Configuration settings will need to be updated when instrument specifications or components change (temperature probes, calibration).

Each of the configuration menus is explained in detail in the following sections. To access the configuration options, click Configure from the VISCPRO® primary display and select the desired instrument.

Print Instrument and Tray Settings

The Print Instrument and Tray Settings option prints instrument and tray settings. When you select this option, a standard Print window is opened. Select the desired print settings and click OK to print out a hard copy of the instrument settings, including Instrument and Configuration ID, Model, Serial Number, Firmware Version, Temperature Probe Calibration Data, and Cell Constants at all calibration temperatures. You may wish to retain the printout for diagnostics, verification and record-keeping purposes.

Instrument Settings

Select Instrument Settings to open the Instrument Settings window, which provides features for describing the CMRV and controlling the instrument. These settings apply to the instrument as a whole.

Use the ID field to input instrument identification information using up to 30 alphanumeric characters.

All other Instrument Settings (Serial Number, Firmware Version, and Port Setting) are non-editable and derived by VISCPRO® queries to the MRV microprocessor.

Instrument Settings window button options:

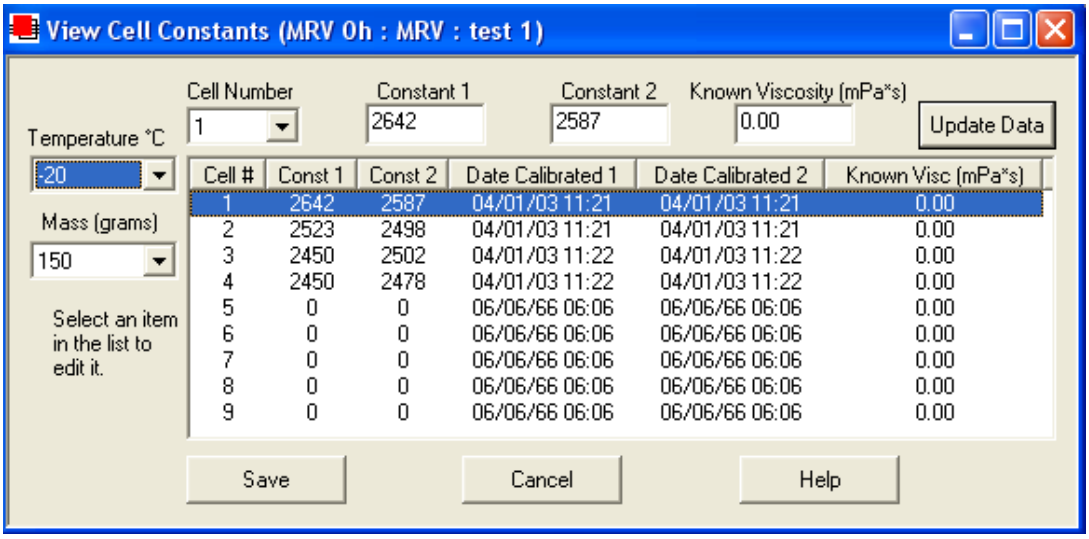
OK	saves the current instrument settings and exits the Instrument Settings window·
Cancel	closes the Instrument Settings window without saving any configuration changes.

Profile Designer

The Profile Designer option opens the Profile Designer window, enabling selection and editing of temperature profiles. For information using the Profile Designer and Profile Editor, see Chapter 14, *Designing Customized Profiles*.

View Cell Constants

The View Cell Constants option opens the View Cell Constants window. You can view current cell constants from this window, and you can edit them if you are logged in to VISCPRO® as a Manager.



Cell #	Const 1	Const 2	Date Calibrated 1	Date Calibrated 2	Known Visc (mPa*s)
1	2642	2587	04/01/03 11:21	04/01/03 11:21	0.00
2	2523	2498	04/01/03 11:21	04/01/03 11:21	0.00
3	2450	2502	04/01/03 11:22	04/01/03 11:22	0.00
4	2450	2478	04/01/03 11:22	04/01/03 11:22	0.00
5	0	0	06/06/66 06:06	06/06/66 06:06	0.00
6	0	0	06/06/66 06:06	06/06/66 06:06	0.00
7	0	0	06/06/66 06:06	06/06/66 06:06	0.00
8	0	0	06/06/66 06:06	06/06/66 06:06	0.00
9	0	0	06/06/66 06:06	06/06/66 06:06	0.00

The View Cell Constants window

Viewing Cell Constants

To view cell constants for a specific temperature, click ▼ from the temperature field to display the valid calibration temperatures. Then click the desired temperature to select it. Do the same for the test Mass.

Editing Cell Constants

To edit Cell Constants, follow the instructions below:

1. Log into VISCPRO® as a Manager.
2. Open the View Cell Constants window.
3. Select the desired temperature and test mass (see Viewing Cell Constants, above).

4. Click on the desired cell number (or select it from the drop-down box).
5. Input the desired value(s) for the calibration(s) and the viscosity of the calibration standard. Constant 1 represents the most current calibrated value, and Constant 2 represents the value from the previous cell calibration). The viscosity of the standard is indicated on the bottle label.

NOTE *If constants are edited with invalid information, data from samples tested using the constant information will be compromised.*

6. Click the Update Data button to transfer Constant and Viscosity information to the Cell Constants list box.
7. Repeat steps 4-6 for other desired cells. Then click the Save button to save the updated constant information to the current instrument configuration and exit the View Cell Constants window.

NOTE *If you do not click the SAVE button, updated data will not be saved.*

Saving a configuration

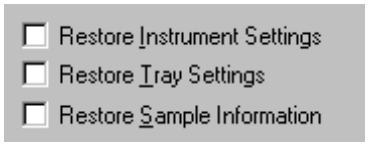
Whenever you have altered an instrument configuration, you may wish to save the resulting settings as a new or existing configuration. To save current settings, use the Save Instrument option:

Procedure

1. From the VISCPRO® primary menu options, select Main.
2. Click on Save Instrument. The Save Instrument window will appear.
3. Select an instrument to apply the current Instrument Configuration settings to.
4. Type a name for the new configuration in the Save As: box. Or click to select an existing configuration name from the configuration list box.
5. Click OK to save the configuration. Or click Cancel to exit the Save Instrument window without saving your changes.

Restoring instrument settings from a saved configuration

There are three options for restoring instrument settings from a saved configuration. These restore options are individually selectable from the View Instrument window.



NOTE *The* Restore Instrument Settings *and* Restore Tray Settings *options are only available if you are logged in as a manager.*

Restore procedure

To restore instrument settings from a saved configuration:

1. Click on View Instrument from the Main menu options.
2. Select the desired instrument from the left list box.
3. Select the desired saved configuration from the right list box.
4. Use the check boxes to select the desired configuration elements to be restored.

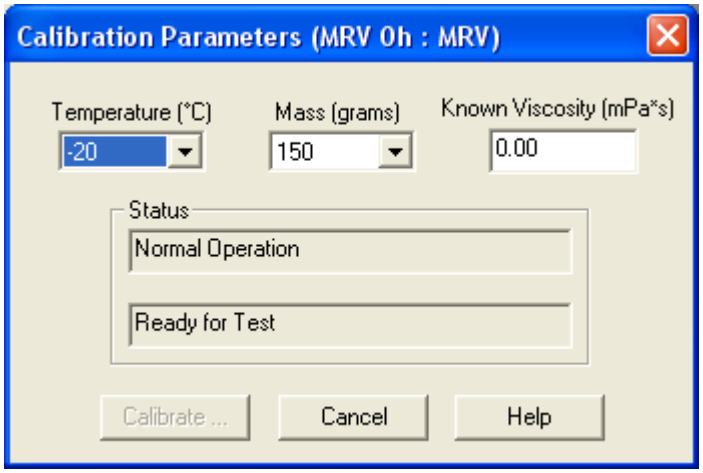
- Restore Instrument Settings restores instrument properties from the saved configuration.
- Restore Tray Settings is not applicable to the CMRV instrument.
- Restore Sample Information restores all sample ID setup information for the Instrument View window from the saved configuration.

5. Click OK. If you clicked the check box to restore instrument, tray or sample settings, the current instrument will be updated with the selected settings.

NOTE *If you have updated the settings, you may wish to save the current instrument/tray/sample configuration by selecting* Save Instrument *from the* Main *menu, inputting the configuration name in the* Save As: *text box, and clicking* OK.

Calibrate Cell Constants

The Calibrate Cell Constants option from the Service menu initiates a software-guided cell calibration procedure. For detailed information on calibrating the CMRV cells, see Chapter 8.



The Calibration Parameters window

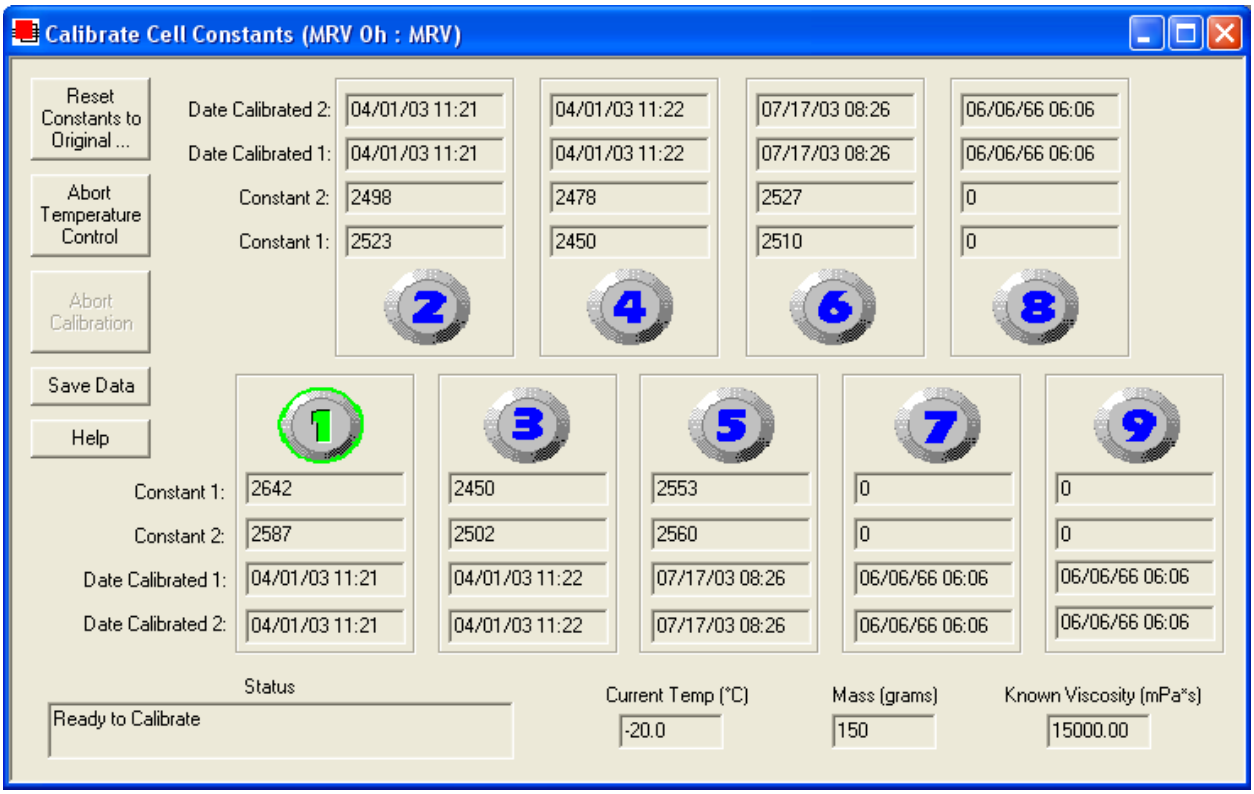
The Calibration Parameters window options are described briefly below:

Temperature: Click ▾ to select the desired temperature for calibration.

Mass: Click ▾ to select the desired test mass for calibration.

Known Viscosity: Enter the known viscosity of the standard, as printed on the standard bottle label.

Calibrate ... : After you have entered the calibration data described above, click the Calibrate ... button to access the CMRV Cell Calibration window.



The Calibrate Cell Constants window

Reset Constants to Original: Click the Reset Constants to Original button to restore constants to the last saved values.

Abort Temperature Control: Click the Abort Temperature Control button to abort CMRV temperature control. The calibration procedure will be halted.

Abort Calibration: Click the Abort Calibration button to abort CMRV calibration. The individual cell calibration will be halted if the Start Test button on the CMRV instrument has not yet been pressed.

Save Data: Click the Save Data button to save the current cell constants to the current instrument configuration.

Service menu options

To access the service options, click Service from the VISCPRO® primary display and select the desired instrument.

MRV Monitor

The MRV Monitor window permits the user to view current operational values for the CMRV instrument. These settings may be helpful to ***CANNON***® technical personnel when troubleshooting difficulties with the CMRV.

Cleaning Service

Select Cleaning Service to open the Cleaning Service window. Then Click the Start Cleaning button to initiate an instrument heating cycle (50°C). The current instrument temperature and instrument status will be displayed in the window. Click the Stop Cleaning Service button when cleaning is completed.

Temperature Probe Calib.

The Temperature Probe Calibration window provides a software interface for calibrating the CMRV block temperature probe. Consult Chapter 7 of the CMRV *Instruction & Operation Manual* for details regarding the software-driven probe calibration procedure.

CHAPTER 10 SUMMARY OF TEST PROCEDURE

In the ASTM D 3829, ASTM D 4684 and ASTM D 6821 test methods, a 10-ml sample is placed in a test cell, pre-heated to a specified temperature, and held at that temperature for a specified time to ensure complete solution of all components of the oil. The temperature of the cell is then lowered to the test temperature at a programmed cooling rate. The test temperature and the cooling program (profile) are determined by the nature of the sample being tested and by the test method being used.

ASTM D 3829 method

ASTM D 3829 uses slow cooling followed by a soak period at the test temperature and requires about 19 hours for completion of the entire test. The test is designed for engine oils.

ASTM D 4684 method

ASTM D 4684 uses much slower cooling and requires between 45 and 54 hours for completion of the test. (The D 4684 temperature cycle is sometimes referred to as the TP-1 cycle.) The test is designed for engine oils.

ASTM D 6821 method

ASTM D 6821 uses slow cooling and requires about 18 hours for completion of the test.The test is designed for drive line lubricants.

ASTM D 6896 method

ASTM D 6896 uses slow cooling and requires between 43 and 45 hours for completion of the test. This test method covers the measurement of the yield stress and viscosity of used diesel oils.

NOTE

CANNON may provide copies of a relevant ASTM Method with your CMRV instrument purchase. Additional reprints of the ASTM test methods may be purchased from:

ASTM
100 Barr Harbor Drive
West Conshohocken, PA 19428

The CMRV-4500 determines the yield stress and apparent viscosity of the sample by measuring the rotational speed of a cylindrical rotor immersed in the sample in the test cell. For ASTM D 3829, yield stress is measured by adding 10-gram disks successively until discernible rotation occurs. Apparent viscosity is then determined by measuring the angular velocity of the rotor when a 150-gram weight is applied.

ASTM D 4684 method

ASTM Method D 4684 describes the procedure for measuring yield stress and apparent viscosity. Yield stress is an indication of a structure that has formed within the oil under the cooling conditions of the test.

NOTE *Most commercial oils do not have a yield stress when tested as specified by the SAE J300 Viscosity Classification.*

For the complete, definitive description of the ASTM D 4684 method, see the provided Standard Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature, Designation: D 4684, also available in the Annual Book of ASTM Standards, Volume 05.03.

NOTE *Nothing in this manual is intended to supersede the provisions of the ASTM test method.*

The cooling cycles used in the ASTM D 4684 test method are sometimes referred to as the TP-1 cycles. For details, see ASTM D 4684 and Henderson, K. O., Manning, R. E., May, C. J., and Rhodes, R. B., "New Mini-Rotary Viscometer Temperature Profiles That Predict Engine Oil Pumpability," SAE Paper No. 850443.

Required test time

The ASTM D 4684 temperature program (profile) requires 45 to 54 hours to complete, depending on the final test temperature. Additional time is required to perform yield stress and apparent viscosity measurements.

ASTM D 3829 method

For the complete, definitive description of this method, see the provided Standard Test Method for Predicting the Borderline Pumping Temperature of Engine Oil, Designation: D 3829, also available in the Annual Book of ASTM Standards, Section 5, Volume 05.03.

NOTE *Nothing in this manual is intended to supersede the provisions of the ASTM test method.*

ASTM Method D 3829 offers the option of reporting that the BPT (borderline pumping temperature) is below a certain temperature. The temperature control profiles for the CMRV-4500 are designed to run the test at the limiting BPT for each viscosity grade. Thus, viscosity or yield stress values must be below the critical values for an oil to be acceptable.

The temperature profile for this method consists of a 2-hour soak at 80°C ± 3°C, a 10-hour nonlinear cool-down to the test temperature, and a 6-hour soak at the test temperature. The entire temperature profile, up to the point of measuring yield stress and viscosity, requires about 18.5 hours.

ASTM D 6821 method

For the complete, definitive description of this method, see the provided Standard Test Method for Low Temperature Viscosity of Drive Line Lubricants in a Constant Shear Stress Viscometer, Designation: D 6821.

NOTE *Nothing in this manual is intended to supersede the provisions of the ASTM test method.*

The temperature profile for this method consists of a 1.5-hour soak at 50°C ± 1°C, a 2-hour nonlinear cool-down to the test temperature, and a 14-hour soak ± 0.02°C at the test temperature. The entire temperature profile, up to the point of measuring yield stress and viscosity, requires 17.5 hours.

ASTM D 6896 method

For the complete, definitive description of this method, obtain a copy of the Standard Test Method for the Determination of Yield Stress and Apparent Viscosity of Used Engine Oils at Low Temperature, Designation ASTM D 6896.

This test method covers the measurement of the yield stress and viscosity of used diesel oils after cooling at controlled rates over a period of 43 or 45 hours to a final test temperature of -20 or -25°C. The viscosity measurements are made at a shear stress of 525 Pa over a shear rate of 0.4 to 15 s^{-1}. This method is suitable for measurement of viscosities ranging from 4,000 mPa-s to 400,000 mPa-s, and is suitable for yield stress measurements of 7 Pa to >350 Pa. The Method is quite similar to ASTM D 4684 except that the preheat phase is accomplished in an oven (not provided with the CMRV) immediately prior to commencing the temperature profile.

SAE J300 notes

SAE Standard SAE J300, Engine Oil Viscosity Classification temperatures, specified according to the viscosity grade, are as follows:

SAE Viscosity Grade	Low-Temperature Pumping Viscosity (cP Max With No Yield Stress)
0W	60,000 at -40°C
5W	60,000 at -35°C
10W	60,000 at -30°C
15W	60,000 at -25°C
20W	60,000 at -20°C
25W	60,000 at -15°C

Source: SAE J300 Revised DEC99

NOTE *The user of the CMRV-4500 is advised to be alert for revisions of the SAE J300 Viscosity Classification.*

Delayed start option

Because of the length of the profile, the starting time should be chosen so that the test temperature will be reached at a convenient time for testing. The delayed start option is quite useful for starting the cooling cycle over a weekend or holiday in preparation for running samples on the following business day. For details, see Chapter 10.

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RUNNING PROFILES

NOTE *The guidelines in this section are not intended to supercede any test method. Always refer to the method for validation of any test procedure.*

Test preparation

To run a temperature profile, first prepare the CMRV-4500 for testing (see Chapter 6). Make sure that the Air/Water Heat Exchanger POWER switch is on and that the unit is operating normally.

Procedure

1. Place 10 ml of test oil in each of the viscometric cells to be used. Any number of cells, one to nine, may be used but all test oils for the run must be for the same test temperature. Use a syringe or small plastic cup to fill the cells.

NOTE *If testing with fewer than nine cells, fill unused cells with 10 ml of a clean oil prior to running the test.*

2. Load the VISCPRO® software and click Main/View Instrument. Select the desired instrument type (MRV) and configuration from the View Instrument window. Then click OK.
3. Record the sample ID for the first calibrated MRV cell by clicking in the Sample ID field and typing the sample name. Then press the Tab key to move the cursor to the next Sample ID field (or just click in the desired ID field). Repeat the process until ID information has been entered for all test samples.
4. (optional) Save your MRV instrument configuration by clicking Main/Save Instrument. Select your instrument type (MRV) and enter a name for the configuration in the Save As: field. Then click OK to save the configuration.

NOTE *You may change the Sample ID at any time prior to initiating the Yield Stress or Viscosity tests. If you change the sample information, you may wish to save the configuration (see step 4, above) before closing the Instrument View window or your changes may be lost.*

5. Carefully insert the rotors into their corresponding test cells, making sure that the rotor tip at the bottom of the shaft slides into the recess at the bottom of the cup.

CAUTION *Do not drop the rotors into place or you may damage the rotor tips.*

6. Secure each rotor in position with a rotor bearing pin.

Winding rotors

7. To wind the rotors in preparation for the profile, slide the pulley-wheel assembly along the track until the pulley is aligned with the first viscometric cell. Use the engraved lines on the slide bar as a guide to determine the proper position of the left side of the pulley-wheel block.

8. Place the loop of a thread over the left end of the crossbar at the top of the rotor shaft.

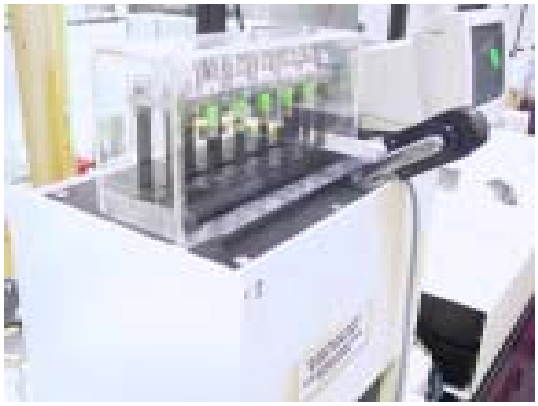
9. Pass the free end of the thread (the end with the plastic ring) over the pulley-wheel and allow it to hang freely in front of the viscometer. While holding the rotor motionless, hook a light weight, such as a large paper clip, on the plastic ring to apply slight tension to the thread.

10. Guiding the thread with your finger, turn the rotor clockwise to wind the thread *above* the crossbar until the knot in the loop has been wound around the rotor shaft. Then pass the thread below the cross-bar and continue turning the rotor clockwise (as viewed from above) to wind 20 closely spaced turns of thread around the shaft *below* the crossbar *without* overlapping the turns. About 200 mm (8 inches) of thread will remain. Place this remaining length of thread over the upper bearing support plate so it hangs to the rear of the viscometer and secure the rotor in place by lowering the rotor locking pin over the rotor crossbar. You may need to turn the rotor slightly to align the crossbar with the locking pin.

11. Repeat steps 8-10 for each of the remaining rotors/cells.

Plexiglas® cover placement

12. Place the Plexiglas® cover in position over the top of the visco-metric cells (see photo). The small hole which allows the -46 to 30°C thermom-eter to extend through the cover should be on the left when viewed from the front of the viscometer.



CMRV 4500 with rotors wound and Plexiglas® cover in place.

CAUTION *If a thermometer is not in place during CMRV-4500 testing, you should seal the thermometer opening in the Plexiglas® cover, particularly when the humidity of the ambient air is high. Otherwise, moisture may con-dense and freeze on the top of the block.*

13. CMRV users following the ASTM D 4684 or ASTM D 3829 method-ology should insert a flexible 3/16"-OD tube from their dry gas supply and regulator through the dry gas purge in the Plexiglas®

cover (Step 9.2.6 in the ASTM D 4684-98 method and step 9.1.6 in the ASTM D 3829 method). The tubing may be removed, along with the cover, prior to viscosity/yield stress testing.

14. Whatever the methodology, the purge should continue throughout the temperature profile using dry gas at a flow rate between 20 and 30 milliliters per minute.

Starting a profile

1. If the View Instrument window is not open, click Main/View Instrument and select the desired instrument type (MRV) and configuration from the View Instrument window. Then click OK.

Polling instruments

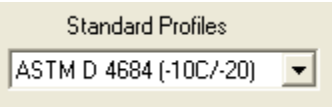
If you are unable to select your CMRV from the list of available instruments in the View Instrument *window, make sure the instrument is turned on and warmed up (see Chapter 6); then select Poll for Instruments from the Main menu.*

2. From the MRV Instrument View window, click the Upload Profile button to open the Upload Profile window.

3. Select a Standard or User-Defined profile from the available profiles in the drop-down box, then click OK.

NOTES

To run samples using -20°C or -25°C calibration data per ASTM specifications, ensure that the correct profile is selected from the ASTM Standard Profile laboratory. Standard Profiles with only one temperature indicated are run using calibration data obtained at -20°C. For profiles with two temperatures indicated, the first temperature refers to the final test temperature for the profile and the second refers to the desired calibration temperature for that profile.



(-10°C profile using -20°C calibration data)

You will not be able to select and run ASTM profiles in cells for which calibration data is unavailable at the specified temperature. The ASTM profiles will not appear in the drop-down list until the number of calibrations required by the method are performed.

4. Click the Run Profile button to open the Run Profile window. The on-board CMRV microprocessor will control the temperature until the profile has been completed. A computer connection is no longer required until it is time to initiate viscosity/yield stress testing.

5. Select the desired End Time for the profile (this is the time you would like to start testing) and click OK. The Start Test button will begin blinking to indicate that profile timing has begun. The profile will be initiated at the appropriate time.

NOTE

The default End Time is the time that the temperature profile would be completed if the profile is started immediately.

5. At the conclusion of the temperature profile you are ready to test samples. See Chapter 11 for the test procedure.

Profile operation notes

Instrument Status window

During the profile, the Instrument View window will display the current status of the profile, the current test temperature, the desired temperature, time elapsed, and the time remaining until the yield stress and viscosity tests should be run. Display data is normally updated every 0.5 seconds. The following status options are available:

RED–Fatal Instrument Fault (unlikely); Instrument stops responding to queries for more than 60 seconds (or 385 seconds during a Viscosity Test)
YELLOW–Instrument Warmup (displayed for 45 minutes after turning on instrument). During this time, instrument calibration cannot be performed. A test can be run on a calibrated instrument only if the "Ignore Instrument Warmup" box is checked in the instrument view.
GREEN–Normal Instrument Operation

Removing thermometer

To reduce the chance of separating the mercury column, you may wish to remove the calibrated thermometer from the CMRV unit prior to running a cooling profile. Store the thermometer in a vertical position. You may replace the calibrated thermometer when the CMRV has cooled to 30°C or lower. If the thermometer is not in place during CMRV-4500 cooling, you should seal the thermometer hole in the Plexiglas® cover, particularly when the humidity of the ambient air is high. Otherwise, moisture may condense on the top of the block.

Verifying temperature

When the profile has concluded, verify the temperature reading and then measure the yield stress and viscosity.

Tolerance problems

If the CMRV instrument fails to maintain temperatures within required tolerances during the profile, the MRVW software will display a warning. The profile will be completed, but displays and printouts of CMRV data will indicate that the profile was out of tolerance.

Completing CMRV tests

Viscosity and yield stress tests should be completed shortly after the completion of the profile.

NOTES

ASTM D 4684 requires completion of yield stress and viscosity tests within 30 minutes of the conclusion of the profile.

If, at the conclusion of a test, the block temperature is more than 0.2°C cooler or warmer than the specified test temperature then the test may not conform to ASTM D 4684 or ASTM D 3829 requirements. Consult the appropriate ASTM method for additional information. If the test is out of tolerance the temperature probe may have to be recalibrated and the test rerun to obtain reliable readings for the desired temperature. Yield stress and viscosity tests may still be performed for the samples, but the calculated values will be indicative of the actual temperature at the end of the profile, not the desired temperature.

Adjusting temperature at the end of a profile

In the event that the CMRV instrument fails to attain the desired temperature at the conclusion of a profile, it is possible to adjust the instrument temperature using the following procedure:

1. Wait until the profie is completed and the Temperature Correction button is active.
2. Click in the Thermometer Temperature field and type the current temperature (as indicated by your calibrated thermometer) to the nearest 0.1°C in the Thermometer Temperature field. Make certain to use the minus (-) sign for subzero temperatures.
3. Click the Temperature Correction button to enter the temperature reading.

NOTE *If you input a temperature but do not click the Correction button, the input temperature value will be stored in the database as the actual temperature for the test.*

4. Wait for the instrument to stabilize at the new temperature for the desired time period.
5. Continue with the Yield Stress and Viscosity test procedures.

NOTES *The Temperature Correction button option is only active at the conclusion of the temperature profile and prior to yield Stress or Viscosity testing.*

If the amount of the Final Temperature adjustment is greater than the tolerances specified in the profile, the temperature probe and CMRV cells should be recalibrated per the manual procedure.

If you do not enter a Thermometer Temperature, the final profile temperature will be recorded as the actual temperature for the test(s).

Displaying a profile graph

Graphing the current profile

To view a graph displaying time/temperature data from the current profile during CMRV testing, click the View Running Profile button from the Instrument View window to view updated data from the current test in graph format (X axis = time; Y axis = CMRV sample temperature). The graph information is updated approximately every 10 minutes.

Graphing earlier profile data

To view a graph of time/temperature data from a previous test (viscosity or yield stress), just configure an analysis for the data (see chapters on Analyses) and right-click anywhere inside the data window for the analysis. Then click the Display Temperature Graph popup menu option.

Mouse-over display features

After you have displayed the profile graph, you can move the mouse cursor over any portion of the graph and the status bar at the bottom of the Profile Graph window will dispay the Time, Actual Temperature and Target Temperature values for that point in the profile.

Zooming in

To view a section of the profile graph in greater detail, click and drag (press and hold down the left mouse button) the cursor to "draw" a box around the desired graph area. Then release the mouse button. The graph will be redrawn to include only the selected area.

Zooming out

To reduce the graph magnification, click the icon.

Refreshing the graph

If you are displaying the profile graph while a temperature profile is running, you may not be viewing the most current temperature data. To ensure that the graph includes the latest information from the CMRV microprocessor, click the Profile Graph window Refresh Graph icon.

Printing a profile graph

To print the profile graph:

1. Display the graph window (see above).
2. Click the Profile Graph window Print icon.
3. Follow Windows® conventions for printer selection and printing. Consult your Windows® manual for more information.

Exporting time/temperature profile data

To export time/temperature data from the current profile:

1. Configure an analysis for the data (see chapters on Analyses) and right-click anywhere inside the data window for the analysis.
2. Then click the Export Time Temp Data popup menu option. The Save As ... window will open.
3. Input the file name and select the desired directory for the data file. Then click OK.

You may import the file data into your word processor or spreadsheet per the import instructions provided with your application. This data provides a minute-by-minute temperature record of the profile in the following format:

XXXX [tab] YYYY [tab] ZZZZ [carriage return]

where X = time in the profile (minutes)
Y = actual temperature as recorded by the CMRV probe (°C)
Z = target temperature required by the cooling profile (°C)

Exporting archived profile data

To export time/temperature data from a previous test (viscosity or yield stress), just configure an analysis for the data (see chapters on Analyses) and right-click anywhere inside the data window for the analysis. Then click the Export Time Temp Data popup menu option.

CHAPTER 12

MEASURING YIELD STRESS AND VISCOSITY

NOTE *The guidelines in this section are not intended to supercede any test method. Always refer to the method for validation of any test procedure.*

Yield Stress and Viscosity testing should take place shortly after the profile is completed.

NOTE *ASTM D 4684 requires completion of yield stress and viscosity tests within 30 minutes of the conclusion of the profile.*

When the CMRV-4500 has reached the final test temperature, the Instrument View window will display the Ready for Test/Instrument Ready status.

The 

(yield stress) and  (viscosity) icons for each sample will also be enabled.

NOTE *The yield stress test must be completed* BEFORE *testing for viscosity.*

To view test results as they are recorded in the VISCPRO database, open and/or configure the appropriate analysis (see the next chapter on Analyses for more information) prior to beginning the tests.

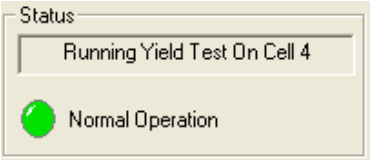
Measuring yield stress

Procedure

1. Remove the Plexiglas® cover from the CMRV-4500 unit.
2. Slide the pulley-wheel assembly along the track until the pulley is aligned with the left side of the shaft of the appropriate rotor. Use the engraved lines on the slide track to determine the proper position of pulley wheel block relative to the rotor.
3. Make sure that the pulley-wheel sensor wire is placed in a position to prevent its interference with the falling hook-cage/weight during yield stress/viscosity testing.
4. Place the rotor thread over the pulley-wheel with the plastic disk hanging in front of the viscometer block and over the edge of the table.
5. Hang the hook-cage on the ring at the end of the thread.

NOTE

ASTM D 3829 and 4684 specify an initial weight of 10-grams, and increase of weight in 10-gram increments. ASTM D 6821 specifies an initial weight of 2.5 grams and increase of weight in 2.5-gram increments.



6. Ensure that a Sample ID has been entered for each sample. Then click  for the desired sample. *OR* use the Tab key to highlight the yield stress icon and then press Enter↵. The Yield LED (light-emitting diode) on the CMRV-4500 will glow and the Start Test button will begin flashing rapidly.
7. Press the flashing Start Test button on the CMRV front panel and proceed immediately to step 8.
8. Slide the rotor locking pin upward to its detent position, allowing the weight/hook-cage to hang free. The Yield LED will flash as the CMRV microprocessor measures the wheel rotation (See *Notes on yield testing* on the next page regarding the ASTM D 4684 method). If no yield stress is observed (sufficient rotation), the blinking Yield Stress light on the instrument front panel will turn off. If it does, conclude the test by lowering the locking pin to prevent the rotor from further rotation.

Adding a 10-gram weight to the hook-cage during yield stress test

9. (Optional) If there is insufficient movement of the rotor during the 15-second sampling period, follow the screen prompts to add weight to the hook-cage per ASTM methodology (see photo). The CMRV-4500 will calculate the range for the yield stress value. If there has not been adequate movement of the rotor by the time the weight load reaches 100 grams, the MRVW software will calculate a minimum value in Pascals for yield stress.

NOTES

When adding weights to the hook-cage, support the hook cage with one hand while keeping some tension on the thread. When releasing the hook cage use a smooth downward motion of the hand to prevent the hook-cage from swinging back and forth and to avoid jarring the rotor.

To view test results as soon as they have been recorded in the database, open an MRV Data Table analysis with the Use Dynamic Update *option (see Chapter 13).*

CAUTION

Make sure to wait for the CMRV software prompts before adding additional weights.

10. If testing viscosity for the sample, follow the directions for viscosity testing (see *Measuring Apparent Viscosity*, next page).

11. Repeat steps 1-10 to perform yield stress/viscosity tests for all remaining cells to be tested in order from left to right.

Notes on yield stress testing

- Step 9 (see previous section) is required for ASTM D 3829.
- The ASTM D 4684 method is a pass-fail method for fresh oils. If the rotor fails to move with the weight of the 10-gram hook-cage, the oil has failed the test. However, the MRVW program permits adding of additional weights. If this alternate method is preferred, continue with the procedure as described in step 9. Otherwise, click the Abort Test button to abort yield stress testing on that cell.

NOTE *Do not abort CMRV temperature control until you have finished all yield stress and viscosity tests for the cells.*

- Pulley-wheel motion is detected by the digital-optical sensor. Adequate rotor movement is defined as 13° of rotation for ASTM D 4684 and ASTM D 6821 (This is equivalent to 3 mm of motion by the crossarm). For ASTM D 3829, 10° of rotation is required.
- If yield stress testing on a cell is aborted before adequate rotor movement is detected, the resultant calculated yield stress will be based on the highest weight used. For example, if the operator aborts a yield stress calculation after testing with a total of 30 grams with no rotor movement, the CMRV software will report yield stress greater than 105 Pascals (Y>105).

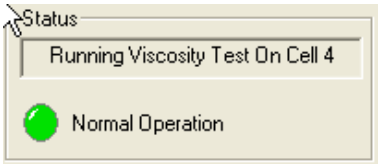
Measuring apparent viscosity

After the yield stress test has concluded, you may measure apparent viscosity using the procedure below:

1. Place the pulley-wheel in line with the appropriate viscometric cell and place the rotor thread over the pulley-wheel.

NOTE *ASTM methodology requires testing the samples in sequence from left to right.*

2. Ensure that a Sample ID has been entered for each sample. Then click  for the desired sample. *OR* use the Tab key to highlight the desired viscosity test icon and then press Enter↵. The Viscosity LED (light-emitting diode) on the CMRV-4500 will glow and the Start Test button will begin flashing rapidly.



3. Carefully place the large hook-weight on the end of the thread (see photo, next page), supporting the weight with your hand to prevent rotation of the rotor.

5. Press the flashing Start Test button and proceed immediately to step 6.
6. Lift the locking pin and release the weight by lowering your hand quickly and smoothly.

   The CMRV-4500 will measure the speed of rotor rotation by timing the revolution(s) of the pulley-wheel as the weight falls.

Placing the large hook-weight in preparation for the test.

NOTE *The total number of rotations measured by the CMRV-4500 during the viscosity test depends on the viscosity of the sample and the values chosen in the Advanced Settings box. Default values for the Advanced Settings correspond to the specifications of the ASTM method selected for the profile.*

7. When the Viscosity LED on the CMRV front panel stops flashing, indicating the conclusion of the viscosity test, remove the hook-weight from the string.

CAUTION *Do not remove the weight while the Viscosity LED is still flashing.*

NOTE *To view test results as soon as they have been recorded in the database, open an MRV Data Table analysis with the* Use Dynamic Update *option (see Chapter 13).*

8. To test additional cells, repeat steps 1-7 above, testing in order from left to right.

After all viscosity tests have been concluded, select End Profile from the Instrument View window to terminate temperature control of the CMRV.

NOTE *No further testing can be conducted after temperature control has been aborted.*

Notes on viscosity testing

Do not let the large hook-weight swing back and forth during testing or the apparent viscosity measurement may be distorted.

Viscosity data

The computer determines the apparent viscosity, along with the time required for rotation of the rotor. Time and temperature data for the test is recorded in the associated `.ttd` file.

Notes on ASTM methods

The protocols for measuring viscosity differ considerably between the ASTM methods. For further information on the methodology used to measure viscosity, consult the applicable ASTM method.

Printing yield stress/viscosity test results

To print the CMRV data form, including viscosity and yield stress test results:

1. Open and/or configure the appropriate analysis.
2. Use the mouse to highlight the desired data.
3. Click Print from the Main menu options.
4. Follow Windows® conventions for printer selection and printing. Consult your Windows® manual for more information.

Exporting yield stress/viscosity data

To export yield stress and viscosity test data to an ASCII tab-delineated file, create an MRV Export Analysis (see chapters 13 and 17).

Temperature/time data

To export time/temperature data from the associated `.ttd` file for the profile, see *Exporting Time/Temperature Profile Data* in Chapter 13.

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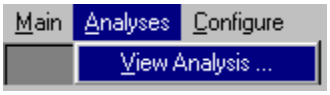
CHAPTER 13

ANALYSIS CONFIGURATION OPTIONS

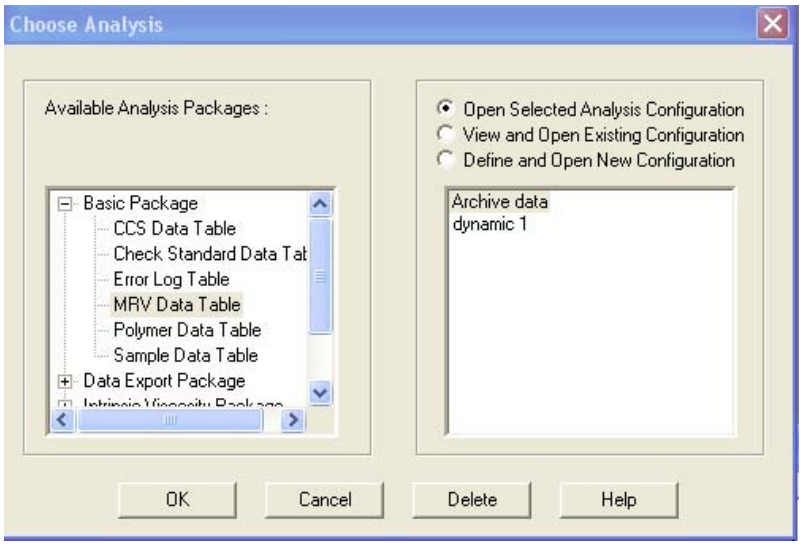
Data obtained from all instruments during sample testing is stored in the central VISCPRO® database. To view data, you must create an analysis configuration requesting the desired sample information in the desired format. Analysis configurations can be saved and later restored. The analysis configuration options provide powerful tools for reporting sample information. Analyses may be displayed on the computer screen, printed, or output via the computer RS-232 port.

Creating an analysis

1. Click Analyses from the VISCPRO® primary menu options.
2. Click View Analysis ... from the Analyses menu options. The Choose Analysis window will appear.



3. Highlight the desired analysis from the list of available analyses.



NOTE *Use the directory tree structure to browse the report options. Click on the ⊞ or ⊟ icons to reveal/hide analyses.*

4. Click on the radio button corresponding to the desired analysis action:

   The Open selected Analysis option will open the selected analysis without providing an opportunity for modification of the analysis.

   The View and Open Existing Configuration option will permit the user to view/modify an existing analysis (see notes and procedure following).

   The Define New Analysis option will create a new analysis (see notes and procedure following).

NOTES

If no analyses have been created, none will appear in the text box on the right side of the window, and only the Define New Analysis option will be available. If you have already configured and saved an analysis, its name will appear in the list box. If you select an existing configuration and click OK, the analysis will be performed using the current configuration settings. It will not be necessary to complete the remaining steps in this procedure.

5. Click OK. If the Open Selected Analysis option was selected, the analysis will be immediately displayed. If the View and Open Existing Configuration or Define New Analysis options were selected, the Analysis Configuration window will appear. The Analysis Configuration window consists of tabbed pages with filter options appropriate for the analysis.
6. Click on the tab corresponding to the filter you wish to set and complete the configuration options. For further information on selecting filter options, see the following sections of this chapter, as well as the chapter corresponding to the specific analysis.
7. When you have completed the configuration, click OK. The program will prompt you to save the configuration.
8. Click Yes to save the configuration. The Save Configuration window will appear. Type the name of the new configuration in the Save As: field.

   Or click the name of a preexisting configuration in the Existing Configurations list box (If you select this option, you will replace the existing configuration with the new configuration settings).
9. Click OK. The analysis will be performed and displayed using the selected configuration settings.

NOTES

You may click Cancel *from the* Save Configuration *window to exit without saving configuration changes.*

You may display several analyses simultaneously by repeating the instructions above. Use the tiling options available from the Window *menu to display multiple analyses in the desired window format (horizontal, vertical or cascade view options are available).*

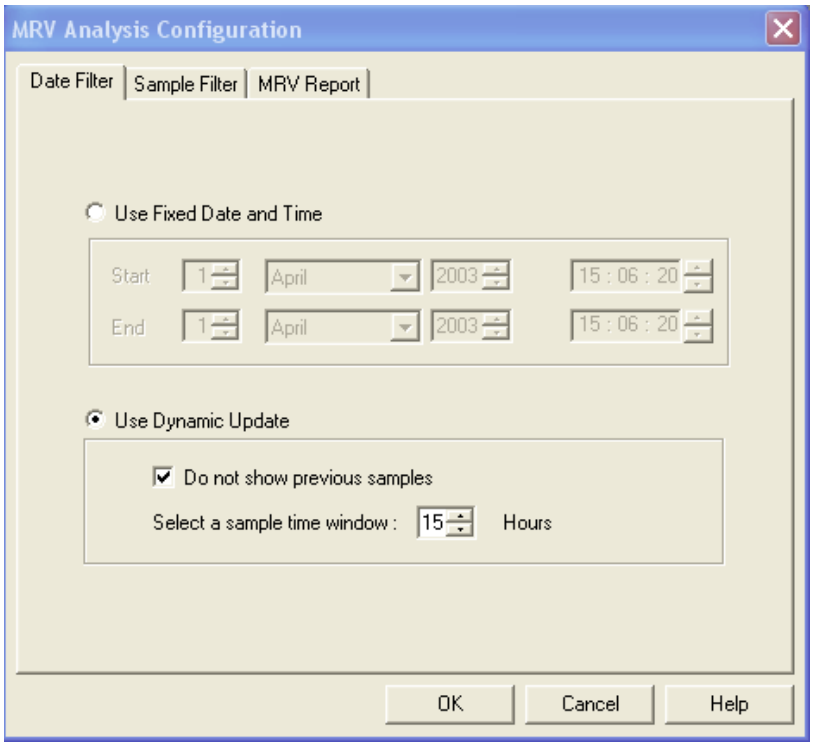
Sorting analysis data

After you have displayed an analysis, you may sort alphanumerically by any of the table headings (the default sort for most reports is Time Stamp). To sort, simply click on the desired column heading. The table will be displayed with the new sort order.

NOTE *The* Sort *function is only available for an analysis when the* Dynamic Update *mode option is NOT selected. To restore sort functionality for an analysis, reconfigure the analysis by clicking* Configure Analysis *from the* Analyses *menu. Then access the* Date *filter options for the analysis and click the* Use Fixed Date and Time *radio button* . *Set the Date/Time parameters and click* OK *to create the new analysis.*

Using the date filter

Use the date filter to select date/time parameters for the analysis. To use the date filter, click the Date Filter tab from the analysis configuration window.



To define a Fixed Date and Time, click the corresponding radio button . Then use the spin controls and/or list box selection options to set the appropriate date/time parameters. All samples tested after the start date/time and before the end date/time, inclusive, will be included.

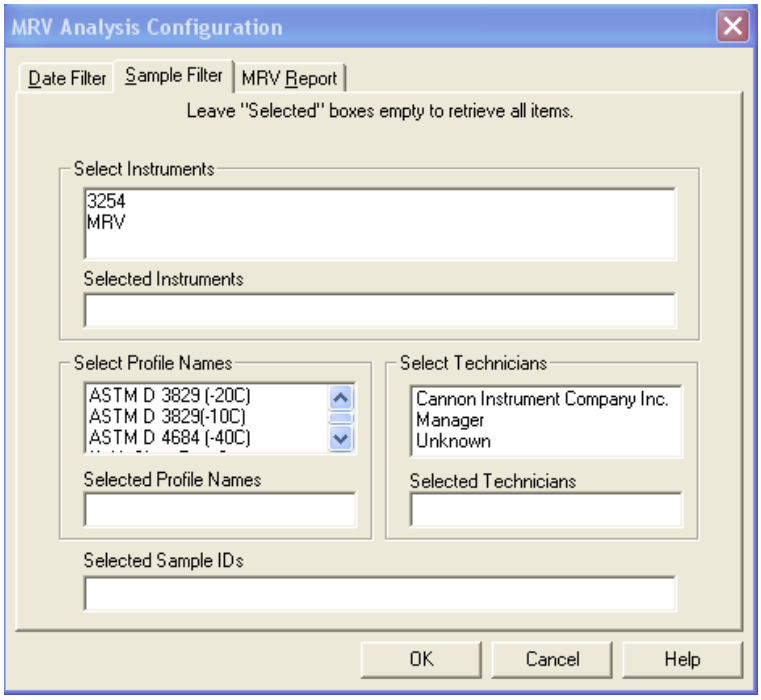
To automatically update the report with sample data as tests are completed, click the Use Dynamic Update radio button. Click the Do not show previous samples box if you do not wish to display samples tested prior to the time the analysis is opened.

Use the spin controls to select the Sample Time Window (the desired range of recent samples to be included in the analysis). Data from samples tested within [x] hours will be displayed in the analysis. Note that the analysis sorting options are disabled if you are using Dynamic Update.

EXAMPLE *If the* Do not show previous samples *box was unchecked and a Sample Time Window value of 5 hours was selected, the analysis (when opened) would display data for all samples tested within the last five hours.*

Using the sample/error filter

Use the sample filter to limit the analysis to samples which have been tested with certain instruments, profile names, by certain technicians, or which have certain Sample ID characteristics. To filter samples using these variables, click the Sample Filter tab from the analysis configuration window.



NOTE *For the error analysis, this tab is labelled* Error Filter *and the filter options are limited to instrument and technician).*

Then select the desired instruments and profile names from their respective list boxes. To select a range of profile names/instruments, click on the first desired item and then hold down the [⇧ Shift] key while clicking on the last desired item in the sequence. To individually select profile names/instruments from the list boxes and add them to the analysis, hold down the [Ctrl] key while clicking on each desired profile/instrument.

To filter by Sample ID characteristics, place the pointer/cursor in the Sample ID field and type the desired sample IDs, or leave the field blank to include all sample IDs for the selected instruments. You may use wildcards (%,_) to select a range of samples. For example, S% would include data from all samples starting with S. %S% would include data from all samples containing S. The underscore (_) is a single-character wildcard. You may use multiple IDs separated by a comma. For example, CL%,MRV% would display all samples beginning with CL or MRV.

NOTE *If no instruments/profile names/Sample IDs are selected, the analysis will display data for ALL instruments/profiles/Sample IDs.*

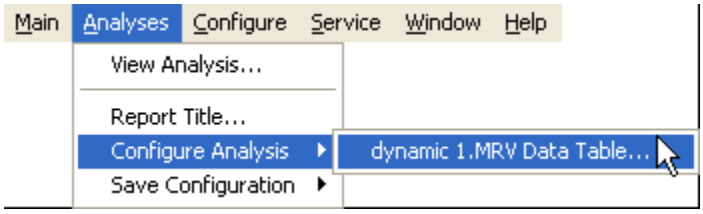
Using the report/port output filter

Use the Report or Port Output filter to determine which data will be calculated and/or included in the analysis, and/or in what sequence that data will be displayed. Report/Port Output filter options will vary depending on the nature of the analysis. For more information on Report/Port Output filter options, please see the chapter on the specific analysis.

Reconfiguring a displayed analysis

An on-screen analysis may be reconfigured using the same filtering tools available when creating a new configuration. To access configuration options for a displayed analysis:

1. Select Analyses from the VISCPRO® primary menu options.
2. Select Configure Analysis from the Analyses options.



3. Select the desired analysis from the available analyses. The Sample Analysis Configuration window will appear.
4. Reconfigure the analysis as desired by clicking the tabs to access the Date, Sample and Report filtering options (see previous sections). When done, click OK.

5. You will be prompted to save the new analysis configuration. After you make your selection(s), the analysis will be performed and displayed using the new configuration settings.

Resizing table columns

To resize columns from a displayed analysis for easier viewing/printing, move your mouse pointer/cursor to the edge of the desired column heading. The mouse pointer will change to a bi-dimensional arrow.

Click and drag the edge of the heading to the new location and then release the mouse button. The entire column will be resized as you drag.

User column size settings will be maintained as long as the analysis window is open.

Saving a current analysis configuration

To save a current analysis configuration:

1. Select Analyses from the VISCPRO® primary menu options.
2. Select Save Configuration from the Analyses menu options.
3. Select the desired analysis. The Save Configuration window will appear. Type the name of the new configuration in the Save As: field. Or double-click the name of a preexisting configuration in the Existing Configurations list box to replace the existing configuration with the new configuration settings.
4. Click OK.

NOTE *You may click* Cancel *from the* Save Configuration *window to exit without saving configuration changes.*

Deleting an analysis configuration

You can delete an existing analysis configuration from the Choose Analysis window by highlighting the desired configuration in the list box and clicking the Delete button or pressing the Delete key. The configuration will be immediately and permanently deleted.

Printing an analysis

To print the complete analysis, select Print from the VISCPRO® Main menu while the analysis is being displayed. If multiple VISCPRO® windows are open, click the analysis window for the analysis you want to print to make it the active window before you select Print. Then choose

print options from the Windows® Print window and click OK to print the analysis. (Consult your Windows® manual and printer/print driver documentation for more information on print settings).

It is also possible to select individual or multiple samples from an analysis for printing (see next section).

NOTES

The font size for printed analyses will be automatically adjusted to fit data columns to the selected printer paper size. If the font is too small, or if columns of data are missing or truncated, try using print options to set your printer to print in landscape instead of portrait orientation. Or create two analyses for the desired data instead of just one.

The Print *option from* Main *will not be accessible unless the analysis window is the active window. Click on the desired window to make it the active window.*

Keystrokes for selecting data for printing

You can print data for a selected sample or samples from an on-screen analysis by highlighting the desired sample data and then using the Print option from the VISCPRO® Main Menu.

To select data for a single sample, click on the line of data associated with the sample on the screen display. To print a sequential range of samples, highlight the first sample in the range, then hold down the ⇧ Shift key and click on the last sample in the range. To individually select test data from the on-screen list box for printing, hold down the Ctrl key while clicking on each desired entry.

When all desired data has been selected, click on Print from the Main menu. Make certain that the Selection radio button has been selected from the Print range options. Then click OK to print to the selected printer.

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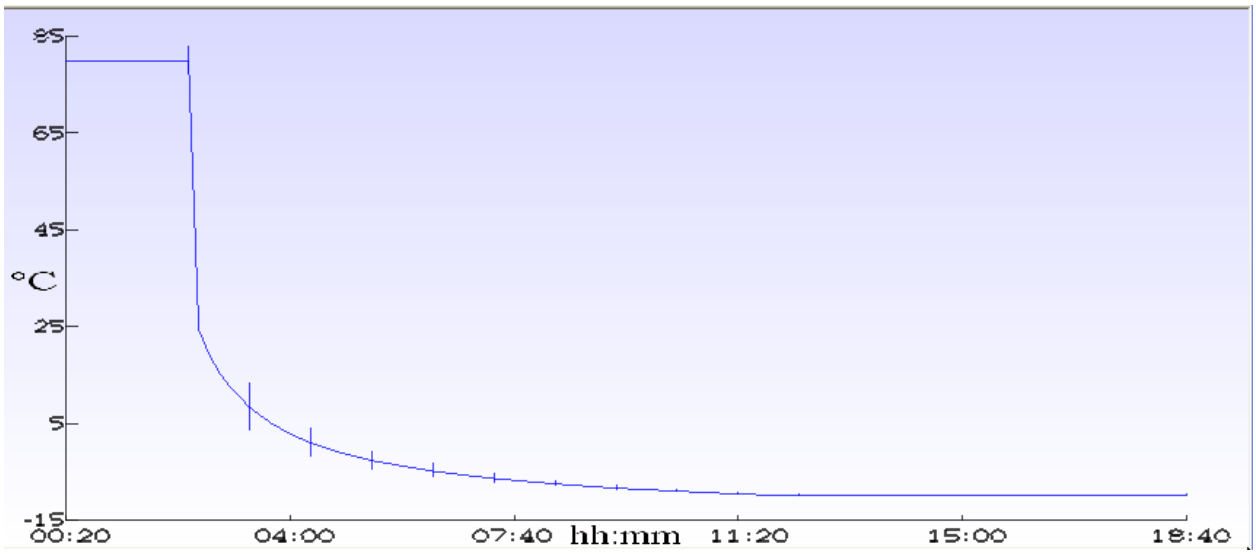
CHAPTER 14

DESIGNING CUSTOMIZED PROFILES

Cooling Profiles

The cooling profile may be pictured graphically as a curve (temperature over time) calculated from up to 25 individual user-defined data points.



To design a profile, you will use the Profile Editor from the VISCPRO® Profile Designer window to input *time*, *temperature* and (if desired) *tolerance* values for each point:

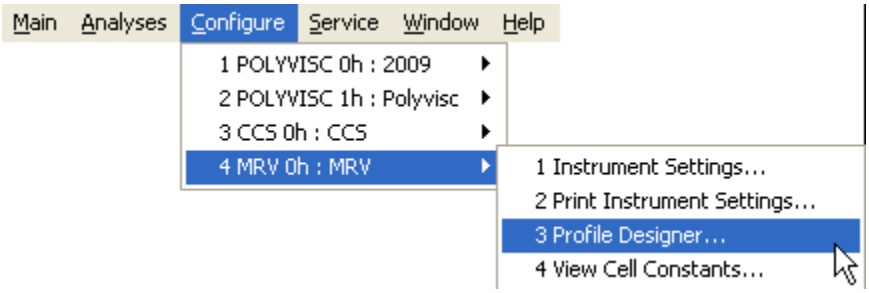
Time:	The time during the sample-run at which a desired temperature is to be achieved. Acceptable values for hours are 0-99. Acceptable values for minutes are 0-59. Note that the first point in a profile should NOT have a null value of 0 hours AND 0 minutes.
Temperature:	The required CMRV temperature at the particular time specified. Acceptable parameters are +90°C to -40°C.
Tolerance:	The acceptable CMRV temperature variance (to the nearest 0.1°) from the specified temperature value (in °C). This field may be left blank if no tolerance is required.

The Profile Designer

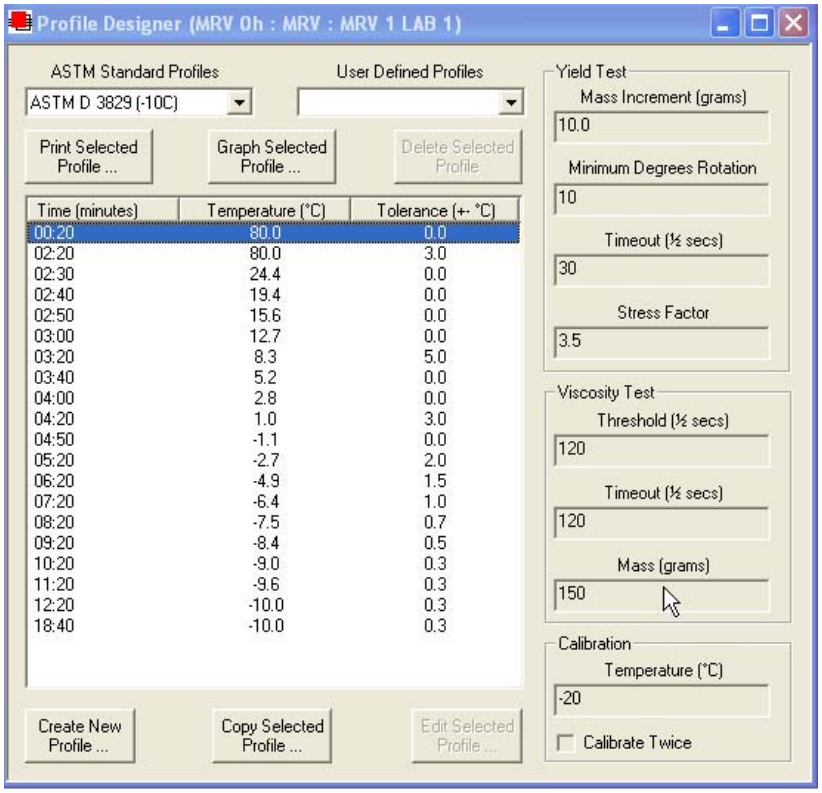
Cooling profiles are displayed and maintained using the VISCPRO® Profile Designer window. The Profile Designer window provides a user-friendly interface for selecting and/or creating profiles and, if necessary, modifying them to create additional profiles.

Opening the Profile Designer

To create a new profile or modify an existing profile, Click Configure/ MRV/Profile Designer.



The Profile Designer window will open.

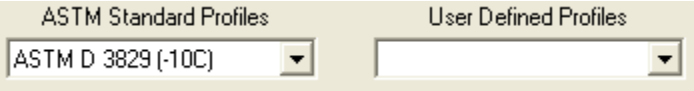


The Profile Designer window

The Profile Designer window provides button options for copying and modifying existing profiles or creating entirely new profiles. It also provides buttons for management of profile data, including displaying and printing a graph of the profile and deleting unwanted profiles from

the profile library. The Profile Designer window also displays Yield Stress and Viscosity test parameters for the profile. The Profile Designer interface options are explained briefly in the following section:

Interface options



The profile library

The profile library consists of two types of profiles—ASTM-defined profiles and User-defined profiles.

Click the "down" arrow ( ) to display the list of available profiles. Then click the desired profile to select it and display the Time, Temperature and Tolerance data for each defined point of the profile.

Time (minutes)	Temperature (°C)	Tolerance (+- °C)
00:20	80.0	0.0
02:20	80.0	3.0
02:30	22.7	0.0
02:40	17.4	0.0
02:50	13.5	0.0
03:00	10.3	0.0
03:20	5.6	5.0
03:40	2.2	0.0
04:00	-0.3	0.0
04:20	-2.4	3.0
04:50	-4.7	0.0
05:20	-6.5	2.0
06:20	-9.1	1.5
07:20	-10.8	1.0
08:20	-12.1	0.7
09:20	-13.1	0.5
10:20	-13.9	0.3
11:20	-14.5	0.3
12:20	-15.0	0.3
18:40	-15.0	0.3

Time/Temperature/Tolerance data from the Profile Designer window

Managing profiles

Click the Print Selected Profile button to print the currently-displayed profile.

Click the Graph Selected Profile button to display a Profile Graph plotted from the defined points of the profile.

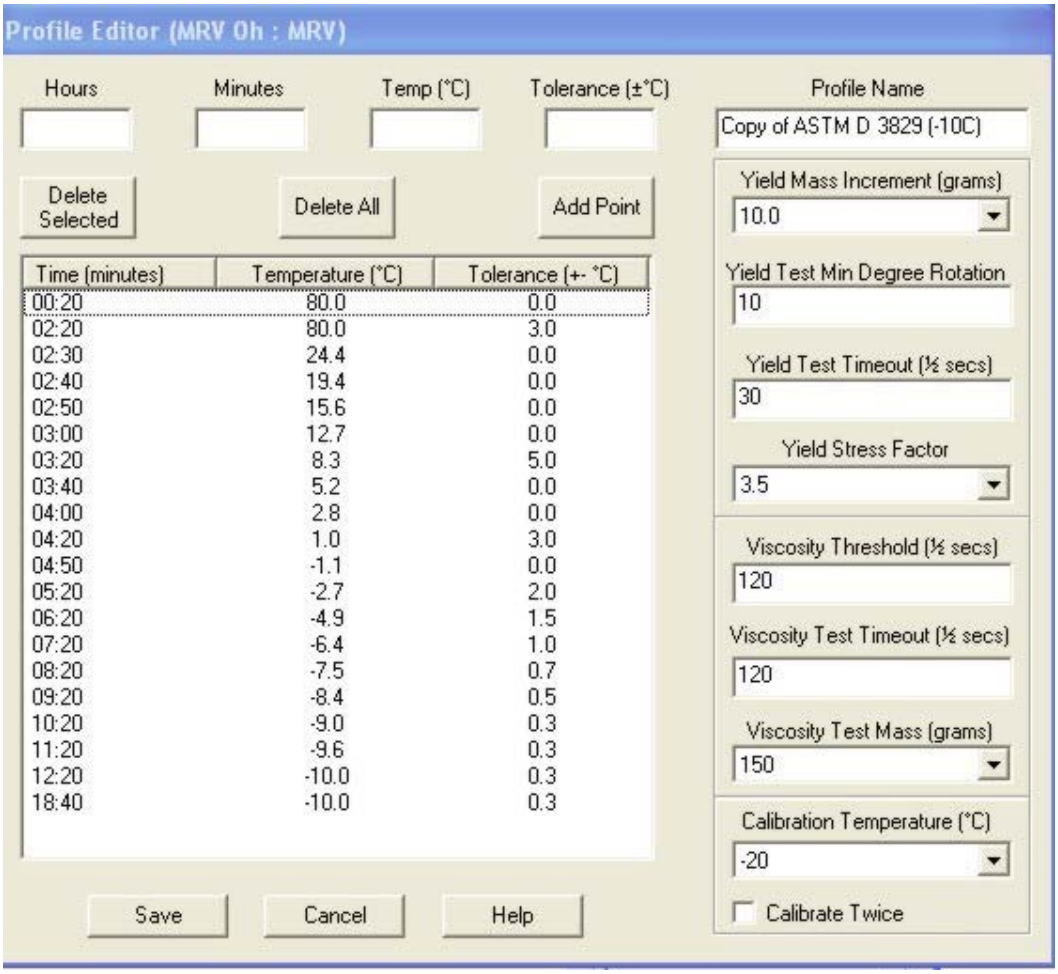
Click the Delete Selected Profile button to delete the currently-displayed User Defined Profile (ASTM Standard Profiles cannot be deleted from the Library).

Using the Profile Editor

Click the Create New Profile button to open the Profile Editor and begin creating a new profile OR

Click Copy Selected Profile to *copy* the currently-selected profile to the Profile Editor and begin adapting it to your specifications OR

Click Edit Selected Profile to open the Profile Editor and begin editing the currently-selected User Defined Profile (ASTM Standard Profiles cannot be edited).



The Profile Editor window (all fields editable)

NOTE *ASTM-defined profiles may be selected and viewed but may not be altered. To make revisions to an ASTM-defined profile, you must first Copy Selected Profile ... and then Save it as a User-defined profile.*

1. To define the cooling profile, input desired information (Hours, Minutes, Temperature and Tolerance) in the appropriate fields for a single point in the temperature profile.

Hours	Minutes	Temp (°C)	Tolerance (±°C)
2	30	15	.5

Adding a data point to the profile

2. Click the Add Point button to add the data to the profile.

NOTES *Tolerance is the amount of temperature variation permitted for a given temperature/time point in the cooling profile. If the temperature, as measured by the CMRV-4500 temperature probe, varies from the temperature specified in the profile by an amount greater than the tolerance value for that data point, the data will be tagged as "Profile out of tolerance" in displays and printouts of profile data.*

You cannot enter a tolerance value for the first profile point. Leave the tolerance field blank for that point.

The first data point in the profile must be the highest temperature in the profile.

3. Repeat steps 1 & 2 to add up to 25 data points in the cooling profile.
4. Input the desired data for Profile Name, Yield and Viscosity Test parameters, and Calibration protocol. Then click Save to save the new User Defined profile.

NOTE *If you do not rename the profile, the default name will be the same as the original profile with the* (Copy) *prefix added. You cannot use an existing cooling profile name for a new profile!*

Editing points

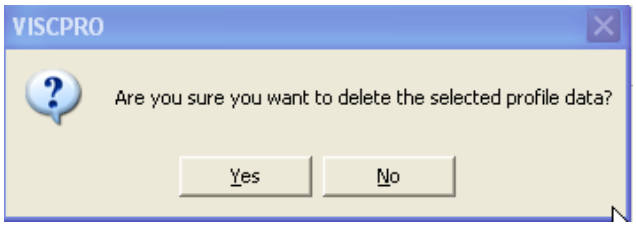
To edit a point, double-click the point in the point list. This transfers the point data to the Profile Editor.

Edit the values for *time* (hours and minutes), *temperature* and/or *tolerance* in the Profile Editor and Then click Add Point.

Deleting points

To delete a point, highlight the point in the point list; then click the Delete Selected button *OR* press the Delete key on your computer keyboard.

NOTE *To select multiple points for deletion, hold down the* Shift *or* Ctrl *keys while clicking on the points to be deleted. To de-select any point, just click on it again.*



TO delete the point click Yes. To keep the selected point(s) click No.

Cooling profile limitations

CMRV cooling capacity

The CMRV cooling capacity changes proportionally with the temperature at which the instrument is controlling. Greater cooling capacity is achieved at warmer temperatures, and capacity decreases as temperature decreases. This makes linear rates-of-cooling impossible in relatively short time frames.

Correcting profiles

If the rate-of-cooling for a profile exceeds the cooling capacity of the instrument, one of three things must be done:

- Lengthen the time between the two fixed temperature points
- Decrease the temperature change between the two fixed times
- Apply a combination of the two previous options.

When a profile data point with a specified tolerance is entered in the Profile Designer, software calculations are automatically made to determine if the rate-of-cooling relative to the previously-entered point is within the instrument's capability. It is assumed that the instrument can achieve the temperature specified by the previous point. If no tolerance is specified for that point, then this assumption may or may not be warranted. For this reason, it is possible to design a profile that the instrument is incapable of achieving. The software will only flag those points that are absolutely impossible to realize. This suggests that experience and experimentation are needed to properly design profiles which can be run successfully.

NOTE

The ASTM D 3829 and ASTM D 4684 profiles supplied with the MRVW software define non-toleranced points which are outside of the instrument's capability, but these are merely necessary stepping stones which permit the instrument to attain proper temperature control at the subsequent temperatures that are toleranced.

Profile Designer test parameters

The Profile Designer displays important test parameters for Yield Stress and Viscosity testing. These values are editable from the Profile Editor. For all ASTM profiles in the profile library, these values have been preset in conformity with current ASTM specifications.

NOTE *When the user is designing an entirely new profile "from scratch", the test parameters will default to ASTM D 4684 specifications. Copies or modifications of standard profiles will default to the parameters associated with the ASTM method (D 3829 or D 4684).*

Changing test parameters

To change test parameters:

1. Open the Profile Designer.
2. Select the desired profile and click the Create ..., Copy ... or Edit ... button as desired. The Profile Editor window will open.
3. Enter appropriate test parameter values. See the chart below for information on default test parameters.
5. Make any other necessary changes to the profile; then save the profile by clicking the Save button from the Profile Editor window.

NOTE *The new settings will be effective for that profile and any copies or modifications based on that profile.*

Profile Designer Test Parameters

Option	Default	Description
Mass increment	10	Amount of mass added at each repetition of yield stress testing. A ten-gram hook-cage and nine additional 10-gram weights are provided for CMRV testing. The ASTM D 6821 Method specifies increments of 2.5 grams.
Yield Test Minimum Degrees Rotation	10	This parameter adjusts the amount of pulley-wheel motion required by the digital-optical sensor for a determination of no yield stress. The 13° setting is for ASTM D 4684 and ASTM D 6821. For ASTM D 3829 use 10°.
Yield/Viscosity Test Timeout	30 or 120 (15 or 60 seconds)	Amount of time (in 0.5 second increments) allocated for each test. The default Timeout value for Yield Stress testing is 15 seconds and the default value for Viscosity testing is 60 seconds.
Viscosity threshold	20 or 120 (10 or 60 seconds)	Amount of time (in 0.5 second increments) permitted for the first ½ revolution of the rotor shaft if measuring three full rotations. ASTM D 3829 specifies 60 seconds; ASTM D 4684 and ASTM D 6821 specify 10 seconds.
Viscosity test timeout	120 (60 seconds)	Maximum amount of time (in 0.5 second increments) permitted for completion of the viscosity test.
Calibration temperature	-20 (°C)	The cells can be calibrated at multiple temperatures. This setting selects the cell constants used for determining viscosity. This value should ordinarily be the final temperature of the profile.
Calibrate Twice?	not checked	The cell calibration may be performed twice if desired by the user. Empirical testing suggests that a double calibration may enhance test accuracy.

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CHAPTER 15

MRV DATA TABLE ANALYSIS

The MRV Data Table analysis is designed to permit convenient viewing of data collected from samples which have been tested with the CMRV.

The sample analysis displays sample data in a tabular format. In addition to Sample identification (ID), the following data may be included:

- Sample ID—Sample identification information
- Test Date—Date the sample was measured
- Test Time—Time the sample was measured
- Cell Num—Number of the test cell (1-9)
- Profile Name—Name of cooling profile used for test
- Prof Start Date—Date the profile began
- Prof Start Time—Time the profile began
- Temp Data File—The .ttd file associated with the sample test
- Technician—Technician name (the individual logged in at the time the test was completed)
- Instrument Type—The instrument model identification
- Instrument ID—The unique instrument identification information
- Instrument S/N—The instrument model serial number
- Yield Stress—Yield Stress test result
- Y. S. Factor—Yield Stress factor for the profile
- Total Yield Mass—Yield Stress total mass added during test
- Test Temp—Temperature at which the sample was tested
- Therm Reading—Reference thermometer value (input by user)
- Viscosity—Viscosity of sample
- Visc Time 1—Time elapsed during the viscosity test
- Visc Rev 1—Number of rotor revolutions during the viscosity test
- Cell Constant—Percentage difference between calculated and known viscosities
- Viscosity Mass—Mass used to test for viscosity

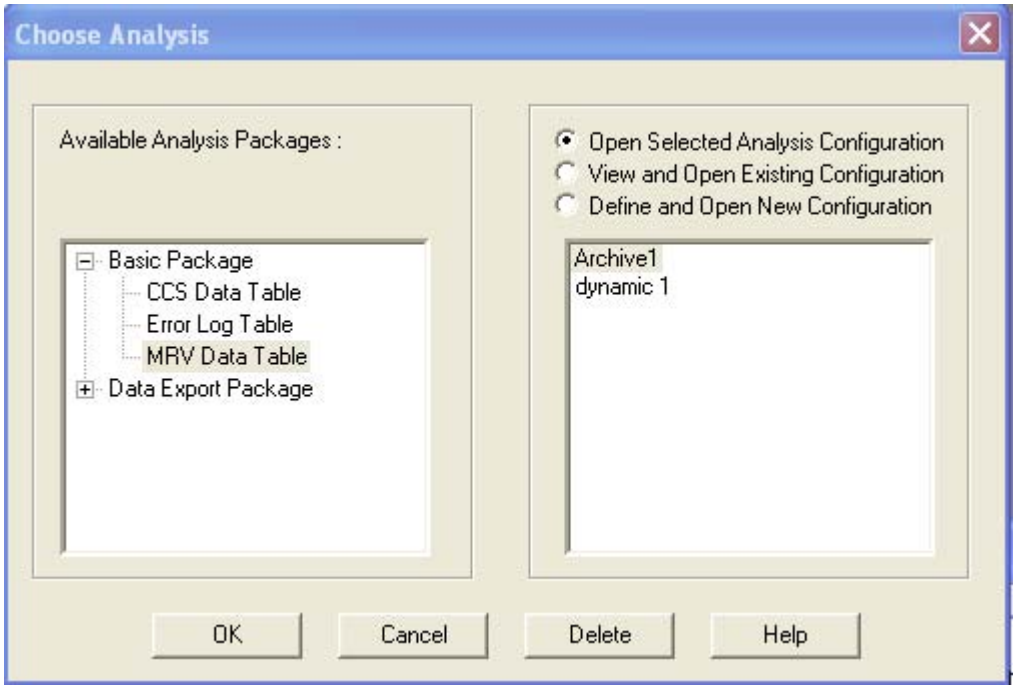
Reporting options

The MRV Data Table analysis can present data for any or all samples residing in the database. Several powerful filters may be used to create useful reports. These filters may be used by making selections from the tabbed property sheets found in the CMRV Analysis Configuration window. Once the appropriate filters have been designated, the resulting report configuration can be saved for future use.

Configuring the MRV Data Table

For general information on using analyses, see Chapter 13. To access and configure the MRV Data Table, follow the procedure below:

1. Select Analyses from the VISCPRO® primary menu options.
2. Select View Analysis ... from the Analyses menu. The Choose Analysis window will appear.
3. Double-click Basic Package (or click the adjacent "⊞"sign) from the list of Available Analysis Packages.
4. Select MRV Data Table from the Basic Package report options.



The Choose Analysis window

5. Click on the Define and Open New Configuration radio button (or verify that the option is selected).

NOTE *If you have already configured and saved an analysis, its name will appear in the list box on the right side of the window. If you click on an existing configuration and click* OK, *the analysis will be performed using the selected configuration settings. It will not be necessary to complete the remaining steps in this procedure.*

6. Click OK. The CMRV Analysis Configuration window will appear.

   The Sample Analysis Configuration window consists of three tabbed pages:

Date Filter | Sample Filter | MRV Report

- **Date Filter**—allows you to select date/time parameters for the analysis (see Chapter 13 for additional details).
- **Sample Filter**—allows you to select which tests will be included in the analysis (see Chapter 13 for additional details).
- **MRV Report Filter**—allows you to select what sample data will appear in the Sample Data Table and how the data will be displayed

7. Click on the tab corresponding to the filter you wish to set and complete configuration options per the instructions below:

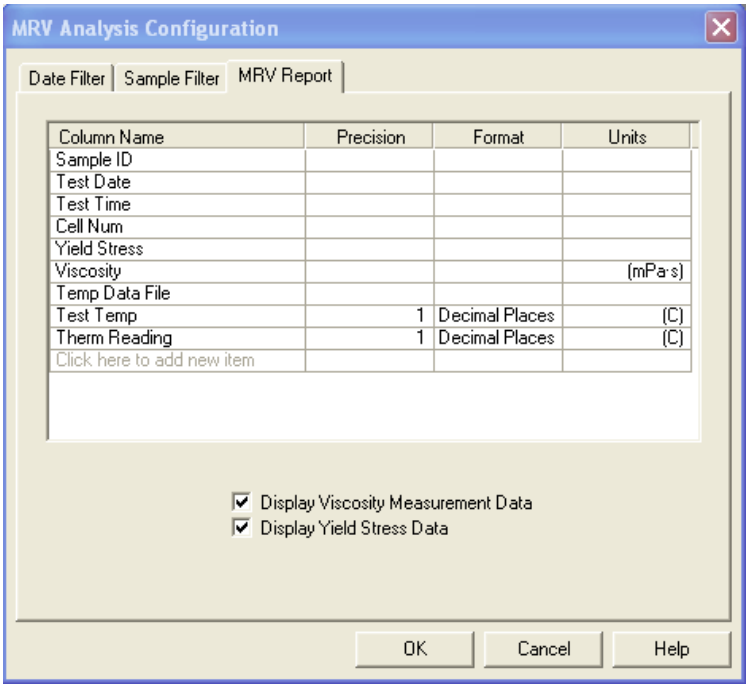
Date/Sample filters

Complete selection of Date and Sample Filter options per the instructions in Chapter 13.

CMRV Report filter

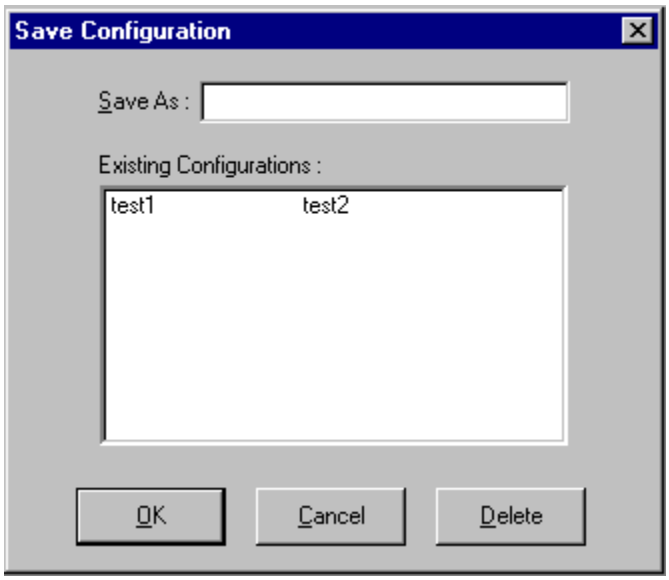
To select specific data for the analysis, click CMRV Report. Then click in the Column Name field to select desired data. You can also click the right mouse button in the Column Name field to delete or to insert additional columns of data. To change precision values for data, *triple-click* in the Precision field and type the number desired.

After individual options have been selected, use the related spin controls to determine the appearance of data (precision/rounding, unit of measure, etc.) for viscosity, temperature and other selected items. Use the check boxes to filter by data type (Viscosity, Yield Stress, or both).



CMRV Report data filter options

8. When you have completed the configuration, click OK. The program will prompt you to save the configuration.
9. Click Yes to save the configuration. The Save Configuration window will appear.



The Save Configuration window

10. Type the name of the new configuration in the Save As: field. Or click the name of a preexisting configuration in the Existing Configurations list box to replace the existing configuration with the new configuration settings.
11. Click OK. The analysis will be performed and displayed using the selected configuration settings.

NOTES

You may click Cancel *from the* Save Configuration window *to exit without saving configuration changes.*

You may display several analyses simultaneously by repeating the instructions above. Use the tiling options available from the Window *menu to display multiple analyses in the desired window format (horizontal, vertical or cascade view options are available).*

Exporting archived profile data

To export time/temperature data from a previous test (viscosity or yield stress), just configure an analysis for the data and right-click anywhere inside the data window for the analysis. Then click the Export Time Temp Data popup menu option.

CHAPTER 16

ERROR LOG TABLE ANALYSIS

The Error Log Table is designed as a troubleshooting tool to display error messages generated by the software during automatic processing of sample data.

The Error Log Table displays data in a tabular format. In addition to an error description, the following data may be included:

- Time—Time at which the error occurred
- Date—Date at which the error occurred
- Error Source—Source of error
- Instrument ID—Instrument identification (if applicable)
- Sample ID—Sample identification
- Tray Index—Identifies the Sample Tray number (always “1” for the CMRV instrument)
- Smpl Index—Indicates the number of the test cell (if applicable)
- Bulb—This VISCPRO reporting option is not applicable to CMRV analyses
- Technician—Technician logged on at the time of the error

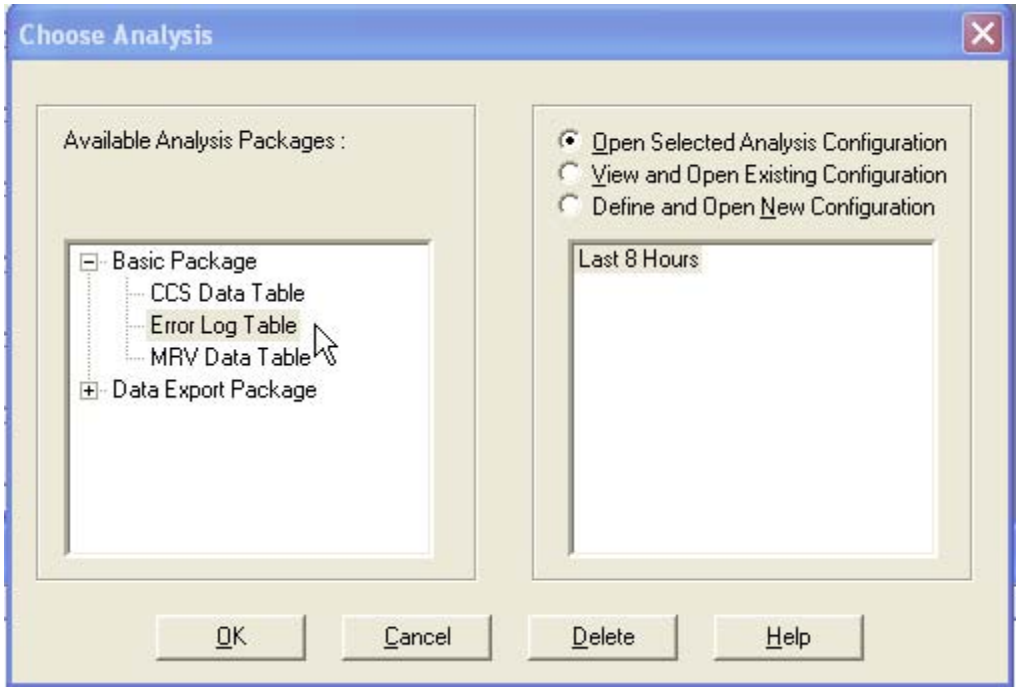
Reporting options

The Error Log analysis can present data for any errors encountered during sample runs for which data resides in the database. Several powerful filters may be used to create useful Error Log reports. These filters may be used by making selections from the tabbed property sheets found in the Error Log Configuration window. Once the appropriate filters have been designated, the resulting report configuration can be saved for future use.

Configuring the Error Log analysis

For general information on using analyses, see Chapter 13. To access and configure the Error Log Table, follow the procedure below:

1. Select Analyses from the VISCPRO® primary menu options.
2. Select View Analysis ... from the Analyses menu. The Choose Analysis window will appear.
3. Select the Error Log Table from the list of analyses included in the Basic Package.



Choosing the Error Log Table analysis

4. Click on the Define and Open New Configuration radio button (or verify that the option is selected).

NOTE *If you have already configured and saved an analysis, its name will appear in the list box on the right side of the window. If you click on an existing configuration and click* OK, *the analysis will be performed using the selected configuration settings. It will not be necessary to complete the remaining steps in this procedure.*

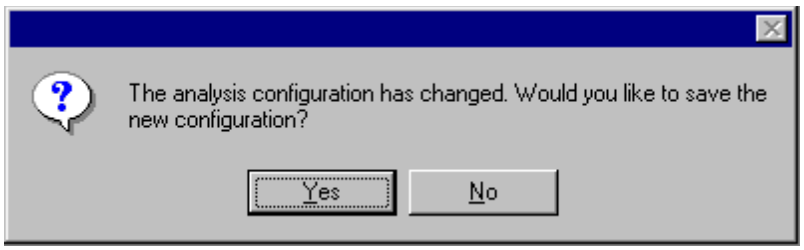
5. Click OK. The Error Log Configuration window will appear.

   The Error Log Configuration window consists of tabbed pages with filter options.

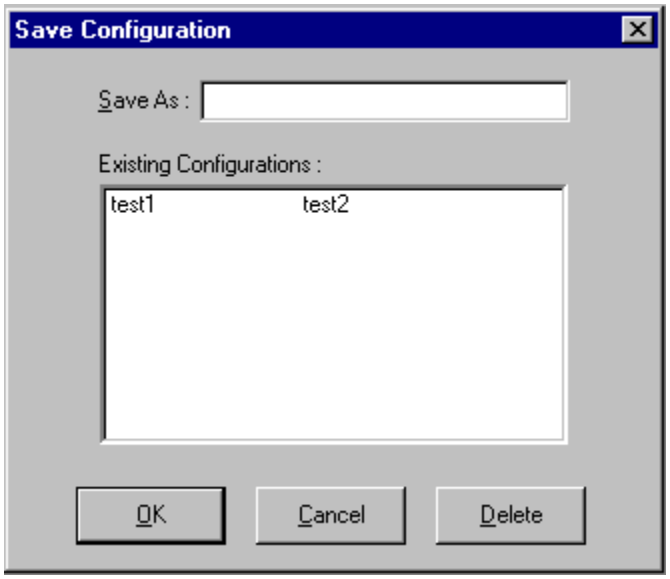
- **Date Filter**—allows you to select date/time parameters for the analysis (see Chapter 13 for additional details).
- **Error Filter**—allows you to select which profiles/technicians/tests will be included in the analysis (see Chapter 13 for additional details).
- **Error Report**—allows you to select what sample data will appear in the Error Log Table and how the data will be displayed.

6. Click on the tab corresponding to the filter you wish to set and complete configuration options. Use the check boxes to select which data to include in the report.

7. When you have completed the configuration, click OK. The program will prompt you to save the configuration.



8. Click Yes to save the configuration. The Save Configuration window will appear.



The Save Configuration window

9. Type the name of the new configuration in the Save As: field. Or double-click the name of a preexisting configuration in the Existing Configurations list box to replace the existing configuration with the new configuration settings.

10. Click OK. The analysis will be performed and displayed using the selected configuration settings.

NOTES

You may click Cancel *from the* Save Configuration window *to exit without saving configuration changes.*

You may display several analyses simultaneously by repeating the instructions above. Use the tiling options available from the Window *menu to display multiple analyses in the desired window format (horizontal, vertical or cascade view options are available).*

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EXPORT ANALYSES

The VISCPRO® Export analyses (MRV Data Export and Error Data Export) provide a convenient operator interface for configuring sample or error information from the sample database for serial output and exporting it in ASCII text format. The three port output filters (Date Filter, Sample Filter/Error Page and Port Output Format) permit the user to select and output desired data to a file, LPT port or serial port.

NOTE

Once the analysis has been exported, it cannot be reconfigured like other VISCPRO® analyses. This prevents duplicate data from being resent to network collection systems your lab may have in place. To re-send data, close the analysis window (you may save the configured analysis if you desire) and then recreate the analysis.

Analysis descriptions

The MRV Data Export analysis replicates the reporting options of the CMRV Sample Data Table, making it possible to export any data associated with sample tests. The Error Data Export analysis provides a means of exporting error and instrument status information in a report that may be useful for troubleshooting instrument performance.

Available data for analysis

In addition to exporting the selected data, the VISCPRO data export analyses display it on the computer screen in a tabular format. The following data is included in the MRV Data Export Analysis:

- Sample ID—The ID for the test sample
- Viscosity—Viscosity for the test sample
- Yield—Yield Stress for the test sample
- Profile—Temperature profile used for testing
- Test Date—The date of the test
- Test Time—The time of the test
- Start Date—The starting date of the temperature profile
- Start Time—The starting time of the temperature profile
- Temp °C—The test temperature
- Therm Temp—The reference thermometer temperature as input into the VISCPRO software by the user prior to testing
- Cell Num—The cell number associated with the test data
- Data File—The time/temperature profile data file associated with the test data
- Instr Type—The instrument type associated with the test data
- Instr ID—Instrument ID
- Instr S/N—The serial number of the instrument associated with the test data
- Delay—Delay time before transmittal of serial data

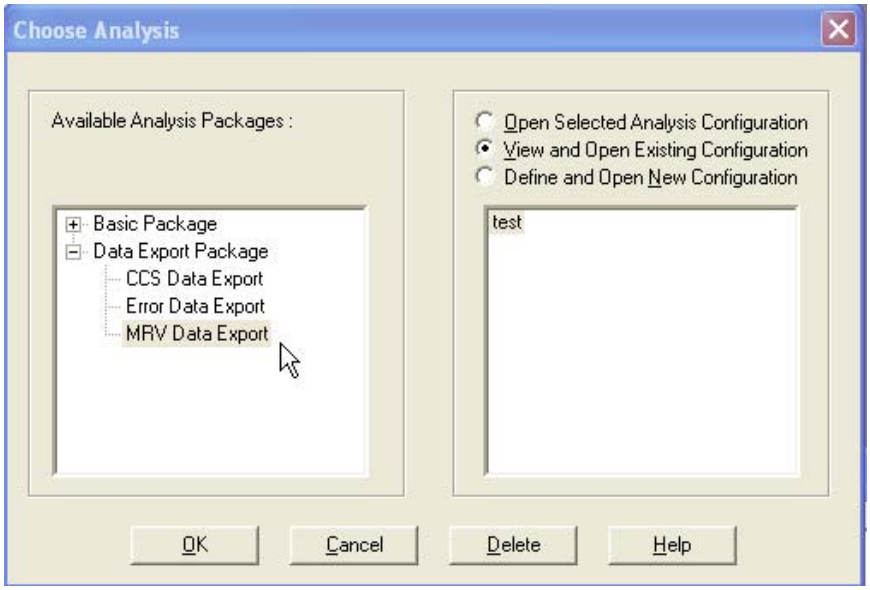
- ASCII Code—An ASCII character code input by the user, as defined by its byte code
- Smpl Type—the type of sample
- Visc Time—Time required for viscosity test completion
- Visc Rev.—Number of revolutions during viscosity test
- Cell Const—Cell constants associated with the test
- Mass—Test weight (in grams)
- Cal Temp—Cell calibration temperature
- Cal Visc—Viscosity of calibration standard
- Mass Inc.—Mass increment (in grams)
- Total Mass—Total mass recorded for yield stress measurement
- Space—Inserts a space in the report
- CR—Carriage Return (returns to the beginning of the line)
- LF—Line Feed (starts a new line in the report)

The following data is included in the Error Data Export analysis:

- Error—Displays text associated with the error
- Source—Identifies the source of the error (machine, software, etc.)
- Instr. ID—Identifies the specific instrument associated with the error
- Technician—Technician name (the individual logged in at the time the test was completed)
- Tray Index—Identifies the Sample Tray number (always “1” for the CMRV instrument)
- Smpl Index—Indicates the position of the sample in the numeric test sequence (Sample Table position)
- Bulb—Not Applicable for CMRV instrument
- Sample ID—Sample identification information
- Date—Date the sample was measured
- Time—Time the sample was measured
- Delay—Delay time before transmittal of serial data
- ASCIII Code—An ASCII character as defined by its byte code
- Space—Inserts a space in the report
- CR—Carriage Return (returns to the beginning of the line)
- LF—Line Feed (starts a new line in the report)

Configuring the Port Export analyses

1. Select Analyses from the VISCPRO® menu options.
2. Select View Analysis from the Analyses menu options
3. Double-click Data Export Package from the list of available analysis types.



Choosing an analysis

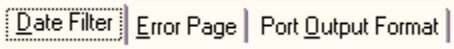
4. Select the desired Data Export analysis option. The CMRV Ports Output Configuration window will open.

5. Click the Define and Open New Configuration radio button to define a new analysis configuration.

NOTE *If you have already configured and saved an analysis, its name will appear in the list box on the right side of the window. If you click on an existing configuration and click* OK*, the analysis will be performed using the selected configuration settings. It will not be necessary to complete the remaining steps in this procedure.*

6. Click OK. The ASCII Ports Output Configuration window will appear.

   The ASCII Ports Output Configuration window consists of three tabbed pages:



- **Date Filter**—allows you to select date/time parameters for the analysis (see Chapter 13 for additional details).
- **Sample Filter/Error Page**—allows you to select which temperature profiles/errors/technicians/instruments will be included in the analysis (see Chapter 13 for additional details).
- **Port Output Format**—allows you to select the output port(s), what sample data will appear in the output analyses, and how the data will be displayed/sent.

7. Click on the tab corresponding to the filter you wish to set and complete configuration options per the following instructions:

Filters

a. Complete selection of Date and Sample/Error filter options per the instructions in Chapter 13.

Ports

b. Click the Port Output Format tab and click Add Port from the button options to open the Select Port window. Select the desired serial port(s) and/or files for output and verify the configuration settings for each. Then Click OK. Added ports will be displayed in the port list box.

NOTE

If you select NEW FILE *for output, click the* ... *button to open the Windows* Save As: *box. Select the desired directory and type the desired file name in the* File Name: *text box. If you select an existing file, ASCII port analysis data will be appended to the file.*

Make certain that you have selected the desired port for configuration by clicking on the port name in the Add Port *list box* ***prior*** *to selecting output data and formatting options for that port. OUTPUT FOR EACH ADDED PORT MUST BE CONFIGURED SEPARATELY (see note below).*

Configuring output

d. Select the desired port/file for configuration by clicking the name of the port/file in the port list box. Then click the radio button corresponding to the desired locale format (U.S. or local). Your choice will determine the formatting of numeric data, dates and choice of decimals or commas as placeholders.

Delaying serial output

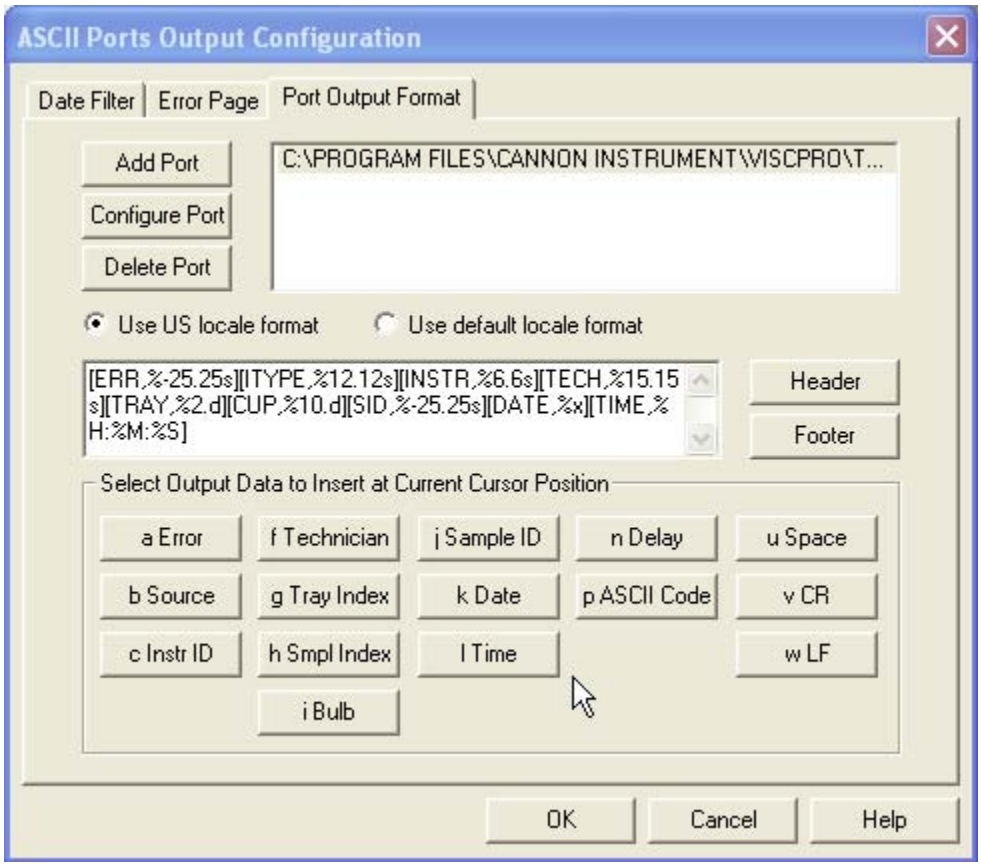
e. You may delay data transmission of serial output for a time parameter you specify by clicking the Delay button to insert the delay code into the Configure list box, Header or Footer. The Delay Configuration window will appear. To set the time of the Delay, type a numeric value in the appropriate field, and click on one of the radio buttons to select the correct unit of time. Then click OK.

Selecting output data

f. Click the buttons corresponding to the data types you wish to output on the report. As you do so, the appropriate coding for the output analysis will be automatically inserted in the text box.

NOTE

For some data output options, you will need to select the desired output field length using the spin controls provided in the Format Data Output *window. Experienced users may type code directly into the text box by clicking in the text box to place the cursor at the appropriate point. The text box information may also be manipulated using the mouse click-and-drag technique to highlight data and then using standard Windows® cut (Ctrl-**X**), copy (Ctrl-**C**), and paste (Ctrl-**V**) keyboard combinations. In this way, formatting data can easily be copied from one port configuration to another.*



The Port Output tab

Adding a header

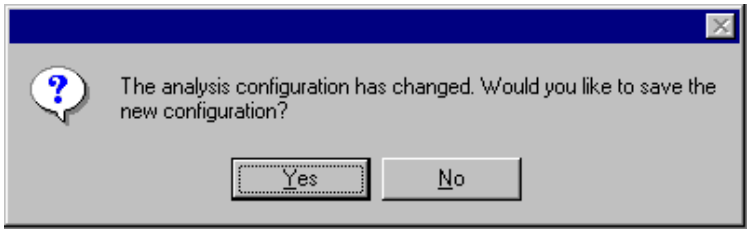
g. If you would like to include a header at the beginning of the analysis, click the Header button and add the desired text string via the keyboard. Format the entry as desired using the Carriage Return (CR) and Line Feed (LF) options as necessary to indicate line breaks. Then click OK.

Adding a footer

h. If you would like to include a footer at the end of the analysis, click the Footer button and add the desired text string via the keyboard. Format the entry as desired using the Space, Carriage Return (CR) and Line Feed (LF) options. Then click OK. (Space—Inserts a blank space, CR—Inserts a carriage return code, and LF—Inserts a line feed code)

NOTE *If you have selected the* Dynamic Update *option using the* Date *tab options, the footer will not be sent until the analysis window is closed.*

8. When you have completed the configuration, click OK. Serial data will be routed to the appropriate ports/files and you will be prompted to save the configuration.



9. If you do not wish to save the configuration, click No. The analysis will be displayed and the data will be sent to the selected ports. If you wish to save the configuration, click Yes. The Save Configuration window will appear. Type the name of the new configuration in the Save As: field. Or double-click the name of a preexisting configuration in the Existing Configurations list box to replace the existing configuration with the new configuration settings. Then click OK. The saved analysis will be displayed using the selected configuration settings, and the data will be sent to the selected ports.

NOTES

You may click Cancel *from the* Save Configuration window *to exit without saving configuration changes.*

The Port Output Analysis cannot be reconfigured. This avoids duplication of output data for collection devices your facility may have in place. You may still view configuration options for a displayed analysis by selecting Configure Analysis from the Analyses menu and choosing the correct analysis.

Re-sending export data

To re-send Port Output Analysis data for a displayed analysis, first save the analysis by clicking Analyses/Save Configuration*, selecting the desired analysis, typing the analysis name in the* Save As: *list box and clicking* OK*. Then close the* Port Output Analysis *window and re-select* Port Output Analysis *by clicking* Analyses/View Analysis *from the primary menu options. Then click on the desired configuration from the list of saved configurations and click OK.*

Exporting specific sample data

To re-send data from specific samples, use Sample Filter options, including wildcard characters if desired, to reconfigure the analysis to send only the necessary data. See Chapter 13 for more information on using sample filter options.

Port selection

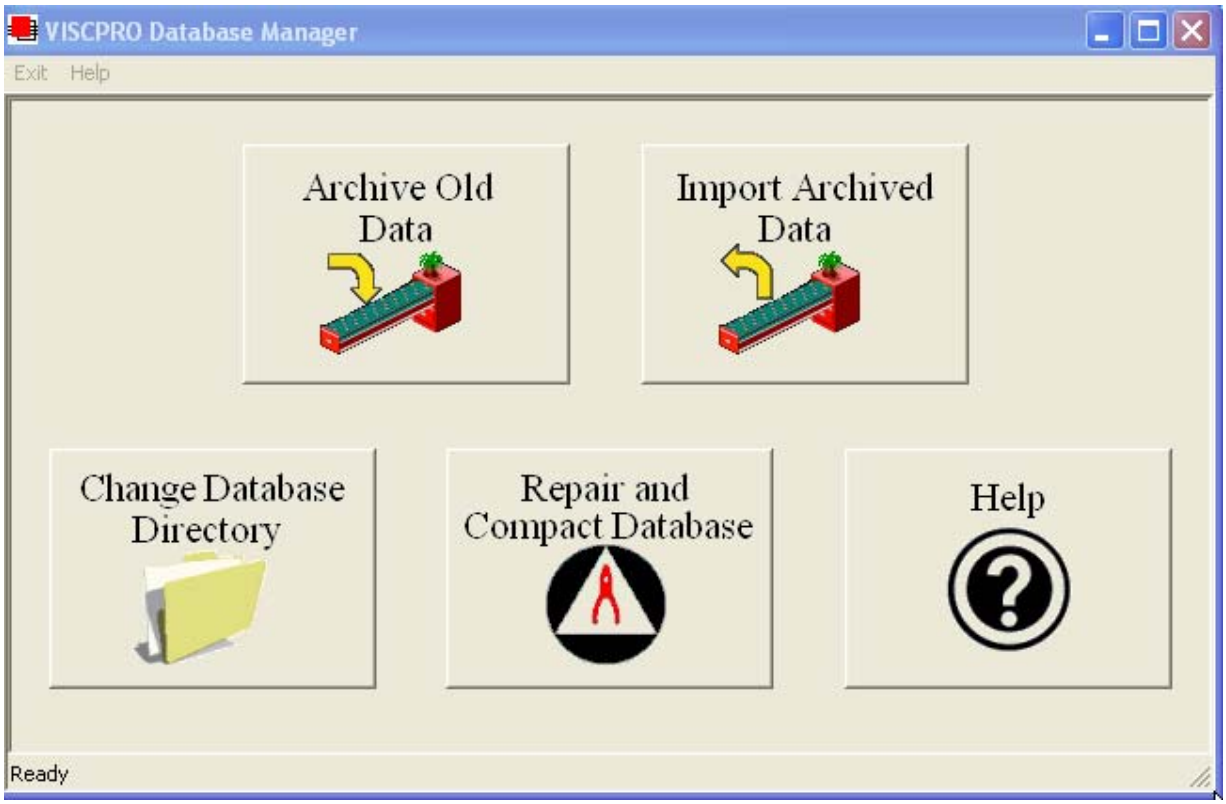
Make certain that you have selected the desired port for configuration by clicking on the port name in the Add Port *list box* ***prior*** *to selecting output data and formatting options for that port. OUTPUT FOR EACH ADDED PORT MUST BE CONFIGURED SEPARATELY.*

CHAPTER 18

USING THE DATABASE MANAGER

The Database Manager is a separate software program which is automatically installed in the same directory as your VISCPRO® software. The Database Manager provides options for managing the VISCPRO® database, including functions for:

- archiving old data
- importing archived data to the working database
- changing the database directory
- repairing/compacting the database



The Database Manager interface

Periodic archiving

CANNON® Instrument Company recommends periodic archiving of sample data to limit the size of the operating database and enhance the software response speed when generating analyses and accessing the database.

Starting the program

To start the Database Manager software:

1. Exit the VISCPRO® application. Then click on the Windows® Start bar.
2. Select Programs/VISCPRO/VISCPRO Database Manager from the list of options.

Archiving old data

When to archive

Data from the VISCPRO® database should be regularly archived in order to maintain the utility of the database file and to provide an additional level of security for your test data. The archive program allows you to back up existing data and/or remove it from the working database.

One recommended archive strategy would be to archive data older than 60 days at the end of each month, removing it from the working database. This will result in a working database of manageable size and a series of archive files, each containing a month of data. If necessary, archive materials could be temporarily imported into the working database for historical reporting.

Archive procedure

1. Select Archive Old Data from the button options. A Windows® Save As … window will appear.
2. Use the Windows® controls to select the drive and directory (folder) you wish to use for the archive file.
3. Enter the name of the archive file into the File name text box.
4. Use the spin controls to select the desired date. Data from sample runs completed prior to that date will be copied to the archive file.

NOTE *If you would like to remove archive data from the working database, click the* Remove Archived Data *check box.*

5. Click Save to copy archive information to the selected archive file. Or click Cancel to exit the Save As archive window without saving data to the archive file.

Changing the database directory

Changing the database location can facilitate its use by multiple networked computers. As the database grows, it may be desirable to relocate it to a different directory or hard drive. The Change Database Directory option does not physically transfer the database files from one

location to another. Rather, it allows the user to select the location for the working database. The database must first be archived (see previous page) or copied to the desired location BEFORE using Change Database Directory.

Change . . . procedure

1. Select Change Database Directory from the button options. A Browse … window will permit you to select the correct location for the database (`SAMPLES.mdb`) file.

NOTE *The current database directory is indicated at the top of the window.*

2. Select the correct drive and use the Windows® controls to select the directory (folder) you wish to identify as the database location.
3. Click on OK to confirm database directory selection. Or click Cancel to close the window without selecting a directory.

NOTES *You may only select a directory which contains a valid working database (SAMPLES.mdb) file.*

Click Network to access network map options. See your Windows® documentation for additional information.

Importing archived data

1. Select Import Archived Data from the button options. An import window will appear.
2. Use the Windows® controls to select the directory (folder) of the archive file to be restored to the working database.
3. Enter the name of the archive file into the File name text box.
4. Click Open to copy information from the selected file to the working database. Or click Cancel to exit the import window without importing archive data.

Repairing/compacting the database

Select Repair and Compact Database from the button options. The database will be automatically updated.

NOTE ***CANNON®** recommends that the Repair and Compact Database utility be run at least once a week if possible to provide additional stability for the database.*

Exit

When you have completed database management procedures, click Exit to exit from the Database Manager program. Or just close the Database Manager window  .

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CHAPTER 19

WARRANTY/RETURN INFORMATION

Products limited warranty

In addition to other manufacturers' warrantees, ***CANNON***® Instrument Company ("the Company") warrants all products (other than reagents and chemicals) delivered to and retained by their original purchasers to be free from defect in material and workmanship for one year from the date of the Company's invoice to the purchaser. For a period of one year from the date of such invoice, the Company will correct, either by repair or replacement at the Company's sole election, any defect in material or workmanship (not including defects due to misuse, abuse, abnormal conditions or operation, accident or acts of God, or to service or modification of the product without prior authorization of the Company) without charge for parts and labor. The determination of whether any product has been subject to misuse or abuse will be made solely by the Company.

The Company shall not be liable for any special, incidental, or consequential damages, or any damage to plant, personnel, equipment or products, directly or indirectly resulting from the use or misuse of any product. Representations and warranties made by any person, including dealers and representatives of the Company, which are inconsistent, in conflict with, or in excess of the terms of this warranty shall not be binding upon the Company unless placed in writing and approved by an officer of the Company.

Reagent and chemical warranty

CANNON® Instrument Company ("the Company") warrants all reagents and chemicals sold by the Company and delivered to and retained by their original purchasers to conform to the weight, specifications and standards stated on the package. The Company will, at its sole option, either replace or refund the price (net of freight, handling charges and taxes), of any reagent or chemical sold by the Company which does not conform to such weight, specifications and standards upon the prompt return of the unused portion. Except for replacement or refund of the net price, the Company shall not be liable for any damages occurring as a consequence of the failure of any reagent or chemical sold by the Company to conform to the weight, specifications and standards stated on the package.

Before returning a ***CANNON***® product for repair or service, make every attempt to identify the problem. If, after careful checking, the problem remains unidentified or unsolved, telephone ***CANNON***® Instrument Company (or the local service agent) to consult with a product specialist. If the specialist cannot recommend a simple solution or repair, ***CANNON***® will authorize the return of the product through the issuance of a Return Authorization number (RA).

CANNON® Telephone Number	814-353-8000
CANNON® Fax Number	814-353-8007

Products returned to ***CANNON***® must be carefully packed. Ship prepaid to the following address:

CANNON Instrument Company
ATTN: Return Authorization # _____
2139 High Tech Road
State College, PA 16803 USA

Please include the following:

Required information

- The Return Authorization number (RA).
- The name and telephone number of the person at your company to contact regarding the product.
- Shipping and billing instructions for the return of the product to your location.
- A detailed explanation of the reason for the return.

If the product is not covered by warranty, the customer will be provided with an estimate of the repair costs and asked for approval before any repairs are made. The customer will be required to issue a purchase order for the cost of the repairs.

Hazardous materials

Stringent government regulations restrict the shipment of mercury. Please contact ***CANNON***® before returning a product that could possibly contain mercury.

Shipping notification

Products returned without prior notification (by either telephone or fax), or without Cannon's authorization, will not be accepted.

The customer may be billed a testing fee if a product is returned to ***CANNON***® and found to be working properly.

APPENDIX A — TROUBLESHOOTING

Instrument status window not updating

- Check serial cable connections.
- If the status field in the Instrument View window indicates the CMRV is idle, then give the command to initiate the desired operation.
- If the temperature control lights on the controller are lit or blinking, close the Instrument Status window and reopen it.
- If temperature control lights on the controller are not lit or blinking, you may have a controller problem. Restart the instrument and try again.

The CMRV-4 is not heating properly

- Check to make sure the thermistor is seated securely in the CMRV-4 block.
- Make sure CMRV PUMP and HEATER connections are correct and secure.

The Yield and Viscosity lights on the CMRV front panel are blinking rapidly.

- Power down the controller for at least four seconds and then switch the controller back on. If the lights continue to flash, there is an internal problem with the controller.

CMRV cooling/temperature control problems

- Check to make sure the thermistor is seated securely in the CMRV-4 block.
- Make sure CMRV PUMP and HEATER connections are correct and secure.
- Check the Air/Water Heat Exchanger power connections
- Make sure the Air/Water Heat Exchanger power is on.
- Make sure the DC Power lamp on the exchanger is lit. If it is not, check to see if the Coolant Flow LED on the exchanger is lit in synchronization with the Cooling LED on the CMRV controller.
- If the Coolant Flow LED on the exchanger is lit in synchronization with the Cooling LED on the CMRV controller, check the tubing connections between the exchanger and the CMRV chassis and make certain that the DC power cable is correctly connected to the CMRV chassis (see Chapter 4). If cable connections are OK, there may be a problem with the relay in the Air/Water Heat Exchanger.
- If the Coolant Flow LED on the exchanger is NOT lit in synchronization with the Cooling LED on the CMRV controller, check the tubing connections between the Air/Water Heat Exchanger and the CMRV.

- Check the level of the water/antifreeze mixture in the exchanger reservoir and add more mixture if necessary. Also check for pinched hoses or obstructions in the hoses/connectors. If necessary, detach the hoses per manual instructions, remove any obstructions, and reconnect the hoses. If these steps do not solve the problem, the relay in the controller or the Air/Water Heat Exchanger may be defective.

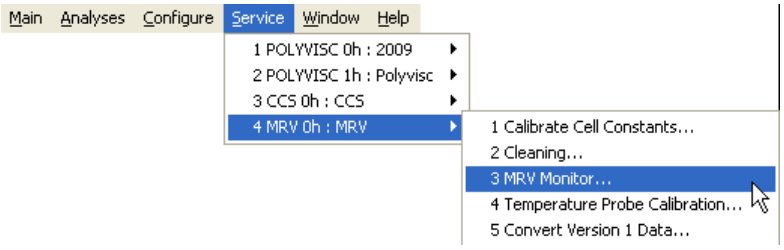
Yield stress or viscosity test results inconsistent.

- Check for damaged rotor tips or rotor pins and replace if necessary.
- Make sure that the block thermometer reading is identical to temperature probe indications on the CMRV computer screen. If there is a significant difference, recalibrate the temperature probe and the cells and run the sample again.
- Check for condensation/crystallization of water vapor on rotors/cells due to excessive humidity.
- Check for inadequate cleaning of rotors/cells, especially with PAO oils.

NOTE *You must recalibrate all viscometric cells following a temperature probe calibration to ensure accurate calibration constants for each cell.*

Test icons "greyed out"--unable to initiate viscosity tests

- The serial port may be locked. Wait for the previous test to time out (about six minutes) and see if the icons become active again.
- The profile may not be completed. Verify that the Remaining Time for the profile is 0:00.
- The instrument may not be communicating with the computer. Log into VISCPRO as a Manager and click Service/MRV/Monitor to open the MRV monitor. If the data window is updated regularly with new data, then communication is being maintained.



CHAPTER B

APPENDIX B — REPLACEMENT PARTS LIST

Part/Catalog No.	Description
9727-T10	N105B PINT VISCOSITY STD
28.0075	TUBING SET
50.105	SET OF WEIGHTS
50.89	WEIGHT HOLDER CAGE
50.90	WEIGHT (10 GRAM)
50.91	WEIGHT (150 GRAM)
52.4530	PLEXGLAS COVER ASS'Y
50.92	THREAD W/LOOP & RING SET (Set of 9)
51.1007	ROTOR LOCKING PINS (10)
51.1015	ROTOR COLLAR SET (1)
51.2003	BEARING PLATE
80.2210	RS232 AT MODEM CABLE
51.1016	ROTOR BEARING PIN
51.2046	PROBE ASSY, TEMPERATURE CMRV4
51.2055	TIMING WHEEL CMRV4
52.4506	VISCOMETRIC CELL ROTOR
52.4550	CMRV-4500 GAS PURGE OPTION

NOTE *All replacement parts should be purchased through an authorized representative of **CANNON**® Instrument Company.*

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APPENDIX C— THERMOMETRY

Kinematic viscosity and temperature

Kinematic viscosity is an extremely temperature-sensitive measurement - a change of 1°C can sometimes lead to a viscosity change of 10 percent or more. Therefore, it is not surprising that temperature measurement and control are the most common problems encountered by laboratories performing accurate kinematic viscosity measurements.
Although capillary viscometers typically measure kinematic viscosity with a precision of several tenths of one percent, measurements accurate to within one tenth of one percent (0.1%) are possible. To achieve this, temperatures must be measured with an accuracy of 0.01°C, and be maintained within a range of ± 0.01°C.

Thermometers

The ideal reference thermometer is a high-quality standard platinum resistance thermometer with a precision bridge. Because many laboratories cannot justify the cost of such a thermometer, ***CANNON***® Instrument Company recommends the use of a calibrated ASTM kinematic viscosity thermometer.

ASTM Thermometers

Each ASTM kinematic viscosity thermometer measures only 3 degrees on a scale subdivided into 0.05°C units (equivalent thermometers are available with Fahrenheit scales). These thermometers contain an ice-point scale which allows recalibration by determining the ice-point temperature.

Thermometer Calibration

Calibration of the thermometer is very important. Often the true temperature of a liquid differs markedly from that shown on the thermometer scale. It is not uncommon for kinematic viscosity thermometers to give readings varying as much as 0.1°C from the actual temperature. The true liquid temperature is obtained by applying the proper correction (as noted on the original calibration certificate) to the reading showing on the thermometer scale and including any difference obtained in a recent ice-point measurement of your thermometer.

Thermometer Immersion

Proper thermometer immersion is critical for viscosity measurements. Even a calibrated thermometer will read incorrectly if it is improperly immersed in the bath. “Total immersion” kinematic viscosity thermometers should be used with the bulb and entire mercury column beneath the surface of the liquid, but with the emergent stem above the surface at ambient temperatures.

NOTE *Different thermometers have different installation requirements. Refer to the information included with the thermometer in use for specific installation instructions.*

ASTM thermometer tables

The following tables show the ASTM thermometers available from ***CANNON***® Instrument Company:

ASTM CENTIGRADE THERMOMETERS

TYPE	CATALOGUE #	RANGE
74C	9311-K47	-55.4 to -52.6°C
73C	9311-K45	-41.4 to -38.6°C
126C	9311-K77	-27.4 to -24.6°C
127C	9311-K81	-21.4 to -18.6°C
72C	9311-K42	-19.4 to -16.6°C
128C	9311-K84	-1.4 to +1.4°C
44C	9311-K10	18.6 to 21.4°C
45C	9311-K20	23.6 to 26.4°C
118C	9311-K60	28.6 to 31.4°C
28C	9311-K05	36.6 to 39.4°C
120C	9311-K65	38.6 to 41.4°C
46C	9311-K30	48.6 to 51.4°C
29C	9311-K07	52.6 to 55.4°C
47C	9311-K40	58.6 to 61.4°C
129C	9311-K88	91.6 to 94.4°C
121C	9311-K70	98.6 to 101.4°C
110C	9311-K50	133.6 to 136.4°C

ASTM FAHRENHEIT THERMOMETERS

Type	Catalogue #	Range
74F	9311-L80	-67.5 to -62.5°F
73F	9311-L73	-42.5 to -37.5°F
126F	9311-L98	-17.5 to -12.5°F
72F	9311-L66	-2.5 to +2.5°F
128F	9311-L97	29.5 to 34.5°F
44F	9311-L31	66.5 to 71.5°F
45F	9311-L38	74.5 to 79.5°F
118F	9311-L94	83.5 to 88.5°F
28F	9311-L10	97.5 to 102.5°F
46F	9311-L45	119.5 to 124.5°F
29F	9311-L17	127.5 to 132.5°F
47F	9311-L52	137.5 to 142.5°F
48F	9311-L59	177.5 to 182.5°F
129F	9311-L99	197.5 to 202.5°F
30F	9311-L24	207.5 to 212.5°F
110F	9311-L87	272.5 to 277.5°F

NOTE *International shipments may be subject to special shipping regulations.*

ASTM D 445 — Checking the ice point

Frequency

To achieve an accuracy of ± 0.02°C for calibrated kinematic viscosity thermometers, a check at the ice point must be made. New thermometers should be checked monthly for the first six months, then once every six months.

Method

The following text outlines procedures for checking the ice point of a thermometer. The text is adapted from:

1994 Annual Book of ASTM Standards, Volume 05.01, Method E77

ASTM Method E77 contains a detailed procedure for the measurement of ice points. The instructions listed here are specifically designed for the mercury-in-glass “kinematic viscosity” thermometers described in Table 2, and may not apply to other thermometers.

The ice point reading of kinematic viscosity thermometers should be taken eight minutes after it has reached the test temperature. The measurement should be expressed to the nearest 0.01°C or 0.02°F.

Use clear pieces of ice, preferably made from distilled water. Do not use any cloudy portions. Rinse the ice with distilled water and crush or shave it into small pieces. Do not touch the ice with bare skin, or any chemical contaminants.

Fill the Dewar vessel with the crushed ice and add enough distilled (and preferably precooled) water to form a slush. Do not float the ice.

Place the thermometer into the slush, packing the ice gently around the stem. Make sure the thermometer is deep enough such that the slush covers the 0°C (32°F) graduation. As the ice melts drain some of the water and add more crushed ice. Avoid thermometer contact with the sides of the Dewar vessel.

After the thermometer has been in the slush mixture for 3 minutes, raise the thermometer a few millimeters and tap the stem gently. Observe any changes in the temperature reading. Repeat this procedure at 1 minute intervals until temperature readings agree within one tenth of division. Alternatively, some of the ice may clump around the stem above the ice point, forming a deep narrow channel which enables the observation of the temperature reading while kept below the level of the ice. If this is the case, observations can be made as described above, without raising the thermometer.

Record and compare successive readings. If they are higher or lower than the readings from a previous calibration, readings at all other temperatures should be correspondingly increased or decreased.

NBS Monograph150: Joining separated mercury columns

The following text outlines procedures for joining separated mercury columns in thermometers. The text is adapted from:

NBS MONOGRAPH 150 Liquid-In-Glass Thermometry
Wise, Jacquelyn A.

NOTE

Many inquiries are received concerning separated mercury column which occur especially during shipment. Since no means of avoiding such occurrences has yet been found, some directions for joining mercury may be helpful and are described below.

(A)

The bulb of the thermometer may be cooled in a solution of common salt, ice, and water (or other cooling agent) to bring the mercury down slowly into the bulb. If the salt solution does not provide sufficient cooling, carbon dioxide snow (dry ice) may be used. Since the temperature of dry ice is approximately -78°C (-108°F), and mercury freezes at approximately -40°C (-40°F), the mercury will solidify. Cool only the bulb and never the stem or mercury column. Moderate tapping of the bulb on a rubber stopper or similar soft spongy object, or the application of centrifugal force, by swinging the thermometer in a short arc (i.e. use of centrifugal force), usually serves to unite the mercury in the bulb. Care must be taken to warm the top of the bulb first, so pressures in the bulb due to expanding mercury may be relieved.

(B)

If there is a contraction chamber above the bulb or an expansion chamber at the top of the thermometer, the mercury can sometimes be united by warming the bulb until the column reaches the separated portions in either enlargement. Great care is necessary to avoid filling the expansion chamber completely with mercury, which might produce pressures large enough to burst the bulb. (The expansion chamber should never be more than 2/3 full). Joining the mercury is more readily accomplished if the quantity in either cavity has been shattered into droplets by tapping the thermometer laterally against the hand.

This procedure should not be used it if requires the thermometer to be heated above 260°C (500°F) and the bulb should never be heated in an open flame.

(C)

As a last resort, especially for thermometers having no expansion chambers, small separated portions of the column can sometimes be dispersed if mercury is warmed into droplets tiny enough to leave space for the gas to by-pass. The thermometer is heated, and the droplets are collected by the rising mercury column.

Organic liquid procedures

The procedure for thermometers containing organic liquids is similar. Separated liquid in the stem can be vaporized and permitted to drain down the capillary. Another method consists of gently tapping the stem above the separation against the palm of the hand, forcing the organic fluid to break away from the wall of the capillary and flow down the bore to join the main column.

Uniting gas bubbles

Minute gas bubbles, which are sometimes found along the surface of the mercury in the thermometer bulb, may be collected by "washing" the bulb with a large gas bubble. Bring all of the mercury into the bulb as outlined in section (A). Hold the thermometer in a horizontal position and gently tap it against the hand to form a large gas bubble. Force the bubble to travel around the walls of the bulb by rotating the thermometer and tapping it against the palm of the hand. When the entire surface has been "washed" rotate the bubble to the top of the bulb and reunite the mercury as described above.

All of these manipulations require patience, and experience is helpful, but they will yield results if care is used. Results can be verified by checking the ice point or some other reference point on the scale.

Viscosity standards

CANNON® Instrument Company recommends that laboratories check their kinematic viscosity measurements with viscosity standards. If the laboratory is using ***CANNON***® calibrated viscometers and has developed a good measuring technique, kinematic viscosity determination using a standard will often point to temperature errors.

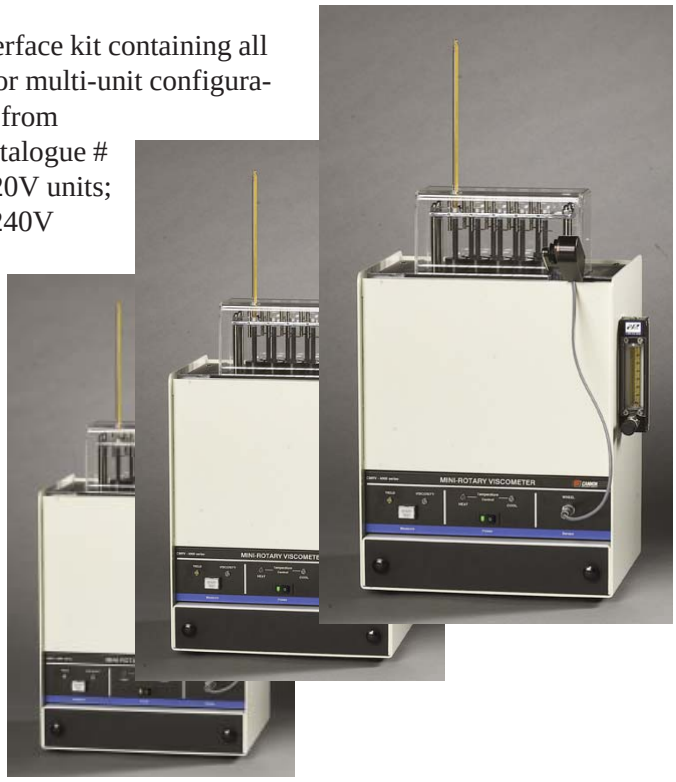
Viscosity standards should *not* be used to establish the correct temperature of the bath, however. Bath temperature should be checked and corrected by applying the reliable thermometric techniques outlined above.

APPENDIX D — MULTI-UNIT CONFIGURATION

Introduction

The CMRV 4000 Series instrument have been designed to permit multi-unit configurations of up to four CMRV units. Configuration is accomplished via a “daisy-chain” technique using RS-485 connections.

A multi-unit interface kit containing all required items for multi-unit configuration is available from ***CANNON***® (Catalogue # 9728-R40 for 120V units; #9728-R45 for 240V units).



Placement of multiple units

The practical “hands-on” realities of viscosity and yield stress testing suggest orientation of CMRV units in close proximity with the computer controlling the testing. Appropriate cables (8' lengths) are provided with the interface kit for this purpose.

Procedure

Using the interface kit provided by ***CANNON***®, complete the multi-unit configuration as follows:

1. Make sure the power is switched off to the computer and all instruments to be configured.
2. Locate the RS-232 to RS-485 converter provided with the interface kit.

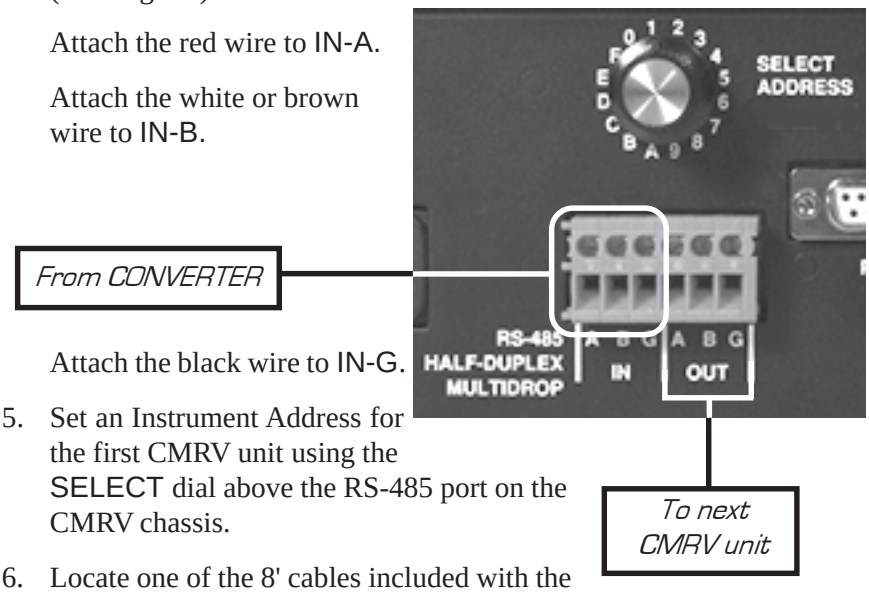
3. Plug the converter's RS-232 25-pin connector into the COM port you selected for multi-unit configuration during installation of the CMRV software. If you are using COM 1, a DB-25 to 9-pin adaptor may be required.

4. Select a CMRV unit as the first in the "daisy chain" and attach the three wires from the converter to the **ABG** connection marked IN on the RS-485 port on the back of the first CMRV chassis as follows (see diagram):

   Attach the red wire to IN-A.

   Attach the white or brown wire to IN-B.

RS-485 connections on the CMRV chassis



   Attach the black wire to IN-G.

5. Set an Instrument Address for the first CMRV unit using the SELECT dial above the RS-485 port on the CMRV chassis.

6. Locate one of the 8' cables included with the interface kit.

7. Connect one end of the cable to the RS-485 port on the first CMRV unit as follows:

   Attach the red wire to OUT-A, the white/brown wire to OUT-B, and the black wire to OUT-G.

8. Connect the other end of the cable to the second CMRV chassis by attaching the red wire to IN-A, the white/brown wire to IN-B, and the black wire to IN-G.

9. Set an Instrument Address for the second CMRV unit using the SELECT dial above the RS-485 port on the CMRV chassis. *The address must be different than that of the first CMRV.*

10. To daisy-chain additional CMRV units (up to a total of four), use additional lengths of cable provided with the interface kit and continue in the manner described in steps 6-9. *Make sure to select a unique instrument address for each CMRV added to the chain.*

NOTE *Each additional CMRV should be connected to the previous CMRV in the daisy-chain.*

11. When all CMRV units have been connected, plug the converter power supply into an appropriate electrical outlet to complete your installation. Check serial connections by running a cleaning cycle on all instruments per manual instructions.

CHAPTER 7

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