

RSO™

RHEOMETER

Operating Instructions





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ORIGINAL INSTRUCTIONS

RSO™ Operator Instructions

1. INTRODUCTION

The Brookfield RSO Rheometer is a rotational and oscillatory controlled-stress rheometer used in quality control, product development, and research. The measuring drive developed for this instrument utilizes a high precision dynamic drive system with an optical encoder for absolute position measurement of spindle deflection.

There are four basic methods of measurement available with the RSO Rheometer:

- Rotational measurement under controlled shear rate (CSR)
- Rotational measurement under controlled shear stress (CSS)
- Oscillatory measurement under controlled shear stress (CSS)
- Oscillatory measurement under controlled deformation/strain (CD)

The RSO Rheometer has all the functionality of a standard Brookfield rotational viscometer, performing rotational tests with pre-set speed or shear rate. The RSO Rheometer is even more versatile because it can also perform tests with a pre-set torque or shear stress and measure the resulting shear deformation of the test substance via angular deflection of the measuring element. The RSO controlled stress capabilities can be used for experiments such as:

- (1) Measurement of the “static” yield stress – eliminating the multi-shear rate test that requires math model extrapolation; and
- (2) Creep and Recovery of numerous materials.

Additionally, the RSO Rheometer is equipped with a powerful motor with a usable torque range of 0.005 to 100 milliNewton-meters, mN-m or mNm. As a result, the RSO Rheometer is appropriate for rheological measurements over a wide range of sample viscosities. Furthermore, the oscillatory mode measures viscoelastic material responses that cannot be measured in rotational tests. One advantage of small-amplitude oscillatory rheometry or “SAOS” is that the small strains or deformations can probe weak structures without destroying them (e.g., testing weak gels, etc.)

The Brookfield RSO Rheometer incorporates the following features:

- Air-bearing, drag cup motor, capable of both rotational and oscillatory measurements.
- Digital control of rotational speed, shear rate, torque, or shear stress.
- Pre-designed rotational measurement programs for analysis of viscosity flow curves, creep and recovery behavior, yield stress, and thixotropic properties.
- Pre-designed oscillatory test methods: amplitude sweep, frequency sweep, time-dependent or temperature-dependent behavior.

- Automatic adjustment of control parameters during measurement.
- Direct indication of measured and calculated values of speed, shear rate, torque, shear stress, shear strain, viscosity, temperature, and time.
- Graphical display of measured results in real-time.
- The internal storage of data, including test parameters, measured values, and calculated values.
- User interface via a touchscreen display.
- Quick-connect coupling system for easy spindle attachment.
- Barcode reader for automatic spindle recognition.
- USB port for connection to a computer or a USB flash drive.
- Operation in standalone mode via touchscreen display or with a computer system running Rheo3000 application software.
- Dual Configuration Modes to allow for Cone, Plate, and Coaxial Cylinder Spindles and Accessories. *

*Measuring Systems (hereinafter referred to as “Spindles”) and Accessories are not part of the standard delivery of the RSO Rheometer and must be ordered according to the user’s measuring requirements.

The following additional services are available to support the use of the RSO Rheometer:

- Start-up Assistance
- Instrument Training
- Rheo3000 Software Training
- IQ/OQ/PQ (Installation, Operation, and Performance Qualification)

1.1 Obligation to Instruct

The RSO Rheometer should only be operated by qualified personnel.



Please read the operating instructions before using the instrument.

1.2 Safety Information

Read the operating manual carefully, follow all instructions provided, and observe all safety notes to ensure the proper and safe use of this measuring instrument. If you have any questions, please contact AMETEK Brookfield Technical Support or an authorized dealer.

This instruction manual uses the following safety notes and symbol categories:



Warning ... a situation which may result in injuries to people or damage to property, environment, software, data, or test results if ignored. The warning must be strictly observed.



Mandatory ... an important precaution.



Info ... important or useful comments and information.

1.3 Safety and Hazard Information



This instrument is not intended for use in an explosive or otherwise potentially hazardous environment.



If RSO Rheometer is used in a manner not specified by the manufacturer, the protection measures integrated into the instrument may be impaired.



In case of emergency, turn off the instrument and then disconnect the electrical cord from the wall outlet.

1.4 General Handling and Operational Safety

When moving the RSO short distances (i.e., during Setup), first protect the instrument by inserting the black foam rubber stopper between the rheometer head and base. Ensure that the sample plate is at a safe temperature. During transportation, hold the instrument only by its base. Never hold the instrument by the head to carry it. Never lift the instrument by the spindle or its coupling. Protect the instrument against heavy bumps, vibrations, or shocks that might impair the rotation of the coupling. Use a rolling cart for transportation whenever possible.



The RSO Rheometer weighs approximately 70lbs.(32kg) and requires two people to safely lift.



Make sure that the instrument is in a clean, dry working environment (dust-free, moderate temperature, low humidity, etc.), see section IV.2.2 Ambient Conditions.

1.5 Dangers in Handling the Machine



Be aware of substances placed under test that may release poisonous, toxic, or flammable gases at the temperatures which they are subjected to during the testing.



If dangerous vapors can be released by heating the material, appropriate ventilation is required.



If flammable substances are tested, the temperature must be 25 °K below the flashpoint of the material. In general, the flashpoint of the test sample material must not be below +205°C (+401°F).



DO NOT touch rotating spindles. Damage to the spindle and/or RSO may occur.

Safeguard any loose-fitting clothing (sleeves). Remove any jewelry, rings, watches, etc.

Protect long hair. Tie hair back or work with a cap or hairnet.

Cone and Plate Spindles can eject bits of the sample from the plate during high-speed tests.



The user should wear eye protection and protective clothing during testing.



Wear gloves to protect against skin contact with potentially irritating or harmful substances.



High Magnetic Fields. Pacemakers or other similar implanted devices may be affected.



Burn Hazard. Allow Sample Plate, Water Jacket, and Hoses to cool before touching or removing them.



Electrical Hazard. Unplug damaged power from the wall outlet cord before removing from RSO.



Laser Bar Code scanner in use. Avoid Direct Eye Exposure.



Compressed Air in use.

Class A instrument

Repair service should only be performed by AMETEK Brookfield's trained service team, see Appendix F: Warranty and Repair.

1.6 Ergonomics

Ensure your planned work area is at a comfortable height with a proper stool or seat. Allocate enough space to allow for a PC and external temperature control device to be within easy reach.

1.7 Unpacking



The RSO Rheometer weighs approximately 70lbs.(32kg) and requires two people to safely lift.

When transporting the device to the place of use, regulations must be observed. See section VII Transport and Storage.

1.7.1. Unpacking

- Cut the straps from around the box and pallet.
- Remove the top cover.
- Open the internal box top and remove the filter system and accessories.
- Remove the top of the box and the outside sleeve.
- Remove the top foam piece from the head of the instrument.
- With two people, carefully remove the RSO from the bottom foam tray. Lift by the base of the instrument and place it on a sturdy bench.
- Remove shipping strap, plastic bag, and protective foam disc from the instrument.

SAVE ALL PACKING MATERIALS, INCLUDING FOAM INSERTS.

1.7.2. Damages in Transit

Check the instrument for transport damage after unpacking. If any transport damage is detected when unpacking the instrument, please inform the carrier and contact AMETEK Brookfield or your local authorized dealer. The cause for shipping damage should be resolved before any use of the instrument.



Do not attempt to operate the instrument or any accessories that show any evidence of damage.

1.7.3. Scope of Delivery

Please check to be sure that you have received all components, and that there is no damage. If you are missing any parts, please notify AMETEK Brookfield or your local agent immediately. Any shipping damage must be reported to the carrier.

When unpacking the RSO Rheometer, the shipment container will include:

Standard RSO Components		Quantity
RSO Rheometer	varies	1
AC Power Cord	varies	1
PC-USB Cable (A-B)	-	1
Certification of Test	-	1
Rheo3000 Software (30-Day Trial)	-	1
Operating Instructions	M01-908-A0518	1

Optional accessories ordered with the RSO Rheometer, such as spindles and temperature control elements are packaged and shipped in separate shipment containers.

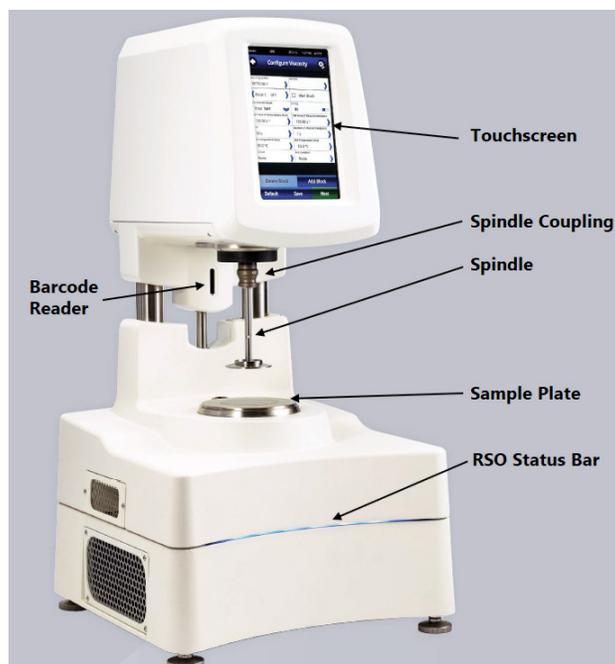
1.8 Features

Primary RSO Rheometer Features

- Touchscreen
- Spindle Coupling
- Spindle (Cone or Plate)
- Barcode Reader
- Sample Plate (Peltier)
- RSO Status Bar
- Bubble Level Tool (not shown in the picture)

Additional Accessories (not shown in the picture) that are available for the RSO Rheometer include:

- Coaxial Cylinder Spindles
- External Temperature Sensor Pt100 (PN: PT-E)
- Water jacket for temperature control with Coaxial Cylinder Spindles (PN: FTKY3)
- Solvent Trap for use with highly volatile test materials (PN: RSTRAP)
- Rheo3000 Software



1. 8. 1. Touchscreen

All user inputs in standalone mode are done via the touchscreen. The touchscreen doubles as both an input and an output device.

The touchscreen is resistive, meaning that it responds to light pressure. Tap lightly with a finger or stylus to select the desired option on the touchscreen. Tap and drag your finger to scroll. Multi-touch options are not available due to the resistive touchscreen.

Replace the protective film on the display when damage or heavy wear is evident.

1. 8. 2. Utilities and Connections

Utilities

Input Voltage: Universal Power Supply (90 - 275 VAC)

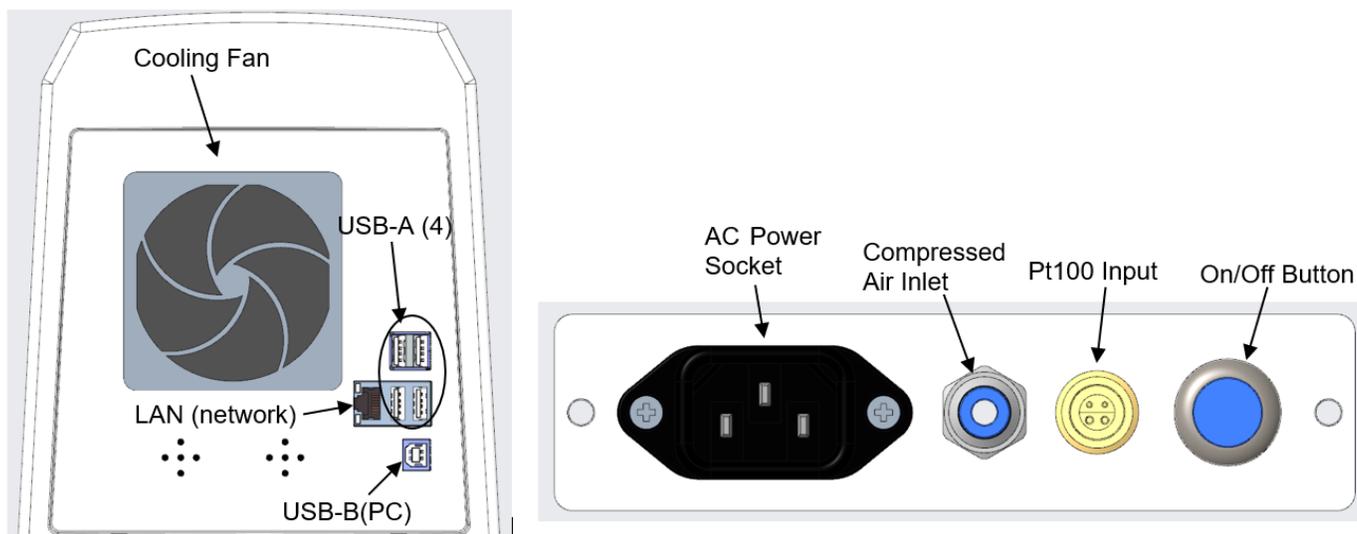
Input Frequency: 50/60 Hz

Power Consumption: 400 VA

Power Cord Color Code:

United States		Outside United States
Hot (live)	Black	Brown
Neutral	White	Blue
Ground (earth)	Green	Green/Yellow

Connections for the electrical components of the RSO Rheometer are located on the back of the instrument, as shown in below.



Head:

- 1x USB-B (PC)
- 4x USB-A
- LAN (network)

Base:

- ON/OFF button
- AC power
- External Pt100 temperature sensor input
- Compressed air inlet

Connect or disconnect all cables from the RSO Rheometer only while the instrument is turned off. See section IV.2.7 Interfaces.

1.9 Rheometer Setup

The following section provides setup information for the RSO Rheometer. When transporting the device to the place of use, regulations must be observed. See section VII Transport and Storage.

1.9.1. Space Requirement

Find a comfortable, convenient work area for the setup of the RSO Rheometer.



The instrument should be placed upright on a stable, flame-resistant, level table.

There should be a free space of at least half a meter to the right, left, and rear of the device to ensure cooling.

A grounded AC plug outlet is needed to operate the RSO Rheometer.

Ensure that there is enough room to place some spindles, measuring substances, and peripheral devices.

1. 9. 2. Ambient Conditions

The RSO Rheometer's operating environment should be indoors and away from any extreme or heavily fluctuating ambient conditions.



If dangerous vapors can be released by heating the test sample, proper ventilation, such as an overhead lab hood, is strongly recommended.



The RSO Rheometer should be placed in an area where it will not be exposed to

- excessive dirt or dust,
- direct sunlight,
- objects that emit strong heat (e.g. radiators),
- objects with strong electromagnetic fields,
- liquids or corrosive chemicals.



For optimal performance, be sure that the following ambient conditions are maintained:

- Temperature between +10°C and +40°C (+50°F and 104°F)
- Relative air humidity between 20% and 80%

1. 9. 3. AC Power Connection

The supplied AC Power Cord is used to power the RSO Rheometer.



Always connect the power cord to a properly grounded socket. To avoid electric shock or damage to system components, always use a properly grounded plug to connect the power cord.



Be sure to observe the following instructions:

- Always inspect the Power Cord for defects/damage before plugging it into an outlet.
- Never use a damaged Power Cord. If necessary, contact AMETEK Brookfield or the authorized dealer from whom you purchased the instrument for a replacement Power Cord.
- The Power Cord should always lay flat and uncovered.
- Position cables and Power Cord in a way to ensure that no one will stumble over them.
- The Power Cord and the cables must never be in contact with liquids.

Connecting the AC Power Cord:

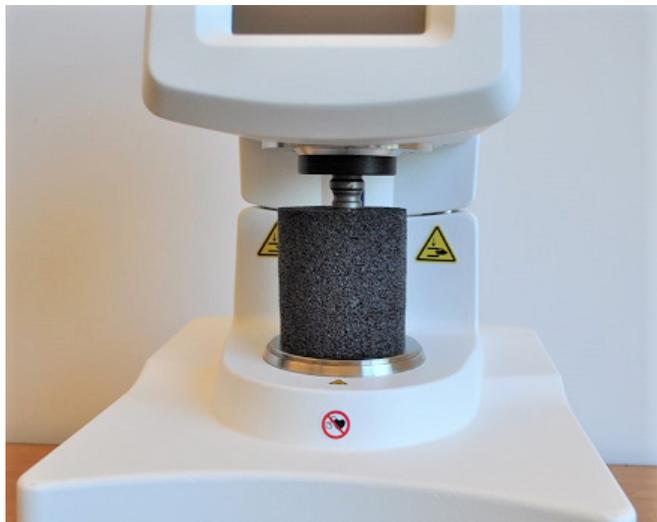
- Insert the female end of the Power Cord into the AC Power In socket on the back of the RSO Rheometer.
- Plug the Power Cord into a grounded AC outlet.



The AC input voltage and frequency must be within the appropriate range. See section X.1 Power Supply

1. 9. 4. Remove Foam Shipping Block

To remove the Foam Shipping Block, turn on the device. See section IV.3 Power Up. It is not necessary to have compressed air available. As soon as the RSO Rheometer starts to lift its head, the foam block can be removed. See figures.





Save the foam block for future shipping purposes.

Turn the RSO off.

1. 9. 5. Level the Instrument

Place the supplied Bubble Level in the center of the RSO Sample Plate, being careful not to scratch the plate.

Adjust the RSO Rheometer feet until the bubble is inside the center ring of the Level.



After earthquakes, other ambient influences, or anytime that the RSO is moved, it is recommended to check the bubble level.

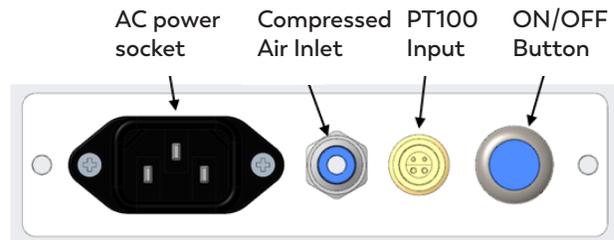
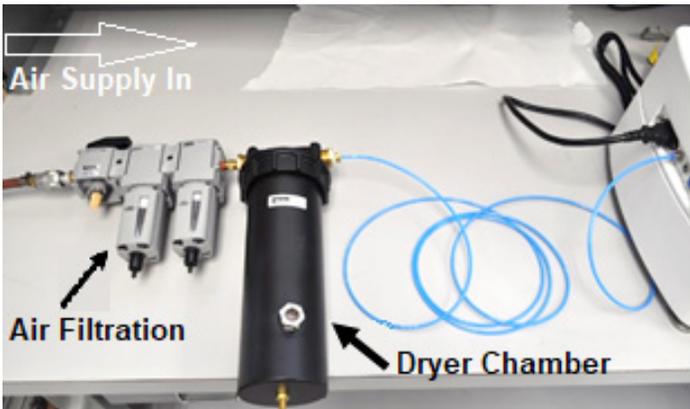
1. 9. 6. Air Supply & Filter System Connection

A 6-9 Bar (72.5-116psi) Compressed Air Source is required to operate the Air Bearing Motor of the RSO Rheometer. Compressed Dry Air (CDA) must meet ISO 8573-1 class 1.5.1 to ensure air bearing motor is not damaged.



The supplied filter/dryer system is required for operation! Not using this system will result in damage to your Air Bearing Motor!

- 1) Setting up the filter system and air supply:
 - a. Fill the Air Filtration Dryer Chamber with the supplied desiccant.
 - b. Connect an air supply to the Air Filtration inlet.
 - c. Connect supplied plastic tubing to RSO air input.
 - d. Turn on air supply and the set regulator to 6 bar / 87 psi.



The air filtration and dryer system is critical to the operation of the RSO and the use and maintenance is required for Warranty coverage. Failure to use the air filter/dryer system will lead to severe damage to the air bearing motor.

It is important to periodically check the status of the desiccant to determine it has not become too saturated with moisture. The desiccant will change color to indicate when it has become saturated with moisture. Please See Appendix D for details on the color change and maintenance of the desiccant in the dryer chamber.



All pipes, hoses, and fittings must have a rating of the maximum pressure of the compressor. Compressed air pipelines should be identified (psi) as to maximum working pressure.



Air supply shutoff valves should be located (as near as possible) at the point-of-operation.

Hoses should not be strung across floors or aisles where they are liable to cause personnel to trip and fall. When possible, air supply hoses should be suspended overhead, or otherwise located to allow efficient access and protection against damage.

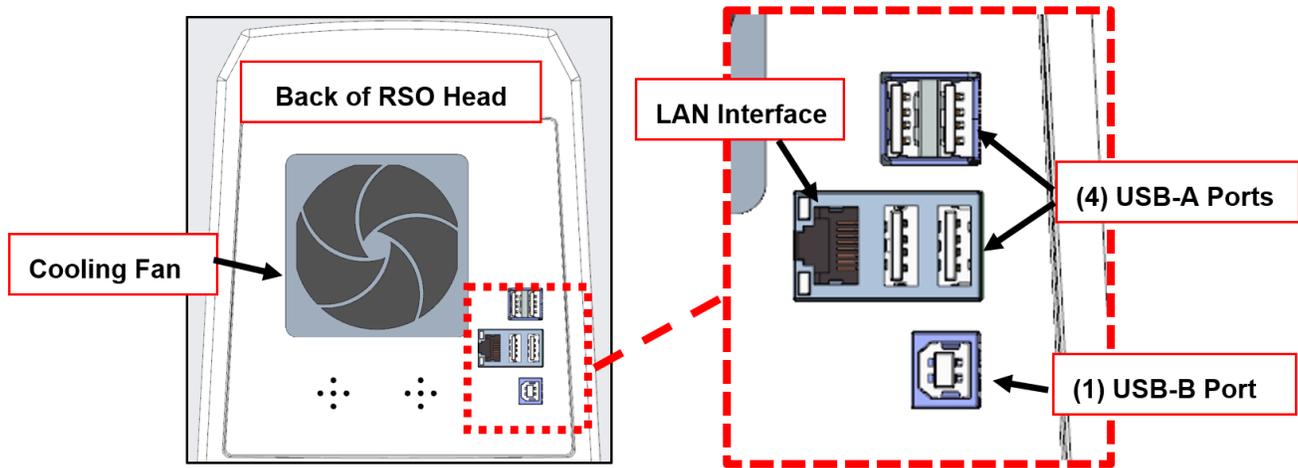
Hose ends must be secured to prevent whipping if an accidental cut or break occurs

Air lines should be inspected frequently for defects, and any defective equipment repaired or replaced immediately.

1. 9. 7. Interfaces



Connect or disconnect any cables from the RSO Rheometer only while the instrument is turned off (LAN and USB interfaces excluded).



1. 9. 8. Drive System

The movement of the head is controlled by a linear drive system that will assist in the loading of spindles and will also automatically set the required gap in CPS (Cone/Plate System) mode. There are several predefined positions which the vertical drive system approaches during normal operation:

-CPS home position



- CPS zero gap position



-CPS filling position



-CPS gap position



-CC (Coaxial Cylinder) position



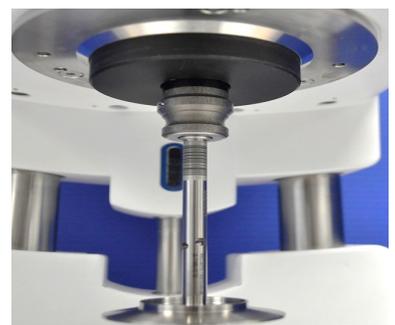
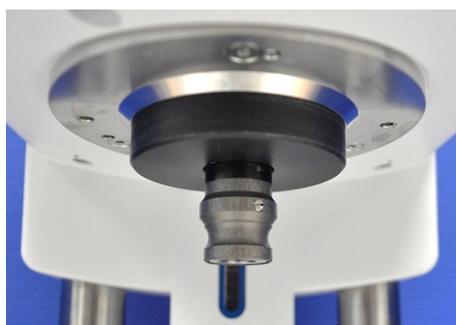
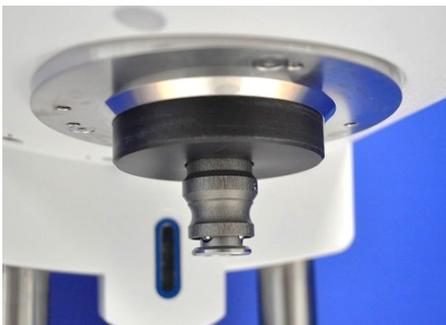
- Parking position (when shutting down in CPS Mode)



1. 9. 9. Quick Coupling

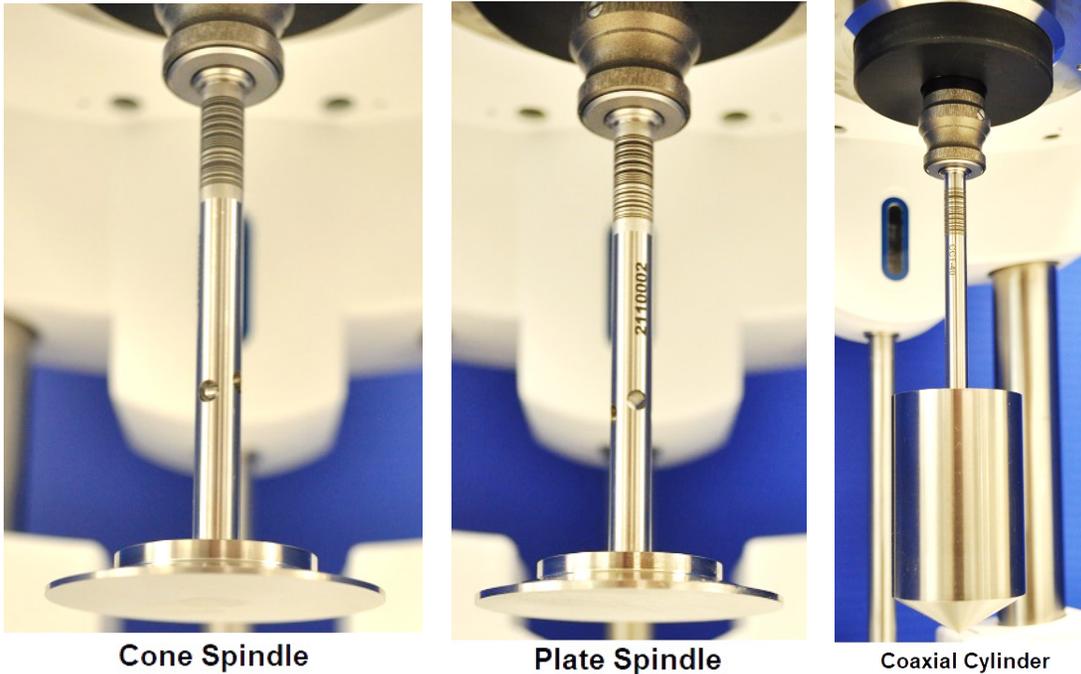
Open the coupling on the instrument and gently insert the spindle. Close the coupling. The spindle should be locked firmly in place. Once the coupling is closed, the barcode should be read automatically by the instrument's built-in barcode scanner. The spindles should be handled with care. Ensure no material is on the coupling or barcoded shaft of the spindle.

To remove the spindle, open the coupling. In CPS mode the instrument head will lift away from the spindle automatically. In CC Mode, the spindle will gently sink into the sample cup. In either mode, if the spindle becomes stuck in the coupling, gently pull down on the spindle to detach.



1.10 Spindles

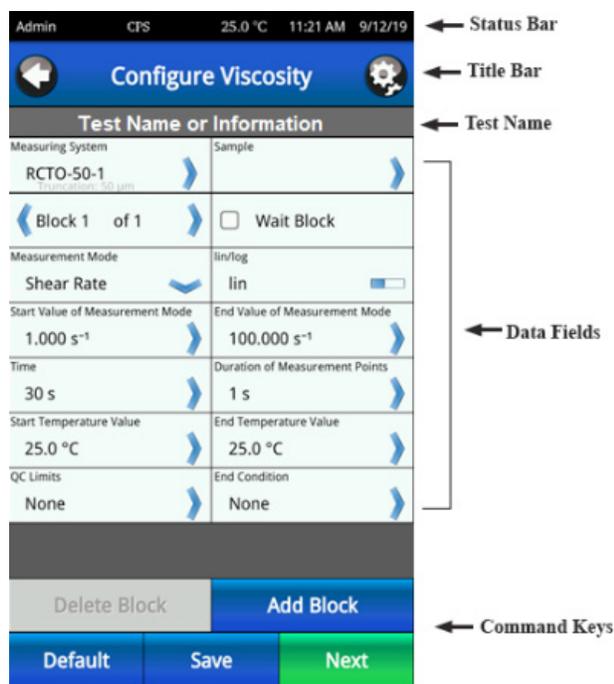
The RSO offers 3 types of spindles: Cone geometry for Cone-Plate measurements, Plate geometry for Plate-Plate measurements, and Coaxial Cylinders when used is CC mode. Each spindle can be supplied in stainless steel or titanium.



The spindles have a unique barcode that the instrument will recognize. The first time you attach the spindle you will be asked to enter the details from the spindle certificate for all cone spindles. Plate spindles and Coaxial Cylinder spindles details will already be set in the instrument firmware.

The Moment of Inertia will have to be calibrated the first time you attach any new spindle to the RSO Rheometer.

1.11 Key Functions



Title Bar: The Title Bar identifies the activity to be conducted in the current view and includes any navigation icons that are relevant.

Test Name: The Test Name identifies the name or other important information about of the currently loaded test.

Data Fields: The Data Fields include test parameters or results.

Command Keys: The Command Keys indicate action that can be taken. These keys will vary from view to view depending on what actions are relevant.



1.12 Rheo3000™ Software (Optional)

Rheo3000™ software is optional and allows for the automation of measuring procedures, modeling, and analysis of measured data and report printout through a PC.

Rheo3000™ minimum system requirements:

- CPU with at least 1.5 GHz frequency
- 1 GB RAM (primary storage)
- 2.5 GB free fixed-disk capacity
- Operating system Microsoft (32bit or 64bit) Windows
- Vista, 7, 8 or 10
- Mouse and keyboard
- VGA graphic adapter with 1024 x 768 resolution and monitor
- 2 USB ports for rheometer and temperature accessory control
- Application software package Rheo3000



The application software for the RSO Rheometer (Rheo3000 software package) is available separately and is not required for the operation of the RSO Rheometer. In the following cases, however, it is highly recommended:

- Extensive rheological analyses
- Graphical evaluation
- Evaluation using mathematical models
- Automated measurements
- Research and development

2. INSTALLATION AND TEST SET-UP

This section will be dealing with the installation and set-up of the RSO Rheometer. Read each step thoroughly before proceeding.

2.1 Air & AC Power Up



Compressed Air Supply should be turned on before RSO power up.

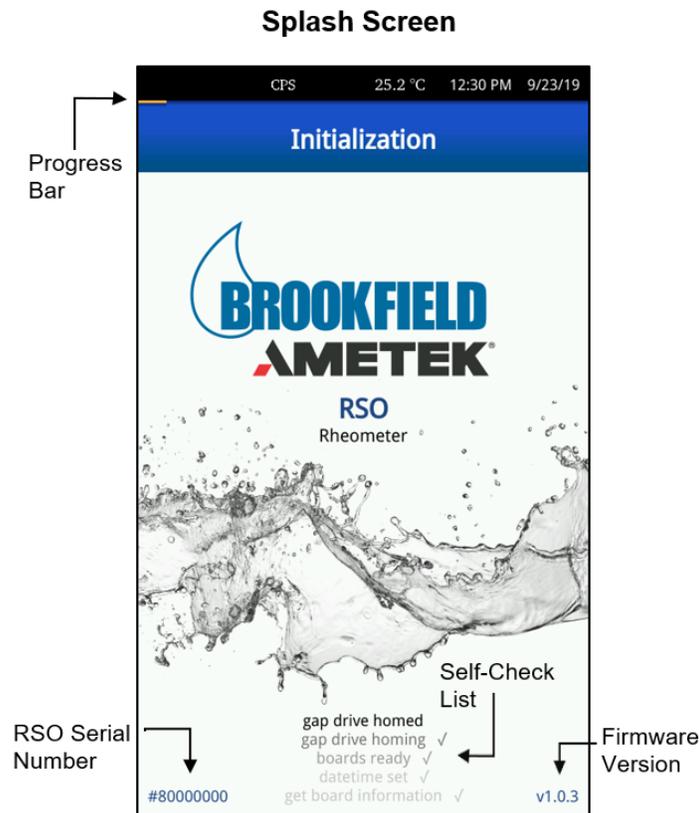
2.1.1. Power Button

Ensure that no spindles are attached to the coupling. Press the Power button on the RSO.

2.1.2. Initialization

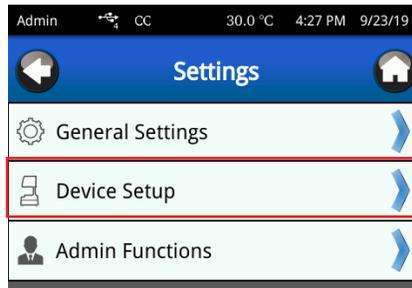
After a few seconds, the RSO splash screen will be displayed.

The RSO head will begin to rise into an upper set position while it runs self-checks. These can be viewed at the bottom of the screen. This screen also shows your RSO's Serial Number and the installed firmware version.

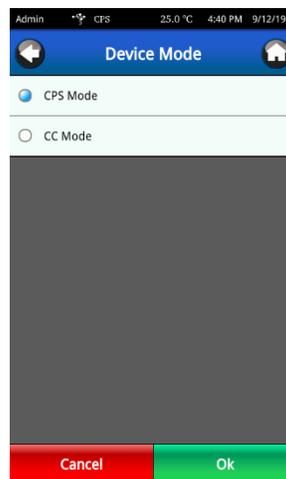


2.2 Select Device Mode

- From the Main Menu, press the Settings icon  in the upper right corner of the screen.
- Press Device Setup on the Settings screen

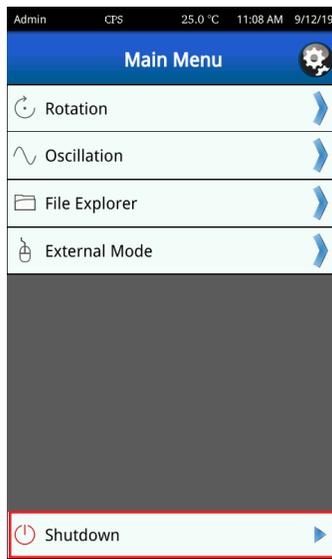


Choose your desired configuration, either CPS or CC Mode. Press Ok.



- Follow the instructions in the pop-up.

2.3 Power Down.



Ensure that no spindle is attached to the instrument. Press the Home button in the upper right corner of the screen to proceed to the Main Menu screen. At the bottom of the Main Menu Screen is the Shutdown button. Press this to shut down the RSO.

Another option to power the rheometer down is to use the On/Off button on the back of the base.



After shutting down the RSO Rheometer, the instrument and spindles must be cleaned. [See Section 6. Maintenance and Care](#)

3. SPINDLES AND SAMPLE PREPARATION

This section provides instructions on how to prepare spindles and sample materials for measurement with the RSO Rheometer. Read each step thoroughly before proceeding.

The general procedure for measurements with an RSO Rheometer is the following:

1. Connect the Power Cord.
2. Connect a PC, if required.
3. Assemble any accessories to be used (e.g. FTKY3 water jacket).
4. CC mode: Connect a Pt100, if required.
5. Remove any attached spindle.
6. Turn the power button ON and wait until the main menu is shown by the touch screen display system.
7. If using external software control, turn on the computer system and put instrument into External Control mode.
8. Prepare the sample.
9. Attach the spindle.
10. Start a measuring program.
11. Begin fluid circulation if external temperature control, e.g. a bath, is being used. Wait until the substance to be measured has reached the desired temperature.
12. Start measurement.
13. After completion of the measurement, turn off temperature control and wait until your sample has cooled down to a safe temperature.
14. Remove and clean the spindle.

3.1 Preparing Samples

To perform measurements with the plate integrated in the instrument and a cone or plate spindle, the CPS mode should be used. If the FTK is used, the measurements must be made in CC mode. See section VI.4 CC and CPS for more information.

3.1.1. Using CPS Mode

To use the instrument in the CPS mode you must first select the CPS mode from the settings menu.

Navigate to Settings → Device set up → Device Mode, select CPS mode, and press OK.

The cone/plate and plate/plate spindles consist of the fixed bottom plate on the instrument and the upper measuring cone or plate element that is set to the required gap.

To carry out measurements, please select a spindle suited for the desired measuring range and your rheological requirements.

To prepare a sample with a cone or plate spindle:

1. Ensure that the spindle coupling is open. If it is closed, open the spindle coupling by lifting the outer coupling sleeve up. The inner ring of the coupling will be visible under the coupling sleeve. Identify figure.
2. When the coupling is opened, the instrument's drive system will automatically move the rheometer head to the raised position.
3. Insert the spindle of choice into the coupling. Be careful to insert the spindle shaft into the coupling without bumping against it. Close the coupling by sliding the coupling sleeve down.
4. After setting up the appropriate test program, hitting the next button will begin the Zero Gap setting procedure. After the Zero Gap has been set, the instrument will temper in position, if required, and then the head will lift to the filling position.
5. Load the prepared sample onto the center of the bottom plate. The appropriate sample volume is indicated on the spindle datasheet. Avoid air bubbles in the sample material, as they may result in irreproducible or false data.

3.1.2. Using CC Mode

To use the instrument in the CC mode you must first select the CC mode from the settings menu.

Navigate to Settings → Device set up → Device Mode, select CC mode, and press OK.

Ensure that the spindle coupling is open. The device will then move into the higher position for use with the CC spindles and FTKY3 temperature control device.

Now connect the RSO-CC adapter kit.

3.2 FTKY3 and Temperature Control Device

To prepare a sample for testing in a cylinder spindle with FTKY3 temperature control:

1. Assemble the FTKY3 temperature control device as instructed.
2. Set the fluid circulation bath to the intended sample temperature.
3. Determine the sample volume appropriate for the spindle to be used (refer to appendix data sheets for standard spindles). Fill the sample cup with sample material accordingly. Avoid trapping air bubbles in the sample material, as they may result in irreproducible or false data. Be sure to use a sample cup designed for use with the FTKY3.
4. Carefully insert the spindle into the sample cup. Avoid introducing air bubbles to the sample. The figure shows how the spindles should look so far.
5. Ensure that the spindle coupling is open. If it is closed, open the spindle coupling by lifting the outer coupling sleeve up. The inner ring of the coupling will be visible under the coupling sleeve. The figure shows an open spindle coupling.
6. Remove the threaded ring for securing the sample cup from the FTKY3 device.
7. Insert the sample cup into the water jacket from below and reattach the threaded ring to secure the sample cup in place. Be careful to align the spindle shaft with the coupling. The figure shows a closed spindle coupling.
8. Reattach the threaded ring to the instrument to secure the sample cup in place.
9. Insert the spindle into the coupling. Be careful to insert the spindle shaft into the coupling without bumping against it. Close the coupling by sliding the coupling sleeve down.
10. Begin circulation to the FTKY3 water jacket. Wait for the sample to come to temperature.
11. Proceed with measurement.

To disassemble a cylinder spindle used with the FTKY3 temperature control device:

1. Take note of the operating temperature. Allow the spindle to cool to a safe temperature before disassembling.
2. Release the spindle by opening the spindle coupling.
3. Unscrew the threaded ring securing the sample cup. Remove the sample cup and threaded ring.
4. Remove the spindle from the sample cup.
5. Dispose of the used sample material properly.
6. Clean the spindle and sample cup. To clean the sample cup, unscrew the sample cup bottom and clean each piece of the sample cup separately. Do not use any object in cleaning that might scratch the spindle or sample cup pieces.
7. Store the spindle on a soft surface or in its original container.

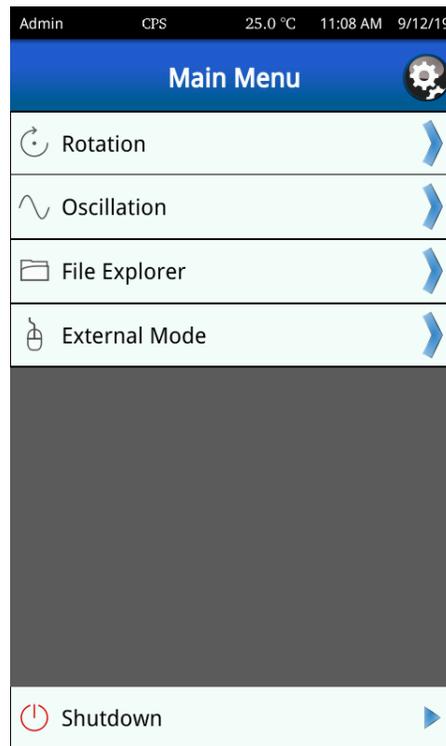
4. OPERATION

Before operating the RSO Rheometer, you must set it up. See Section IV Assembly and Commissioning.

4.1 User Interface

4.1.1. Main Menu:

After a successful startup, the Main Menu is displayed. The user may click the house symbol , if displayed, to return to the Main Menu from other views.



4.1.2. Status Bar

The RSO Rheometer will display a status bar at the top of the screen.



This status bar will indicate logged in user, connection status of USB flash drives, operational mode, temperature, time, and date. The status icons are defined as:

User	User Name	Name of logged in user. To log out see section VI.3.2 Log Out.
	USB icon with numbers from 1 to 4	Indicates physical USB-A connections. connections (e.g., USB flash drives). If you plugged in a USB flash drive, it can be accessed by the build in file explorer, see section VI.7 File Explorer.
CC CPS	operational mode	Mode of testing. It can be CC or CPS. Switching these modes can be done in Settings. See Section VI.4 CC and CPS.
	attention sign	Indicates a system warning (yellow) or fault (red). If you want to look up the cause. See section VI.8.2 Log.
Pt 100	Pt100 sign	When device is in CC mode and a Pt100 temperature sensor is plugged at the back, the Pt100 sign will show up. See Section V.2 FTKY3 and Temperature Control Device.
23°C	temperature	Displays the current temperature of the plate (of the FTK if device is in CC mode. See Section V.2 FTKY3 and Temperature Control Device).
10:31 4/9/19	time and date	Current time and date. To change it, see section VI.8.3 Set Date and Time.

4.2 Navigation

Navigation of the instrument features is done using a variety of data fields, arrows, command keys, and navigation icons. The operating system has been designed for intuitive operation and employs color to assist the user in identifying options.

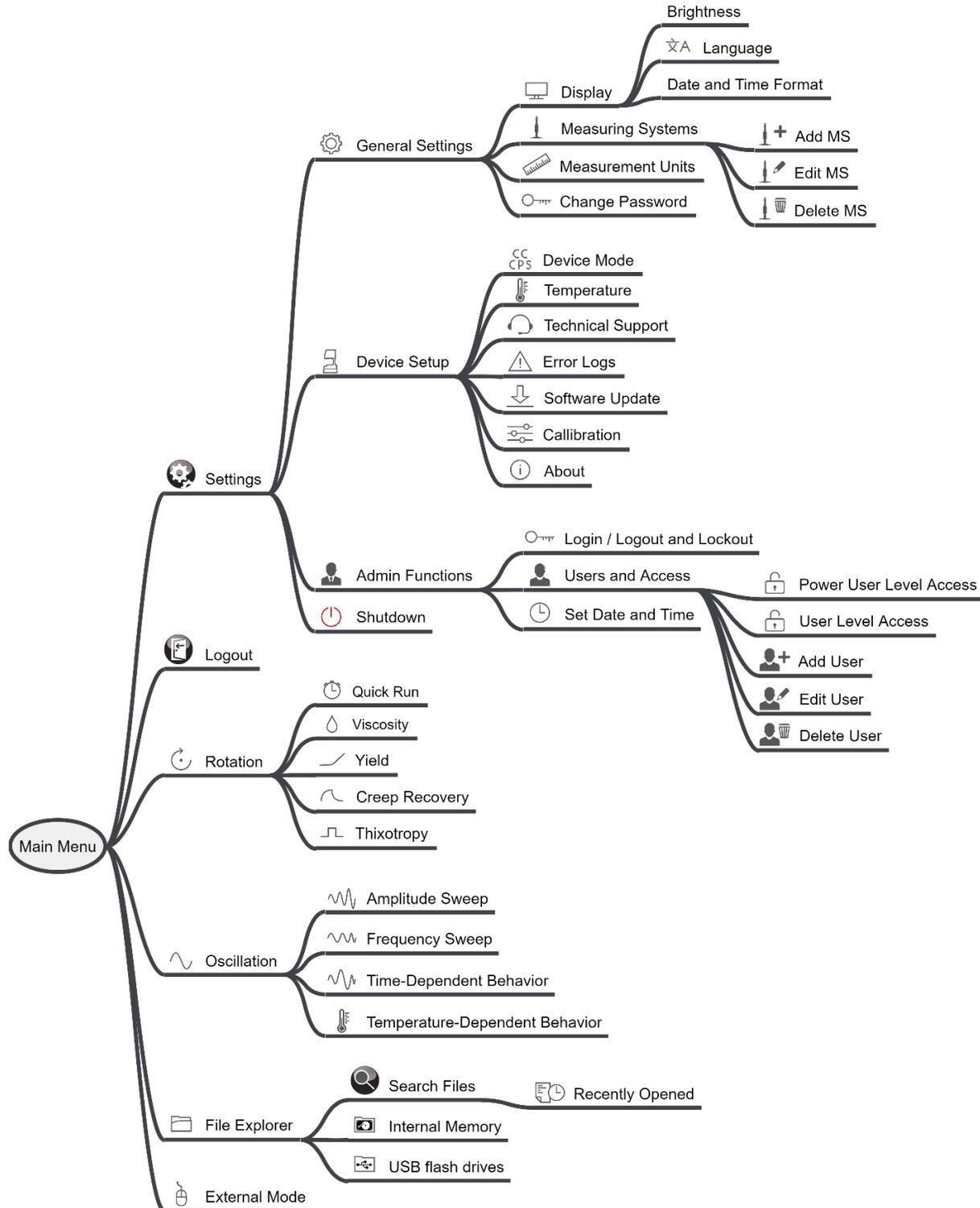
	Data fields require that the user touches the screen to initiate the data entry/selection process. These fields are normally outlined in black. They include a blue arrow.
	Blue arrows to the right indicate that options exist for a data field. These buttons lead to a new screen. If the arrow is greyed out, the button is not accessible, or the data field cannot be changed.
	Blue arrows pointing down indicate that you can make a dropdown selection. A small panel below the button will appear and you can select the desired item.
	Blue switches indicate that the option can be toggled. Each switch has two different stages.
	Command keys are buttons that direct the RSO Rheometer to perform a specific action such as save a data set or stop a program. Command keys are presented in a variety of colors. These keys are found at the bottom of the screen.
	Navigation Icons are found in the title bar to the left and right. These buttons will take you to specific areas of the operating system.

Main navigation items are shown below.

	main menu
	settings menu
	back (return to previous screen)
	search files
	log out (will only be available if the administrator has activated user log in)

4.2.1. Menu structure

The following is a schematic representation of the touch screen menu system for the RSO Rheometer, starting with the home screen menu.



4.3 Log In, Log Out, Lock Out

The RSO Rheometer may be set up for a single user (used by one or more operators) or for multiple users who access through a login and password. If user accounts are enabled by the administrator, users can log in, log out, and be locked out.

4.3.1. Log In

To log in, the user must select their account name. The required password can be entered through the keypad. If locking is enabled, the user will be locked out after a certain number of failed login attempts.

4.3.2. Log Out

Main Menu → Logout



To log out, the user must go back to the main menu and select the door icon at the top of the screen. After confirmation, the login menu will be displayed.

If the timed logout is activated by the administrator, the screen will go blank after a longer period of no user interaction. The user can log in again and start where they left off.

4.3.3. Lock Out

If the Lock Out option is activated by the administrator, the user will be locked out after a certain number of failed login attempts. A locked account can only be reset by an administrator, (see chapter VI.8.3 Users and Access).

4.4 CC and CPS

The RSO Rheometer has two operation modes: CPS and CC. The following section will focus on this.

To switch between modes, see section VI.8.2 Device Mode.

4.4.1. Difference

The standard configuration is the CPS mode. This uses Cone spindles or Plate spindles, in Cone-Plate and Parallel-Plate (or “Plate/Plate”) geometries. The RSO’s Peltier plate provides temperature control in this set-up. The CPS mode may be used to test a wide viscosity range, with the possibility of very high shear rates and/or very small sample size.

The RSO also can be set up to use Coaxial/Concentric Cylinder geometry, referred to as “CC” geometry. This may allow testing of samples with viscosities that are lower than those that the CPS mode can handle.

4.4.2. RSO Configuration

4.4.3. Temperature control

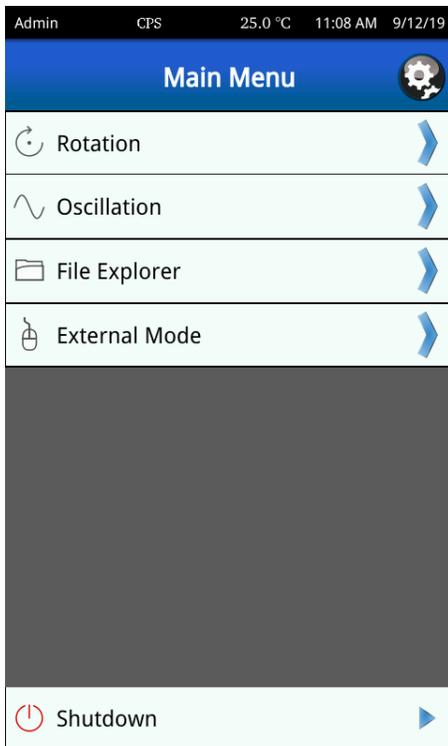
The RSO has a temperature sensor that is built into the measuring plate of the instrument. The temperature is measured continuously and is displayed on the touch screen display status bar. This is for the CPS mode.

In the CC mode, the FTKY3 jacket is connected and the Pt100 from the water jacket is connected to the back of the RSO. The temperature is controlled by an external circulating water bath. Depending on the configuration, this can be controlled via the Rheo3000 software.

4.5 Rotational Measurements

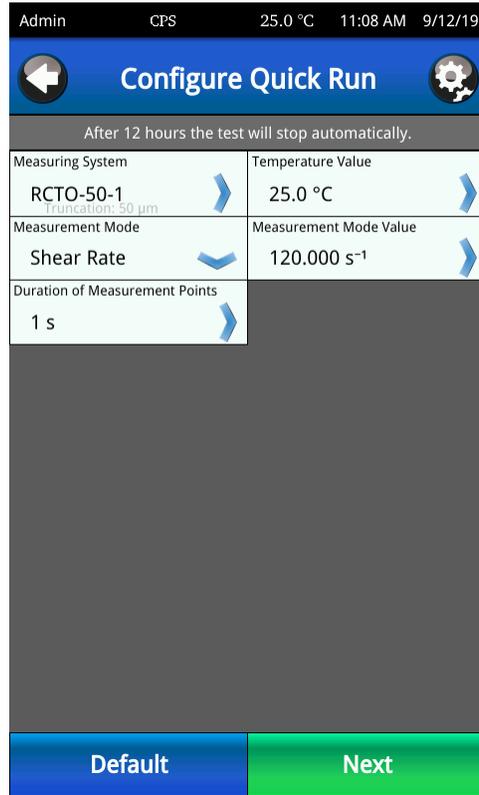
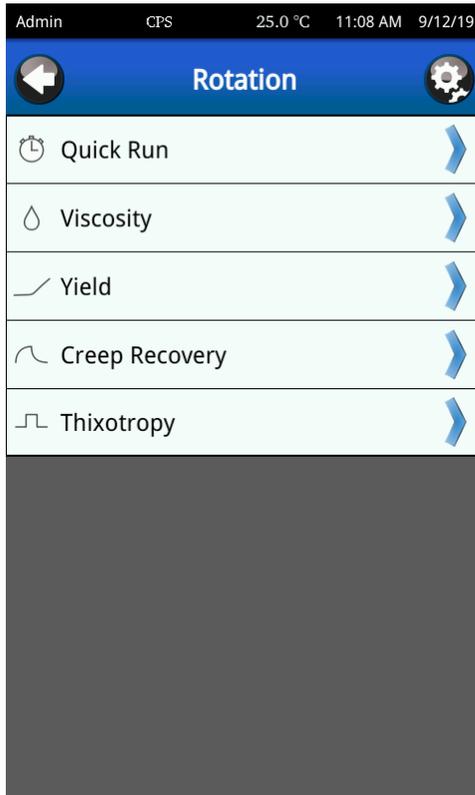
4.5.1. General

Main Menu → Rotation 



Quick Run

Main Menu → Rotation → Quick Run

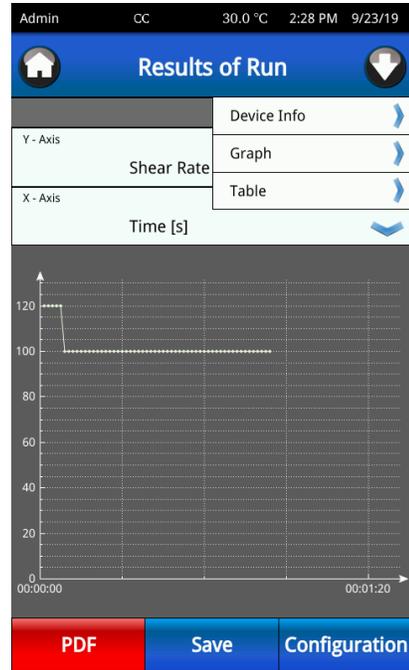
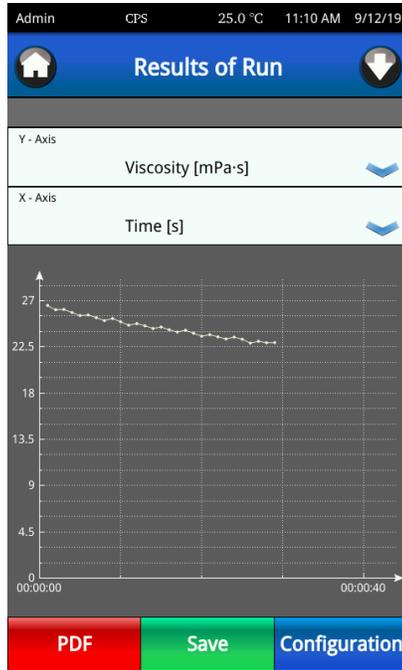
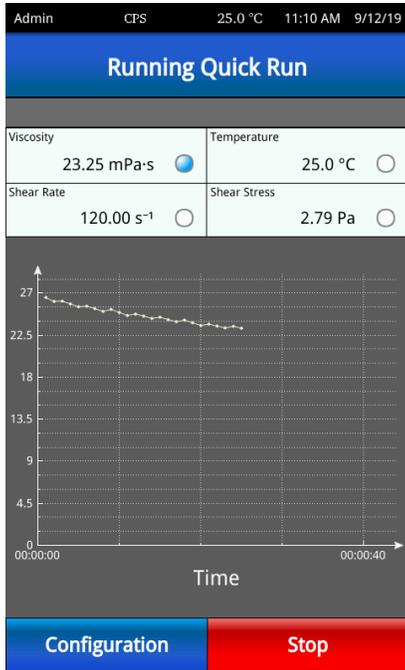


CONFIGURATION

Attach spindle and close coupling. Select manually, if automatic recognition failed. Choose control mode, Shear rate / Shear stress / RPM / Torque. Select control speed or torque. Select data point collection rate (1 MP/second). Press start and the test will commence and continue until stop is pressed or 12 hours have elapsed. Use the “configuration” button during the test to change the control speed or torque at run time.

Interpretation

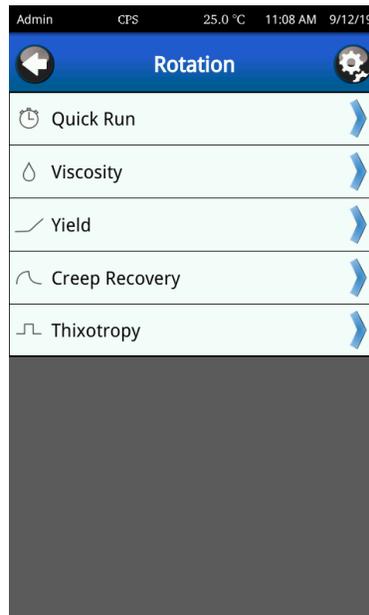
During the experiment, the live graph can be configured to display viscosity, shear rate/stress, or temperature as a function of time. After the test, switch to the “Results” view which shows viscosity, shear rate, shear stress, and temperature in a table or a configurable graph (click  to select).



You can save the data or create a PDF document.

4.5.2. Viscosity

Main Menu → Rotation → Viscosity



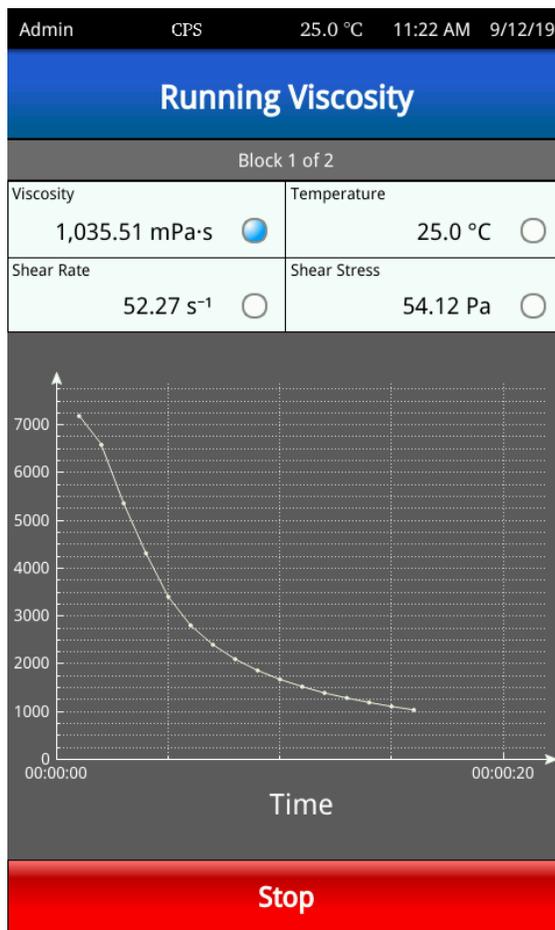
Configuration

Admin		CPS		25.0 °C		11:21 AM		9/12/19	
<div style="display: flex; justify-content: space-between; align-items: center;"> ← Configure Viscosity ⚙️ </div>									
Measuring System					Sample				
RCTO-50-1 <small>Truncation: 50 µm</small>									
<div style="display: flex; align-items: center;"> ⏪ Block 1 of 1 ⏩ </div>					<input type="checkbox"/> Wait Block				
Measurement Mode					lin/log				
Shear Rate					lin				
Start Value of Measurement Mode					End Value of Measurement Mode				
1.000 s ⁻¹					100.000 s ⁻¹				
Time					Duration of Measurement Points				
30 s					1 s				
Start Temperature Value					End Temperature Value				
25.0 °C					25.0 °C				
QC Limits					End Condition				
None					None				
Delete Block					Add Block				
Default			Save			Next			

Admin		CPS		25.0 °C		11:21 AM		9/12/19	
<div style="display: flex; justify-content: space-between; align-items: center;"> ← Configure Viscosity ⚙️ </div>									
Measuring System					Sample				
RCTO-50-1 <small>Truncation: 50 µm</small>									
<div style="display: flex; align-items: center;"> ⏪ Block 2 of 2 ⏩ </div>					<input type="checkbox"/> Wait Block				
Measurement Mode					lin/log				
Shear Rate					lin				
Start Value of Measurement Mode					End Value of Measurement Mode				
100.000 s ⁻¹					1.000 s ⁻¹				
Time					Duration of Measurement Points				
30 s					1 s				
Start Temperature Value					End Temperature Value				
25.0 °C					25.0 °C				
QC Limits					End Condition				
None					None				
Delete Block					Add Block				
Default			Save			Next			

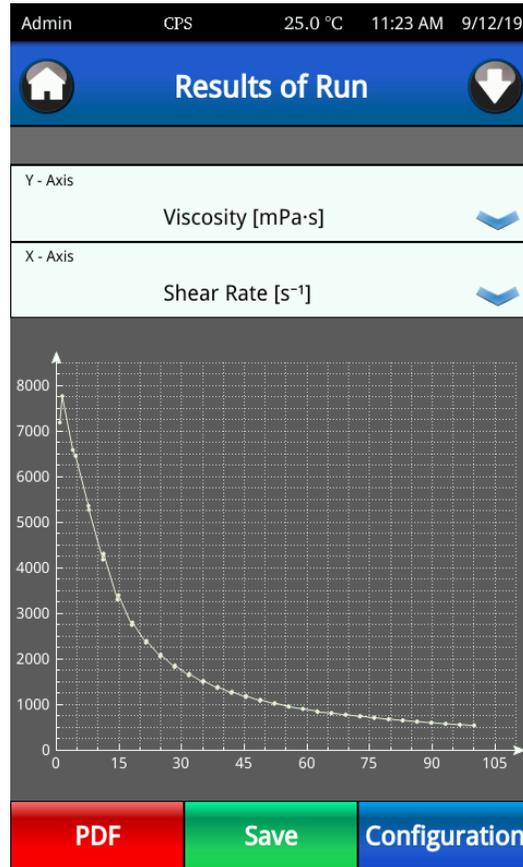
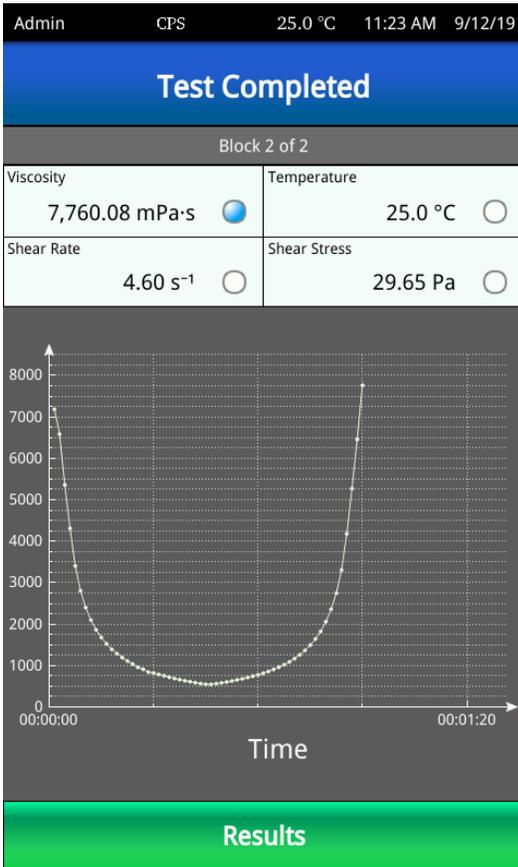
In this mode we can run a single block or create an experiment consisting of a sequence of blocks. For example, block one can be the ramp up from 1 to 100 s⁻¹ and the second block can be the ramp down 100 to 1 s⁻¹. The maximum number of blocks is 10.

Select or attach spindle. Choose control mode, Shear rate / Shear stress / RPM / Torque. Select control speed or torque. Select linear or log data collection. Select the start value for the block. Select the end value for the block. Select data point collection rate (1 MP/second). To create a new block click add block. To start the test click next.



Interpretation

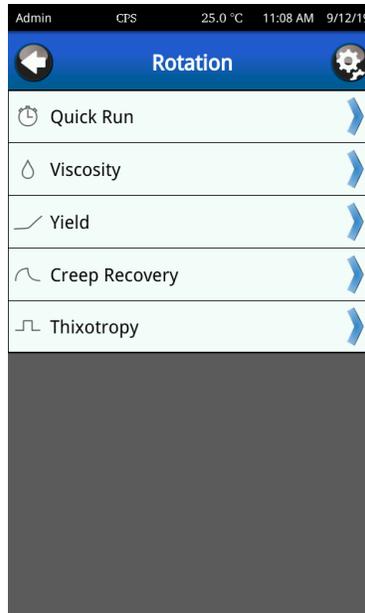
During the experiment, the live graph can be configured to display viscosity, shear rate/stress, or temperature as a function of time. After the test, switch to the “Results” view which shows viscosity, shear rate, shear stress, and temperature in a table or a configurable graph (click  to select).



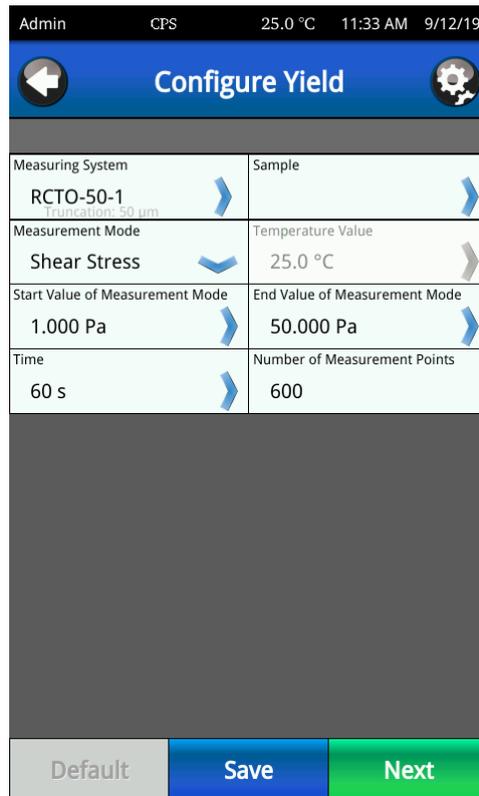
4.5.3. Yield

This test is used to calculate the yield point of the sample (onset of flow). The yield stress is the stress required to make a solid-like material flow like a liquid. The test is run in controlled stress mode. The control parameter is either shear stress or torque, and the resulting strain is recorded. The applied stress is increased slowly on the sample, to reach the point at which the material starts to flow.

Main Menu → Rotation → Yield

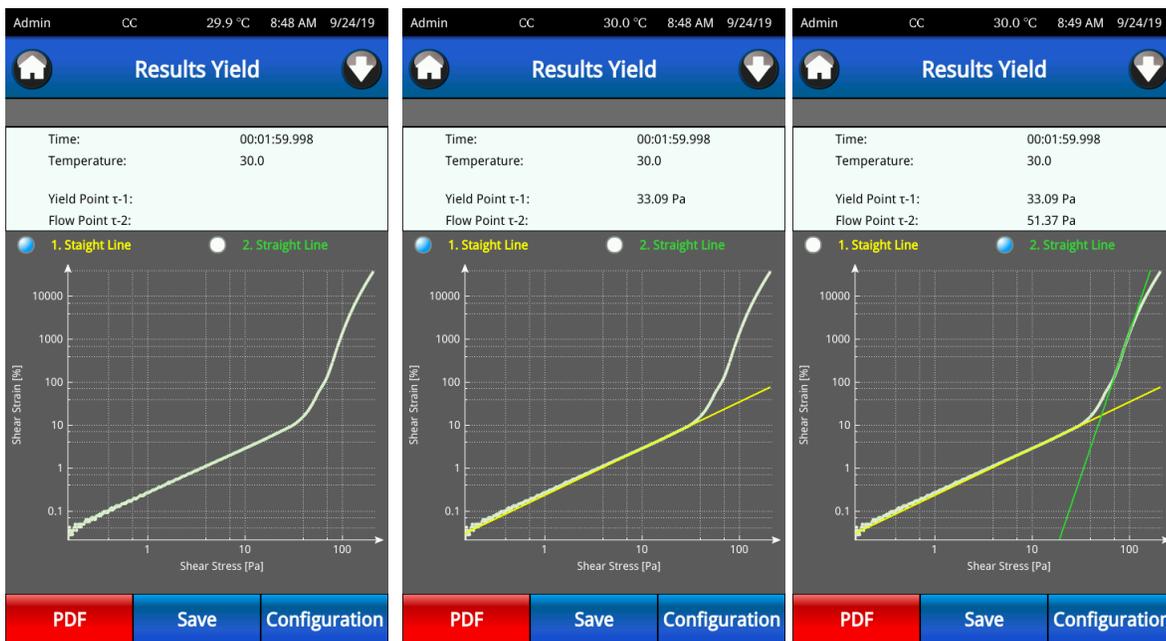


Configuration



Do not apply too much stress, because once the material starts to flow, the test will be reaching the finishing point.

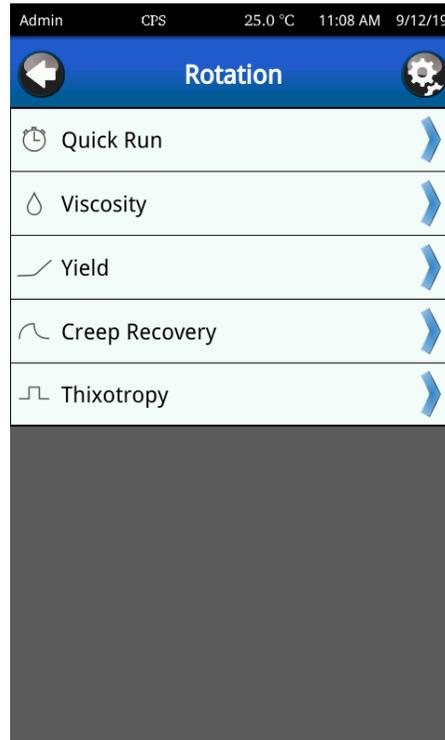
Interpretation



By clicking appropriate points of the graph, line 1 is to be placed manually in the linear-elastic range, and line 2 in the flow range. From these lines, the software determines both the yield and flow point

4.5.4. Creep Recovery

This test is used to determine the elastic recovery of a sample. We apply constant stress below the yield value for a period of time and measure the resulting deformation. We then release the stress and monitor the sample recovery.



Configuration

Admin 25.0 °C 12:10 PM 9/12/19

Configure Creep Recovery

Measuring System RCTO-50-1 Truncation: 50 µm	Sample
Creep-Part	Recovery-Part
Measurement Mode Shear Stress	Value of Measurement Mode 10.000 Pa
Time 30 s	Number of Measurement Points 30
Constant Temperature Value 25.0 °C	

Default Save Next

Admin 25.0 °C 12:20 PM 9/12/19

Configure Creep Recovery

Measuring System RCTO-50-1 Truncation: 50 µm	Sample
Creep-Part	Recovery-Part
Measurement Mode Shear Stress	Value of Measurement Mode 0 Pa
Time 30 s	Number of Measurement Points 30
Constant Temperature Value 25.0 °C	

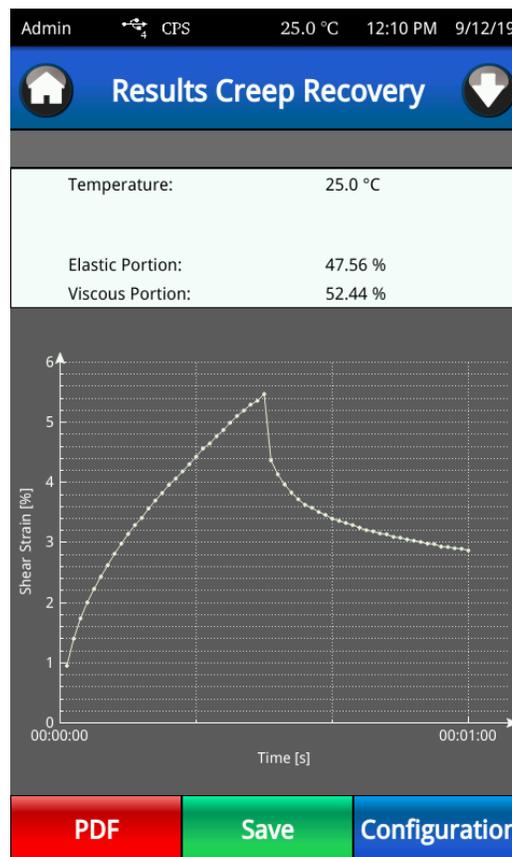
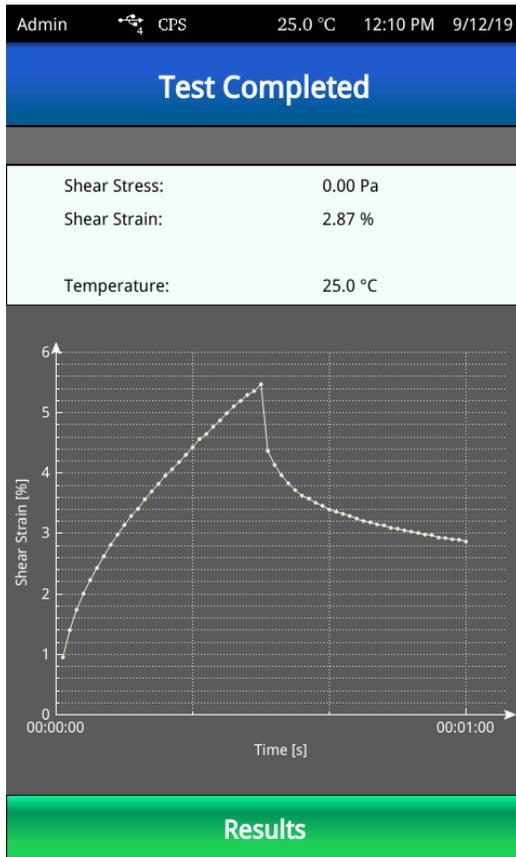
Default Save Next

Attach the spindle. “Creep Part” is selected and then the Measurement Mode. Shear Stress mode is used in this example. The “hold” stress (“Value of Measurement Mode”) is set. It is recommended that between $\frac{1}{3}$ and $\frac{1}{2}$ the yield value be used. Select the duration, the time, of the hold stress (usually 30 seconds), and the number of data points; 1 point/second is recommended.

“Recovery part”: (1) The stress is automatically zero, “0”. (2) The Recovery Time, set by the operator, is usually the same as the Creep Time.

Interpretation

The data is visually shown on the graph. Once the test is complete, we get a value of the elastic portion of the sample and a value of the viscous portion of the sample.



During the Creep portion, the constant applied stress causes the sample to deform so that the Shear Strain increases over time. This is a type of “flow” or viscous behavior. During the Creep Recovery, the applied stress is nearly instantly removed, and it becomes zero. The sample’s elasticity causes the material to try to go back or recover its original shape or position, like a recoiling spring. The Shear Strain decreases during recovery. A viscoelastic material exhibits both viscous and elastic behavior. So, although there is some viscous flow, it does not fully recover. The Elastic Portion and Viscous Portion % are calculated by using the maximum Creep Strain % and the Strain % value at the end of the Recovery.

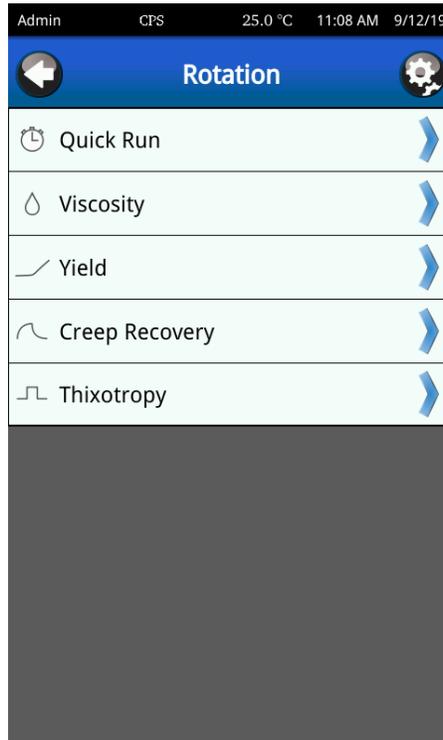
The maximum Shear Strain value occurs at the end of the Creep step, while the Final Shear Strain is the value at the end of the Recovery step.

$$\text{Elastic Portion \%} = [(\text{Maximum Strain} - \text{Final Strain}) / (\text{Maximum Strain})] \times 100\%.$$

$$\text{Viscous Portion \%} = (\text{Final Strain}) / (\text{Maximum Strain}) \times 100\%.$$

4.5.5. Thixotropy

Thixotropy is the decrease in apparent viscosity over time, at a constant shear rate or shear stress. The apparent viscosity of a thixotropic material increases over time when the shear rate or shear stress is decreased and held at the new, lower value. Some paints and coatings are thixotropic, as are many ketchups/catsups and hair conditioners, for example.



There are various types of thixotropic tests. Our method is a typical, widely used, three-step thixotropy test: low shear, high shear, and low shear. The low-shear step provides a reference value. The high-shear step decreases the viscosity by breaking down the sample's structure. The final, low-shear, recovery step provides a measure of how the material structure recovers, as shown by the increase in apparent viscosity over time.

Configuration

Admin CPS 25.0 °C 12:26 PM 9/12/19		
Configure Thixotropy		
Measuring System RCTO-50-1 <small>Truncation: 50 µm</small>	Sample	
Measurement Mode Shear Rate		
1. Reference	2. High-Shear	3. Regeneration
Value of Measurement Mode		
1.000 s ⁻¹		
Time		
10 s		
Number of Measurement Points		
10		
Constant Temperature Value		
25.0 °C		
Default	Save	Next

Admin CPS 25.0 °C 12:26 PM 9/12/19		
Configure Thixotropy		
Measuring System RCTO-50-1 <small>Truncation: 50 µm</small>	Sample	
Measurement Mode Shear Rate		
1. Reference	2. High-Shear	3. Regeneration
Value of Measurement Mode		
10.000 s ⁻¹		
Time		
30 s		
Number of Measurement Points		
30		
Constant Temperature Value		
25.0 °C		
Default	Save	Next

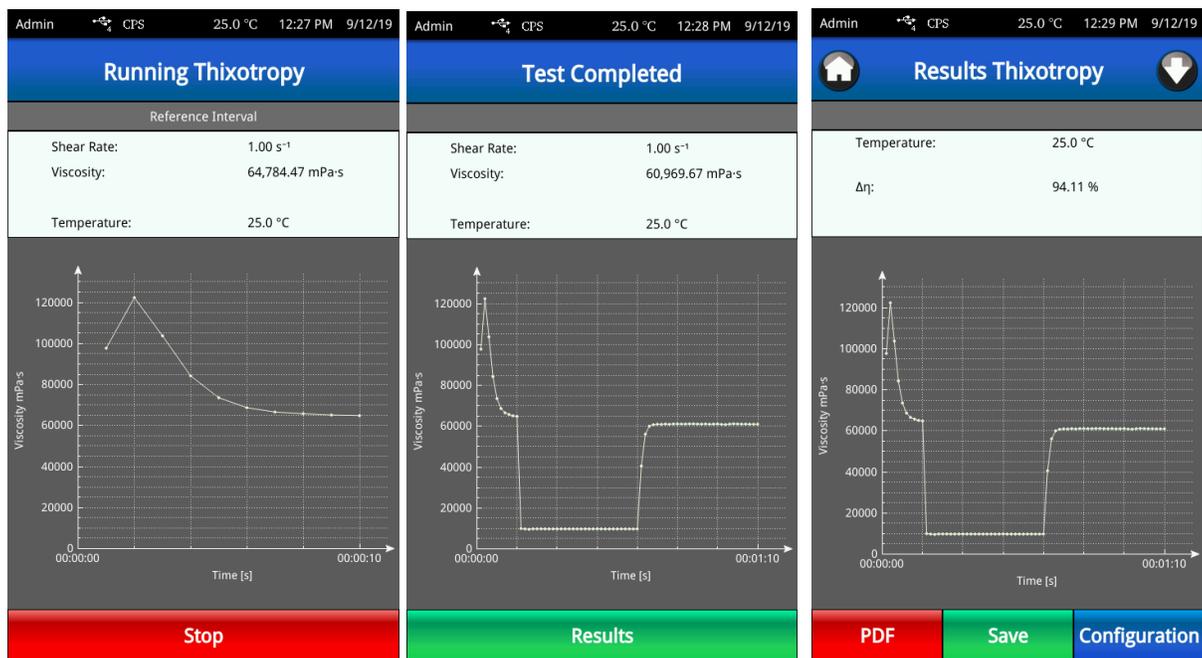
Admin CPS 25.0 °C 12:26 PM 9/12/19		
Configure Thixotropy		
Measuring System RCTO-50-1 <small>Truncation: 50 µm</small>	Sample	
Measurement Mode Shear Rate		
1. Reference	2. High-Shear	3. Regeneration
Value of Measurement Mode		
1.000 s ⁻¹		
Time		
30 s		
Number of Measurement Points		
30		
Constant Temperature Value		
25.0 °C		
Default	Save	Next

In our example, the Measurement Mode is Shear Rate.

Attach the spindle, enter a Sample name (if desired), select the Reference block, set the Value (Shear Rate, in this case) then set the Step Time, Number of Measurement Points, and Temperature.

- Select the High-Shear block, then set the parameter values.
- Select the Regeneration block, select the same shear rate value as used in the reference block, and the same time as that used in the high shear block. Set the Number of Measurement Points and Temperature.
- Touch “Next” to proceed.

Interpretation



The graph shows the viscosity change in the three steps, and the result is shown as a percentage regeneration of the sample.

$$\Delta\eta = [(\text{Viscosity at end of Regeneration}) / (\text{Viscosity at end of Reference step})] \times 100\%$$

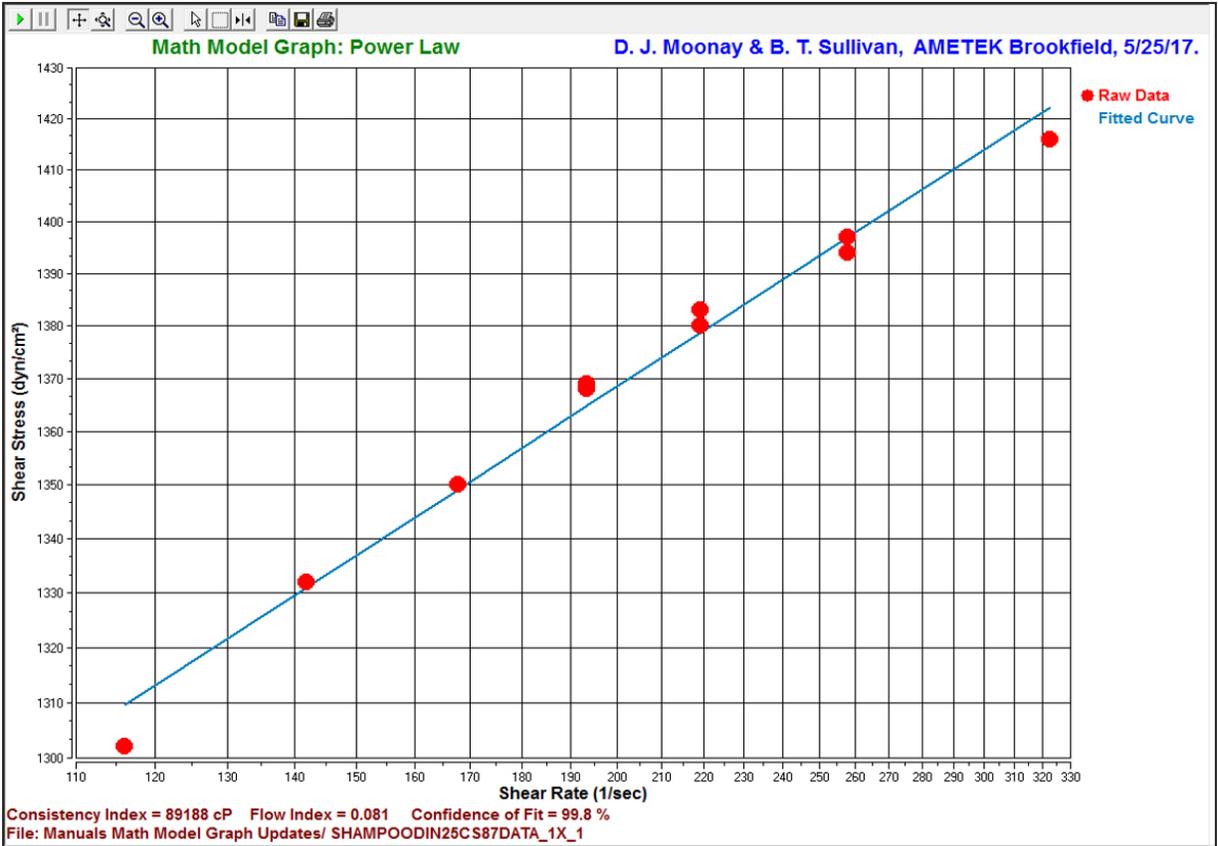
4.5.6. Math Models

The Power Law (Ostwald) Model

$$\tau = k\dot{\gamma}^n \quad (\tau = \text{shear stress, } k = \text{consistency index, } \dot{\gamma} = \text{shear rate, and } n = \text{flow index})$$

What does it tell you?

The Power Law model provides a consistency index, k , which is a product's viscosity at one reciprocal second. (Reciprocal seconds are the units of measurement for shear rate.) It also provides a flow index, n , which indicates the degree with which a material exhibits non-Newtonian flow behavior. Since Newtonian materials have linear shear stress vs. shear rate behavior and n describes the degree of non-Newtonian flow, the flow index essentially indicates how "non-linear" a material is.



When $n < 1$ the product is shear-thinning or Pseudoplastic. This means the apparent viscosity decreases as shear rate increases. The closer n is to 0, the more shear thinning the material is. When $n > 1$ the product is shear-thickening or Dilatant. Their apparent viscosity increases as shear rate increases.

When should you use it?

This model should be used with non-Newtonian, time-independent fluids that do not have a yield stress. These fluids will begin to flow under any amount of shear stress. Graphs of such material generally intersect the y-axis at 0.

An Example of the Power Law Model at Work

Shampoo

Flow Index (n) = 0.081

Consistency Index (k) = 89,188 cP

Formulators at a personal care company would like to use a substitute ingredient to decrease cost. They use the Power Law model to evaluate the effect the new ingredient will have on the behavior of their shampoo. They need to know how it will behave during processing and how it will behave when it is being used by the customer.

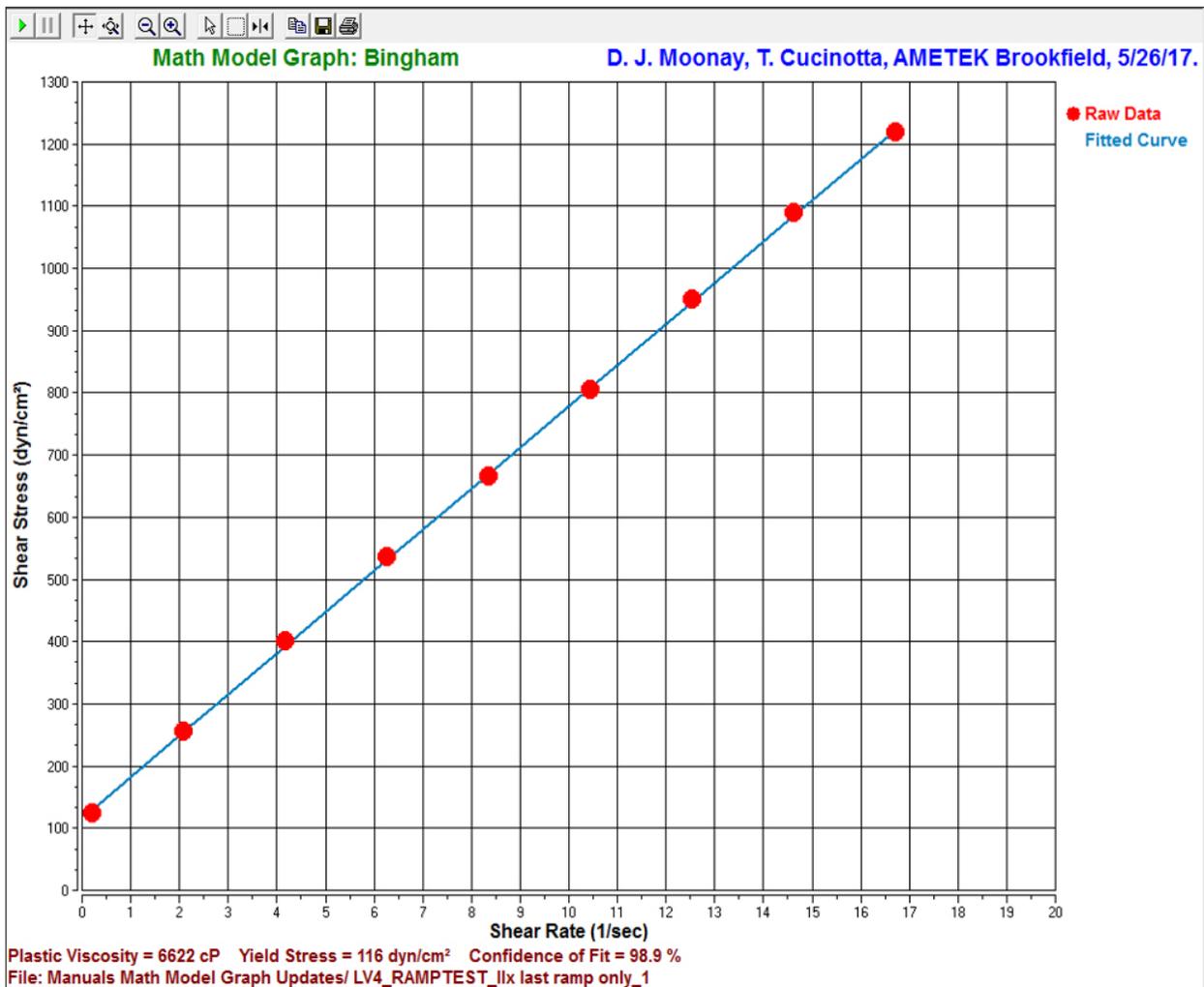
With the new ingredient the shampoo has a flow index (n) of 0.081. This indicates that the shampoo is shear-thinning enough to flow properly during processing and that it will flow properly for the end-user. The consistency index, k , indicates how the shampoo behaves when it experiences low shear rates. The power law values show that the shampoo becomes quite thin at process shear rates and therefore it can be easily pumped into filling equipment, hold tanks, etc. The consistency index of 89,188 cP shows that the shampoo is very viscous at low shear rates, and as a result, it will appear to customers to be “rich and creamy” while still being easy to apply.

The Bingham Model

$$\tau = \tau_0 + \eta D \quad (\tau = \text{shear stress}, \tau_0 = \text{yield stress}, \eta = \text{plastic viscosity}, \text{ and } D = \text{shear rate})$$

What does it tell you?

The Bingham model indicates a product’s yield stress, τ_0 , which is the amount of shear stress required to initiate flow. It also provides the plastic viscosity, η , which is the viscosity after a product yields.



When should you use it?

This model should be used with non-Newtonian materials that have a yield stress and then behave in a Newtonian fashion once they begin to flow. As a result, the shear stress-shear rate plot forms a straight line after yielding. (Products that have a yield stress only begin to flow after a certain amount of shear stress is applied. They are also called “viscoplastic”. Their shear stress vs. shear rate graphs intersect the y-axis at a point greater than 0.)

An Example of the Bingham Model at Work

Drilling Fluid

Plastic Viscosity (η) = 6622 cP

Yield Stress (τ_0) = 116 dynes/cm²

A manufacturer of drilling fluid applies the Bingham Model to ensure the quality of their product. Results from a recent batch, shown in the figure, showed that the yield stress and plastic viscosity were both below the pass/fail criteria, which would cause the fluid to insufficiently

The Casson Model

$$\sqrt{\tau} = \sqrt{\tau_0} + \sqrt{\eta D} \quad (\tau = \text{shear stress, } \tau_0 = \text{yield stress, } \eta = \text{plastic viscosity, and } D = \text{shear rate})$$

What does it tell you?

The Casson model provides parameters similar to that of the Bingham model. However, unlike the Bingham model, it was developed for materials that exhibit non-Newtonian flow after yielding. The Casson model indicates the product’s yield stress (τ_0) which is the amount of shear stress required to initiate flow, and the product’s plastic viscosity, η , which is the viscosity of the product after it yields.

When should you use it?

The Casson model should be used with non-Newtonian materials that have a yield stress and that do not exhibit a “Newtonian-like” behavior once they begin to flow. This model is most suitable for fluids that exhibit Pseudoplastic or shear thinning, flow behavior after yielding. These fluids have a non-linear flow curve. The point at which it crosses the y-axis is the product’s yield stress (τ_0). To protect the point at which the curve will intersect with the y-axis, the Casson model linearizes or straightens the plot by taking the square root of the data. To ensure accurate extrapolation to yield stress it is best to take some data at low shear rates.

An Example of the Casson Model at Work

Pharmaceutical Gel

Plastic Viscosity (η) = 331 cP Yield

Stress (τ_o) = 325 dynes/cm

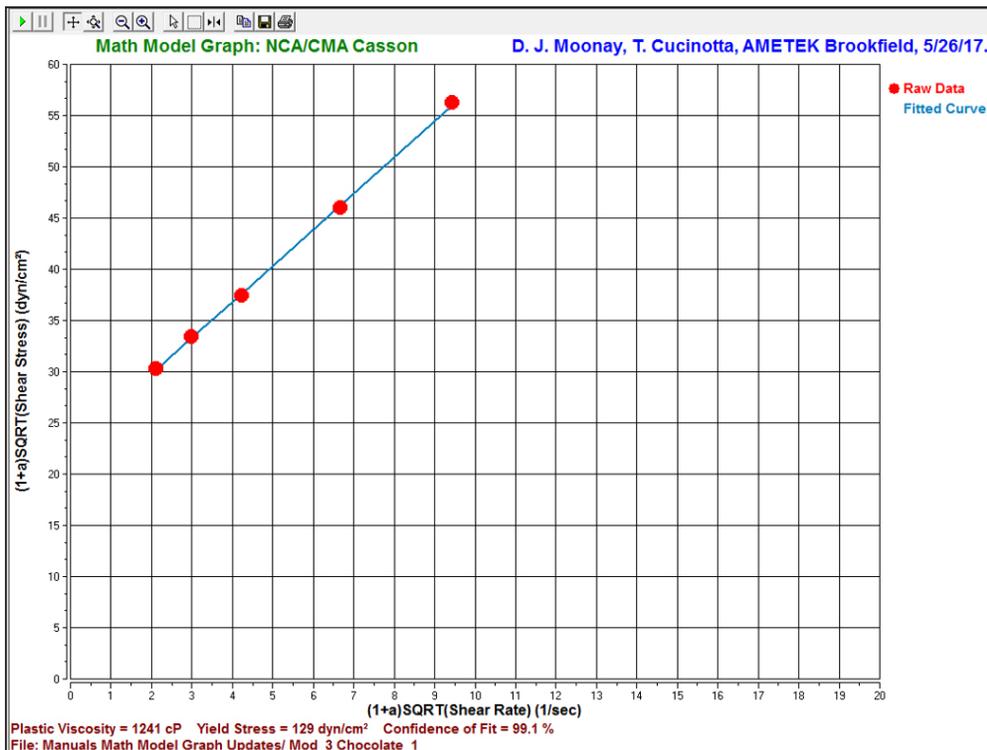
Before releasing a new over the counter gel, a pharmaceutical company needs to learn how it will behave which is being used by the end customer. They perform a full viscosity profile and apply the Casson model. From the results, shown in the figure, they learn that their ointment has a higher yield stress, τ_o , and a lower plastic viscosity, η , than they originally intended

As a result it is difficult or dispense from its container (due to the high yield stress) and it does not hold its shape very well (due to the low plastic viscosity), making it difficult to apply a small amount to the affected area of the skin. Based on this data, formulators are able to modify the ingredients accordingly. Once a formulation is established, multi-point tests and the Casson model are performed as a QC tool to check batches before and after processing.

The NCA/CMA Casson Model

$$(1 + a) \sqrt{\tau} = 2\sqrt{\tau_o} + (1 + a) \sqrt{\eta \dot{\gamma}} \quad (\tau = \text{shear stress, } \tau_o = \text{yield stress, } \eta = \text{plastic viscosity, and } \dot{\gamma} = \text{shear rate})$$

The NCA/CMA Casson model is designed by the National Confectioners Association and the Chocolate Manufacturers Association as the standard rheological model for the industry. This model determines yield and flow properties under specified conditions and closely approximates the plastic behavior of chocolate before final processing.



When chocolate is used for enrobing, it must have a yield stress high enough to stay in place once it enrobes the filling. In the case of decorating chocolate, the yield stress must be high enough so it can keep its shape once it has been squeezed into place through a nozzle. For molding chocolate, the plastic viscosity must be low enough to completely fill the mold.

Other Models

Newton model:

• This is the simplest; Newtonian liquids have a viscosity that, at constant Temperature & Pressure, is independent of shear rate.

$$\tau = \eta \cdot \dot{\gamma}$$

τ = shear stress, η = viscosity, $\dot{\gamma}$ = shear rate

Casson-LC-ANZ Model

$$(1 + a)\sqrt{D} = 2\sqrt{k_4} + (1 + a)\sqrt{k_5 \cdot \tau}$$

a = coaxial cylinder gap constant (it depends upon geometry), D = shear rate, k_4 and k_5 are adjustable parameters, τ = shear stress

Steiger-Ory Model

$$\dot{\gamma} = k_1 \cdot \tau + k_2 \cdot \tau^3$$

τ = shear stress and $\dot{\gamma}$ = shear rate,

The Steiger-Ory k_1 and k_2 are adjustable parameters.

• This model was originally developed by researchers in the European pharmaceutical industry

Best Model

- Rheo3000™ determines the model which best fits the data, based upon the highest Stability Factor.

Rheotec Weighted Model

- This is a “generic” model that may be weighted to an operator-specified number of data points.

$$y = [f(x_{-1}) \cdot W + f(x)] / (W + 1)$$

Windhab Model

- This model was developed in Europe, to fit chocolate viscosity data.

$$\tau = \tau_0 + \eta_{\infty} \cdot \dot{\gamma} + (\tau_1 - \tau_0) \cdot (1 - e^{-\left(\frac{\dot{\gamma}}{\dot{\gamma}^*}\right)})$$

τ = shear stress, τ_0 = yield stress, η_{∞} = high shear rate viscosity, $\dot{\gamma}$ = shear rate,

τ_1 = shear stress corresponding to “maximum shear induced structuring”,

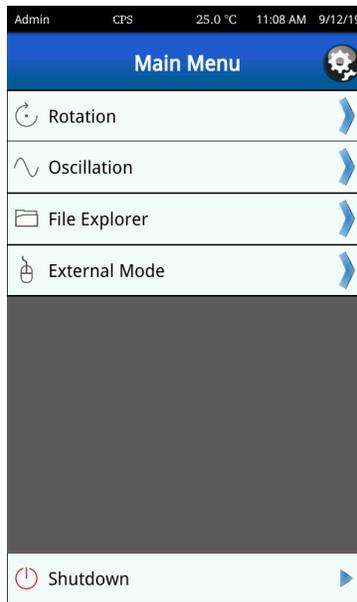
$\dot{\gamma}^*$ = the shear rate at which approximately $(1 - 1/e)$ or ~63% of the structure has been built up.

Ref.: ICA Analytical Method 46, “Viscosity of Cocoa and Chocolate Products”, 2000.

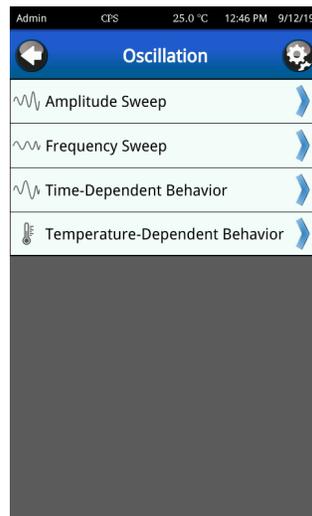
4.6 Oscillation Measurements

4.6.1. General

Oscillatory measurements are typically made to determine the viscous and elastic behavior of a sample. They give information about the material's structure (typically before the onset of flow) as a function of time, temperature, stress/strain, and frequency of the oscillation. The RSO has an air bearing which allows for these measurements to be made at very low stresses and frequencies to determine the structural behavior of the material.



4.6.2. Amplitude Sweep



Amplitude Sweep oscillates the spindle at a constant frequency but increasing or decreasing the amplitude of strain or stress applied to each oscillation in a sweep.

Configuration

The screenshot shows a mobile application interface for configuring an 'Amplitude OSC' test. The top status bar displays 'Admin', 'CPS', '25.0 °C', '12:47 PM', and '9/12/19'. The title bar is blue with a back arrow on the left and a gear icon on the right. The main content area is a table of settings:

Measuring System	Sample
RCTO-50-1 <small>Truncation: 50 µm</small>	
Amplitude Mode	Frequency
Shear Stress <input type="checkbox"/>	1.592 Hz
Start Amplitude	End Amplitude
10.000 Pa	100.000 Pa
Temperature	Number of Points
25.0 °C	90

At the bottom of the screen are three buttons: 'Default' (blue), 'Save' (blue), and 'Next' (green).

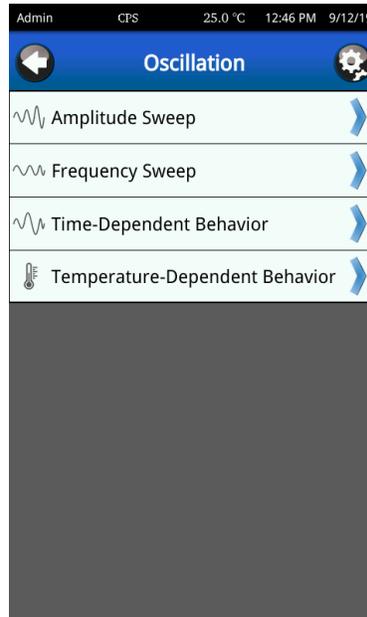
Insert spindle, choose amplitude mode (strain or stress-controlled), select the frequency of the oscillation. Choose the start and end amplitudes of stress or strain. Select the number of measuring points for the test.

Interpretation



Results listed are the Yield Point and the Flow Point. The Yield Point is the point at which G' begins to decrease significantly from its plateau value. The Flow Point is defined as the point at which $G' = G''$, when their respective curves cross over. G' is the Storage Modulus, a measure of the elastic behavior, how input mechanical energy is stored in the material. G'' is the Loss Modulus, a measure of the viscous behavior, how input mechanical energy is lost by the material. "Tan Delta", the loss tangent, is the ratio: $\tan \delta = G''/G'$.

4.6.3. Frequency Sweep

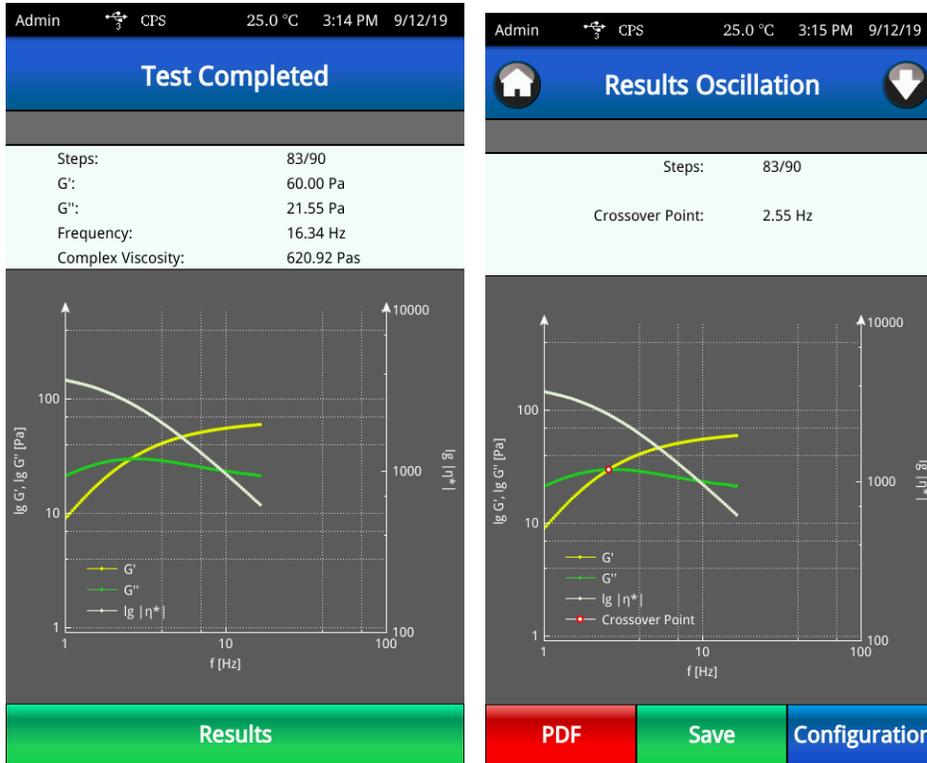


The frequency sweep oscillates the spindle at a selected shear stress or strain but changes the frequency of the oscillation from low to high or vice versa.

Configuration



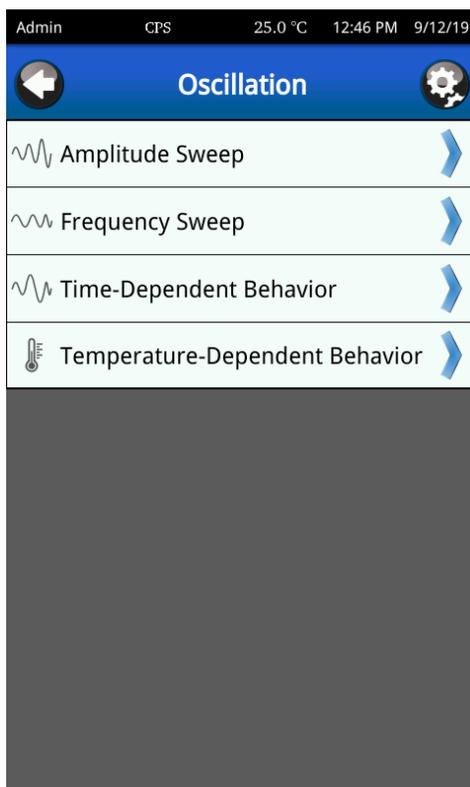
Attach the spindle, select the Amplitude Mode (stress- or strain-controlled), set the amplitude of the stress or strain, enter the start frequency and end frequency, and the number of points. The results are displayed on logarithmic scales as G' , G'' and $|\eta^*|$ - the storage modulus, loss modulus, and complex viscosity.



Interpretation

The Crossover Value is the oscillatory frequency at which $G' = G''$. In the above example, G' increases with increasing frequency. G' is initially less than G'' but becomes greater than G'' . This indicates a change from liquid-like behavior to solid-like behavior.

4. 6. 4. Time-Dependent Behavior



This test is used to monitor the behavior of materials whose viscosity significantly changes over time. A constant frequency and temperature are commonly used (e.g., materials forming gels or, conversely, materials breaking down). Glue “curing” is a practical example.

The user-selected temperature stays the same throughout all the blocks, in CPS mode. The frequency, amplitude, and time may be set to be different in each block, however.

Configuration

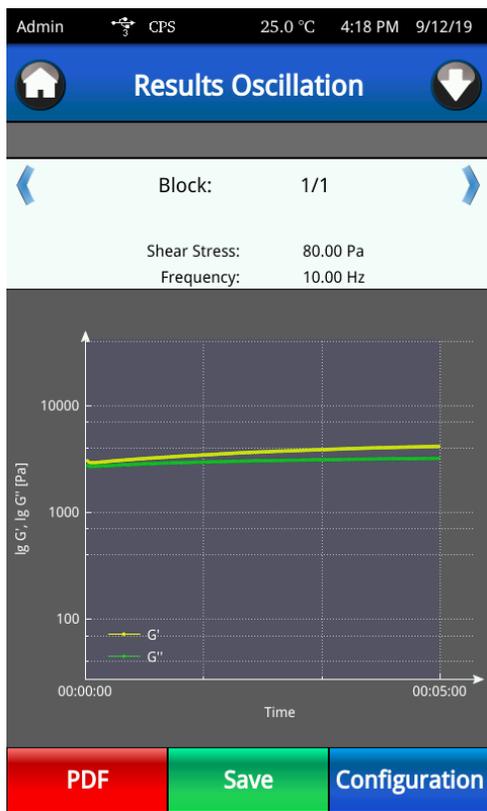
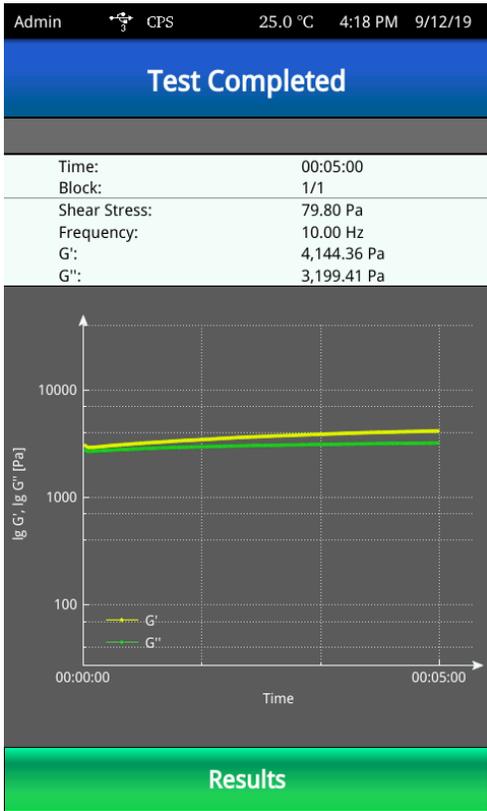
The screenshot displays the 'Time OSC' configuration interface. At the top, the status bar shows 'Admin', signal strength, 'CPS', '25.0 °C', '3:24 PM', and '9/12/19'. The title bar contains a back arrow, 'Time OSC', and a settings gear icon. The main content area is divided into several sections:

- Measuring System:** 'RCTO-50-1' with a sub-note 'Truncation: 50 µm' and a right arrow.
- Sample:** A blank field with a right arrow.
- Block:** 'Block 01 of 01' with left and right arrows.
- Amplitude Mode:** 'Shear Stress' with a toggle switch and a right arrow.
- Amplitude:** '50.000 Pa' with a right arrow.
- Frequency:** '5.000 Hz' with a right arrow.
- Time:** '300 s' with a right arrow.
- Temperature:** '25.0 °C' with a right arrow.

At the bottom, there are five buttons: 'Delete Block' (grey), 'Add Block' (blue), 'Default' (grey), 'Save' (blue), and 'Next' (green).

Attach the spindle, choose the amplitude mode of stress or strain, and select the test frequency, amplitude, and duration of the block. You can add blocks at different constant frequency or amplitude.

Interpretation

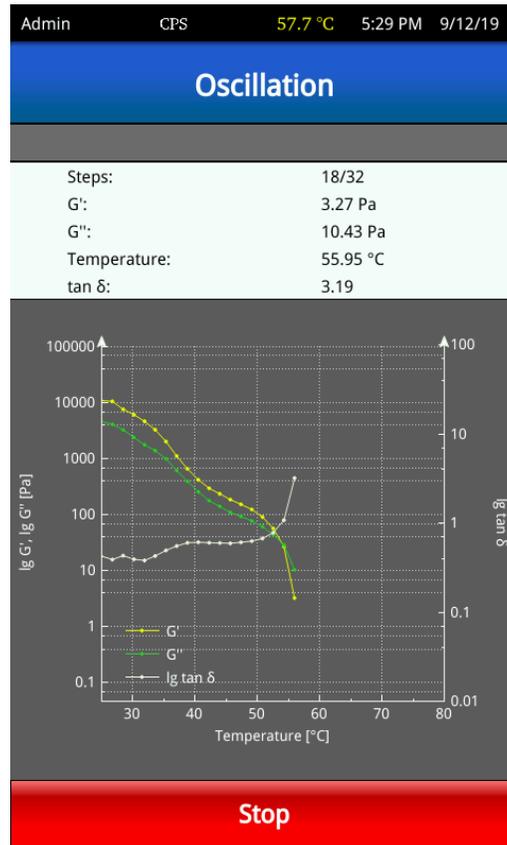


4. 6. 5. Temperature-Dependent Behavior



In this mode, the frequency and amplitude of the measurement stay the same, but the temperature of the test is changed to see what effects temperature has on the sample under the test conditions.

Configuration



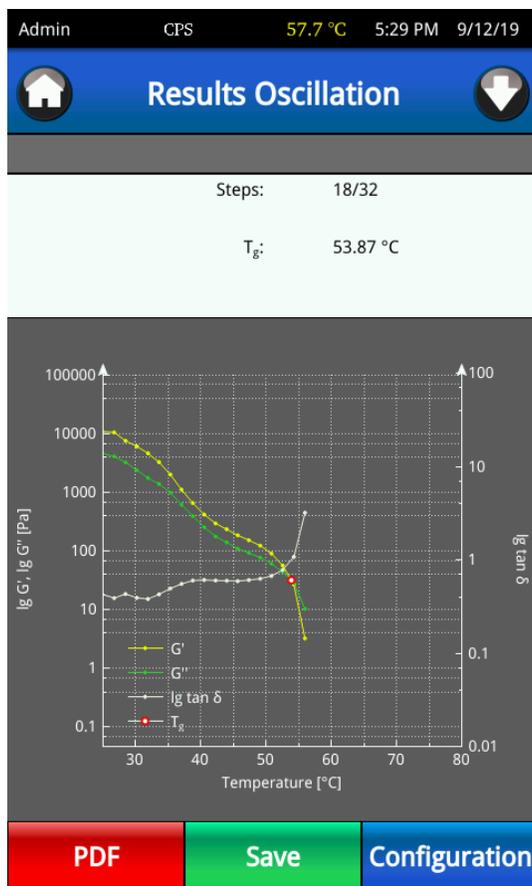
Attach the spindle, choose the Amplitude Mode of Stress or Strain, select the test Frequency and Amplitude. Select the start temperature and the end temperature. Please note that the cone-plate gap is set at the highest temperature.

Interpretation

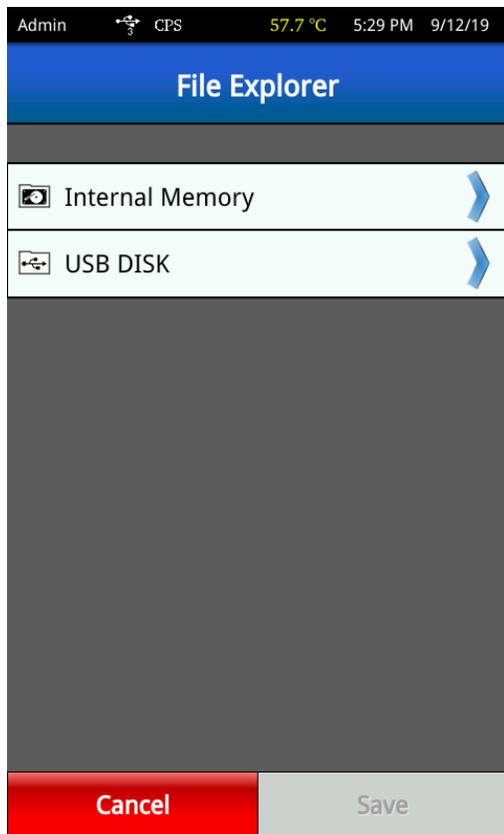


The result is shown as the temperature at which the onset of flow occurs, taken as the point where G' and G'' values cross over each other.

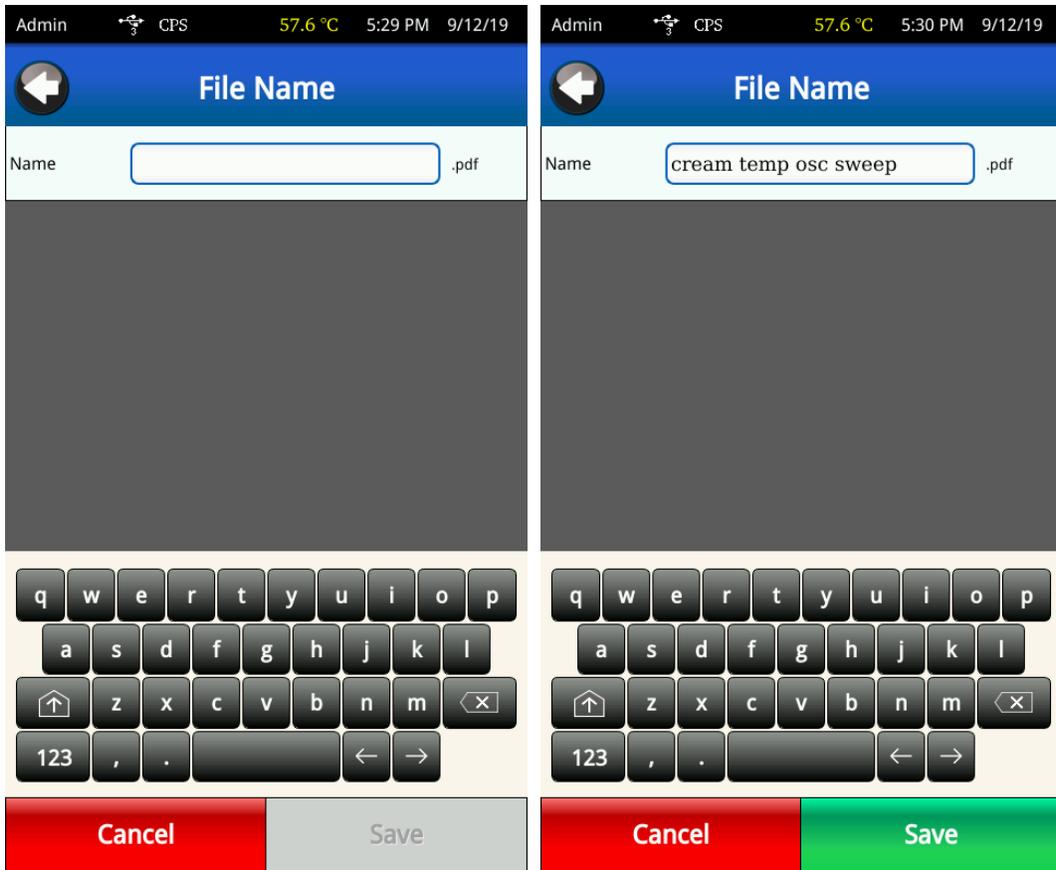
Creating a PDF of the results:



At the end of the test you can choose to make a PDF of the results by simply pressing the red PDF icon.



Choose which location you would like to save the document, and press Save.



Create file name and save.

4.7 File Explorer

Main Menu → File Explorer



In the file explorer all files and folders in the internal memory and on USB flash drives can be managed. USB flash drives can be plugged into the four ports at the back.

4.7.1. Internal Memory

Main Menu → File Explorer → Internal Memory



All measurement results and configurations of the different users are stored in the internal memory.



There is a separate folder for each user, which only he or she can see. The users' folders are stored in the folder "Users". The administrator can see and change all users' folders.

Be aware that if a user gets deleted, his or her folder will also be erased permanently. All measuring data should be copied to a USB flash drive if needed later.

In addition, new folders can be created, and files and folders can be deleted. Files and folders can also be copied and pasted to all directories. See section VI.7.3 Context Menu.

4.7.2. External Memory

Main Menu → File Explorer → Name of USB flash drive



There are no limits to the external memory. Almost all files and folders are displayed (only files that are for the RSO Rheometer) and can be copied, cut, pasted, and deleted.

4.7.3. Search Files

Main Menu → File Explorer → Search Files



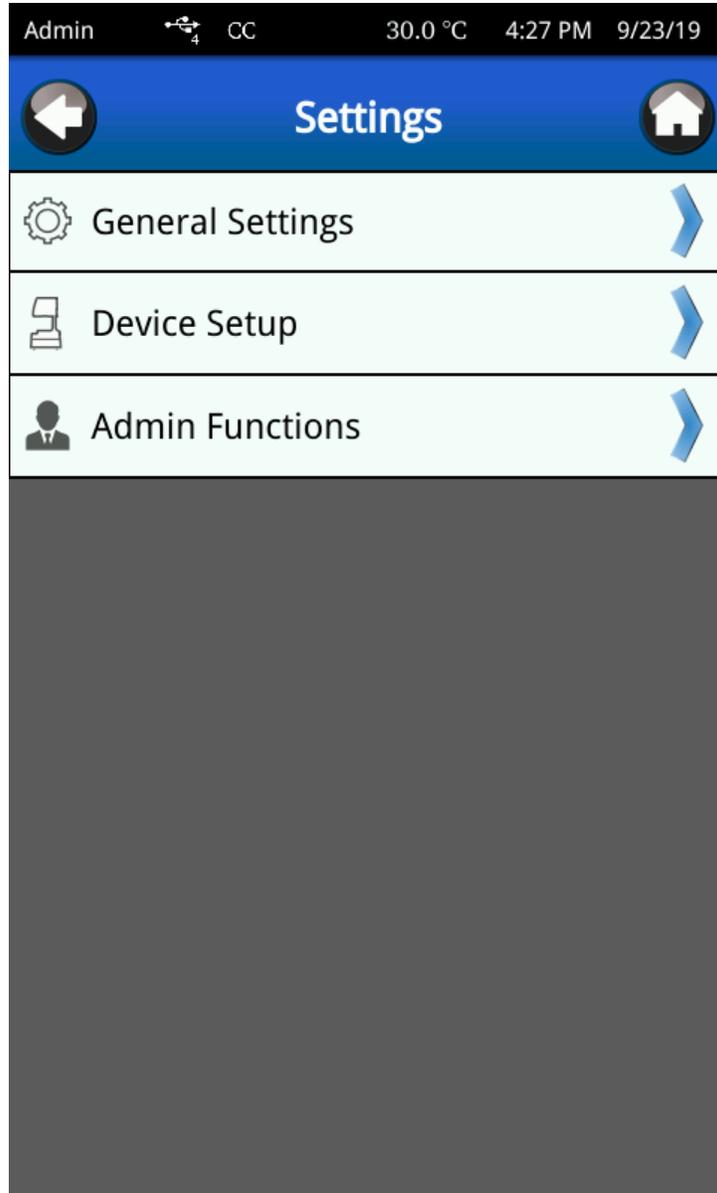
4.8 Settings

MainMenu → Settings



The settings menu provides access to the many controls and features of the RSO Rheometer. This menu can be accessed through the Settings Navigation Icon, which is located in the title bar of most views.

The figure below shows the settings menu which is divided into: General Settings, Device Setup and Admin Functions. Device Setup includes items that affect the complete range of features within the instrument. Admin Functions include items related to administrator level controls.



4. 8. 1. General Settings

Main Menu → Settings → General Settings



The general settings menu includes settings related to specific users and display options. Two general settings and two user settings are available.

The general settings include:

	Spindles	Manage spindles database
---	----------	--------------------------



	Measurement Units	Select the unit of measure for several parameters.
---	-------------------	--

The user settings include:

	Display	Display options including date/time format, decimal separator, language and backlight brightness
	Change password	Change the password for the log in account used to access the RSO Rheometer



Each user can set their own preferences for brightness and language.

Date and Time Format

Main Menu → Settings → General Settings → Display



The display menu displays the current selections for the number format, date format, and day separator.

The formats for numbers, time, and date offer several options.

Date Format	Day Month Year Year Month Day Month Day Year Year Day Month	International Standard Mathematically Structured USA Standard ISO Standard
Date Separator	. / -	Dot Slash Minus
Time Format	12 24	12-hour format with “am” and “pm” 24-hour format without “am” and “pm”
Decimal Point	. ,	D Comma

Brightness

Main Menu → Settings → General Settings → Display



The brightness adjustment applies to all screen views within the RSO Rheometer.



The screen brightness is dimmed automatically after five minutes of no touch screen activity. It will be dimmed to a very low value. A single touch restores the brightness.

Language

Main Menu → Settings → General Settings → Display → Language

The language is set by pressing the language field after pressing on display options. Selecting the appropriate language from the list will implement the language immediately.

Spindles

Main Menu → Settings → General Settings → Spindles



This should be added under the spindle specification tables:

To convert the $T_{\%}$ or “Tau per mille”, or “Tau pro-mille”, or “Tau-prom”:

- Multiply by 20 to convert from Pa/per mille to Pa/mNm
- Multiply by 20000 to convert from Pa/per mille to Pa/Nm

These Tau-prom values allow backward compatibility with the obsolete R/S and R/S+ units, whose torque ranges were only 50 mNm. Tau-prom is multiplied by 1000 to calculate the torque for the obsolete R/S and R/S+.

Measurement Units

Main Menu → Settings → General Settings → Measurement Units



Measurement units may be selected by the RSO Rheometer operator, for some variables.

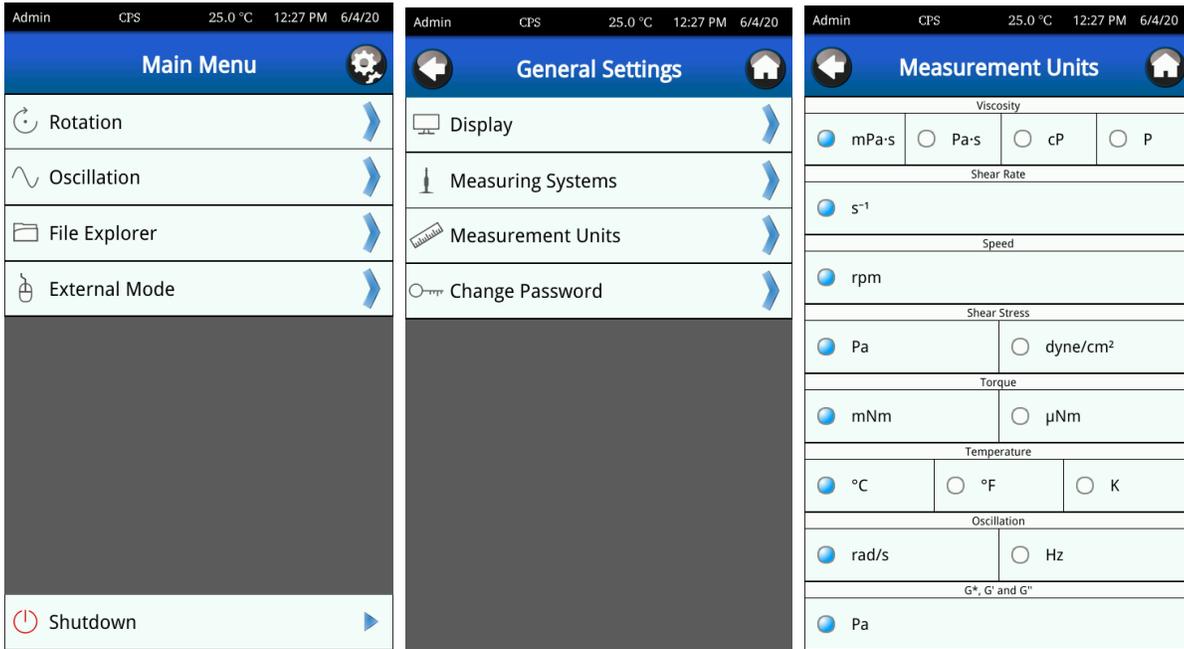
S.I. units are accepted world-wide, although others are used. S.I. units include quantities such as kg, m, s, and K, for example. Derived quantities include N, Pa and rad/s.

The “cgs”, “c-g-s” or “CGS” units include cm, g and s from the metric system. Derived quantities include P, cP, and dyn/cm², for example.

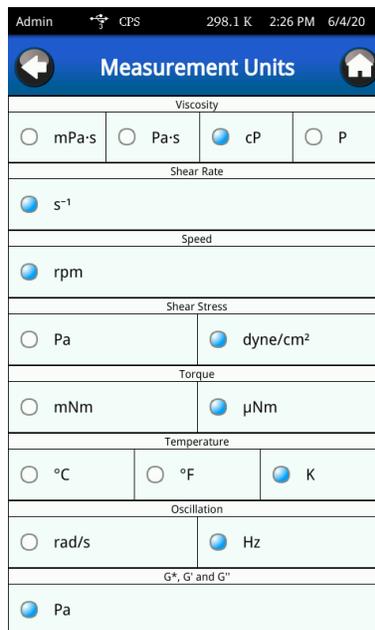
Oscillation: (1) Angular frequency, a displacement per time, rad/s, (2) Regular frequency, cycles per time, cycles/s = Hz. Both may be considered S.I.-unit quantities.

- Most oscillatory rheology data, historically and currently, report data with rad/s and °C.

The operator touches the gear icon to open General Settings, then touches Measurement Units:



Touch the empty circles to change the dimensions or units:



Once the choices are made, touch either the arrow “Back” or the “Home” icon to continue.

1 Pa·s = 1000 mPa·s, 1 mPa·s = 1 cP, and 100 cP = 1 P. 1 mNm = 1000 μNm.

Angular frequency, ω , rad/s = $2\pi f$, where f is the frequency, Hz.

Change Password

Main Menu → Settings → General Settings → Change Password



Any user can change thier his/her own password at any time. The user must enter the current and the new password as well as confirm the new password.



If the administrator password is lost, it can be reset. Please contact AMETEK Brookfield or the local authorized dealer. Remember to have the information found in the Technical Support Info screen available. See section VI.8.2 Technical Support Info.

4. 8. 2. Device Setup

Main Menu → Settings → Device Setup

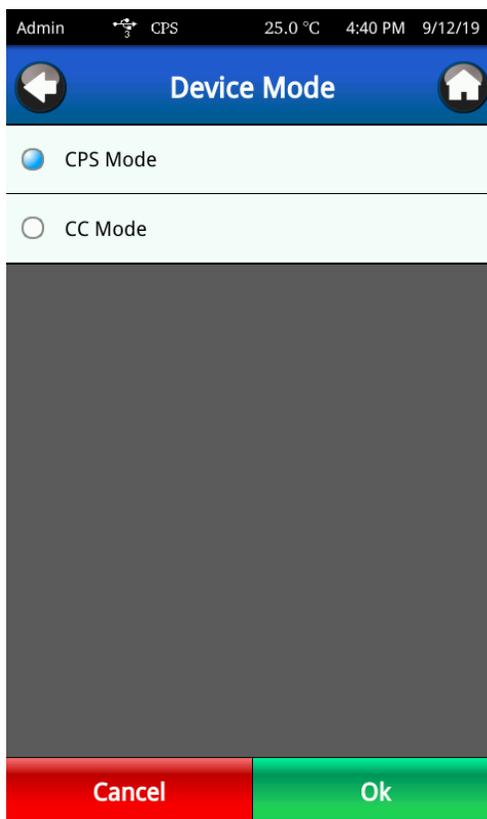


The device setup menu includes settings related to the internal systems and connections of the RSO Rheometer. The following settings are available:

	Device Mode	Switch between CPS or CC mode
	Temperature	Various settings concerning the temperature control system
	Technical Support	Information that may be requested by AMETEK Brookfield technical support staff to assist with troubleshooting.
	Logs	View log of system events, warnings, or errors.
	Calibration	Execute various calibration procedures.
	About	Present basic information about the RSO Rheometer as is done at start up.

Device Mode

Main Menu → Settings → Device Setup → Device Mode

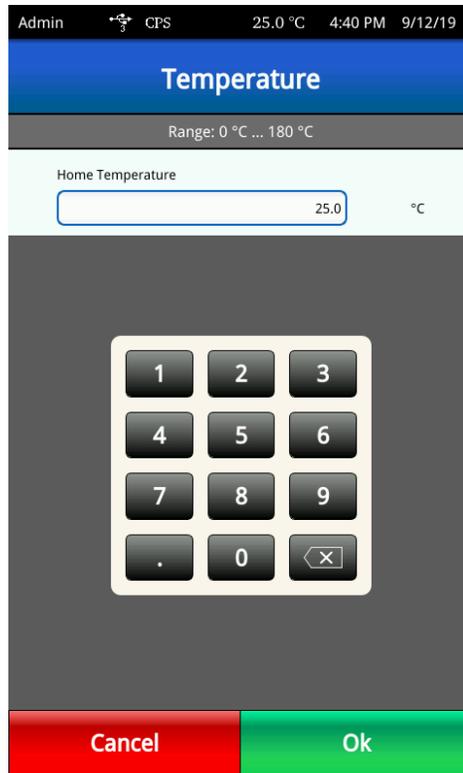
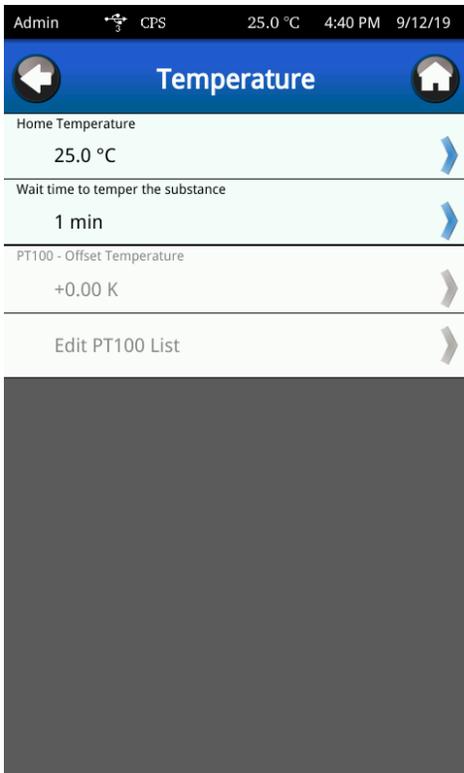


Select which configuration you require for the RSO.

CPS mode is for using Cone-Plate or Parallel-Plate geometry. CC Mode raises the RSO rheometer head, for use with Coaxial Cylinder accessories or other spindles requiring more clearance, such as certain vanes.

Temperature:

Home temperature = commanded temperature if no measurement is running.

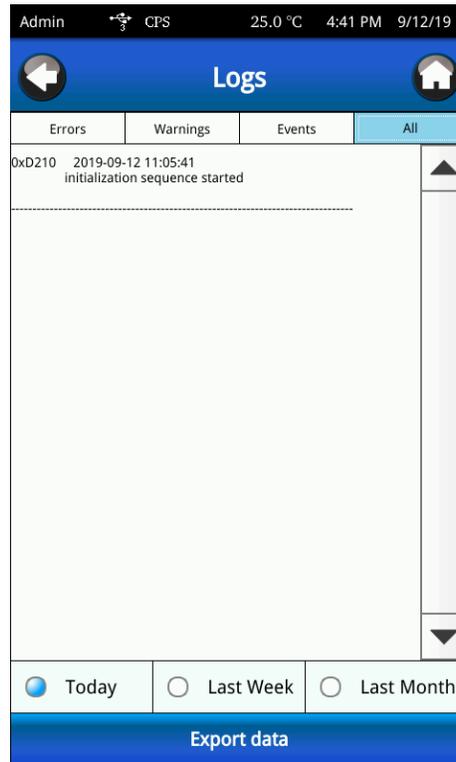


Temperature range can be set from 0 to 180 °C.

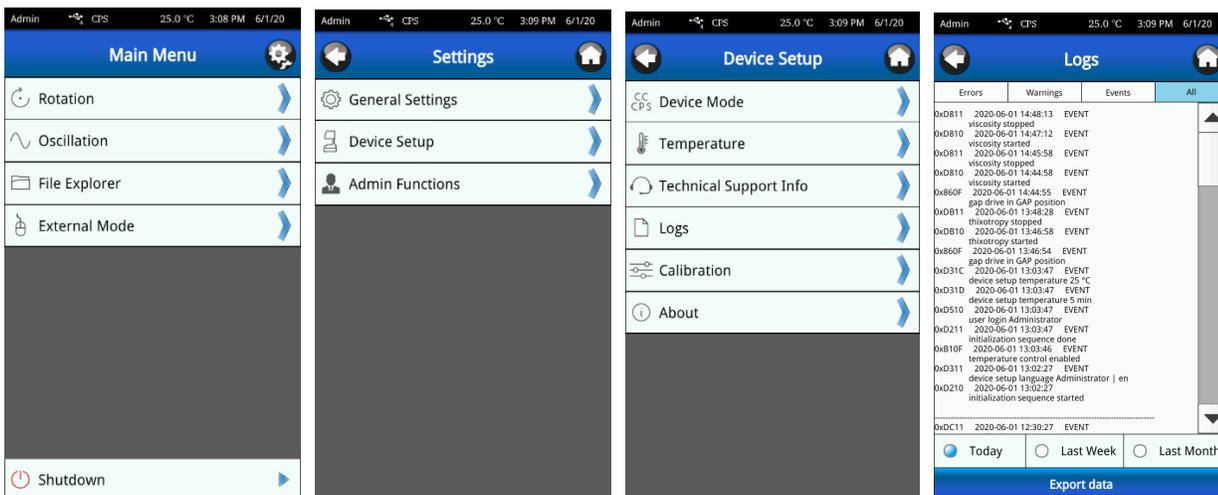
Technical Support Info

Info	Value
Part/SerialNo	PID:RSOAIOTSAB1N SN:80000000 CC:DE
System Cont.	HW:4 AV:0 BOM:1 FW:0.0.2-064 EEP:0
Motor Cont.	HW:5 AV:0 BOM:1 FW:1.0.2-104 EEP:4
Power Cont.	HW:4 AV:0 BOM:0 FW:0.0.1-070 EEP:2
Temp. Cont.	HW:4 AV:0 BOM:0 FW:0.0.1-056 EEP:0
Application	FW:0.0.1-766
Barcode	FUZZYSCAN SE380-0 2.05.03
Sensor	Value
Temp. Motor	35.04 °C
Temp. FTK	125.469 °C
Temp. Plate	24.99 °C
Press. Ch0	5.32 Bar
Press. Ch1	5.33 Bar
Press. Ch2	0.86 Bar
Calibration	Date
Motor Torque Calibration	May/31/2019
Temperature Control Stack Calibration	Apr/03/2019

Log



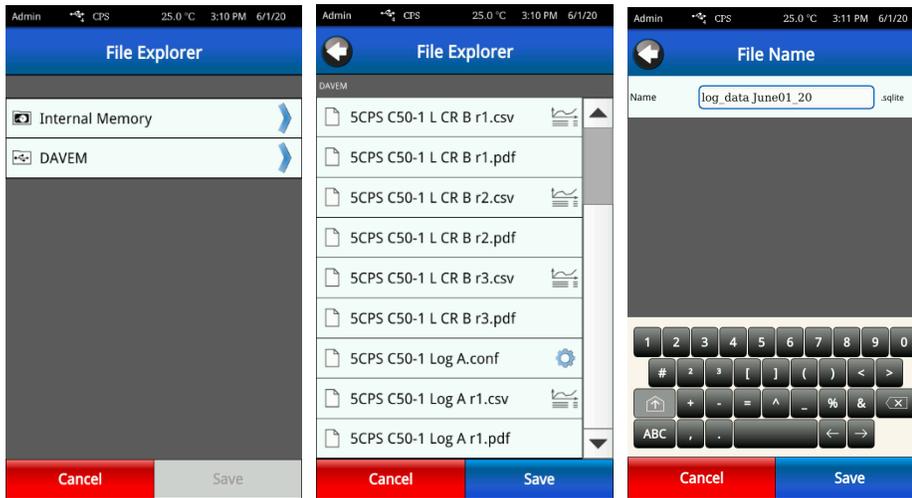
The RSO creates Log files because they help in “debugging,” or in diagnosing conditions that may occur while the instrument is in use. Go to the Main Menu, and touch the Gear icon in the upper right-hand corner to go to the Settings menu. Touch “Device Setup”, then “Logs”, and the Log listing appears:



There are four choices under “Logs”. The operator selects either: Errors, Warnings, Events, or All. An event may include something like a test starting or stopping, for example. “All” will

select Errors, Warnings, and Events all together. The operator chooses one of the following: Today, Last Week, or Last Month. The most recent item is at the top of the list; the listing is from newest to oldest, going top to bottom.

Touch “Export data”, to export a Logfile. The File Explorer appears; in our example, the RSO’s internal drive is listed, along with an operator’s USB drive (flash drive, USB stick). The USB drive name is touched, then “Save”, and the File Name menu appears:

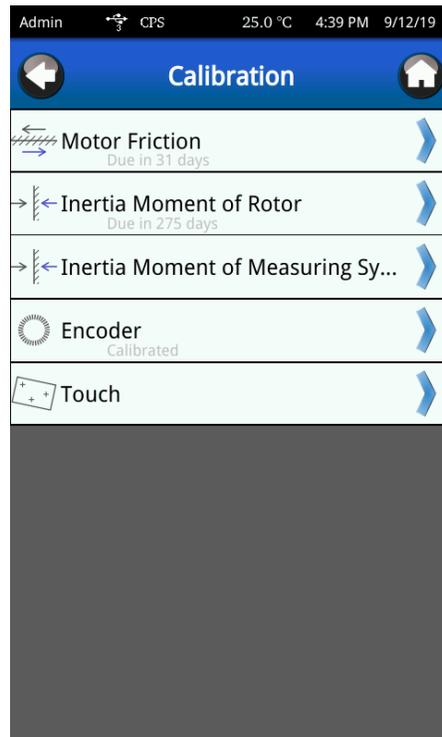


The default filename “log_data.sqlite” appears. However, that filename may be edited by the user; in this case, “log_data Jun01_20.sqlite”. “Save” is then touched, the file is saved, and the Logs list appears again:



The operator can then exit this menu, remove the USB drive, and upload the Log file to his/her PC. The file may then be emailed to the appropriate AMETEK® Brookfield contact, for further technical assistance.

Calibration



Explanation of the available calibrations:

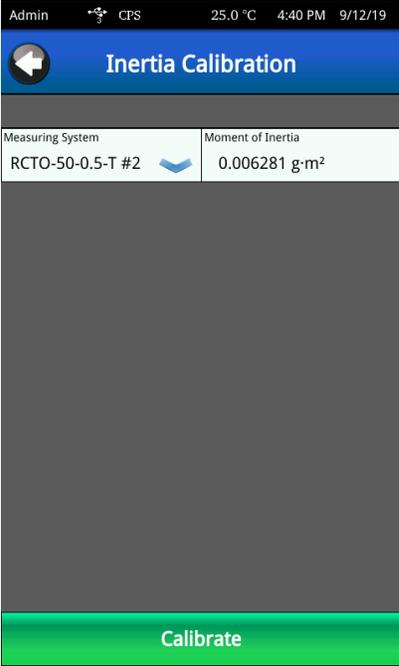
Motor friction: Ensures measurement accuracy (to be repeated monthly).



Rotor inertia: Calibrate the moment of inertia of the rotating parts of the instrument. To be repeated annually.



Periodic checks of rotor inertia ensure accurate measurements in oscillation modes.



Each spindle has its own moment of inertia. Accurate oscillation measurements require the moment of inertia be measured for the specific spindle used for the measurement.

Encoder: Re-home the position sensor. This is only necessary in case of an encoder malfunction.



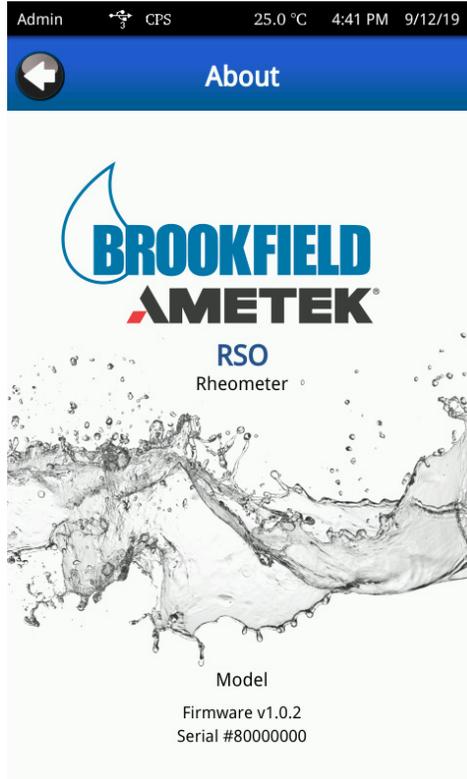
Touch: Calibrate the touch screen. This is only necessary if touch screen position sensing is inaccurate.



About

Information about the RSO:

- The Firmware Version and Serial Number are displayed.



4. 8. 3. Administrator Functions

	Software Update	Perform a software update.
---	-----------------	----------------------------

Login / Logout and Lockout

Users and Access

Set Date and Time

Set Log Level: Configure behavior of event/warning/error logging.

Special Settings: Includes an option to toggle mandatory or optional adding of spindles.

Software Update

4.9 External Mode

Main Menu → External Mode



This section describes how to connect the RSO Rheometer with the remote control software Rheo3000 and how diverse the application possibilities are.

Setup

First, connect the PC-USB interface cable provided into the “PC” / USB-B socket on the back panel of the RSO Rheometer. Do not use any interface cable other than that provided by AMETEK Brookfield. Connect the other end of the cable to an unoccupied USB port on the computer. The device driver installs automatically.

Turn the RSO Rheometer on and go to external mode. This menu can be found directly in the main menu.

All further steps are described in the Rheo3000 software manual.

Range of application

Another level of application can be achieved using the Rheo3000 software. Some possible usages and advantages are described below:

- Control of multiple devices
- Thermostat compatibility
- Freely configurable programs, which can contain loops, handle events and calculate math models
- Title 21 CFR Part 11 conformance
- Measurement data can be stored and retrieved in the database almost without limit
- Different data sets can be displayed simultaneously
- The application is offered in eleven languages
- User management with group policies

5. TRANSPORT AND STORAGE

5.1 Lifting and Carrying

To move the RSO short distances (i.e., during assembly), first protect the instrument by inserting the black foam rubber stopper between the rheometer head and instrument base. See section.



During transportation, at least two people are needed. Each person must use one hand to support the instrument by its stand and one hand to support the instrument by its head.

Never hold the instrument only by its head to carry it and never lift the instrument by the spindle or its coupling.

Use a rolling cart for transportation whenever possible.



Protect the instrument against heavy bumps, vibrations, or shocks that might impair the rotation of the coupling.

5.2 Ambient Conditions for Transport

Always transport the RSO Rheometer in its original carton. Protect it against bumps and shocks. Save the original shipment container for future use (i.e., returning the instrument to AMETEK Brookfield or your local authorized dealer for calibration service).

6. MAINTENANCE AND CARE

Maintenance work may only be carried out by trained and authorized specialist personnel. As maintenance work only cleaning is permitted.

6.1 Cleaning

To clean the RSO Rheometer, turn it off and unplug all cables.

- Use the supplied cleaning cloth to clean the touchscreen display. If necessary, replace the protective foil. Replacements are available from your AMETEK Brookfield dealer (Part No. RSO-3011 - five protective screens and one cleaning cloth).
- Use a dry, clean, soft, and nap-free cloth on the housing. Use natural detergent liquids if necessary.



During cleaning, the temperature of the measuring plate must not exceed +30°C (+86°F). If the measuring plate has higher temperatures, toxic or flammable gases may be emitted from the cleaning agent.



Do not use chemical products such as strong solvents or strong acids to clean the housing, especially the touchscreen display. The paint coat of the RSO Rheometer does resist most solvents and weak acids.



Make sure that no liquid penetrates the housing (E.g. through the instrument connecting sockets) and into the bearings of the measuring drive. This could result in the destruction of the instrument and void the instrument's warranty.

6.2 Maintenance

The RSO Rheometer system is designed for long-term operation.

The user can check measurement accuracy at any time. It is recommended that such measurements be performed with AMETEK Brookfield viscosity standard fluids (mineral oils). Instructions for this calibration process are detailed in Appendix B:

Important guidelines when checking the instrument's measurement accuracy include the following:

- Use temperature control
- Select the appropriate spindle
- Use the AMETEK Brookfield viscosity standard fluid recommended for the chosen spindle
- Carry out measurements at the following pre-set 12.5 mNm, 25 mNm, 37.5 mNm values.

- Read viscosity values from the display on the RSO Rheometer and compare with the known fluid viscosity
- Refer to Appendix B: For complete details on calibration check procedures

In case of instrument failure (or deviation from the mineral oil viscosity value), or should the instrument require repair, please contact AMETEK Brookfield or your local dealer.



Only authorized service personnel may work on the control electronics, all accessories, the measuring device, as well as the Power Cord and all electric circuits and connections! Do not make any technical modifications to the instrument! Any modification will result in the voiding of the instrument's warranty!

6.3 Software Update

See device setup -> software update

7. TROUBLE SHOOTING

The following section describes situations that may occur when operating the instrument. Use the corrective action described in this section. If you need further assistance to fix the problem, please contact AMETEK Brookfield or your local authorized dealer.

7.1 Error Cases

Listed are some of the more common problems that you may encounter while using your rheometer.

Spindle does not rotate

- ✓ Make sure the RSO Rheometer is plugged in.
- ✓ Make sure the motor is ON and the desired rpm is selected.

Spindle wobbles when rotating or looks bent

- ✓ Make sure the spindle is tightened securely to the rheometer coupling.
- ✓ Check the straightness of all other spindles and replace if bent.
- ✓ Inspect the coupling mating surfaces for damage or contamination.

Inaccurate Readings

- ✓ Verify spindle, speed, and model selection.
- ✓ Verify spindle selection is correct on RSO Rheometer.
- ✓ Verify test parameters: temperature, container, volume, method. Refer to:
 - “More Solutions to Sticky Problems”, section III
 - “RSO Rheometer operating instructions”, Appendix D: Variables in Viscosity Measurements
- ✓ Perform a calibration check. Follow the instructions in Appendix B
- ✓ Verify tolerances are calculated correctly.
- ✓ Verify the calibration check procedures were followed exactly.

If the unit is found to be out of tolerance, the unit may need service. See Appendix F: Warranty and Repair.

Over-Torque Error at Start-Up

- ✓ Manual spin coupling and then clear error. (Encoder may not be detected under certain startup conditions).
- ✓ Verify spindle selection is correct on RSO Rheometer.

Communication with Rheo3000 software not working

- ✓ Check that USB-PC cable is plugged into the instrument with USBB and into the computer with USBA.
- ✓ RSO Rheometer must be powered on and the Menu has to be in external mode.
- ✓ Select “Device Watch” in Rheo3000 and click the “Check Communication” button. Rheo3000 will automatically recognize the RSO Rheometer model and serial number.

Display Freeze

Press the power on/off button on the back of the instrument and hold down for 3 to 5 seconds. The instrument will shut down. Press the power on/off button to turn the instrument on. Power up will take place and the home screen will be displayed.

If such an incident happens, AMETEK Brookfield should be contacted. Please export the log files and send them to AMETEK Brookfield or your local authorized dealer so that we can reconstruct and resolve the issue. See section VI.8.2 Log.

7.2 Logs

Log files can be generated as described in section VI.8.2 Log.

8. TECHNICAL SPECIFICATIONS

This section deals with the technical specifications of the RSO Rheometer.

8.1 Power Cord

8.2 Power Cord Color Code:

	United States	Outside United States
Hot (live)	Black	Brown
Neutral	White	Blue
Ground (earth)	Green	Green/Yellow



Main supply voltage fluctuations are not to exceed $\pm 10\%$ of the nominal supply voltage.

8.3 International Protection Marking

IP Code for RSO Rheometer: IP 30



The RSO Rheometer is protected against >2.5 mm objects. Device is not water-proof.

8.4 RSO Rheometer Technical Data

Viscosity range	$0.1 \cdot 10^{-3}$ to $5.4 \cdot 10^6$ Pa·s
Torque range	0.005 mNm to 100 mNm
Torque resolution	0.1 nNm (first Step)
Frequency range	0.001 to 20 Hz, or about 0.006 to 120 rad/s

Speed range	0.001 to 1500 rpm
Angular resolution	1.2 μ rad
CPS Temperature range	0°C to +180°C (+32°F to +356°F)
Range of shear rate	0.013 to $7.8 \cdot 10^3 \text{ s}^{-1}$
Range of shear stress	0.27 to $69 \cdot 10^3 \text{ Pa}$
Input Air Pressure	6 to 9 bar
Clean Dry Air (CDA)	ISO 8573-1 class 1.5.1
Weight (Power Cord included)	31 kg (68 lb)
Dimensions (Width· Height· Depth)	360 x 340 x 600mm (14.2 x 13.4 x 23.6in)
Ambient conditions Temperature in operation Relative humidity (not condensing) in operation	+10°C to +40°C (+50°F to +104°F) 20% to 80%

9. GLOSSARY

CC	Coaxial Cylinder system. In this manual, it is used sometimes to determine the modes of the device. See section V.4 CC and CPS.
CD	Controlled Deformation
CPS	Cone and Plate System. In this manual, it is used sometimes to determine the modes of the device. See section V.4 CC and CPS.
CSR	Controlled Shear Rate
CSS	Controlled Shear Stress
FTK	Water Jacket (Flüssig Temperier Kammer)
PN	Part Number
RSO	Rheometer: RSO stands for Rate Stress Oscillation. “RS” indicates that we can do both CSR and CSS measurements. “O” indicates the ability to do oscillational measurements.

APPENDIX A: GAP SETTINGS PROCEDURE FOR THE RSO RHEOMETER

“The gap” refers to the gap between a truncated-cone or plate spindle and the measuring bottom plate. Cones are truncated to prevent contact between the cone spindle and the measuring bottom plate. The cone spindle gap height is the distance between the truncated flat and the theoretical tip of the cone. This value is indicated on the cone spindle datasheet as the cone truncation value. The gap height for plate spindles is usually determined by the largest particle size in the material. The best practice is to use a gap height 5 to 10 times greater than the largest particle diameter (For example, if the largest particle in the substance is 0.010 mm, then the gap height should be 0.050 to 0.10 mm). If the material does not have large particles, but is highly viscous, experiment with various gap heights to determine what will give the most repeatable viscosity measurements.

Any time a spindle is changed, the gap needs to be set.



Ensure that the spindle and measuring the bottom plate are clean. There should be no sample material on the plate. The rheometer head should be in the raised position. It is also important that the correct spindle is selected at the beginning of the program because the automatic gap control uses the spindle information to adjust to the correct gap height. Spindles with the same basic geometry may still have unique cone truncation heights.

The rheometer head will then automatically move down to the zero-gap position. The hit point is the point at which the spindle touches the bottom measuring plate.



If operating at a temperature greater than +40°C (+104°F), the touchscreen will instruct the user to wait for the spindle to temper for 10 minutes before continuing the gap settings process. Allowing the spindle to temper accounts for any thermal expansion of the spindle which could otherwise result in faulty measurement or damage to the measurement system.

The rheometer head will automatically move to the filling position, and the gap will automatically be adjusted as shown in the figure.

The next screen instructs the user to place the sample material on the plate. Follow the instructions provided in section

APPENDIX B: CALIBRATION CHECK

The calibration check procedure is performed to verify that your RSO Rheometer is making correct viscosity measurements. It can be done in standalone mode or under control of Rheo3000 software. Perform the calibration check with the spindle that is most frequently used with your instrument. You do not need to perform a calibration check with additional spindles unless there is a concern that a specific spindle is not measuring properly.

The calibration check can be performed at regularly scheduled time intervals determined by you (before each shift, weekly, monthly, etc.) or at any time when there is concern that the instrument is not measuring correctly. Before performing the calibration check, it is advisable to perform the Motor Friction calibration.

Use the appropriate viscosity standard for the spindle that you want to test. Consult the following table, which shows the fluid that is recommended for each type of spindle and the required sample volume to perform the calibration check:

Cone Spindle	Fluid	Sample Volume
RCTO-25-1	B41000	0.1 mL
RCTO-25-2	B73000	0.2 mL
RCTO-50-1	B10200	1.0 mL
RCTO-50-2	B21000	2.0 mL

Prepare the proper sample volume for the test and condition to the defined temperature within ± 0.1 K. Mineral oil is highly temperature-sensitive, so it is important to do this correctly.

The calibration check procedure is performed at 3 separate controlled torque values: 12.5 mNm, 25 mNm, 37.5 mNm. The spindle rotates for a minimum of 15 seconds at each torque value. Observe that the viscosity reading remains relatively constant vs. time. The viscosity reading at each torque value is recorded after 15 seconds or a longer time interval of your choosing. The three viscosity readings must each be within $\pm 5\%$ of the actual fluid value for the calibration check to pass.

If the calibration check fails, review each step to make sure that everything was done correctly in accordance with the test procedure. Repeat the test procedure if necessary. Areas for potential error are not having the proper sample volume and not conditioning the sample to the correct temperature. It is also possible that shear heating may occur at the highest 37.5 mNm for certain spindle geometries. If the viscosity value starts to drop, it may be due to shear heating. Record the viscosity reading 15 seconds after the test starts at this torque to minimize potential error. If the instrument fails when you repeat the calibration check, contact AMETEK Brookfield or your local authorized dealer. See [Appendix E: Warranty and Repair](#).

APPENDIX C: SYMBOLS FOR TEST PARAMETERS AND UNITS OF MEASUREMENT

Parameter	Symbol	Unit
Speed	n	[min ⁻¹]
Torque	M	[Nm or mNm]
Temperature	T	[°C, °F, K]
Time	t	[s]
Shear Rate	$\dot{\gamma}$	[s ⁻¹]
Shear Stress	τ	[Pa]
Viscosity	η	[Pa·s, mPa·s, cP, P]
Shear Strain	γ	[%]
Angular Frequency	ω	[rad/s]
Frequency	f	[Hz]
Complex Shear Modulus	G*	[Pa]
Storage Modulus	G'	[Pa]
Loss Modulus	G''	[Pa]

APPENDIX D: Desiccant Information and Replacement

Desiccant Technical Information Document

Dear valued customer,

This technical information document is to inform you that it is required to utilize the desiccant cartridge that was included with your RSO instrument. This is critical equipment for the instrument to operate correctly. Failure to use this in the air line fed to the RSO instrument will result in damage to the instrument and may result in additional incurred cost to repair the unit.

It is important to periodically check the status of the desiccant to determine it has not become too saturated with moisture. The desiccant will change color to indicate when it has become saturated with moisture. The desiccant provided with the instrument will be the appropriate color in Figure 1 when it has not absorbed any moisture (either **orange** or **blue**, depending on the desiccant provided). As it absorbs moisture, it will change color to indicate it is saturated with moisture. It will turn **green** if the original color was orange and will turn **pink** if the original color was blue. As is the case with using the instrument without the desiccant, if the included desiccant has changed color to indicate moisture saturation and you continue to use the instrument, this will result in damage to the instrument and may result in additional incurred cost to repair the unit.



Figure 1 – Desiccant color information

The part number for the replacement desiccant is part RSO-DESICCANT (imaged in Figure 2). This can be ordered by reaching out to our sales team at: ma-mid.sales@ametek.com.



Figure 2 – RSO-DESICCANT

To replace the desiccant in the dryer, ensure air supply is disconnected. Unscrew the hopper containing the desiccant [Figure 3]. Dispose of the spent desiccant and open the 2x bags of replacement desiccant. Pour both bags into the hopper to the appropriate fill level and screw back into the cap [Figure 4]. Turn air supply back on.



Figure 3 – Removal of the desiccant hopper



Figure 4 – Installation of one bag of replacement RSO-DESICCANT (two bags are required to fill fully)

It is recommended to check the desiccant weekly. The desiccant can be viewed through the observation port, circled in red in Figure 3. Slight color change over time is expected. If the more than 75% of the desiccant beads have changed color in accordance with Figure 1, immediately disconnect the air supply and discontinue use of the instrument. Replace the spent desiccant with new desiccant and then reconnect the instrument to air. Following this, perform a calibration verification with your RSO instrument. If the instrument fails the calibration verification, please contact the sales team at ma-mid.Sales@ametek.com

It is also recommended to periodically check the oil and particle traps in line with the desiccant cartridge, shown in Figure 5. If there is visible fluid within these traps, empty them. It is recommended to empty the traps with the air supply on and connected, however, these traps can be emptied in one of two ways:

1. With the air connected:

- a. Unscrew the cap at the bottom of the trap
- b. Allow the moisture to empty
- c. Screw the cap back on

2. With the air disconnected:

- a. Completely remove the traps from the assembly

It is recommended to check the desiccant in accordance with the above paragraph thereafter.

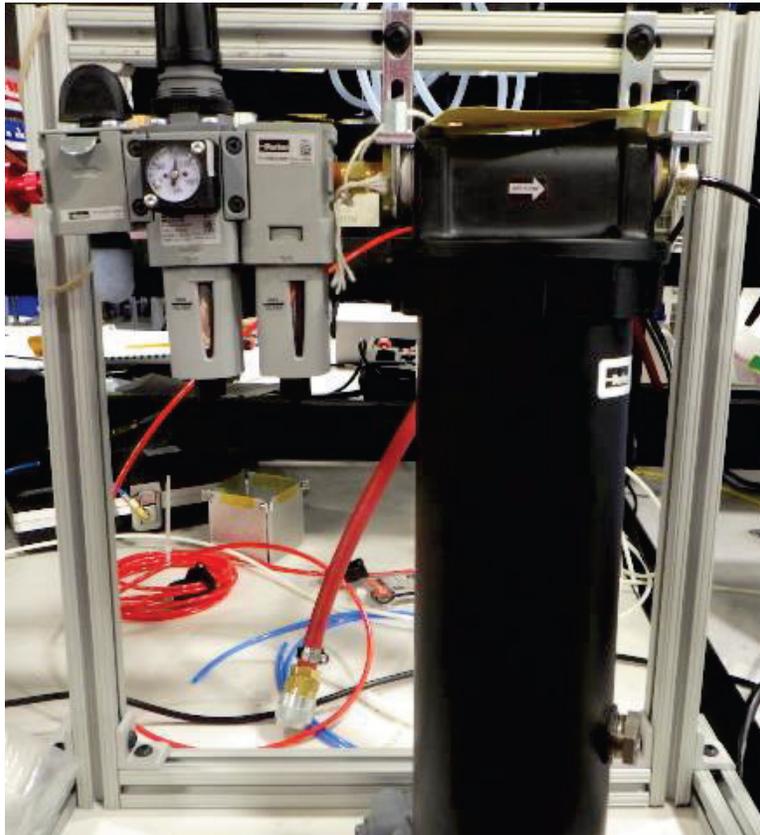


Figure 5 – Oil trap on filter setup

APPENDIX E: ONLINE HELP AND ADDITIONAL RESOURCES

WWW.BROOKFIELDENGINEERING.COM

The Brookfield website is a good resource for additional information and self-help whenever you need it. Our website offers a selection of “how-to” videos, application notes, conversion tables, instructional manuals, material safety data sheets, calibration templates, and other technical resources.

WWW.YOUTUBE.COM/USER/BROOKFIELDENG

Brookfield has its own YouTube channel. Videos posted to our website can be found here as well as other “home-made” videos made by our own technical sales group.

MORE SOLUTIONS TO STICKY PROBLEMS

Learn more about viscosity and rheology with our most popular publication. This informative booklet will provide you with measurement techniques, advice, and much more. It's a must-have for any Brookfield Viscometer or Rheometer operator. More Solutions is available in print and as a downloadable PDF file on the Brookfield website by following this path:

<https://www.brookfieldengineering.com/-/media/ametekbrookfield/tech%20sheets/more%20solutions%202017.pdf?la=en>

TRAINING/COURSES

Whether it is instrument-specific courses, training to help you better prepare for auditing concerns, or just a better understanding of your methods, who better to learn from than the worldwide leaders of viscosity measuring equipment? Visit our Services section on our website to learn more about training.

ONLINE STORE

To purchase accessories and replacement parts for your RSO instrument, please visit store.brookfieldengineering.com.

APPENDIX F: WARRANTY AND REPAIR

AMETEK Brookfield Viscometers/Rheometers are guaranteed for one year from date of purchase against defects in materials and workmanship. The Rheometer must be returned to AMETEK Brookfield or to the authorized dealer from whom it was purchased for a warranty evaluation. Transportation is at the purchaser's expense. The Rheometer should be shipped in its carrying case together with all spindles originally provided with the instrument. If returning to Brookfield, please contact us for a return authorization number prior to shipping. All AMETEK Brookfield DVNext Rheometers are supplied from the factory with a Calibration Seal (located on the back of the viscometer). The warranty stated above will be voided if the Calibration Seal has been damaged. Only AMETEK Brookfield or our authorized servicing dealers may break the Calibration Seal for purposes of instrument repair or recalibration.

For a copy of the Repair Return Form, go to the AMETEK Brookfield website:
www.brookfieldengineering.com/

For repair or service in the United States return to:

AMETEK Brookfield Headquarters

11 Commerce Boulevard
Middleboro, MA 02346 USA
Telephone: (508) 946-6200
FAX: (508) 946-6262

www.brookfieldengineering.com

USA - Chandler, AZ

AMETEK Brookfield
3375 N. Delaware St.
Chandler, AZ 85225 USA
Phone: 800.528.7411
Fax: 602.281.1745

www.brookfieldengineering.com

For repair or service outside the United States, consult AMETEK Brookfield or the local authorized dealer from whom you purchased the instrument.

For repair or service in the United Kingdom return to:

AMETEK (GB) Limited
Brookfield Technical Centre, Stadium Way
Harlow, Essex CM19 5GX, England
Telephone: (44) 1279/451774 FAX: (44) 1279/451775

www.brookfieldengineering.uk

For repair or service in Germany return to:

AMETEK GmbH / B.U. Brookfield
Oberweyerer Straße 21
65589 Hadamar-Steinbach, Germany
Telephone: (49) 7172/927100 FAX: (49) 7172/927105

www.brookfieldengineering.de

For repair or service in China return to:

AMETEK Commercial Enterprise (Shanghai) Co., Ltd Guangzhou Branch
Room 810 Dongbao Plaza, No. 767 East Dongfeng Road
Guangzhou, 510600 China
Telephone: (86) 20/3760-0548 FAX: (86) 20/3760-0548

www.brookfieldengineering.cn

For repair or service in India return to:

AMETEK Instruments India Pvt. Ltd.
207-208, A Wing, 215 Atrium,
Andheri Kurla Road,
Andheri (East), Mumbai

www.brookfieldengineering.in

For repair or service in Thailand return to:

AMETEK (Thailand) Co., Ltd
Bhiraj Tower at Bitec, 23rd Floor, Room no 23009
Sukhumvit Road, Bangna, Bangna
Bangkok 10260 Thailand
Tel : +66(0)83 820 5872
Fax: +66 (0)2 012 7501
<https://store.brookfieldengineering.asia/th>

Onsite service at your facility is also available from AMETEK Brookfield. Please contact our Service Department at your local AMETEK Brookfield Center of Excellence for details.