BROOKFIELD MODEL PVS RHEOMETER INSTALLATION

AND RHEOVISION SOFTWARE

OPERATION INSTRUCTIONS

Manual No. **M/97-580-C0106**

SPECIALISTS IN THE
MEASUREMENT AND
CONTROL OF VISCOSITY

BROOKFIELD ENGINEERING LABORATORIES, INC.
11 COMMERCE BOULEVARD, MIDDLEBORO, MA 02346 USA

TEL 508-946-6200 or **800-628-8139** (USA excluding MA)
FAX 508-946-6262 INTERNET http://www.brookfieldengineering.com

1788Lab INSTRUMENT

LAB Online Exhibition


Operation Manual


knowledge


Action movie

www.1788lab.com E-mail:info@1788lab.com

Any correspondence regarding this document should be forwarded to:

Brookfield Engineering Laboratories, Incorporated
Process Viscometer Division
11 Commerce Boulevard
Middleboro, Massachusetts 02346
U.S.A.
Telephone: (508) 946-6200
FAX: (508) 946-6262
Internet: http://www.brookfieldengineering.com

Table of Contents

Section 1 - PVS Rheometer Description

Section 2 - Installation

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

Section 5 - B.E.A.V.I.S. Programs

Table of Contents (continued)

Figures

Table of Contents (continued)

Table of Contents (continued)

Tables

Section 1 - PVS Rheometer Description

Introduction

The Brookfield Model PVS Rheometer is designed to test small complex samples by simulating process conditions in a bench top environment (sample boil-off problems are eliminated). The PVS Rheometer measures with a coaxial cylinder geometry and delivers excellent accuracy and outstanding sensitivity. Brookfield's Rheovision software controls the PVS Rheometer to ensure that test parameters are followed under the most demanding test requirements.

Brookfield's unique sensor design responds to minute changes in viscosity, mechanically transmitting a rotational torque signal from the pressure containment area without friction.

The Brookfield Model PVS Rheometer, shown in Figures 1-1, can be used in a variety of applications where the viscosity of a fluid must be measured at temperatures which cause samples to vaporize or boil off.

Features and Benefits

The Brookfield Model PVS Rheometer incorporates the following features:

- Portable and compact
- Quick and easy to operate
- Simulates process conditions
- Designed for reliable operation even in severe environments

The PVS Rheometer provides the following benefits:

- Low maintenance required
- Ability to test samples pressurized under many different gases
- Allows testing of samples at extremely low shear rate

Standard Equipment

The PVS Rheometer includes the following components:

- Rheometer sensing unit and power base with over pressure relief valve
- Choice of one geometry including sample cup and one stator/bob geometry set: B1, B2, or B5 with fluid contact parts manufactured from Hastelloy C corrosion-resistant alloy.
- Desktop Computer (PC)
- Rheovision Software which runs on Windows NT, XP or 2000 operating systems
- Interconnecting Cables

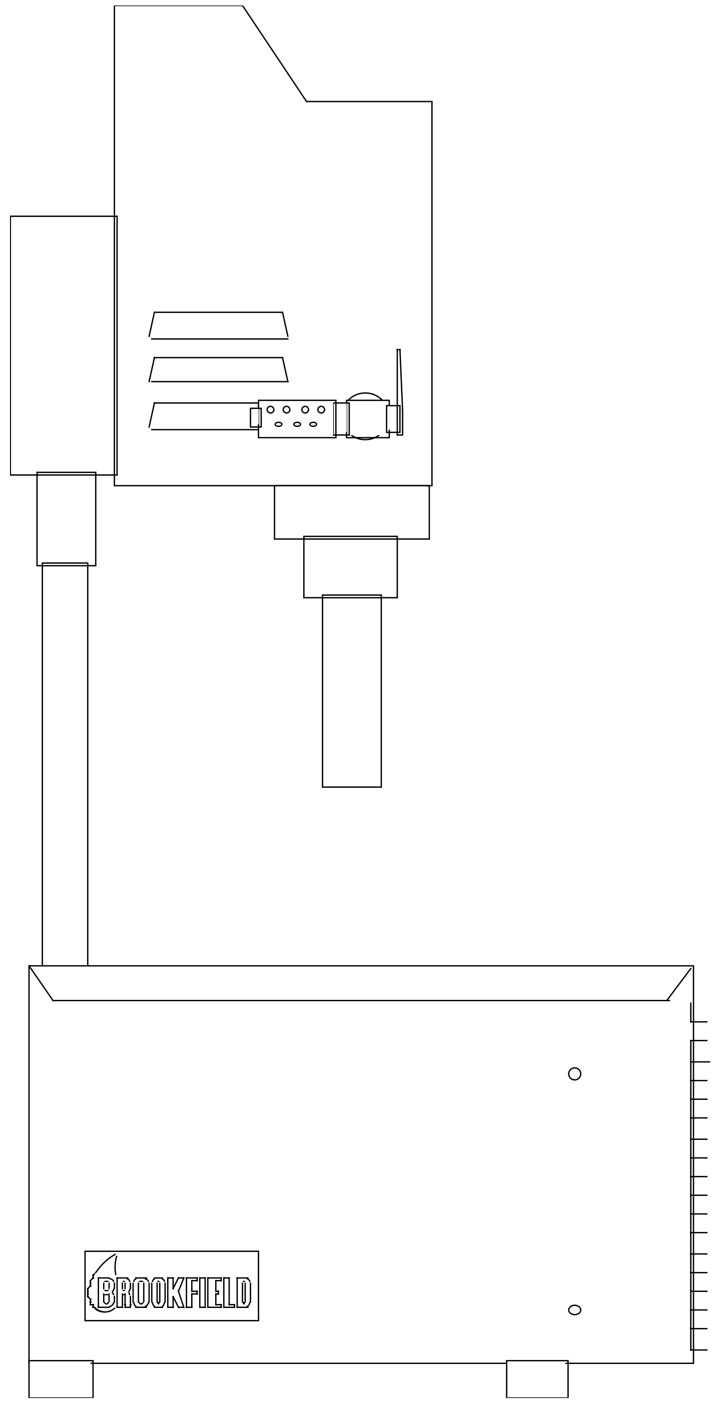


Figure 1-1: Typical Brookfield Model PVS Rheometer

Rheovision Software

Rheovision is designed for use with the Brookfield Engineering Laboratories, Inc. PVS Rheometer and Windows NT, XP or 2000 computer operating systems. Its purpose is to control and collect data from the rheometer and allow it to be saved, viewed, printed, plotted, and analyzed. Its features include:

- An easy to learn and use graphical user interface.
- A scripting language to allow flexible data collection.
- Background execution of data gathers (due to the multitasking nature of the MS-Windows operating system).
- On-line plotting of data during a data gather.
- Background printing of data, graphs, and programs.
- Mathematical analysis of collected data.
- Control of an optional Brookfield Engineering Labs temperatur bath.
- Calculation of industry specific data (Example: API power law calculations for the oil and gas industries). Refer to Appendix C for more information.

Rheovision System Requirements

The system requirements outlined in Table 1-1 must be met in order for Rheovision software to operate properly.

Table 1-1: Rheovision System Requirements

System Parameter	Requirement
Microprocessor	Pentium II (minimum)
Memory	32 MB minimum, 64 MB recommended
Hard Drive	20 MB minimum
Video	VGA (640 x 480 resolution) minimum
Operating System	MS-Windows NT, XP or 2000
Mouse	Required
RS-232 Port	One free COM port required

Registering Rheovision

Fill out and return (by email, fax or mail) the Rheovision Registration form, included with Rheovision to Brookfield Engineering Laboratories, Inc.

Theory of Operation

Brookfield’s unique sensor design responds to minute changes in viscosity, mechanically transmitting a rotational torque signal from the pressure containment area without friction.

The outer cylinder (sample cup) is driven by a stepper motor at speeds from 0.05 - 1000 rpm. The RTD probe measures temperature on the inner cylinder surface (stator/bob) where the shear stress is being measured. The entire sensor assembly is unaffected by changes in either pressure or temperature.

All electronics, bearings, and other sensitive components are completely protected from the influences of both the sample fluid and it’s vapor. The small angle of deflection ($1/2^{o}$ full scale) provides quick response and minimizes hysteresis and lag during speed ramping.

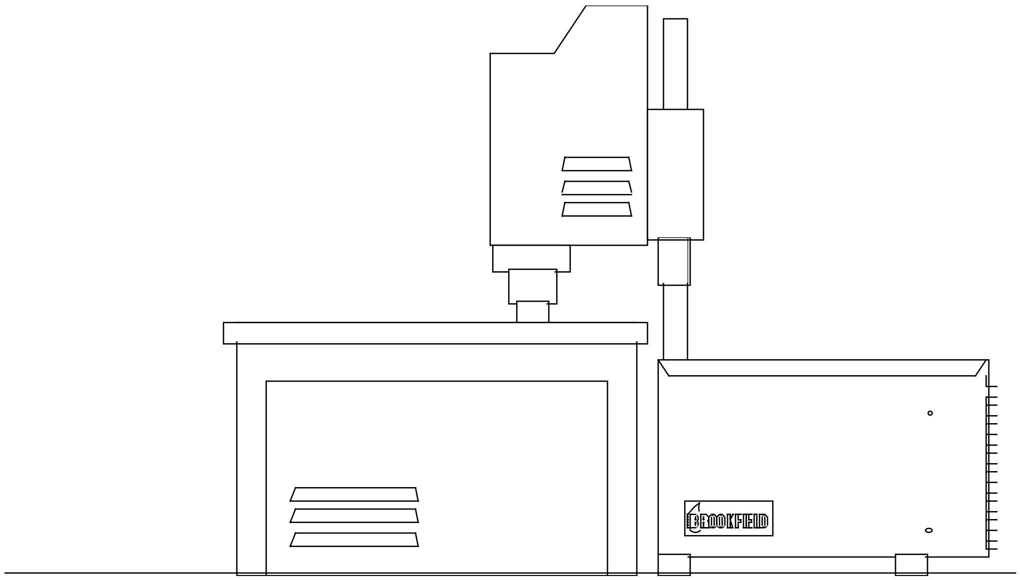


Figure 1-2: PVS Rheometer and Optional Bath

Specifications

The PVS Rheometer specifications are listed in Table 1-2.

Table 1-2: Model PVS Rheometer Specifications

Parameter	Specification
Sample Size	30 - 140 ml
Vapor Space	90 ml
Pressure	0 - 1000 psi
Speed Range	0.05 - 1000 rpm
Shear Rate Range	0.01 sec^{-1} - 1700 sec^{-1}
Repeatability	± 0.2% of full scale range
Temperature Range	-40 - 200°C
Dimensions	12 x 12 x 24 inches (W x L x H) (30.5 x 30.5 x 61.0 cm)
Carrying Case Dimensions	17.5 x 32 x 16 inches (W x L x H) (44.5 x 81.28 x 40.64 cm)
Construction	Hastelloy C Alloy wetted parts
Computer	Desktop PC with Pentium Processor and Windows Operating Systems
Weight (without computer)	40 lbs. (18 kg)
Complete System Weight (in optional carrying case without computer)	75 lbs. (34.01 kg)

Required Utilities

The PVS Rheometer requires the utility connections listed in Table 1-3 to operate.

Table 1-3: Utility Requirements

Parameter	Value
Supply Voltage*	115/230 VAC
Line Frequency	50 or 60 Hz
Power Consumption	~ 65 VA
Certification	CE, UL

*Supply voltage of 230 VAC requires a step down transformer.

Geometry Sets

The geometry sets available for use with the PVS Rheometer are listed in Table 1-4.

Table 1-4: Geometry Sets

Set	Sec-1/RPM	Annulus (inches/cm)	Sample Volume (ml)
B1	1.703	0.046 (0.117)	23
B2	0.377	0.241 (0.612)	53
B5	0.85	0.095 (0.241)	40
TA5*	0.85	0.095 (0.241)	140

* Optional Triple Annulus Geometry Set

NOTE: Refer to Appendix A and contact your local customer support center to order additional geometry sets.

Component Identification

The following paragraphs provide a brief description of each component within the PVS Rheometer. Refer to Figure 1-5 for the component location within the viscometer.

Rheometer Head

The Rheometer head contains the rheometer motor, torque transducer, torsion element and drive assembly. The Rheometer head is supported above the power base by the upright rod and is connected to the power base by motor and torque/temperature signal cables.

Sample Cup

The Sample Cup (outer cylinder) contains the pressurized sample fluid. The sample cup is rotated by a motor and drive assembly which causes the sample fluid to be sheared in the annular space between the cup and the stator/bob.

Power Base

CAUTION

Do not connect/disconnect the Rheometer motor power, signal, or computer cables with power applied to the Rheometer.

The Power Base supports the Rheometer head, and houses the motor drive electronics and signal processors for torque and temperature, power switch and cable connectors for power, signal and computer connections.

Sensing Stack

The Sensing Stack is a replaceable component consisting of a torsion element, mounting tube and drive mounting sleeve.

Stator/Bob

The Stator, also referred to as a bob or inner cylinder, which is mounted on the torsion element, applies torque generated by viscous drag to the torsion element. The dimensions of the stator/bob, in conjunction with the sample cup, are critical to the accuracy of the viscometer. Many different stator/bob sizes are available which provide different viscometer measurement ranges. An Resistive Temperature Detector (RTD) is mounted within the stator/bob.

Torsion Element/Mounting Tube Assembly

The Torsion Element, which is part of the mounting tube assembly, senses the torque from the viscous drag on the stator. The twist or deflection of the torsion element is proportional to the torque applied to it. The torsion element converts shear stress applied to the stator to angular movement.

The mounting tube assembly is used to mount the stator on the torsion element and provides electrical connection between the RTD within the stator and the electronics in the PVS Rheometer power base.

Torsion Element Guard

The Torsion Element Guard is installed with the sample cup and stator removed to protect the torsion element from being damaged.

Safety Relief Valve

The Safety Relief Valve protects the system from excess pressurization and is mounted on the Rheometer pressurization connection. The Safety Relief Valve is designed to open and release pressures in excess of 1200 psi, 200 psi above the maximum operating pressure of 1000 psi.

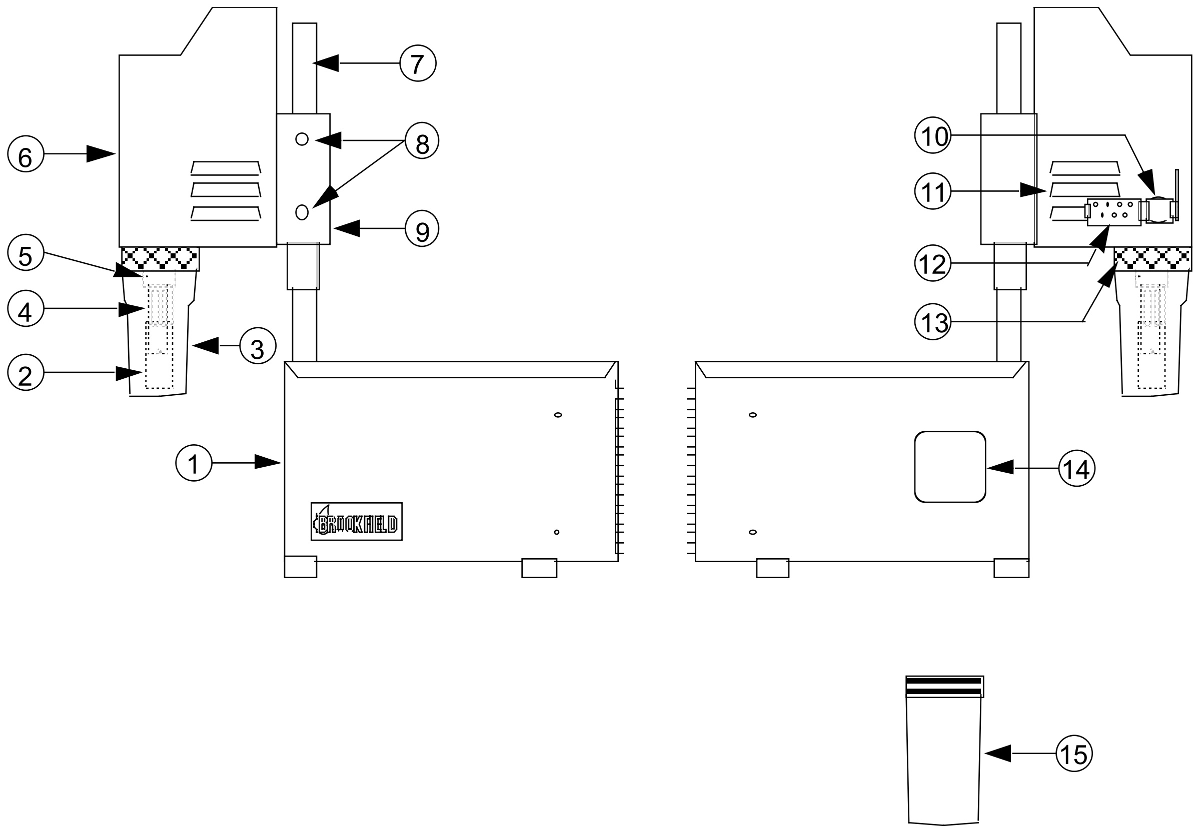
Personal Computer

NOTE: An optional laptop computer can also be ordered from Brookfield Engineering Laboratories, Inc.

The Personal Computer (PC) is used to operate the Rheovision software that controls the PVS Rheometer. The personal computer runs on Windows NT, XP, or 2000 software and should only be used to operate and control the PVS Rheometer.

CAUTION

No other software programs should be running while Rheovision is running. Various software programs may interfere with the operation of Rheovision software and the PVS Rheometer.



LEGEND

1. POWER BASE
2. STATOR/BOB
3. SAMPLE CUP
4. TORSION ELEMENT/MOUNTING TUBE ASSEMBLY
5. BAFFLE
6. RHEOMETER HEAD COVER
7. UPRIGHT ROD
8. PVS RHEOMETER HEAD CLAMPING SCREW
9. RHEOMETER HEAD CLAMP
10. THREE-WAY VALVE
11. LOUVER
12. SAFETY RELIEF VALVE
13. KNURLED RING
14. CABLE CONNECTOR PANEL
15. TORSION ELEMENT GUARD

Figure 1-3: Typical PVS Rheometer Component Identification

Options

The following optional equipment is available to enhance the operation of the PVS Rheometer when installed within certain product applications. Refer to Appendix A and contact Brookfield Engineering Laboratories, Inc. for more information on these options and accessories.

Heating/Cooling Bath

The Heating/Cooling Bath maintains sample temperature to a user selected level. The sample cup is immersed in the bath medium and transmits heat to or from the sample through the sample cup wall. Certain types of heating/cooling baths may be controlled along with the instrument by Rheovision software.

Laptop Computer

The optional Laptop Computer is a configured laptop personal computer which can be used to control the PVS Rheometer when portable operation is required. The Portable computer can also be used in installations where laboratory space limitations exist.

Additional Geometry Sets

One geometry set is provided with the PVS Rheometer. Additional geometry sets are available that contain stator/bobs with different dimensions for measuring various samples. Refer to Table 1-4 for more information.

High Surface Area Triple Annulus

The High Surface Area Triple Annulus geometry is for extra low shear rate measurement (includes one special sample cup, one stator/bob, and two adapters) is also available as an additional geometry set. It uses a B5 stator/bob as the inner component. For a given sample and rotational speed, it provides approximately eight times as much torque as with a B5 geometry set alone.

Contacting Brookfield Engineering Laboratories, Inc.

Refer to Appendix A for customer support information.

Section 2 - Installation

Unpacking and Inspection

NOTE: Upon receipt, inspect the case and PVS Rheometer components for shipping damage. Report any damage to the shipping company immediately.

The shipping cartons should contain the following components:

- PVS Rheometer Head, with torque sensor guard installed
- Power Base
- Personal Computer (shipped separately)
- Bath (if specified - including RS-232 cable) (shipped separately)
- Instruction Manual
- Software CD ROM
- Data Cable (power base to computer RS-232 cable)
- Torque/Temperature Cable (attached to rheometer head)
- Rheometer Head/ Motor Power Cable (attached to rheometer head)
- Stator/bob
- Sample Cup

CAUTION

Whenever the PVS Rheometer is transported, the stator/bob must be removed and the sample cup or torsion element protector installed to prevent torsion element damage.

Tools Required for Installation

The following tools are required to install the PVS Rheometer:

- Flat blade screwdriver
- 7/64 inch hex wrench
- 5/64 inch hex wrench

PVS Rheometer Installation (Without Triple Annulus)

NOTE: Refer to PVS Rheometer Installation (With Triple Annulus) for systems being installed with a triple annulus.

Bath Installation

1. Refer to the Bath Operators Manual to install and setup the bath in the location in which it will operate.

2. Proceed with Power Base Installation.

Power Base Installation

1. Install the power base next to the bath as shown in Figure 2-1.

CAUTION

The PVS Rheometer head is mounted on the support shaft via a spring loaded clamp. Make sure you hold the head in place before releasing the clamp screws to prevent the head from falling or the spring-loaded support shaft from sliding up through the head. Personal injury or possible equipment damage may result.

NOTE: The upright rod is designed to be free to rotate approximately 120º in its suspended position and will allow the head to be lowered only when rotated to the extreme clockwise position. The upright rod will support the head in the upper most position when it is lifted and rotated away from the bath. Refer to Figure 2-2.

2. Install the sample cup on the PVS Rheometer head.

3. Install the PVS Rheometer head loosely on the upright rod.

NOTE: If a pressure connection is required, install enough flexible tubing to allow the PVS Rheometer head to be moved in and out of the bath.

4. If required, connect flexible tubing between the three-way valve (1/8 inch x 27 NPT

ferrule) on the PVS Rheometer head and the pressure source.

5. While supporting the PVS Rheometer head, lower the head into the bath so that the bath fluid level is approximately one inch (25.4 mm) from the knurled ring as shown in Figure 2-1. Push the upright rod down (against spring tension) to its lowest position and while maintaining that position, tighten the clamp screws.

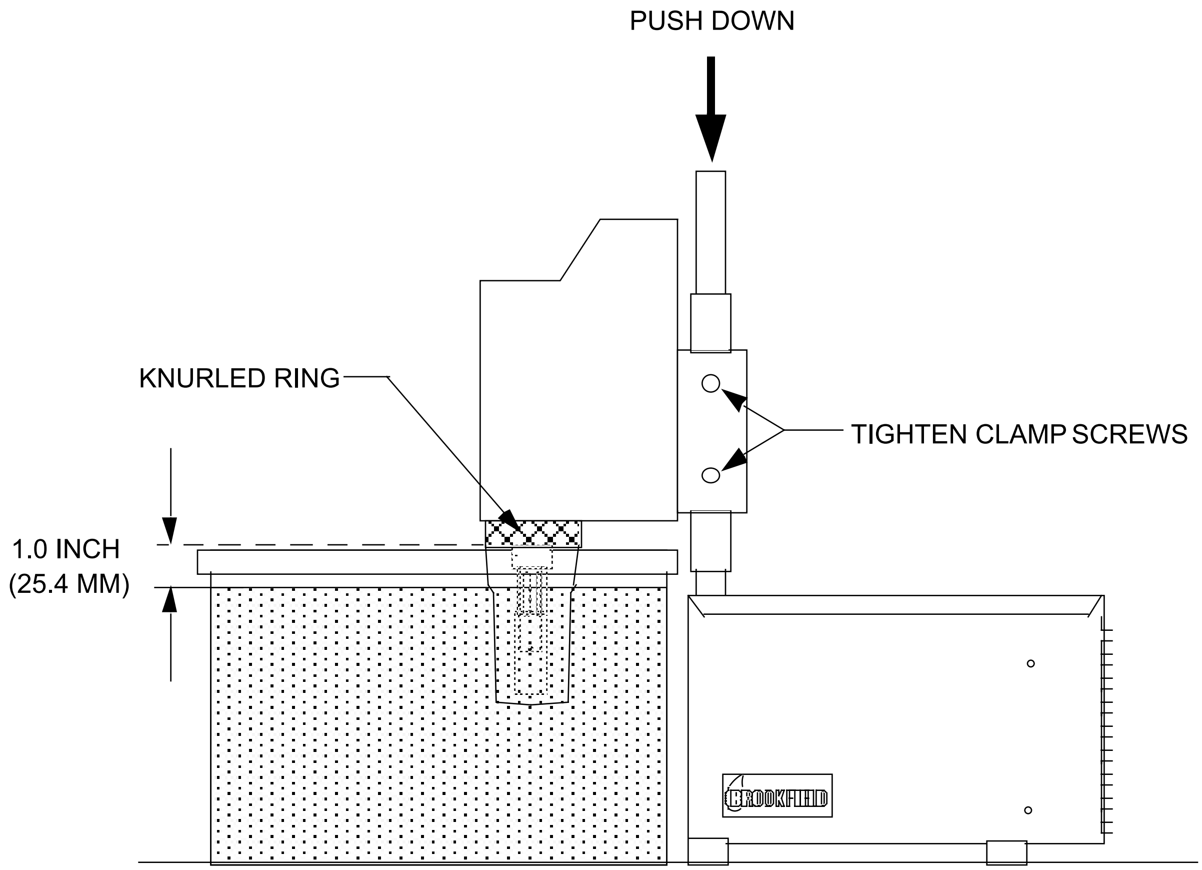


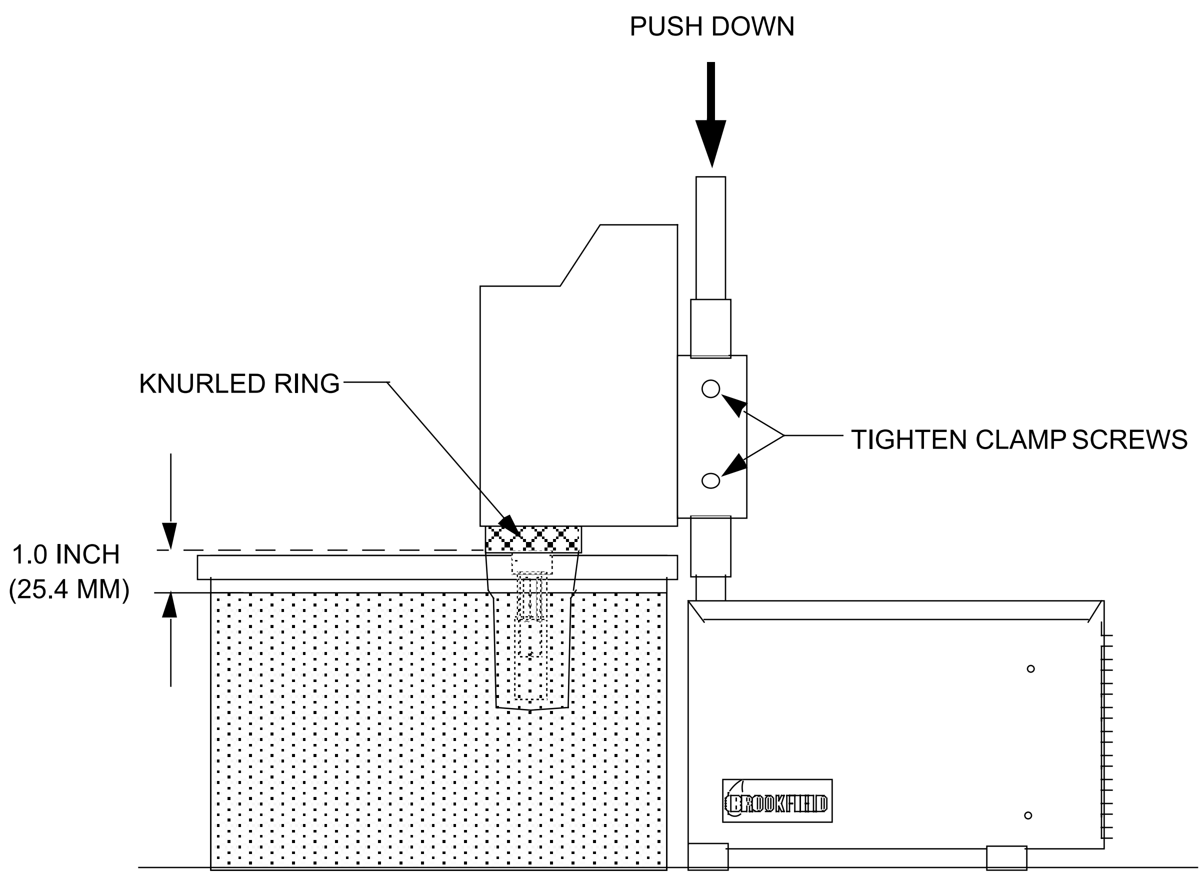
Figure 2-1: Rheometer Head Position and Sample Cup Height

6. Route the motor and RS-232 cables from the PVS Rheometer head to the connectors on the rear panel of the power base as shown in Figure 2-2.

WARNING

Do not connect or disconnect the power cable to/from the PVS Rheometer when connected to a power source. Serious injury and equipment damage may result.

7. Connect the cables to the PVS Rheometer as shown in Figure 2-2 and as follows:
   a. Torque/Temperature cable from Rheometer head.
   b. Bath RS-232 Communications cable.
   c. Computer RS-232 communications cable to the 9 pin connector.
   d. PVS Rheometer Head power cable
   e. PVS Rheometer power cord to a 120 VAC 60 Hz power source.



NOTE: Use either the 9 or 25 pin connector for computer RS-232 connections. Do not connect both connectors to the computer.

Figure 2-2: PVS Rheometer Rear Panel Cable Connections

Personal Computer Installation

1. Place the computer in a suitable location that will allow it to be connected to the PVS Rheometer.

2. Install the computer according to the manufacturer's instructions.

3. Connect the RS-232 cable between the COMPUTER connector on the PVS Rheometer and the COM connector (RS-232) on the computer.

4. Turn power on to the computer and monitor and allow the Windows operating system to initialize.

5. Refer to Rheovision Software Installation.

Rheovision Software Installation

NOTE: Make sure all other software applications on your computer have been closed before proceeding with Rheovision software installation.

1. Insert the CD-ROM disk into the appropriate drive on your computer.

2. Run the setup.exe program by performing one of the following steps:

   a. Using Windows Explorer, open the window of the appropriate drive then select the setup.exe file icon. The setup routine will be executed.

   b. Choose START from the desktop, then select RUN. Select BROWSE and locate the appropriate drive and directory that contains the setup.exe file, then select the setup.exe file icon. Select the OK button. The setup routine will be executed.

3. Once the setup routine has been executed, follow the on-screen prompts to complete Rheovision software installation.

4. When using the CD, select "Rheovision" from the main installation menu. Follow the on-screen prompts to complete the installation.

5. Once Rheovision has been loaded, the Windows operating system must be restarted to complete the installation.

Section 3 - Operation

Power

Turning Power ON

1. Set the power switch on the PVS Rheometer rear panel to the ON position.
2. Refer to the Bath Operators Manual to turn power ON to the bath.
3. Refer to Starting Rheovision to initialize Rheovision.

Turning Power OFF

1. Select Exit on the Rheovision Dashboard page.
2. Refer to the Bath Operators Manual to turn power OFF to the bath.
3. Set the power switch on the PVS Rheometer rear panel to the OFF position.

Starting Rheovision

1. Turn computer power ON and allow the operating system software desktop to appear.
2. Locate and select the Rheovision32 icon within the Rheovision folder on the Start menu. Rheovision software will be initiated.
3. Select the DASHBOARD tab.
4. From the Instrument Status section, select the appropriate computer COM port to which the Rheometer is connected.
5. Once communication with the PVS Rheometer has been established, the data boxes on the Dashboard page will display live rheometer data and the red light next to PVS will change to green.

NOTE: If live data is not visible within the data boxes, refer to Section 6 - Troubleshooting.

Baffle, Stator/Bob and Sample Cup Installation

NOTE: Refer to Figures 3-1 and 3-2 throughout this procedure.

1. Lift and rotate the PVS Rheometer head out of and away from the bath.
2. Remove the sample cup or torsion element guard by holding the cup or guard and by rotating the locking ring.

> **CAUTION**
>
> Do not strike the stator/bob mounting tube or push it sideways during baffle installation.

3. Slide the baffle (split end up) up the length of the stator/bob mounting tube until the baffle seats into the boss immediately above the mounting tube.
4. Using a 5/64 inch hex wrench, tighten the two baffle clamp screws.
5. Install the stator/bob as follows:
   a. Lubricate the stator/bob mounting tube O-ring with an appropriate lubricant compatible with the fluid type and temperature being measured.
   b. While looking down into the stator/bob, rotate the stator/bob so the internal cross bar is aligned in the same orientation as the slot in the stator/bob mounting tube as shown in Figure 3-3.

NOTE: A small depression in the upper horizontal surface of the stator/bob should be positioned away from the mounting post.

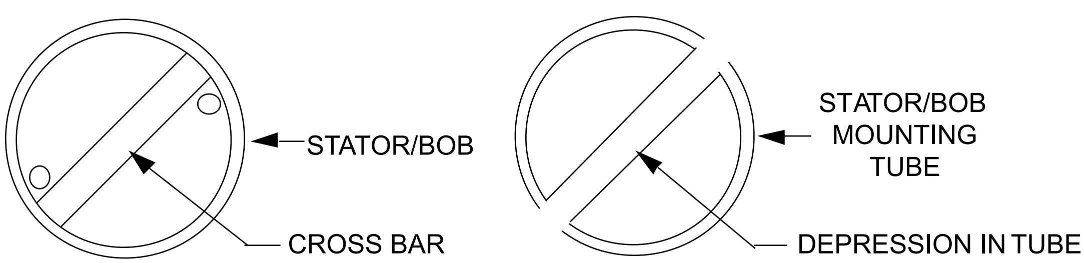


Figure 3-1: Stator/Bob Mounting Tube Alignment (End View)

CAUTION

Forces applied to the stator/bob must be in the same axis of the stator/bob mounting tube. Keep the stator/bob parallel to the stator/bob mounting tube at all times during installation. Otherwise, the stator/bob mounting torque sensor may become damaged.

c. While maintaining the orientation of the stator/bob, push the stator/bob vertically up along the length of the stator/bob mounting tube, as shown in Figure 3-2, until the stator/bob stops at the top of the tube. When properly installed, there should be approximately a 1/8 inch (3 mm) gap between the stator/bob and the baffle. The stator/bob should gently snap into place.

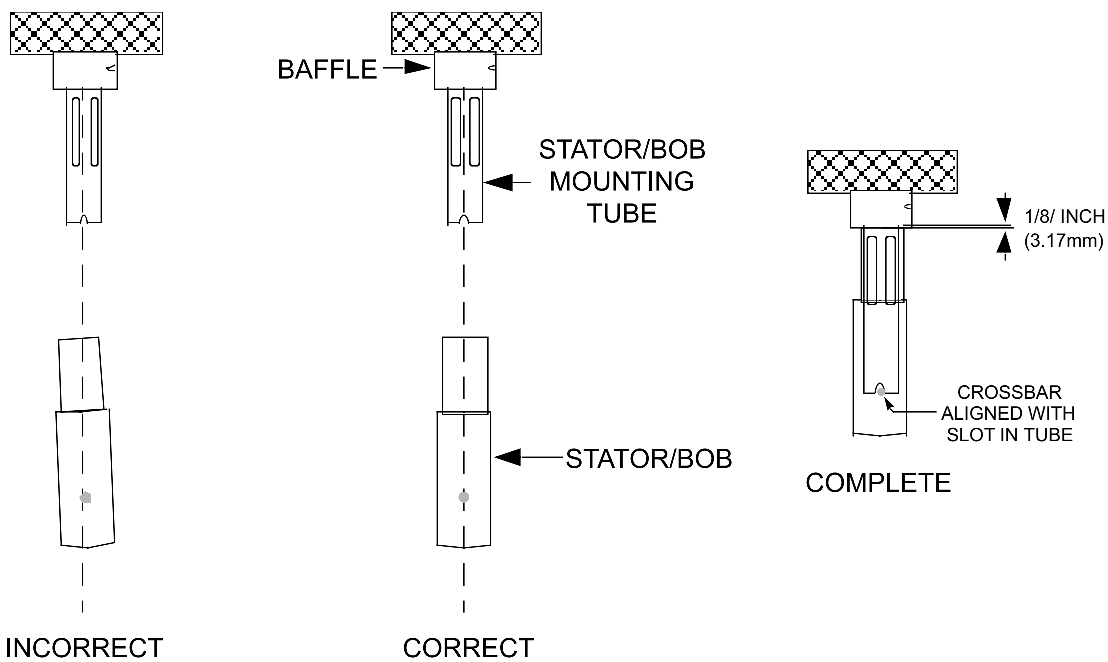


Figure 3-2: Orientation and Force Applied to Stator/Bob During Installation

6. Depending upon the stator/bob being used, fill the sample cup with process fluid as specified in Table 3-1.

Table 3-1: Stator/Bob Sample Volume

Stator/Bob	Sample Volume (ml)
B1	23
B2	53
B5	40

CAUTION

The knurled locking ring that holds the sample cup in place should only be tightened by hand. Do not use a wrench to tighten the locking ring or to hold the cup.

7. Lubricate the sample cup top inner surface with a lubricant that is compatible with the sample fluid and temperature.

NOTE: The knurled ring has a right-hand thread.

8. Carefully install the sample cup by pushing it up squarely. Tighten the knurled locking ring using your other hand.
9. Rotate the sample cup and visually check for run-out errors. If a run-out error is observed, remove the sample cup and repeat steps 7 and 8.
10. Lower and rotate the PVS Rheometer head into the bath.

CAUTION

Do not exceed 1000 psi when adjusting the pressure system regulator. Damage to the sealing components may occur.

11. If required, adjust the pressure source to the appropriate system pressure. Adjust the three-way valve on the PVS Rheometer head to pressurize the head.

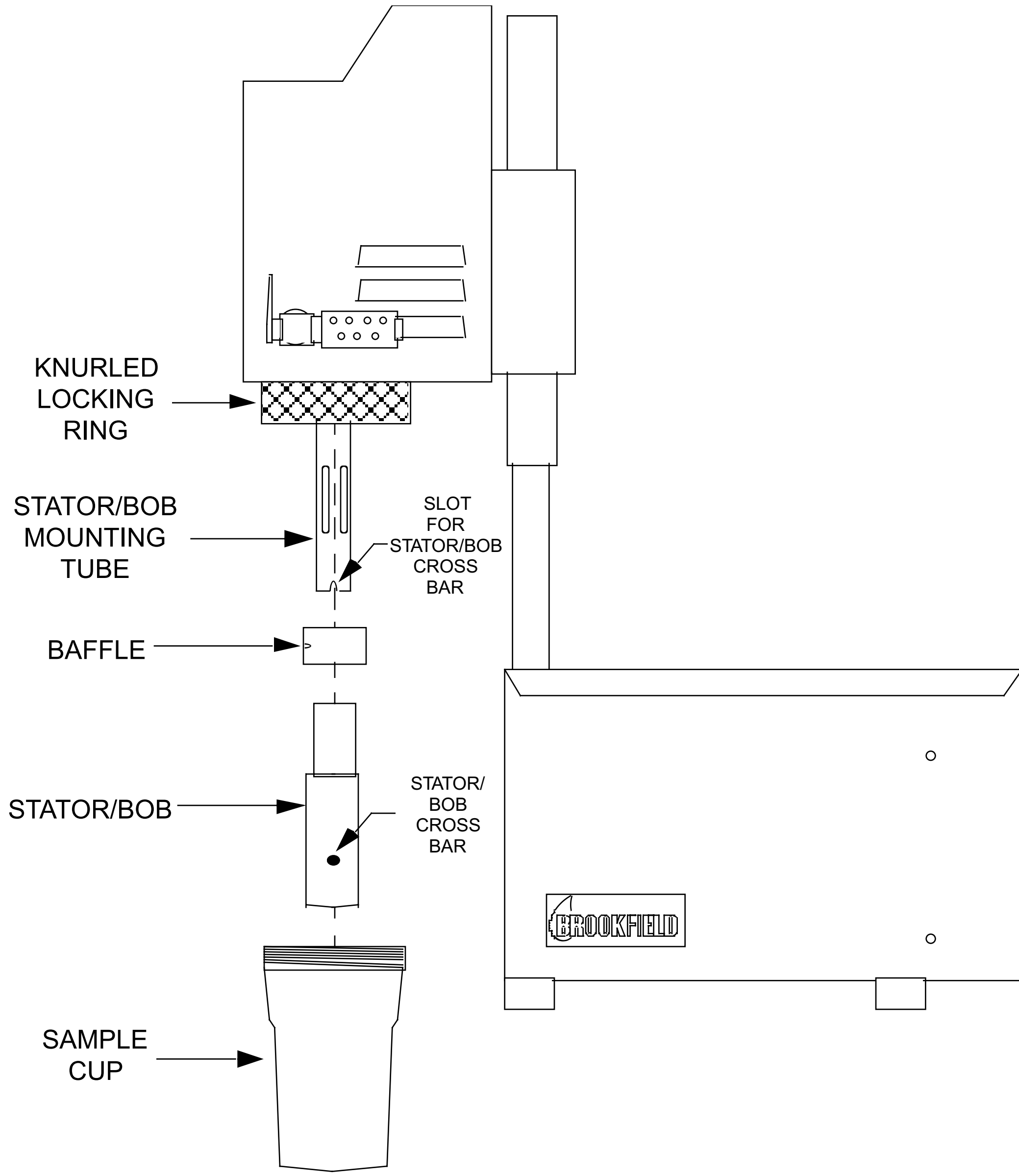


Figure 3-3: Sample Cup, Stator/Bob and Baffle Installation

PVS Rheometer Installation (with Triple Annulus)

The Triple Annulus can be used when low speed, low shear rate measurements are required for solids that are transported within fracturing and drilling fluids.

NOTE: This procedure requires the stator/bob, stator skirt and sample cup and insert.

> **WARNING**
>
> Do not attempt to install the triple annulus until the pressure in the PVS Rheometer head is at 0 psi.

1. Turn the three-way valve on the PVS Rheometer head to de-pressurize the head.
2. Lift and rotate the PVS Rheometer head out of and away from the bath.
3. Remove the sample cup by rotating the locking ring.
4. Remove the stator/bob and baffle.

> **CAUTION**
>
> Do not strike the stator/bob mounting tube or push it sideways during triple annulus installation.

5. Place the stator skirt over the stator/bob. Position the skirt so the anti-rotation pin in the guard fits into the depression in the upper horizontal stator/bob surface as shown in Figure 3-5.
6. Place the sample cup insert into the cup. Position the insert so the anti-rotation pin in the insert fits into the depression in the sample cup lower inner surface as shown in Figure 3-5.

> **CAUTION**
>
> The baffle is not used with the triple annulus. DO NOT reinstall the baffle.

7. Install the stator skirt/bob/stator assembly as follows:

   a. Lubricate the stator/bob mounting tube O-ring with an appropriate lubricant compatible with the fluid being measured.

   b. While looking down into the stator/bob, rotate the stator/bob so the internal cross bar is aligned in the same orientation as the slot in the stator/bob mounting tube as shown in Figure 3-4.

NOTE: The small depression in the upper horizontal surface of the stator/bob used to position the guard should be positioned away from the mounting post.

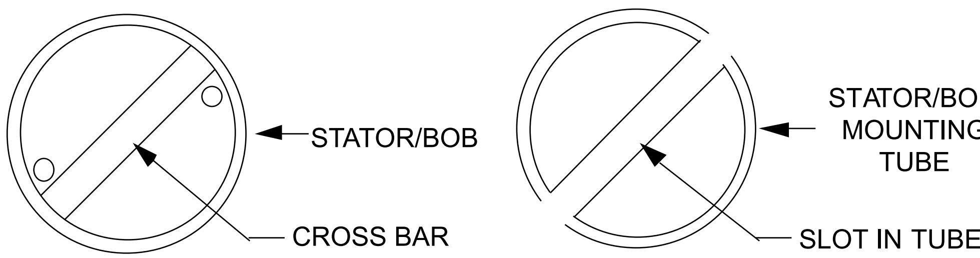


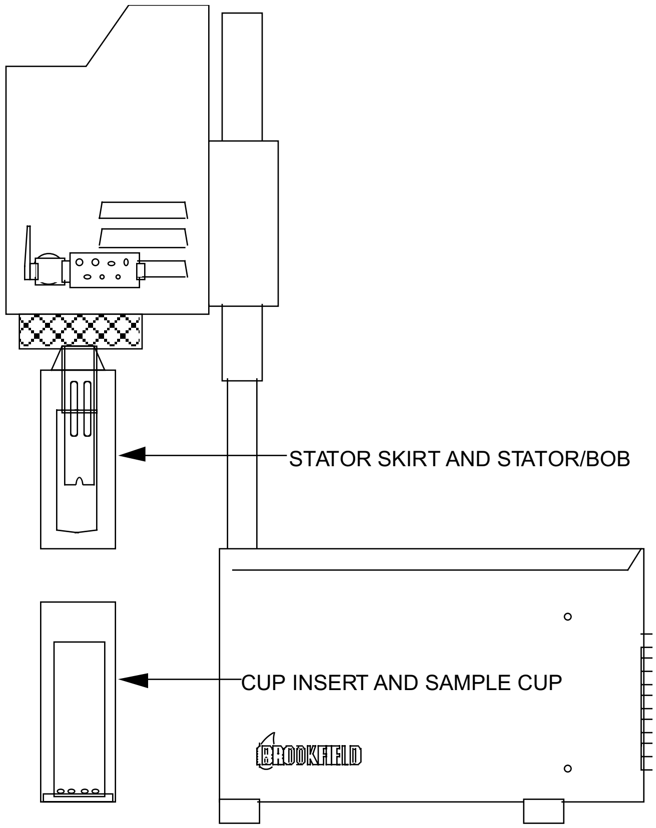
Figure 3-4: Stator/Bob Mounting Tube Alignment (End View)

8. Lubricate the sample cup top inner surface with a lubricant that is compatible with the sample fluid and temperature.
9. Place process fluid into the cup/insert assembly as specified in Table C-1.
10. Carefully install the sample cup by pushing it up squarely. Tighten the knurled locking ring using your other hand.
11. Rotate the sample cup and visually check for run-out errors. If a run-out error is observed, remove the sample cup and repeat steps 10 and 11.
12. Lower and rotate the PVS Rheometer head into the bath.

CAUTION

Do not exceed 1000 psi when adjusting the pressure system regulator. Damage to the sealing components may occur.

13. If required, adjust the pressure source to the appropriate system pressure. Adjust the three-way valve on the PVS Rheometer head to pressurize the head.



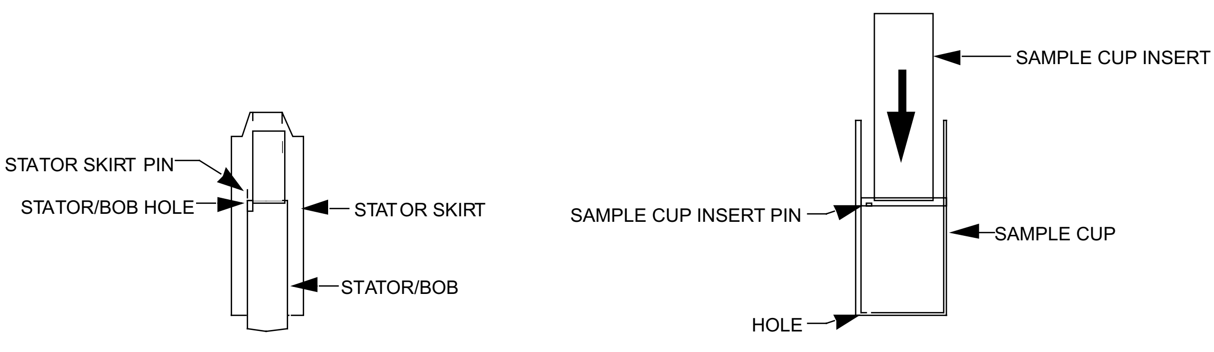


Figure 3-5: Triple Annulus Installation

Cleaning of Wetted Parts

CAUTION

To make sure the PVS Rheometer provides accurate readings, all fluid wetted parts must be kept meticulously clean at all times. Solids can build up on the measuring surfaces and cause inaccurate readings or damage the internal measuring components.

1. Set the power switch on the rear panel of the PVS Rheometer to the OFF position.
2. Shut off the pressure supply to the three-way valve.

NOTE: The three-way valve vents when the arrow on the handle points to the unconnected or venting port.

3. Open the three-way valve to the VENT position to relieve internal PVS Rheometer pressure.
4. Lift and rotate the PVS Rheometer head out of and away from the bath.

NOTE: The knurled locking ring will not be able to be rotated until all internal pressure has been relieved. The knurled locking ring contains a right-handed thread.

5. Remove the sample cup by rotating the knurled locking ring.

CAUTION

Do not strike the stator mounting tube or push it sideways during baffle or stator removal. Forces applied to the stator must be along the axis of the stator mounting tube. Keep the stator parallel to the stator mounting tube at all times during installation. Otherwise, the torsion element may become damaged.

6. While maintaining the orientation of the stator, pull the stator vertically down along the length of the stator mounting tube.
7. Using a 5/64 inch (2 mm) hex wrench, loosen the baffle clamp screws.

NOTE: The baffle is not used with the optional triple annulus geometry set.

8. Slide the baffle down the length of the stator mounting tube and remove it from the mounting tube.
9. Install the PVS Rheometer shipping guard to protect the torsion element.

CAUTION

The sample cup, stator and baffle are made from Hastelloy C alloy. Make sure that these components are not scratched, chemically attacked or dropped while being cleaned.

10. Using an appropriate solvent for the process fluid being measured, clean all surfaces of the sample cup, stator and baffle.

CAUTION

Do not strike the torsion element/mounting tube or push it sideways while cleaning. Otherwise, the torsion element may become damaged.

11. Remove the shipping guard and check the entire length of the torsion element and mounting tube to make sure it is clean. Carefully clean the torsion element to remove debris from all surfaces.
12. Check the inside of the stator for debris. The two pins at the base of the of the torsion element mounting tube and the receptacles inside the stator must be clean in order to provide a temperature signal. Clean and dry if required.

NOTE: Refer to Appendix A and contact Brookfield if the stator must be disassembled for cleaning purposes.

NOTE: Step 13 is not required when using the triple annulus.

13. Install the baffle and tighten the mounting screws.
14. If the PVS Rheometer is to be used immediately, proceed with step 15. If the PVS Rheometer is NOT to be used immediately, reinstall the shipping guard.

> **CAUTION**
>
> Do not strike the stator mounting tube or push it sideways during baffle or stator removal or replacement. Forces applied to the stator must be in the same axis of the stator mounting tube. Keep the stator parallel to the stator mounting tube at all times during installation. Otherwise, the torsion element may become damaged.

15. Carefully install the stator.
16. Charge the sample cup with an appropriate amount sample fluid and install the sample cup.
17. Place the PVS head back into the bath.
18. Close the vent valve.
19. Turn ON the pressure supply to the three-way valve.

Torque Sensor Calibration Test

This procedure can be used to determine if the torque sensor within the PVS Rheometer head is properly calibrated.

1. Lift the PVS Rheometer head out of the bath.
2. Shut off the pressure supply to the three-way valve.
3. Rotate the three-way valve to the VENT position to relieve internal PVS Rheometer pressure.
4. While holding the sample cup, loosen the knurled ring and remove the sample cup.

NOTE: Steps 5 and 6 ensure a raw % torque reading is obtained.

5. Exit from the Rheovision software.
6. Restart Rheovision.
7. Observe the torque display on the Rheovision dashboard. The torque reading must be within 0 ± 2%. If the reading is not within specification, refer to Appendix A and contact Brookfield.

Section 4 - Rheovision Software

Figure 4-1: PVS Seal History Set Up

After the Rheovision Software is installed from the Bundled Software Package CD ROM, the user will be prompted to enter the Serial Number of the PVS Sensing Head so that a Lip Seal History can be created. This is useful for tracking the total time the Lip Seal (PVS-194Y) has been in service. A reminder can be set to replace the Lip Seal after a certain number of days. Lip Seal Maintenance is vital to the long-term reliability of the PVS Rheometer.

On Start up the PVS Seal History will be displayed. Click OK if the S/N of the PVS is correct.

DASHBOARD / MANUAL TEMP, SPEED AND LIP SEAL HISTORY

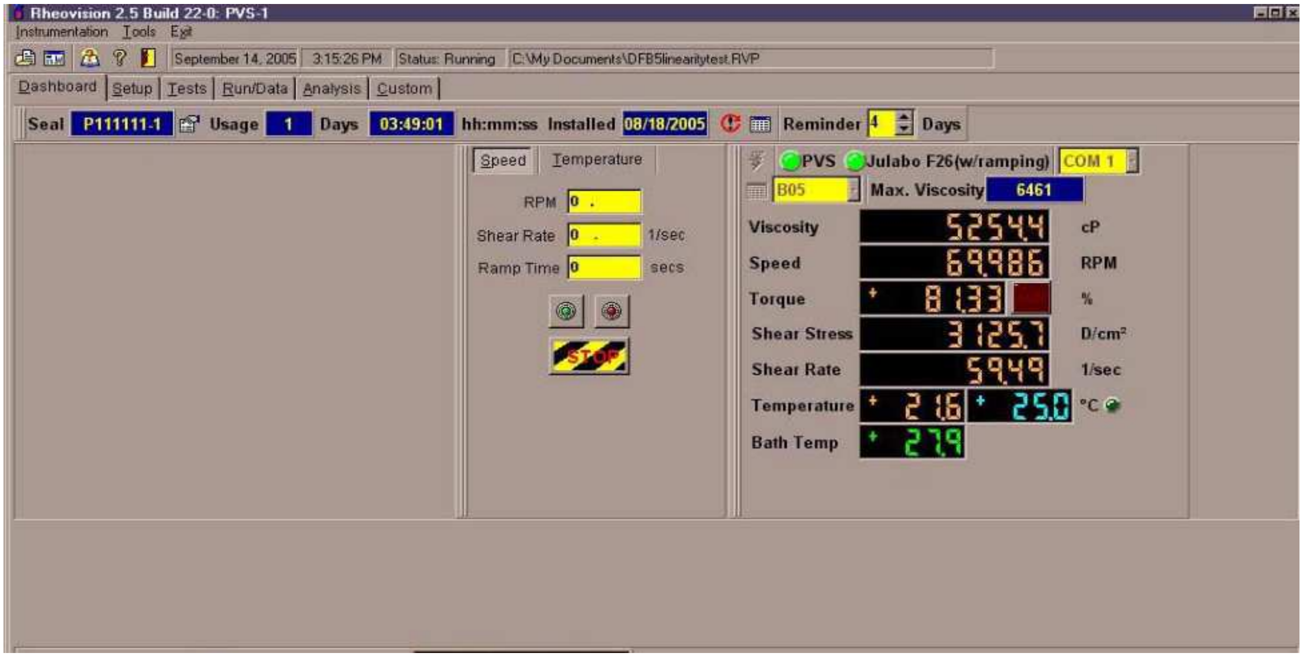


Figure 4-2: Main Dashboard Page

Clicking on the **Dashboard Tab** will open the above window. Shown is the Manual Speed/Temp Control (Box #1) and the Lip Seal History, as well as the Active Dashboard.

Lip Seal History

By clicking in the Seal Reminder Toolbar the user can set a reminder for when the Lip Seal (PVS-194Y) should be inspected or replaced.

Figure 4-3: Lip Seal History

Lip Seal History Descriptions

Seal

This Box displays the Serial Number of the PVS Rheometer Head that is currently being used. By selecting the Properties Icon to the right, the user can select a different PVS Rheometer Serial Number.

Usage

This box displays the total number of days, hours, minutes and seconds the Lip Seal has actually been used under running test conditions.

Installed

This box indicates the date the present Lip Seal was installed.

Seal Reminder Reset

After a Lip Seal has been replaced, clicking this Icon will reset all Lip Seal Timers.

View History

Clicking this Icon will display the Lip Seal History Window Box.

Manual Speed / Temperature Control

Manual Speed

From the Manual Speed Tab, the user can manually select a Speed (RPM), Shear Rate (sec-1) and a Ramp Time to reach the selected Speed / Shear Rate. Clicking the Green Button will start the motor. Clicking the Red Button will ramp the motor to a stop at the same rate it ramped up to speed. The Emergency Stop Button will immediately set the Rheometer Speed to 0 RPM without ramping down

Temperature Control

From the Manual Temperature Tab the user can manually select a temperature for the accessory bath. Clicking the Green Button will start the bath. Selecting the Red Button will cancel the Bath set point and return the Bath to the Standby Temperature Setting.

DASHBOARD PAGE / LIP SEAL HISTORY CONT.

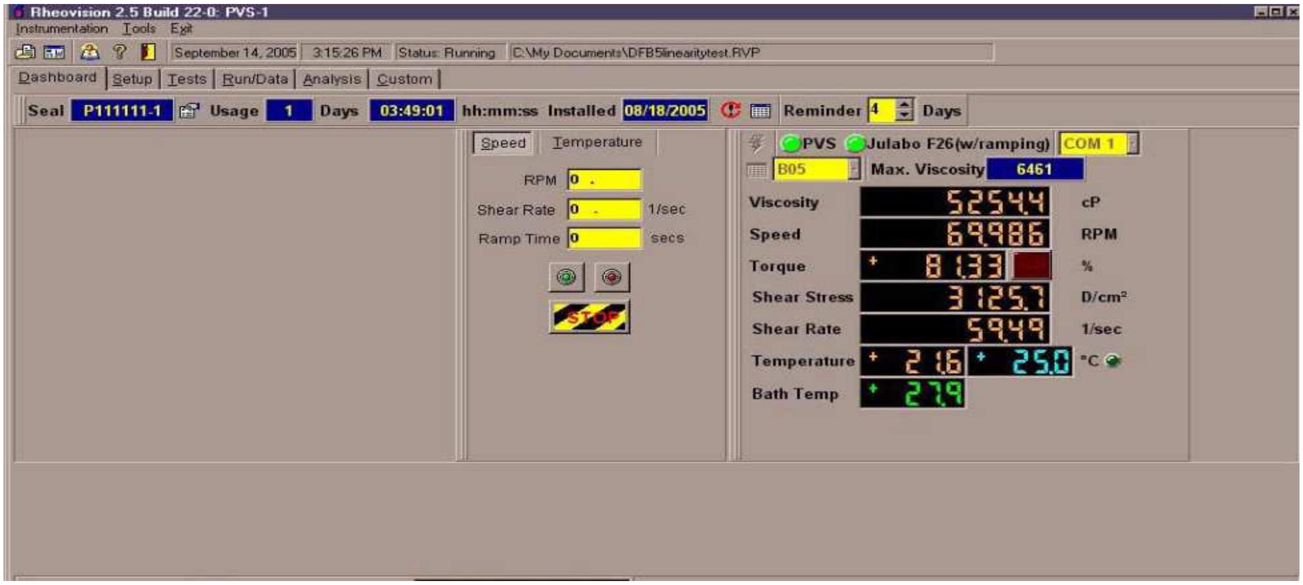


Figure ***Figure 4-4: Dashboard***

BOX #2 is the Dashboard Indicator. Displayed are Viscosity, Speed, Torque in %, Shear Stress, Shear Rate, Sample Temp, Bath Set Point and the Actual Bath Temp. The Geometry (Bob) selected is displayed (see Geometry Selection Section). The two green lights indicate that the PVS & Accessory Bath are on line & "communicating" with the Host PC. The Indicator lights will default to off when not on line. The Drop Down Box marked COM 1 is used to select the correct Com Port. Max Viscosity is the Maximum Viscosity that is calculated based on Geometry Factor from the Bob & Cup Selected, Shear Rate & RPM.

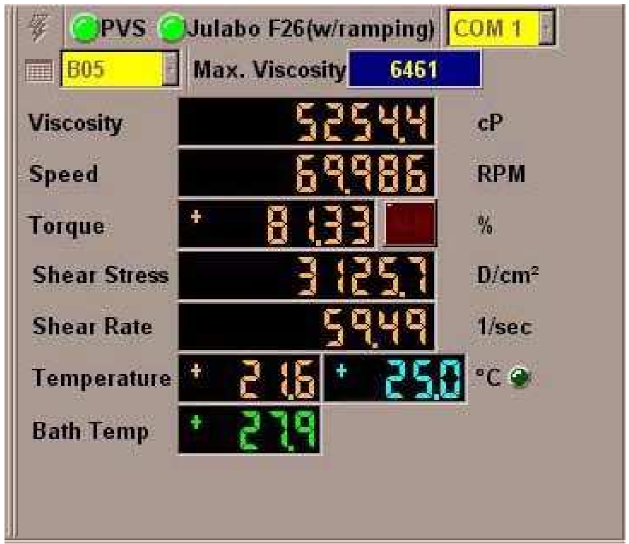


Figure 4-5: Status

Dashboard Screen Descriptions

Viscosity

The Viscosity display indicates the fluid viscosity data measured by the Rheometer in units of Centipoise (cP) or millipascal.seconds (mPa.s).

Speed

The Speed display indicates the current rotational speed of the cup (in rpm).

Torque

The Torque display indicates the % of scale (the % of the Rheometers full scale torque range capability for the model in use) measured by the Rheometer.

Alarm

The Alarm LED illuminates if the Torque Alarms are enabled and a torque alarm condition occurs.

Shear Stress

The Shear Stress display indicates the force per unit area required to move the fluid in units of dynes per square centimeter (D/cm^2) or Newton's per square meter (N/m^2).

Shear Rate

The Shear Rate display indicates the Velocity gradient of fluid rotating with the cup in units of inverse seconds (sec^{-1}).

Temperature

The Temperature display indicates the temperature of the fluid sample by the temperature probe in units of degrees Celsius (°C) or degrees Fahrenheit (°F).

Temperature Controller Setpoint

The Temperature Controller Setpoint display indicates the current temperature set point if a temperature bath is connected, in units of degrees Celsius (°C) or degrees Fahrenheit (°F).

NOTE: The Temperature Controller Setpoint display is blank if no bath is present.

Bath Temperature

The Bath Temp display indicates the current Temperature of the Accessory bath.

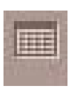
Figure 4-5A: Status Expanded

Geometry

The Geometry Selection drop down box is used to select the geometry (stator & cup combination) for use in the data collection program.

Maximum Viscosity

This box displays the maximum mathematically computable viscosity for the geometry, torsion element, and speed in use.



Geometry Table Button

The Geometry display indicates the stator/bob and cup combination currently installed on the rheometer.

NOTE: The Geometry selected must be manually updated when the actual stator/bob or cup is changed to ensure correct viscosity, shear stress and shear rate calculation. Use the Geometry Table button to display the Geometry Table Dialog Box as shown in Figure TBD

Zero Button

The Zero Button causes the PVS Rheometer to subtract the current % torque reading from all future % torque readings (i.e.: the torque is zeroed).

NOTE: Make sure the system is at rest, (i.e.: speed is 0 rpm, the torque reading is stable and vibration sources have been eliminated) before clicking the Zero Button.

NOTE It may be necessary to remove the sample cup and zero the PVS Rheometer in air if the fluid to be tested has a significant yield stress value.

Instrument Status

The Instrument Status display indicates the type of Rheometer and Temperature Bath connected to the computer. A green light is displayed along with the Instrument/Bath identification.

NOTE: A dim light indicates that an instrument or bath is not connected.

COM Port

The COM port drop down box is used to select a COM (RS-232) port for the rheometer and attached temperature bath. If the port selected is already in use by another application or is unavailable for any other reason, a message box is displayed.

If communication is lost with the PVS Rheometer, the data display will go blank after approximately 10 seconds. If this problem occurs, refer to Section 5 Troubleshooting.

NOTE: Use the appropriate cables for connecting the rheometer and temperature bath (Part number DVP-80 for the PVS Rheometer and Julabo temperature bath). The RS-232 cable for the Thermo-Bath is supplied with the Bath Controller.

TOOL BARS & TOOL ICONS

The following is a description of the Main Tool Bars & Icons:

Figure 4-6: Main Tool Bar

Drop Down Menus are Instrumentation, Tools and the Exit Rheovision Command. These Menus have Icons that match the corresponding functions on the Toolbars.

Figure 4-7: Instrumentation Drop Down Box

INSTRUMENTATION

AUTO ZERO RHEOMETER: Selecting will Zero the PVS by subtracting the "Initial Raw" Torque reading. User should allow the Torque to "Settle" before the Zero is applied.

RUN AT SPEED/TEMPERATURE: Selecting will run the PVS at a specified Speed or Temperature. Selecting will open the Manual Speed/Temp Box.

STOP RHEOMETER: Selecting will stop all current programs currently running.

GEOMETRY TABLE: Selecting will open the Geometry Table (Details in Geometry Section of Manual.)

Figure 4-8: Tools Drop Down Menu

TOOLS: Tools contains commands for Save User Settings & About.

SAVE USER SETTINGS: When changes are made in any user settings including moving or resizing windows (Described in Page Descriptions), selecting this command will save these settings so that when Rheovision is opened again it will default to these settings.

ABOUT: Selecting will Display Revision Levels & System Information.

EXIT: Selecting will Close Rheovision.

Figure 4-9: About Rheovision

Following is a description of the tool bar icons on the application tool bar. From left to right they are: Save User Settings, Default Tool Bar Positions, About, Help and Exit.

SAVE USER SETTINGS:

When changes are made in any user settings including moving screen items to the "Custom Page" (Described in Page Descriptions) selecting this command will save these settings so that when Rheovision is opened again it will default to these settings.

DEFAULT TOOL BAR POSITIONS:

Selecting will reset windows and toolbars to the Default sizes & positions settings, canceling any changes made to Custom Screen also.

ABOUT:

Selecting will Display Revision Levels & System Information.

HELP:

Displays a Rheovision Help File. This feature is currently unavailable.

EXIT:

Selecting will Close Rheovision.

SET-UP HARDWARE / ENVIRONMENT

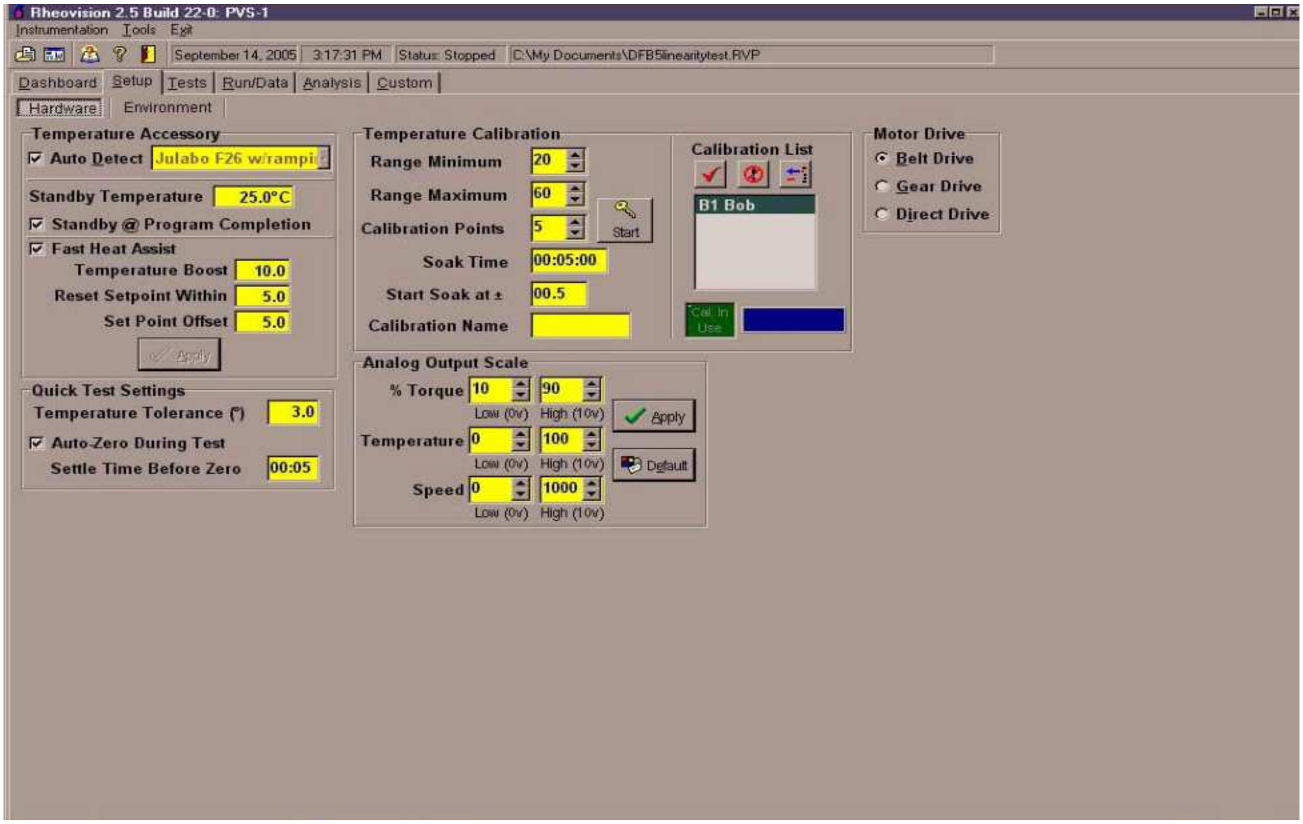


Figure 4-10: Set Up Hardware Page

Clicking **"SET-UP"** & then "**Hardware"** will display the above Screen.

Temperature Bath: If the Auto Detect box is checked when Rheovision starts, it will detect the bath type and temperature of the bath.

NOTE: When Auto Detect is enabled, Rheovision will take longer to start because it is searching for the bath type connected to the PVS Rheometer.

If Auto Detect is not checked, Rheovision assumes the bath type connected to the PVS Rheometer is in the bath type drop-down box to the right of the Auto Detect box.

NOTE: If a bath is not being used, make sure the Auto Detect box is **NOT** checked and that NONE is selected in the bath type drop down box.

Standby Temperature: The Standby temperature controls the temperature of the bath when a data collection program is not running or in conjunction with standby at program completion.

Select the **Apply** button to set the temperature and to save any fast heat assist settings.

NOTE: Enabling the standby temperature does not immediately cause the temperature bath to reach the selected temperature. The next time Rheovision is in Standby mode, the temperature will be adjusted to the standby temperature.

FAST HEAT ASSIST: Sets the Bath to a Higher or Lower Temp than the Set Point to reach Set Temperature faster.

TEMPERATURE BOOST: The amount of boost that is added to the Set Point for fast heat.

RESET SETPOINT WITHIN: When the Sample temp is within the parameter of this number the Set point will return to the Set Point Offset target.

SET POINT OFFSET: The Selected Set Point will be adjusted by this amount to maintain a Sample Temp close to the Set Point. (Useful at Higher Set Point Values.)

QUICK TEST SETTINGS:
TEM. TOLERANCE: This is the +/- tolerance for the Sample Temp to reach in order to go to the next command line of the test.

AUTO-ZERO DURING TEST: The user can have the PVS "Auto Zero" before each ramp in a quick test is performed.

SETTLE TIME BEFORE ZERO: The User can have the Sample "Settle" before any Auto Zero is applied. A command of zero RPM for this time interval is automatically inserted into the program.

ANALOG OUTPUT SCALE:
All analog voltages (VDC) on the PVS are 0-10 Volts. This voltage span can be scaled individually for the % Torque, Temperature and Speed Outputs. Use the Low & High Limit spin boxes to adjust what 0V and 10V corresponds to for each of these data values (torque, temperature, speed).

MOTOR DRIVE SYSTEM: The Motor Drive System buttons select the type of drive unit in your PVS Rheometer.

NOTE: The Belt Drive System has been in production for many years and a Gear Drive system is very rare.

Select the Belt Driven (2.1:1 gear ratio) or Gear Drive (2.1 gear ratio) system.
Gear Drive (1:1) should never be used with the PVS.

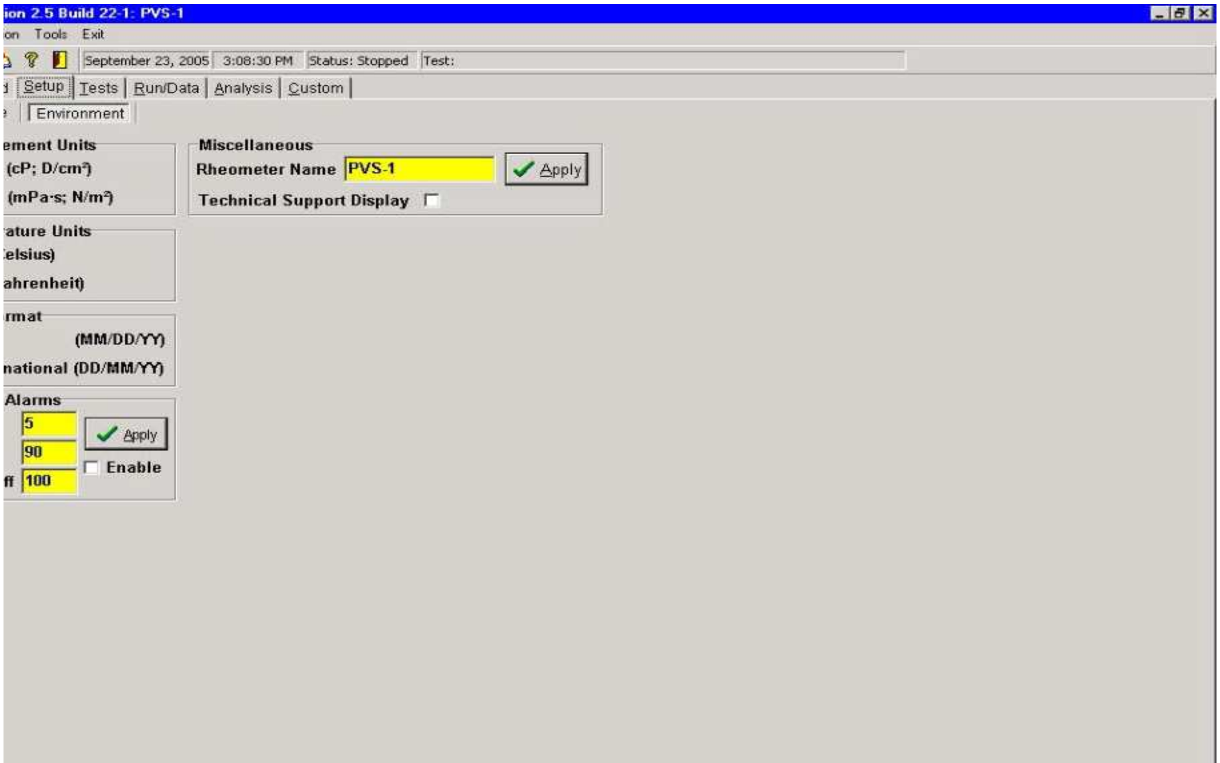


Figure 4-11: Set Up Environment Page

By selecting the **ENVIRONMENT** Tab, the above page will open.

Measurement Units: The Measurement Units radio buttons allow the user to select CGS or SI units to be used during Rheovision Operation.

NOTE: Rheovision must be restarted after changing the Measurement Units setting.

Temperature Units: The Temperature Units radio buttons allow the user to select the temperature scale units Fahrenheit (0F) of Celsius (0C) to be used during Rheovision operation.

NOTE: Rheovision must be restarted after changing the Temperature Units setting.

Date Format: The Date Format radio Buttons allow the user to select the date format (U.S.: mm/dd/yyyy) or (International: dd/mm/yyyy) to be used during Rheovision operation.

Torque Alarms: The Torque Alarm warns the user that the % Torque value has either fallen below (Low Alarm) a preset value or risen above (High Alarm) a preset value.

Torque Alarms can only be tripped if the % torque value falls outside the alarm values and if the PVS Rheometer speed is greater than 0 rpm. Alarms can be enabled by selecting the Enable check box in the Torque Alarms section of the Environment Setup page.

Once alarm values are changed, click the **Apply** button to use the new values.

When an alarm is tripped, a beep will be heard and the red ALARM LED next to the % Torque display on the Dashboard Window will illuminate.

NOTE: If the Motor Off alarm is tripped, in addition to the indications stated above, the Rheometer speed is set to 0 RPM. If a program is running at the time, the Rheometer remains at 0 RPM for the remainder of the program.

Miscellaneous:
Rheometer Name: Enter a customizable name that appears on the Rheovision caption bar and also on the Icon tag when Rheovision main window is minimized on the desktop.

Click the Apply button to use this name.

Technical Support Display: The Technical Support Display is intended for troubleshooting purposes by Brookfield Engineering Laboratories Inc. personnel. When this box is selected, the incoming data from the PVS Rheometer is displayed in its raw format on the Dashboard Window.

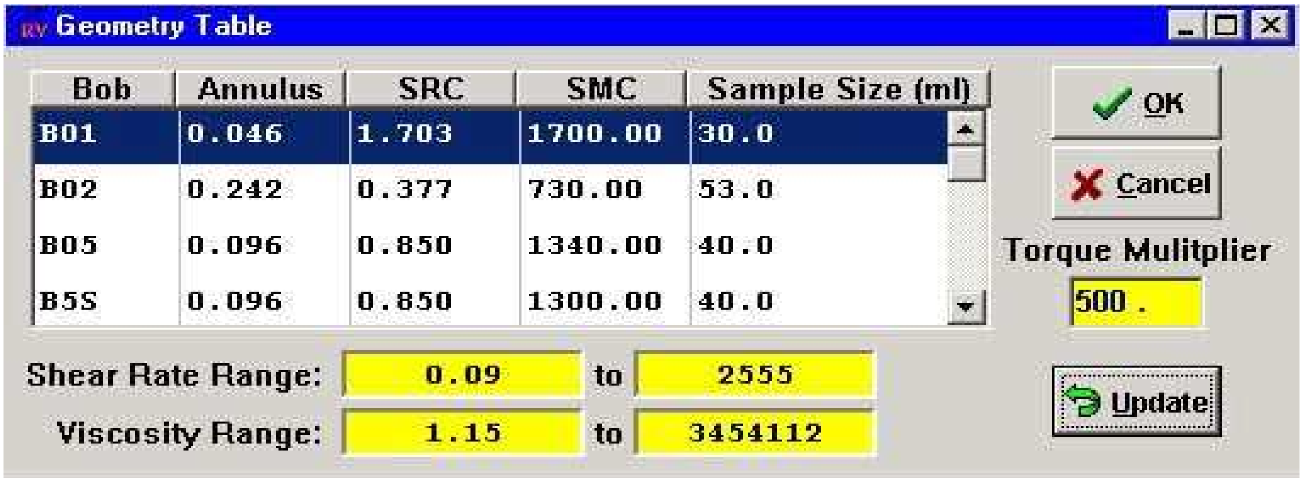


Figure 4-12: Geometry Table

The Grid above lists the different spindles (Bobs) along the following information:

Bob: The type of the Bob used to obtain data.

Annulus: The gap defined by the surface of the Bob and the inner surface of the cylinder (cup) surrounding it.

SRC: The Shear constant for the geometry.

SMC: The Stress constant for the geometry.

Sample Size: The recommended sample size (in ml) for the geometry.

Update Button: Use the Update button to display the range information for the selected geometry. The viscosity and shear rate range information is displayed both numerically in the dialog box.

Torque Multiplier: Enter the Torque multiplier for the torque sensor (torsion element) in this box. The Torque Multiplier for a PVS should be between 450 & 550.

OK Button: Use the OK button to accept the selections made and to close the dialog box.

Cancel Button: Use the Cancel Button to close the dialog box without accepting the selections made.

Stator Temperature Calibration

When using an appropriate temperature bath (models TC501P and Julabo FM26), stators (bobs) should be calibrated to the bath due to the fact that the location of the temperature sensor in the bath is not in the same location as the temperature sensor in the spindle (i.e. the bath's sensor reports the temperature of the bath fluid while the stator's sensor reports the PVS sample temperature). Stator calibration is performed for a user-defined temperature range, usually the temperature range for which viscosity will be measured.

NOTE: When Rheovision is first started, the raw, un-calibrated, sample temperature is used. Calibration data is not applied to the incoming temperature until a new calibration is performed or a previous calibration is selected and used.

The parameters listed in Table 4-1 must be defined for the calibration:

Table 4-1: Stator Calibration Parameters

Parameter	Description
Range Minimum	The low end of the temperature range.
Range Maximum	The high end of the temperature range.
Calibration Points	The total number of temperatures at which data will be taken to perform the calibration. These temperatures are spaced evenly between the Range Minimum and Range Maximum, with these endpoints included in the number of points.
Soak Time	The time that the temperature bath remains at each calibration temperature.
Start Soak At ±	This number indicates how close the temperature bath must be to the next calibration temperature before the Soak Time starts counting down (Ex: 0.5 indicates that when the temperature bath is within ±0.5° of the next calibration temperature, the timer for Soak Time begins).

Table 4-1: Stator Calibration Parameters (Continued)

Parameter	Description
Calibration Name	Assign a name to the temperature calibration to be performed. Once the calibration is complete, the name will be added to the Calibration List.
Calibration List	All Stator Temperature Calibrations are listed here. The three buttons to the left of this list perform the following functions: Use Selected Calibration Button: Use the calibration data selected in the Calibration List box. Use Raw Temperature Button: Use NO Calibration. Display and record the raw, un-calibrated sample temperature data. Remove Cal From List: Remove the selected calibration name from the Calibration List. NOTE: Once a calibration is removed, it cannot be retrieved.

Start Button

Use the Start button to begin the calibration. The Program page will be displayed and the calibration program begins to run. When the calibration program is complete, a calibration curve is calculated using the acquired data. This calibration curve data is saved in the user parameter file (Rheovis.Ini).

NOTE: After stator installation and with the cup removed, lower the PVS Rheometer head into the bath so that the stator is immersed at least three inches but not so high that the bath fluid overflows into the center of the stator/bob.

Cal. In Use

This indicator will be lit (bright green) when a temperature calibration is in use. The name of the calibration in use is also displayed in the box to the right of the indicator.

TESTS IN QUICK TEST & B.E.A.V.I.S. FORMAT

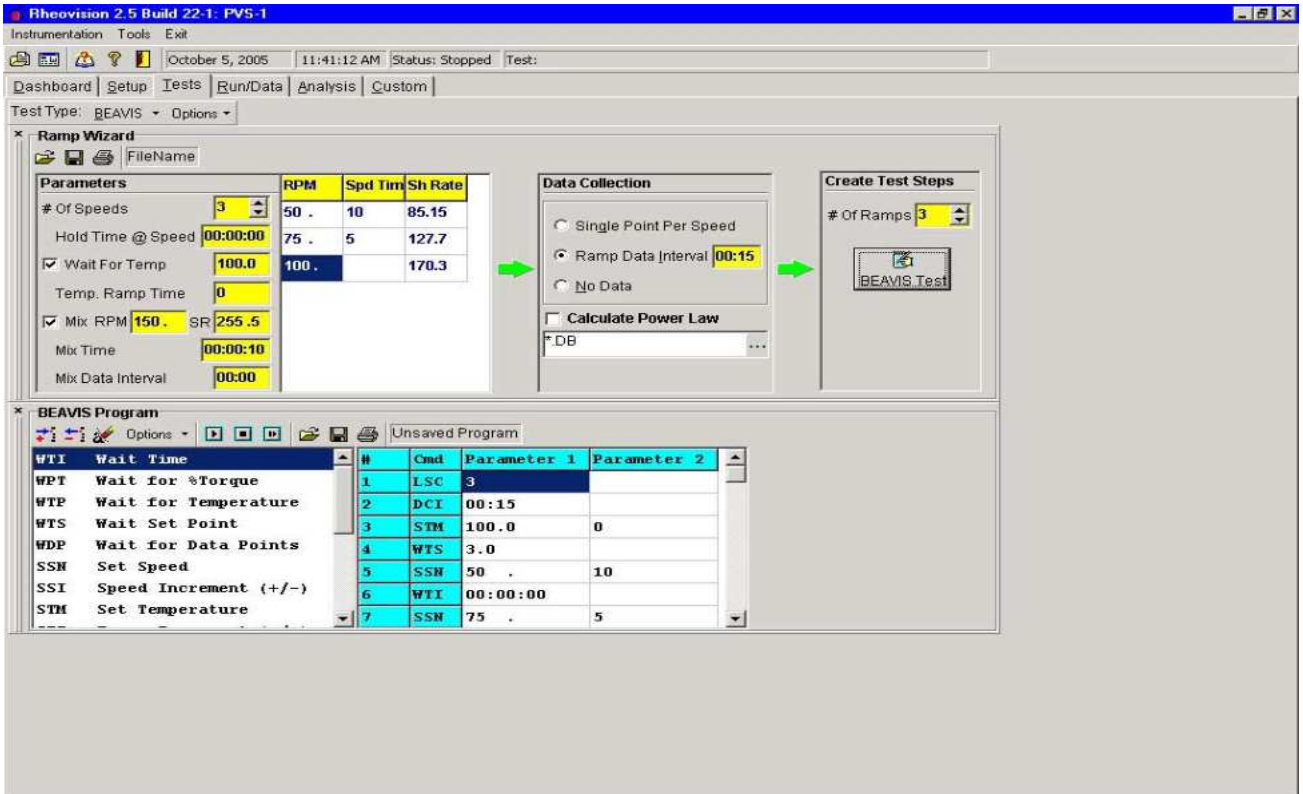


Figure 4-13: Quick Test B.E.A.V.I.S.

RAMP WIZARD: A quick & easy method to create API based tests.

PARAMETERS:

NO of SPEEDS: Allows selection of the number of ramp speeds to be used during test.

HOLD TIME AT SPEED: How long will the selected speed be running for.

WAIT FOR TEMP: The next step in the program will not be performed until a "Target Temp is reached. The Target Temp is manually entered in the box next to Wait for Temp. A +/- Temperature Tolerance can be selected on the Set-Up Tab /Hardware Quick Test Settings Box

TEMP RAMP TIME: If using the Temp Ramping option on Julabo Bath, the user can select a ramp time for the bath to reach the Set Point. This allows for a controlled increase in heating.

MIX RPM: Allows the user to add a separate "Mixing Step" separate from the ramp rpm's. Mix Speed is manually entered in the box next to MIX RPM. This can be entered in either Speed (RPM) or in Shear Rate in the appropriate boxes.

MIX TIME: Allows the user to set how long the Mix RPM will be held.

MIX DATA INTERVAL: Allows the user to select a separate Data Collection Interval during the Mix Step

The Ramp Wizard can be used to create either a Quick Test or a B.E.V.I.S (Brookfield Engineering Advanced Viscometer Instruction Set) Program.

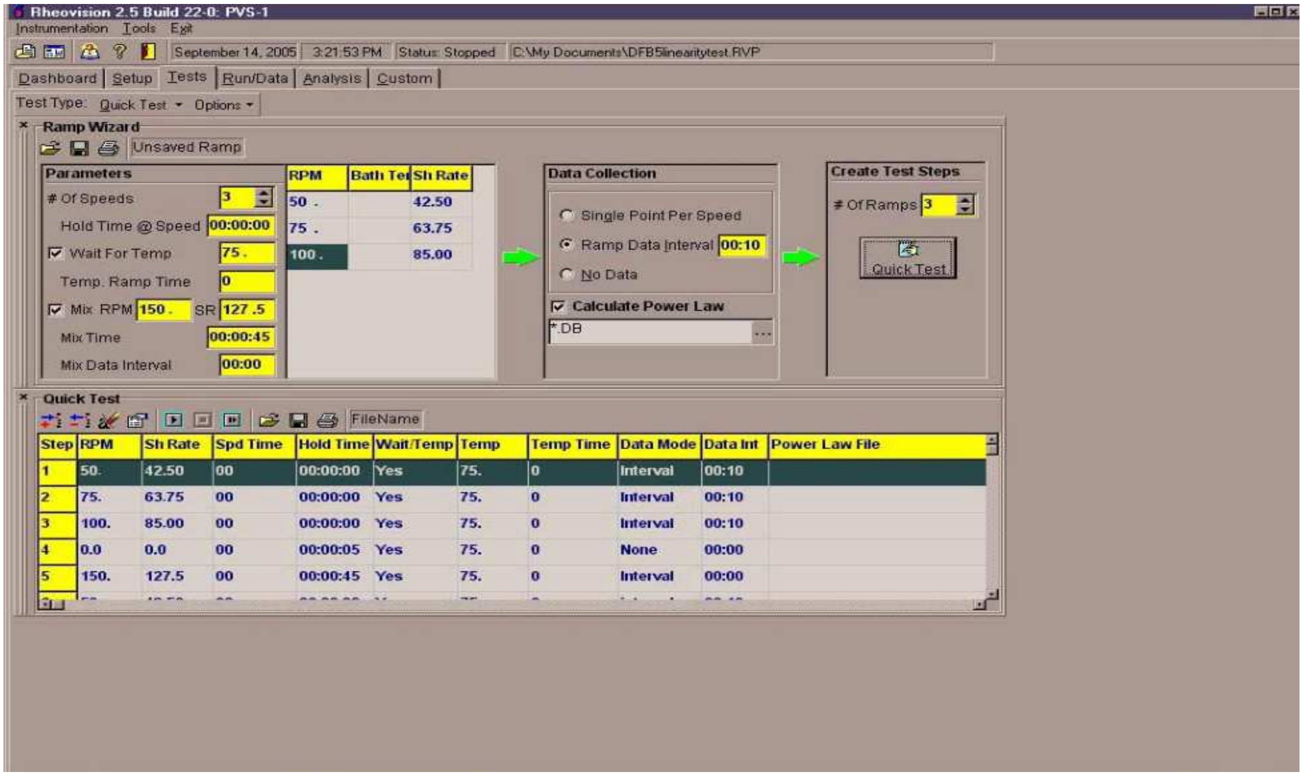


Figure 4-14: Quick Test Format

QUICK TEST FORMAT

Description of Quick Test Tool Buttons:

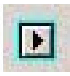
NOTE: Enable Edit must be on in order use these functions.

Insert New Program Line into Grid:
A Program can be manually written in the Program Grid by inserting a Line & editing the individual commands.

Delete Program Line:
While manually writing a Program, an individual line can be deleted.

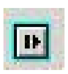
Erase All Program Lines:
Erases ALL Program Lines from Test Grid

Edit Entries in a Program Line:
By clicking the Property Icon in the Test Grid & then selecting a Parameter Field in the Test Grid, the user may modify any Parameter by Double Clicking that field. When completed, Click the Properties Icon again to store any changes.
This may be done DURING a test if desired.



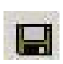
Start Quick Test:
Clicking will start the test. The Save Data File dialog box opens, requiring a valid file name for the data to be saved during the test.

Stop Current Test:
Stops the current test.



Go to Next Step in Program:
Allows the user to Skip a command line during a test.

Load Test Program:
Loads a saved Quick Test Program



Save Current Program:
Saves the current Quick Test Program

Print Current Test Program:
Prints the Command Lines of the Current Program.

OPTIONS: Clicking this command will display a drop down menu. The User can select to run the motor in standard RPM mode or select Shear Rate Mode. In Shear Rate Mode all speed entries (i.e. for SSN & SSI commands) to represent shear rates (units of sec-1) instead of rotational speed (rpm).

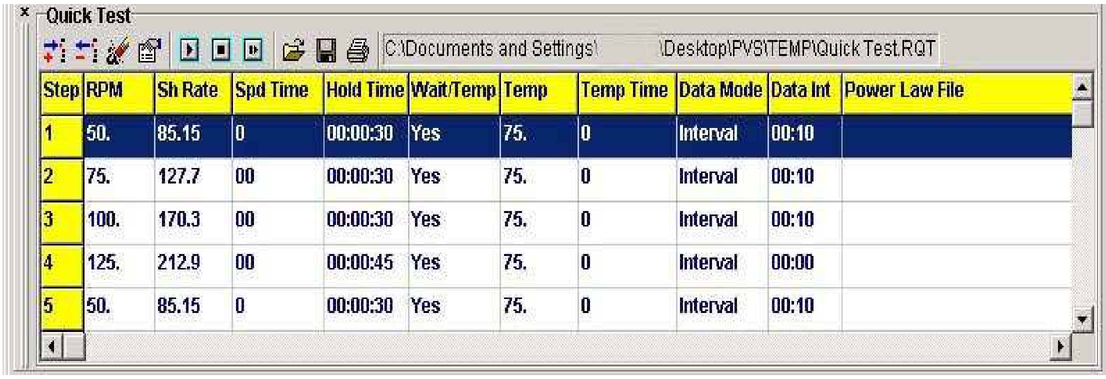


Figure 4-15: Quick Test Command Lines

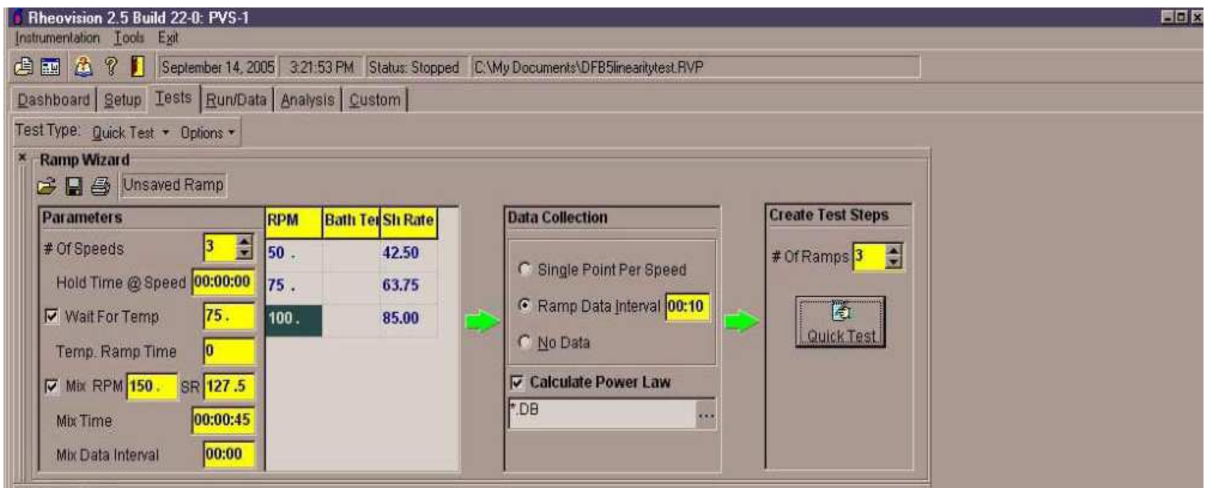


Figure 4-16: Data Collection Page

DATA COLLECTION IN QUICK TEST & RAMP WIZARD

SINGLE POINT PER SPEED: Collect a Data Point One Time Only at a selected speed. This data point is taken just before ramping to the next speed.

RAMP DATA INTERVAL: Collect Data Points at a determined time interval throughout the ramp step.

NO DATA: Do not take any Data Points.
Calculate Power Law: When Selected The API Power Law File is Created & Saved after each ramp, before any mix step.

CREATE TEST STEPS: Allows the user to select how many times the Test Parameters will be repeated.

CREATE QUICK TEST: When all Parameters are created, clicking on the QUICK TEST Icon creates the Test Program and enters the parameters in Quick Test or Bevis Test Grid.

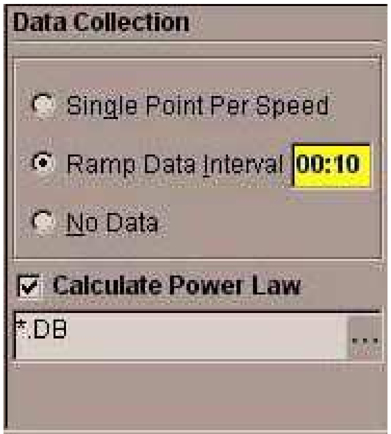


Figure 4-17: Data Collection Set Up

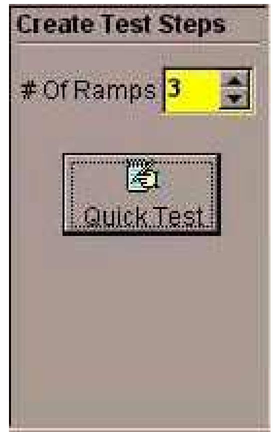


Figure 4-18: Create Test Steps

Loading a Saved & Creating a B.E.A.V.I.S. Program

NOTE: Refer to Section 5 B.E.V.I.S. Programs for more information on B.E.V.I.S Programs.

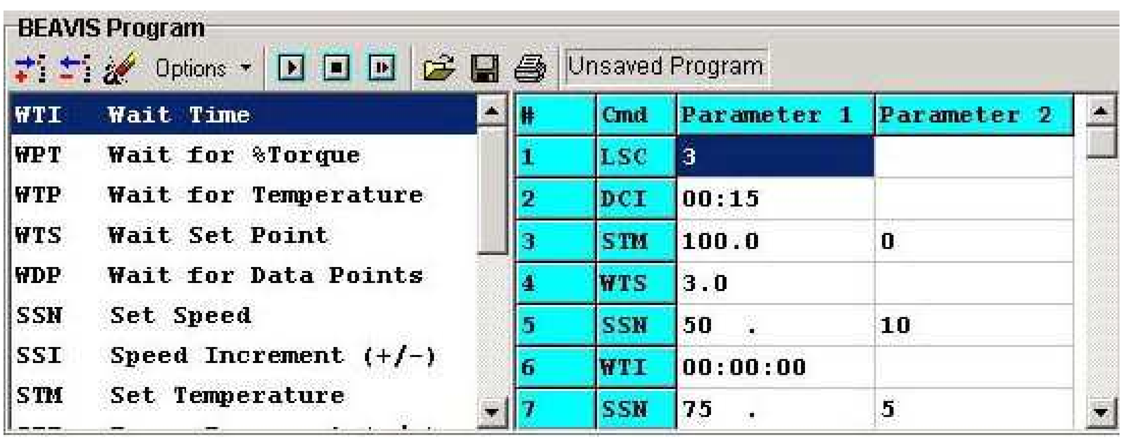


Figure 4-19: B.E.A.V.I.S. Create Test Steps

Loading an Existing Program

1. Select the Load/Open File Icon.
2. Using the Standard Load File Dialog Box select & load the appropriate program file (*.RVP).

Creating a New Program

1. Highlight the Program Grid where you want to insert a command.
2. Highlight the appropriate command in the Command List and either double-click the command or select the **Insert Icon** to place the command in the Program Grid.
3. Continue to build your program in this manner using the **INSERT** Icon to add commands and the **DELETE** Icon to remove unwanted commands.

NOTE: A new command cannot be added until the appropriate command parameter has been entered on the previous line if required.

Saving /Printing a Program

1. Select the **SAVE** Icon to save the program to file using the standard **SAVE FILE** dialog box.
2. Select the **PRINT** Icon to print the Program using the Standard Print dialog Box.

Executing a Program

1. Ensure a new or existing program is displayed in the Program Grid.
2. Ensure Real Time Plotting Parameters have been selected.
3. Select the **Start Program Icon** to begin the program.

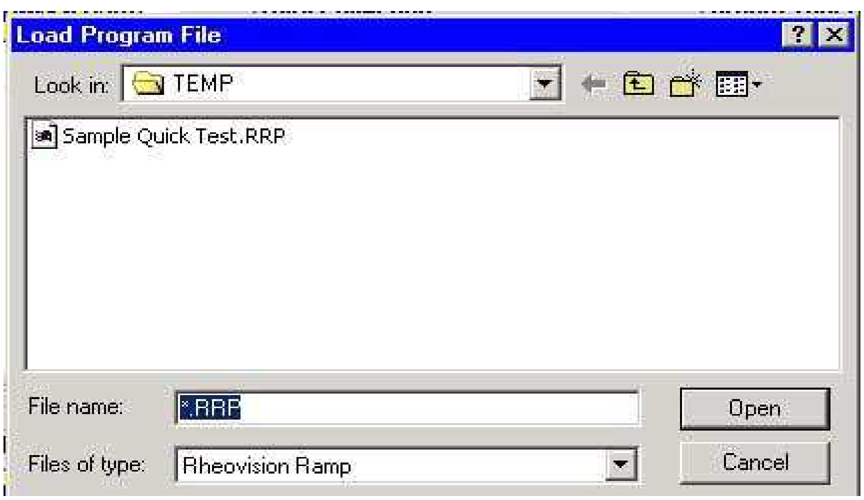


Figure 4-20: Load Saved Ramp Test Box (.RRP)

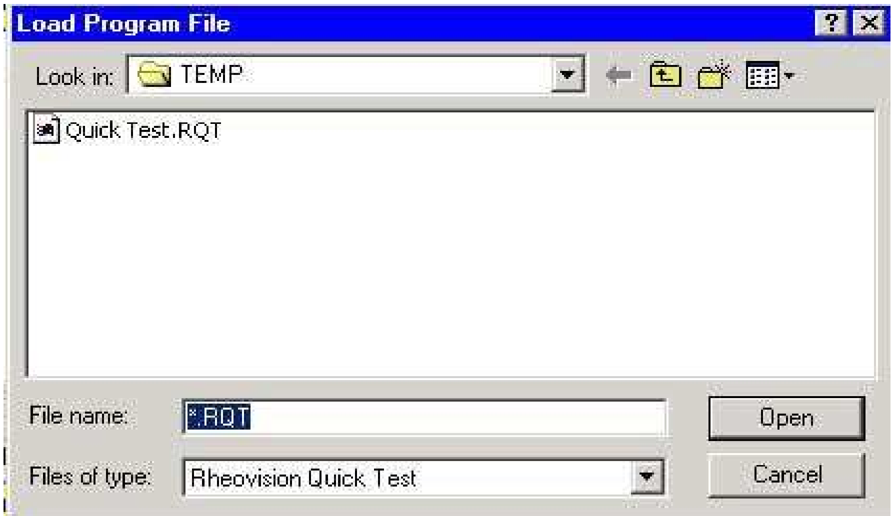


Figure 4-21: Load Saved Quick Test Box (.RQT)

Figure 4-22: Save Quick Ramp Box (.RRP)

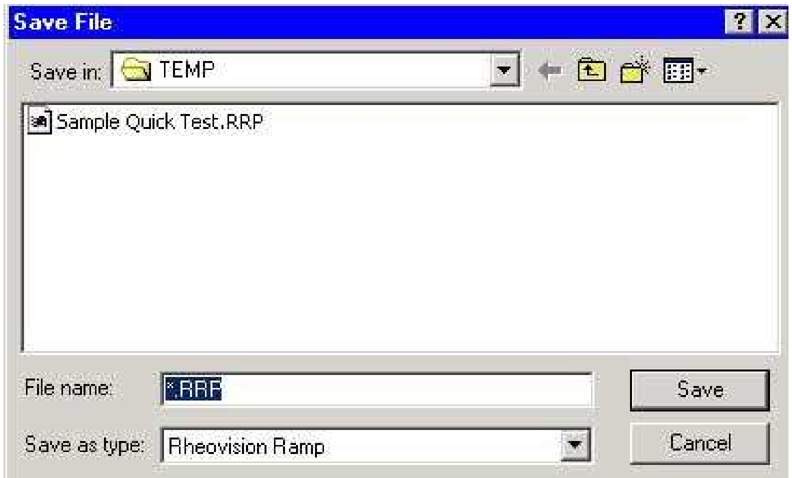


Figure 4-23: Save Quick Test Box (.RQT)

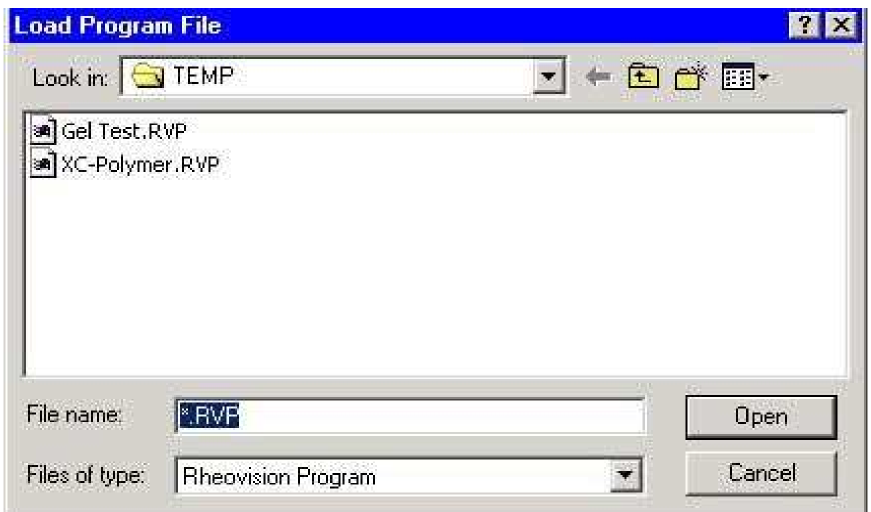


Figure 4-24: Load Bevis Program Box (.RVP)

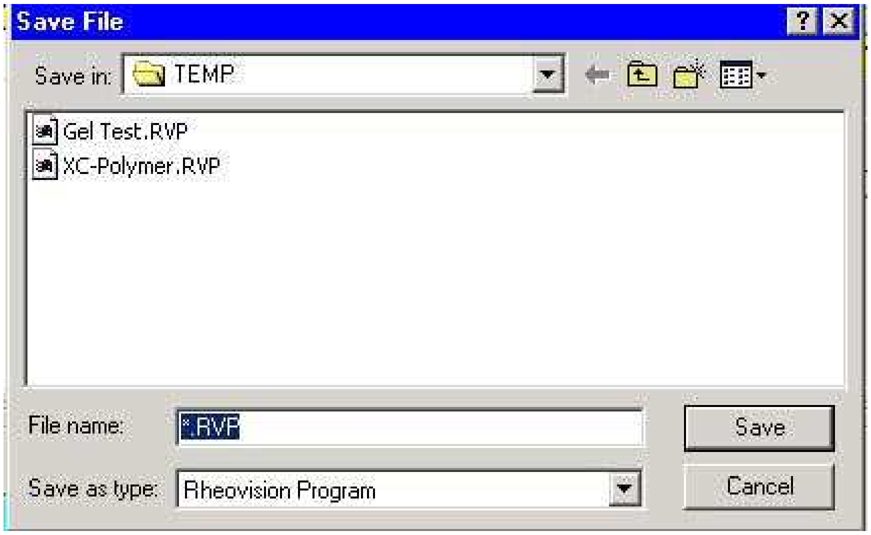


Figure 4-25: Save Bevis Program Box (.RVP)

RUN / DATA SCREEN

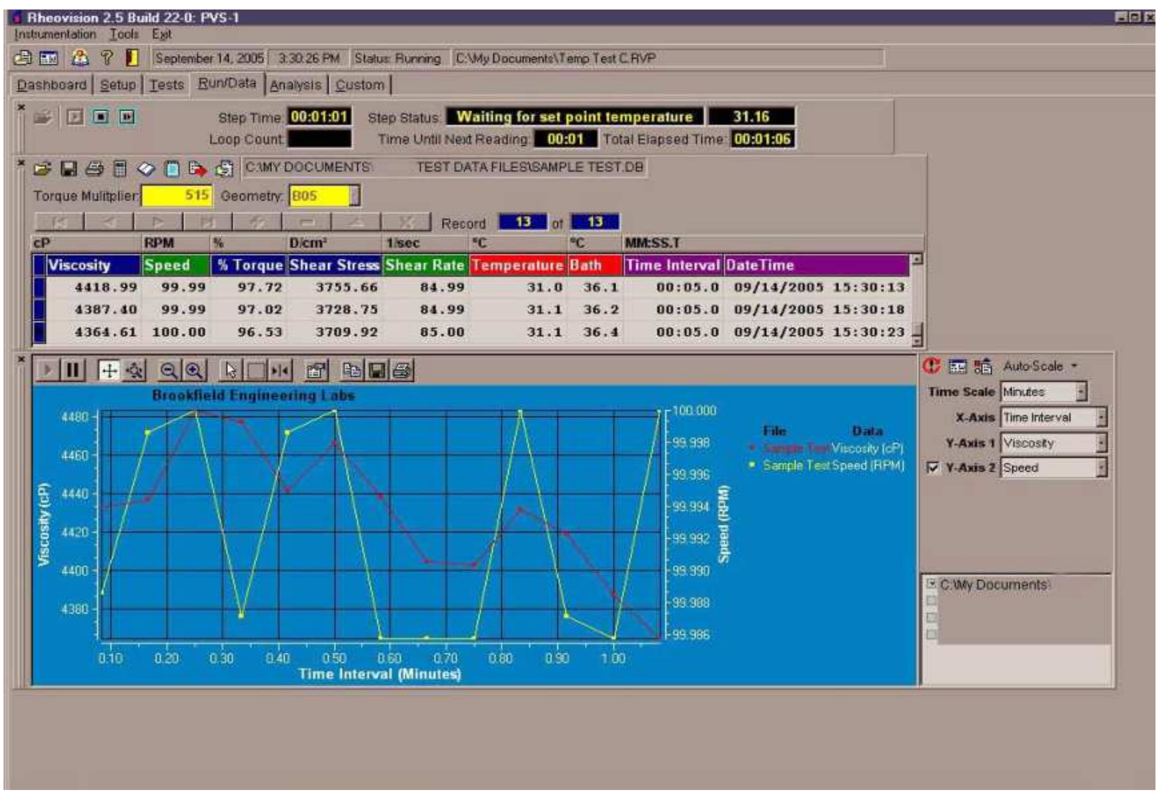


Figure 4-26: Run Data Screen

STATUS TOOLBAR:

STEP TIME: The Step Time Box displays the amount of time the current step (as displayed in the program grid) has been executing.

LOOP COUNT: The Loop Count Box displays the number of loop iterations remaining in the current loop block (consisting of an LSC & LEC command). This is displayed only when a BEAVIS program is being run.

STEP STATUS: The first box within the Step Status area displays the current step's action (i.e. for a WTI command, the box displays the message *COUNTING DOWN TIME INTERVAL*.

The second box displays the pertinent step parameter (i.e. for a wait for torque (WPT) command, the box displays the current % torque value so the user knows how far from the target torque the step is).

TIME UNTIL NEXT READING: Displays how much time is left before the next Data Point will be taken.

READING TIME BOX:

TIME UNTIL NEXT READING: The time that must elapse until another data point is placed in the Capture Buffer. This value is displayed when a fixed data interval is in effect (using the Data Collection Interval (DCI) command. This label can change to **TIME SINCE LAST READING** when there is no fixed data interval in effect.

TOTAL ELAPSED TIME: Displays the Total accumulated running time of the present test.

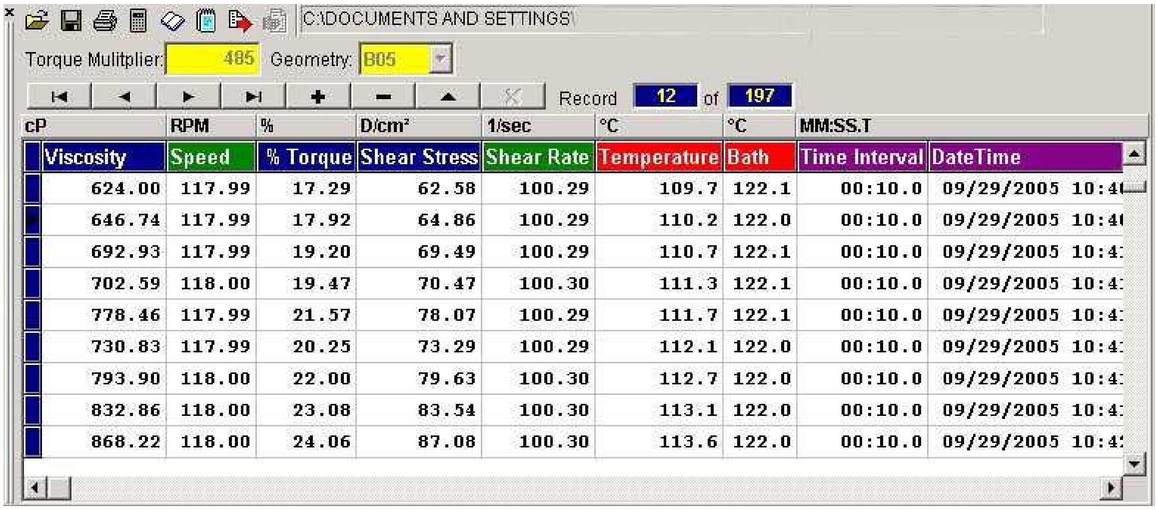
TORQUE MULTIPLIER: Displays the Selected Torque Multiplier determined during a Calibration using Silicone Fluid.

GEOMETRY: Displays the present Bob/Stator used during current test.

The Current Test Readings are displayed in the Test Data Grid as well as a **"REAL TIME"** graphing of the Selected Data Points in the Graphing Screen.

Real Time Plotting allows for Instant Graphing Updates during testing. It allows the operator to "Pause" the Real Time Plotting for an expanded view of specific data points. Moveable Grid Lines on the X&Y Axis allow for exact XY locations points. The ability to have X & Y1 & Y2 Axis is provided. Graphing may be customized for the users need (See Customizing Graph) Finished Graph may be saved as a .BMP format for later uses.

TEST DATA GRID

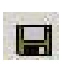


Viscosity (cP)	Speed (RPM)	% Torque (%)	Shear Stress (D/cm²)	Shear Rate (1/sec)	Temperature (°C)	Bath (°C)	Time Interval (MM:SS.T)	DateTime
624.00	117.99	17.29	62.58	100.29	109.7	122.1	00:10.0	09/29/2005 10:4
646.74	117.99	17.92	64.86	100.29	110.2	122.0	00:10.0	09/29/2005 10:4
692.93	117.99	19.20	69.49	100.29	110.7	122.1	00:10.0	09/29/2005 10:4
702.59	118.00	19.47	70.47	100.30	111.3	122.1	00:10.0	09/29/2005 10:4
778.46	117.99	21.57	78.07	100.29	111.7	122.1	00:10.0	09/29/2005 10:4
730.83	117.99	20.25	73.29	100.29	112.1	122.0	00:10.0	09/29/2005 10:4
793.90	118.00	22.00	79.63	100.30	112.7	122.0	00:10.0	09/29/2005 10:4
832.86	118.00	23.08	83.54	100.30	113.1	122.0	00:10.0	09/29/2005 10:4
868.22	118.00	24.06	87.08	100.30	113.6	122.0	00:10.0	09/29/2005 10:4

Figure 4-27: Test Data Grid

Test Data Grid: The Test Data Grid displays collected data during the current test as it is collected. The User can also load Data from a previous test to review Data. Individual Data can be edited and then saved as a new data file or overwrite the current file. Tools are available for Analyzing Data, Adding Notes to the Data, Exporting Data and Loading a Power Law Report. Details of Tools & Icons are:

The Load Icon
displays a standard file load dialog box. This dialog box displays Rheovision data files that were previously saved & can now be loaded.



The Save Icon
displays standard file save dialog box. This dialog box allows data to be saved for later use. Data is saved in a Paradox database file along with an ASCII text file of the same name, which contains user sample name & notes.

The Print Icon
displays the standard Windows Print dialog box, which allows a printer to be selected, its properties changed and data to be printed.

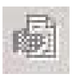
The Analyze Icon
switches to the Analysis Window and displays the results and a graph of the selected math model for the currently displayed data.

The Clear Data Icon
clears all data currently displayed in the grid.

The Notes Icon
allows additional user data to be entered and saved within the data.

NOTE: the notes are saved in a text file using the same name as the data file (Paradox database file) but with an .RVH file extension.

The Export Icon
will open a standard Save File Dialog box to save the data in MS-Excel format (.XLS) for use in other programs.



The Load Power Law Report Icon
displays the open file dialog box from which a report database file is selected and opened. Opening the report field displays an application specific report dialog box.

NOTE: Currently the only application specific report is the API Power Law data for the Oil & Gas Industries.

 Moves the highlight to the first record in the data grid

 Moves the highlight to the previous line in the data grid.

 Moves the highlight to the next line in the data grid.

 Moves the highlight to the last record of the data grid.

 Adds a blank record (data line) at the highlighted line in the data grid

 Deletes the highlighted data line in the data grid.

 Turns Edit Mode ON.

 Turns edit mode off and locks the database.

NOTE: When in the Edit mode, only the Speed, % Torque, Temperatures and Time Intervals may be changed by the user. Rheovision automatically calculates all other parameters. The data will not change until the data field being edited has been exited.

Record Box: The Record boxes indicate the total number of records in the data set and the number of the record currently displayed.

Torque Multiplier: The Torque Multiplier Box displays the Torque Multiplier for the Torque sensor (Torsion Element). The Torque Multiplier is a rheometer calibration parameter. Typical Torque Multiplier values are between 450-550.

Figure 4-28: Graphing Toolbar

DESCRIPTION OF GRAPHING TOOLS

Resume all Real Time Tracking:
Clicking this Icon will cancel all other graph commands and resume Real Time Tracking.

Pause all Tracking:
Clicking this Icon will Pause all Real Time Data Tracking.

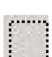
Scroll Axis (all):
Clicking this Icon will allow all Axis to be manually scrolled by placing the curser over the axis & holding down the left mouse button, then dragging.

Zoom Axis:
Clicking this Icon allows manual scaling as in the above description.

Zoom Out all Axis:
Clicking this Icon will Zoom Out all X & Y Axis.

Zoom In all Axis:
Clicking this Icon will Zoom In all X & Y Axis.

Select:
Clicking this Icon cancels any other Icon that is selected.



Zoom Box:
Clicking on this Icon allows the user to place the cursor over any point on the graph and by holding down the left button, can drag a Box an expand that portion of the graph.

Cursor:
By Clicking this Icon, the user can insert moveable XY marker lines. The exact XY coordinates are displayed on the graph. By clicking the File Name in the legend the Cursor Lines will change to the same color as the selected data file.

Properties:
By Clicking this Icon the user can open the Graph Properties Dialog Box to perform any modifications to the Graph Properties.

Copy to Clipboard:
By Clicking this Icon the User can Copy the current Graph to Clipboard for insertion in another Application.

Save to File:
By Clicking this Icon the Current Graph is saved as a .BMP, EMF,.JPG, .PNG Image.

Print:
By Clicking this Icon the Current Graph is printed.

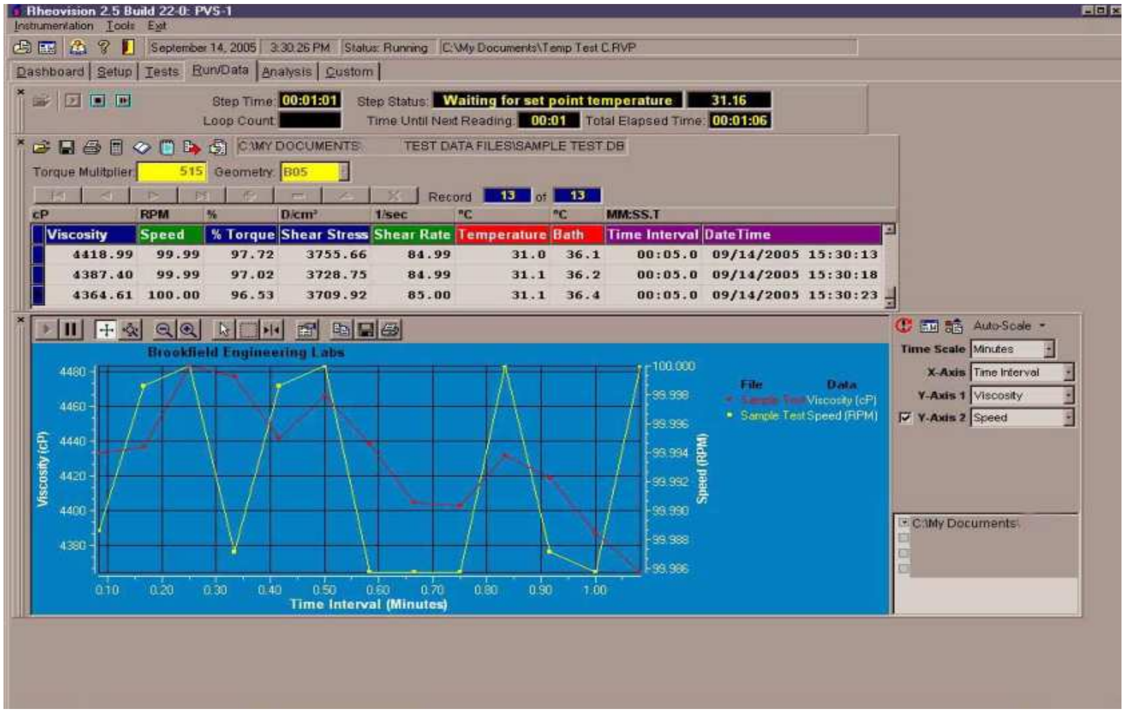


Figure 4-29: Running Test Sample

The Box in the lower right corner displays the current Path & File Name of the Graphed Data. By Double Clicking on the next blank box, a Load Program File dialog box will open. By selecting a Saved Data File (.DB) the graph of that data can be over- layered on the current program for comparison.

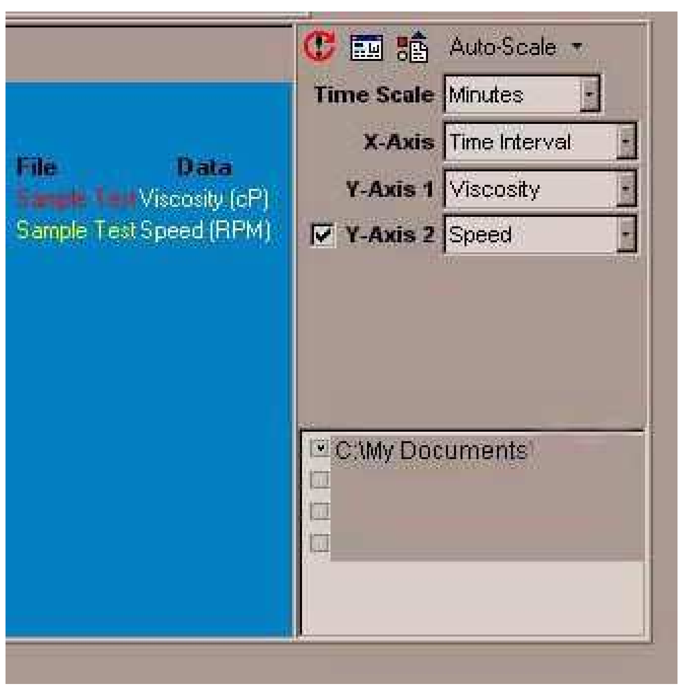


Figure 4-30: Load Saved Graph

Data Sets can quickly be hidden or displayed by checking or unchecking the check box next to the file name.

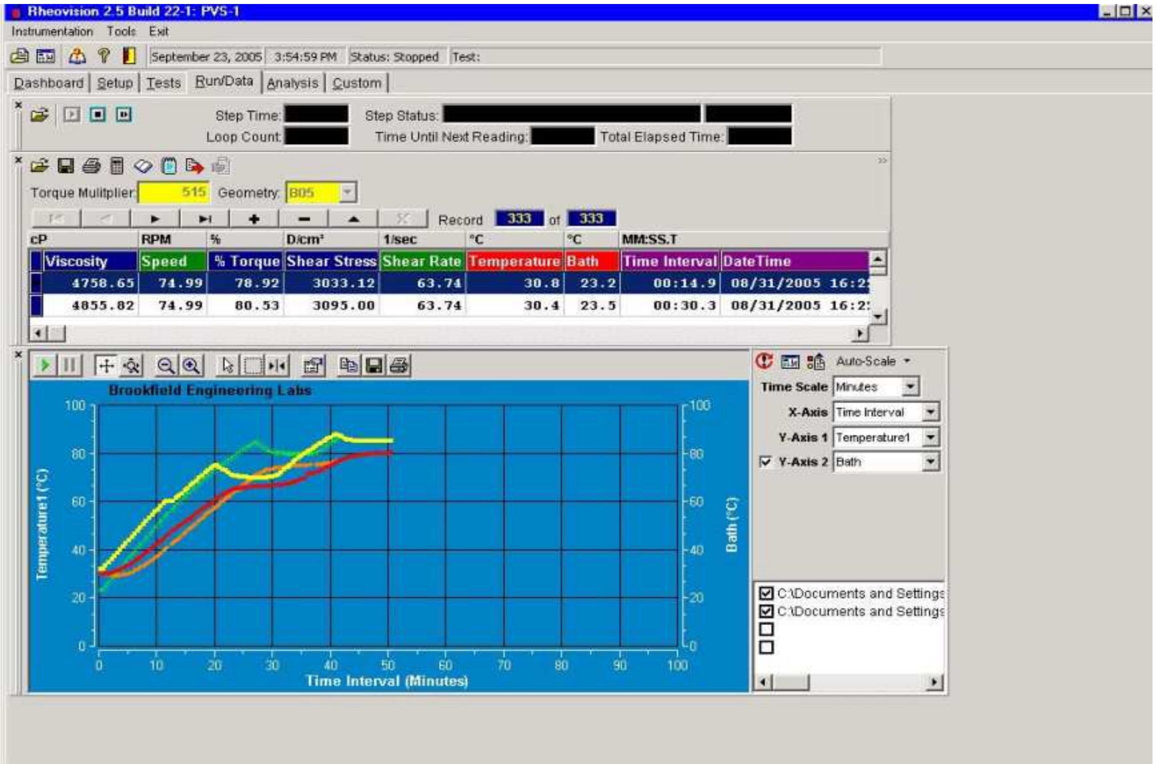


Figure 4-31: Graph Overlay

Sample of two sets of test data over layed on one graph.

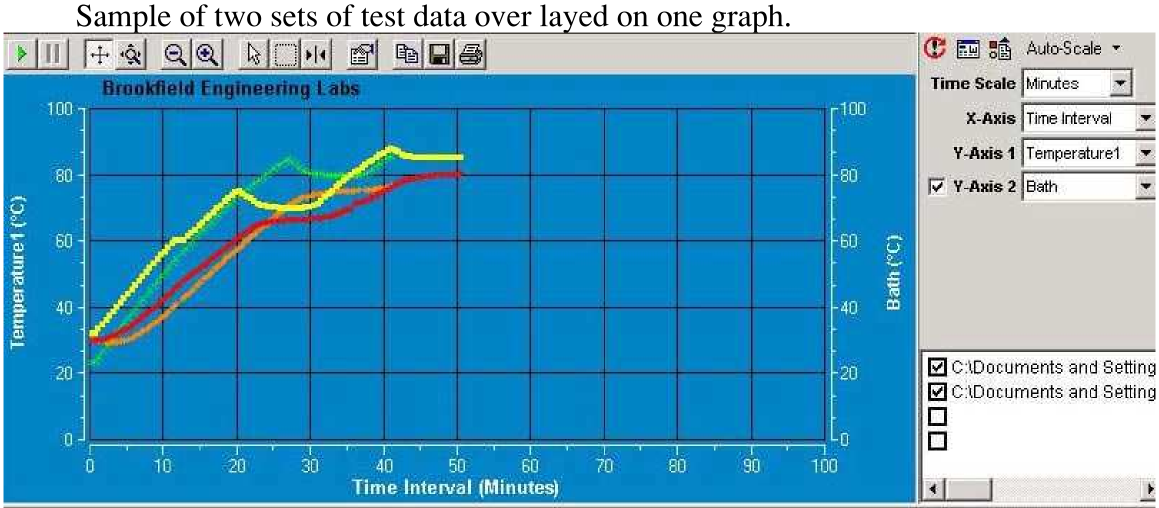


Figure 4-32: Graph Overlay Expanded

CUSTOMIZING GRAPHS

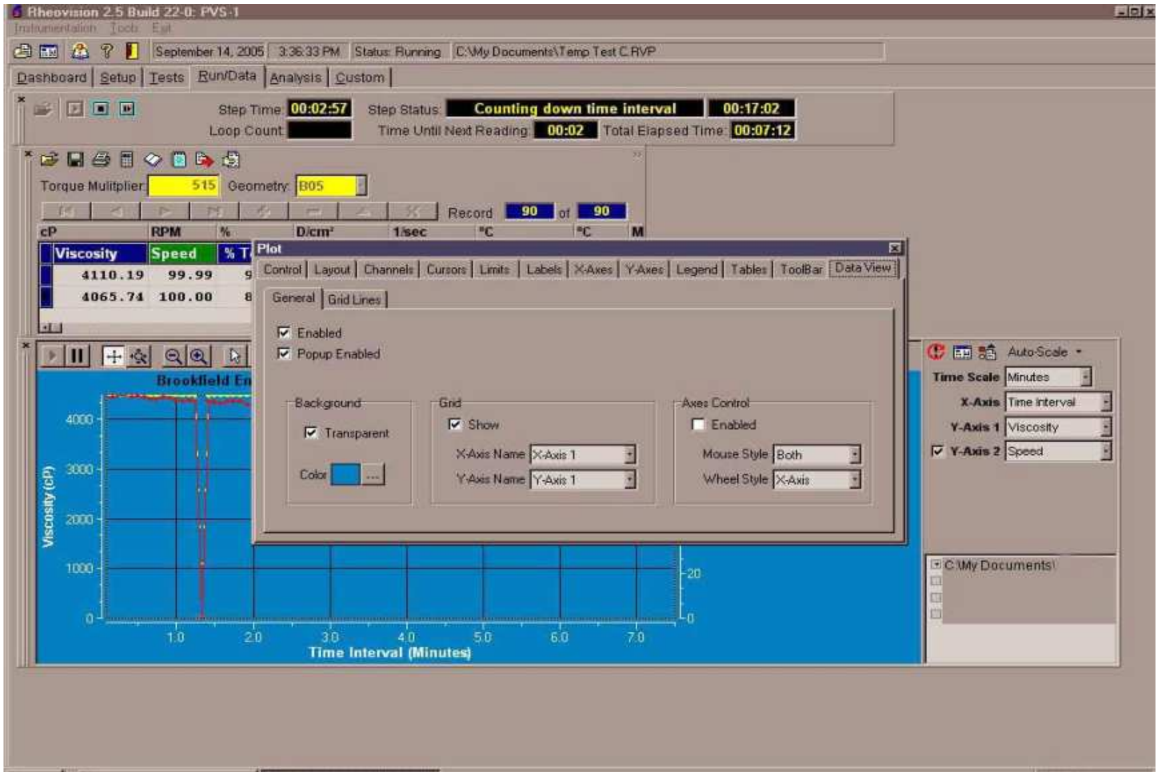


Figure 4-33: Customize Graph Overview

CUSTOMIZING GRAPH:

By Right Clicking inside the Graph Area a Command Box will open titled "Edit" Left. Clicking on this box will open the Plot Properties Dialog Box pictured above. Individual properties of the Graph may be modified by clicking the Tab for that function. By Closing the Plot Properties Dialog Box any changes will be Auto Saved.

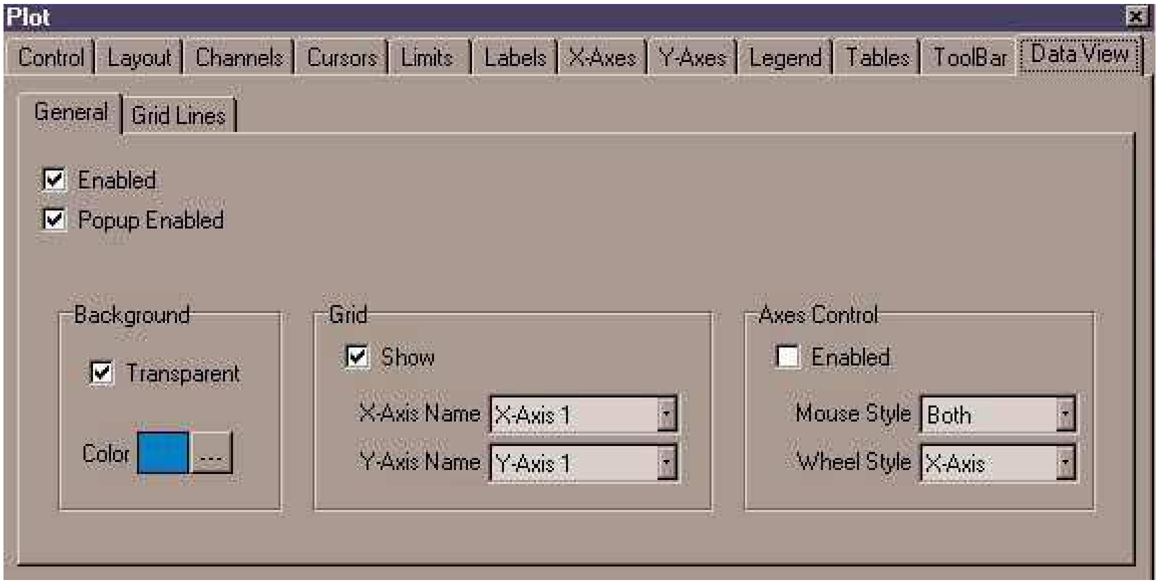


Figure 4-34: Customize Graph Overview Expanded

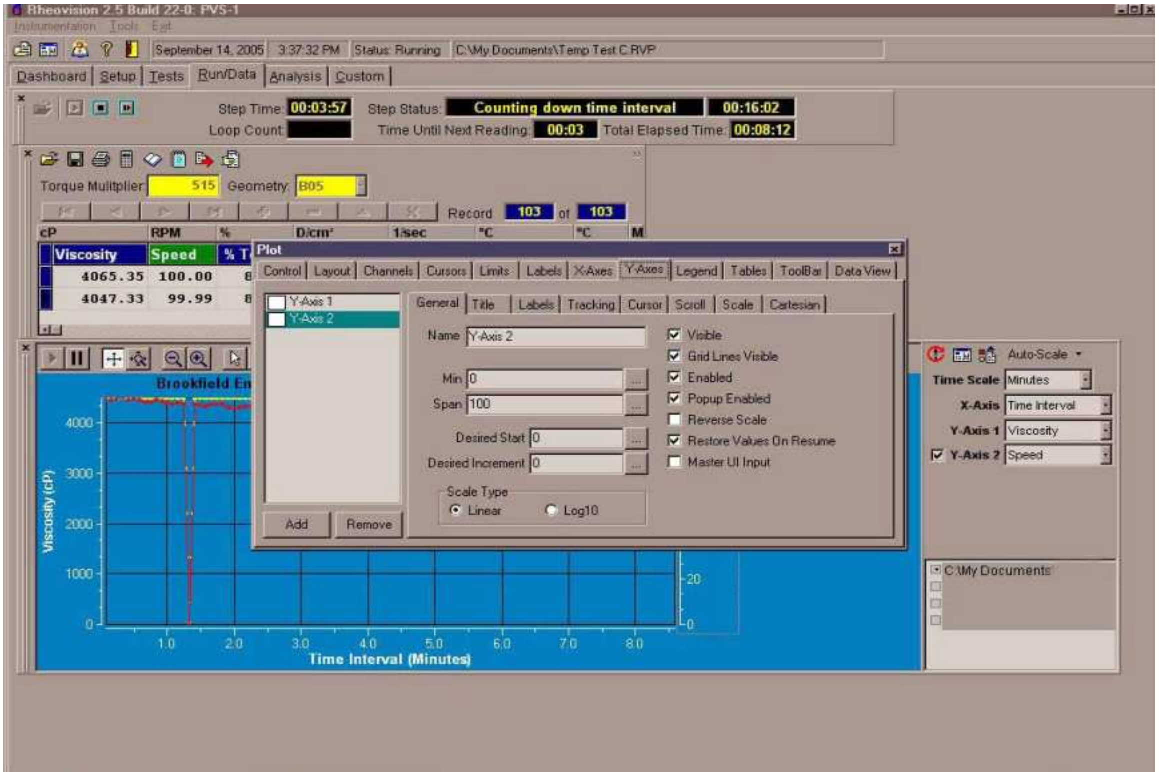


Figure 4-35: Customize Y-Axis Plot

By Right Clicking over either Y-Axis a Command Box will open titled "Edit". Left. Clicking on this Box will open the Plot Properties Dialog Box pictured above. Individual properties of the Axis's may be modified by Clicking on the Tab for that function. By closing the Plot Properties Dialog Box changes will be Auto-Saved.

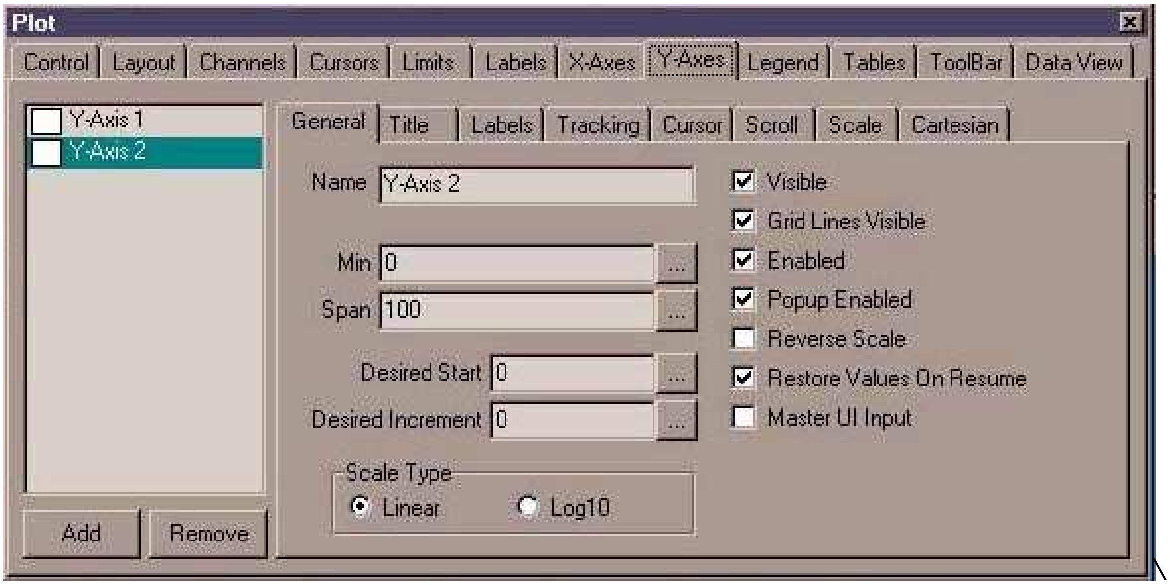


Figure 4-36: Customize Y-Axis Plot Expanded

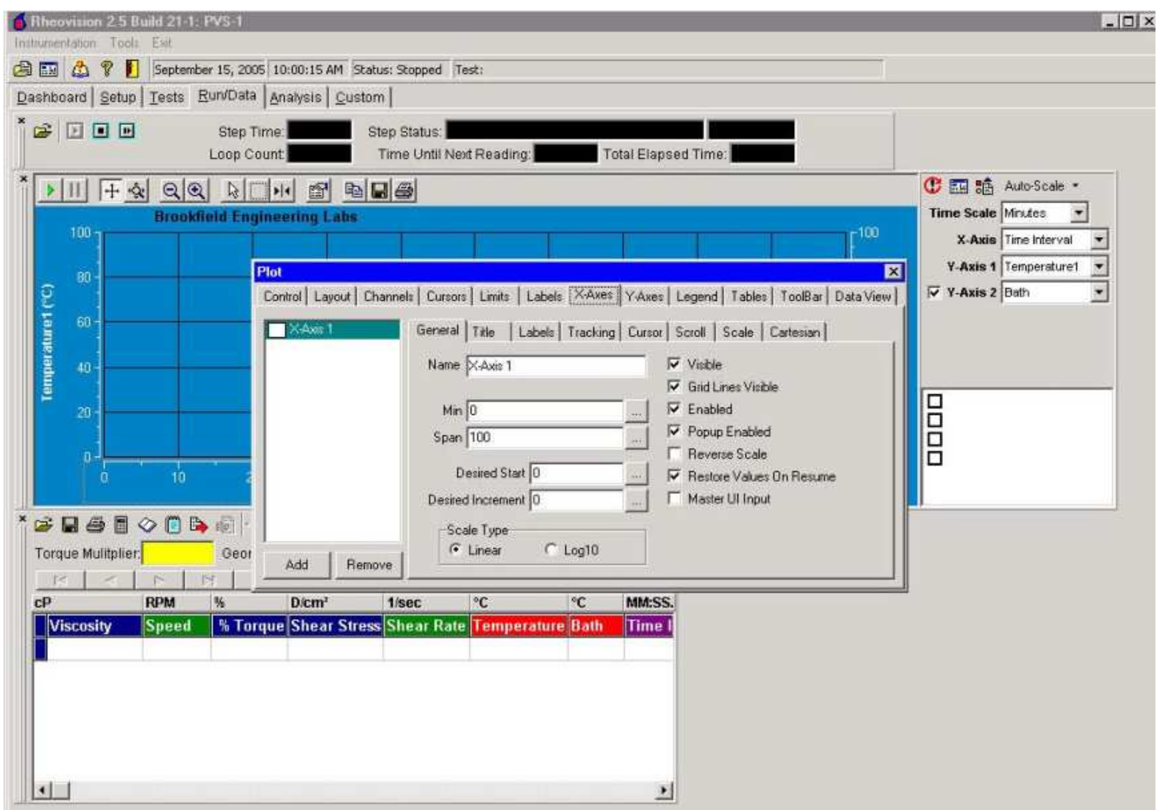


Figure 4-37: Customize X-Axis Plot

Analysis Page

The Analysis page, shown in Figure 4-, is used to mathematically analyze selected data using various models associated with viscosity measurement and rheology. The results are displayed both numerically and graphically, and they can also be printed to hard copy.

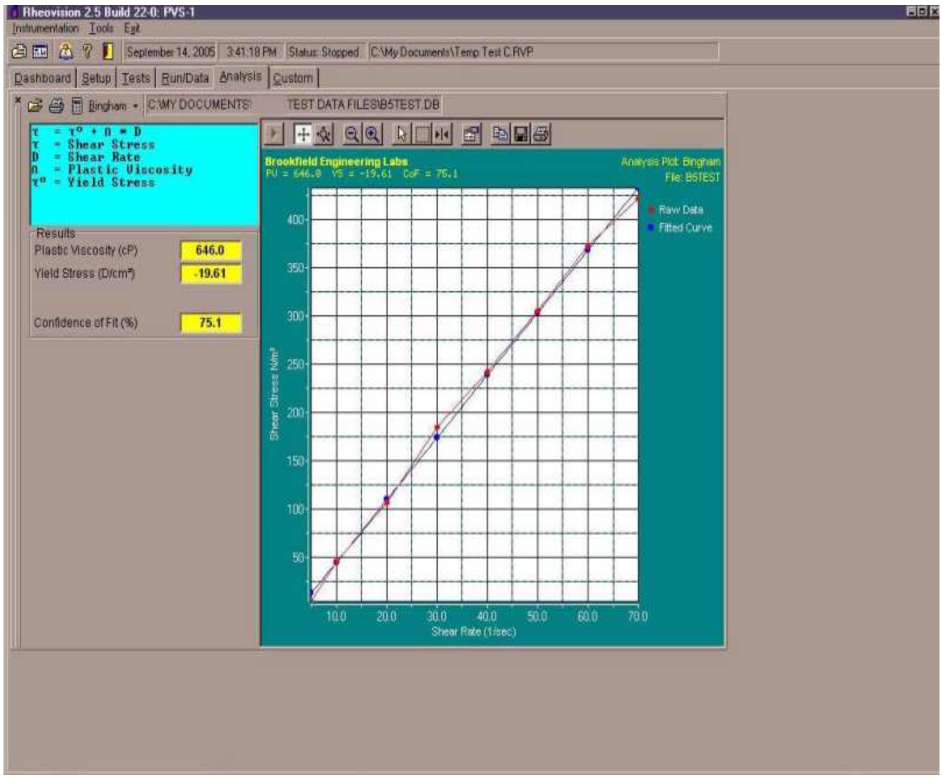


Figure 4-39: Analysis Page

Analysis Page Operation

1. Select the **LOAD** button to select and load a data file.
2. Choose the analysis method from the Model box. As each model is selected, the equation for that model is displayed in the equation box.
3. Select the **PRINT** button to print the data, numeric results, and corresponding graph.

Analysis Page Description

The Analysis page is shown in Figure 4- and described in the following paragraphs.

Models

Bingham

The Bingham equation is used to calculate the viscosity of materials that only flow after the application of a sufficiently large yield stress, to. These materials are referred to as Bingham plastic fluids and are described by the equation in Figure 4-40.

$$\tau = \tau_o + \eta D$$

SHEAR RATE
PLASTIC VISCOSITY
YIELD STRESS
SHEAR STRESS

Figure 4-40: Bingham Equation

The calculated parameters for this model are:

- Plastic Viscosity (cP or mPa·s)
- Yield Stress (Dynes/cm^2 or Newtons/m^2)
- Confidence of fit (%)

NOTE: In all cases, confidence of fit is a measure of how well the data fits the best fit curve for this equation with 100% being the best fit.

A plot of shear stress versus shear rate is displayed for this model.

Casson

The Standard Casson method is a direct implementation of the original Casson equation. A plot of the square root of shear stress versus the square root of shear rate is displayed for this model. The Standard Casson equation is shown in Figure 4-41.

$$\sqrt{\tau} = \sqrt{\tau_o} + \sqrt{\eta D}$$

SHEAR RATE
PLASTIC VISCOSITY
YIELD STRESS
SHEAR STRESS

Figure 4-41: Casson Equation

The calculated parameters for this model are:

- Plastic Viscosity (cP or mPa·s)
- Yield Stress (Dynes/cm^2 or Newtons/m^2)
- Confidence of fit (%)

NOTE: In all cases, confidence of fit is a measure of how well the data fits the best fit curve for this equation with 100% being the best fit.

A plot of the square root of shear stress versus the square root of shear rate is displayed for this model.

NCA/CMA Casson

This Casson method is derived from the standard set forth by the National Confectioners Association (NCA) and the Chocolate Manufacturers Association (CMA). Although based on the original Casson equation, this implementation has been tailored by the NCA and CMA specifically to applications involving chocolate. The Chocolate Casson equation is shown in Figure 4-.

$$(1 + a)\sqrt{\tau} = 2\sqrt{\tau_o} + (1 + a)\sqrt{\eta D}$$

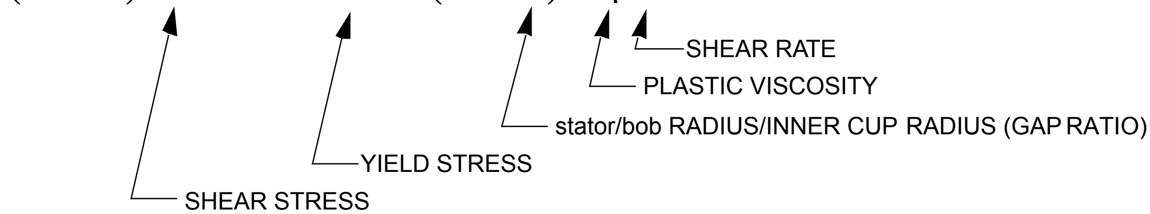


Figure 4-42: Chocolate Casson Equation

The calculated parameters for this model are:

- Plastic Viscosity (cP or mPa·s)
- Yield Stress (Dynes/cm^2 or Newtons/m^2)
- Confidence of fit (%)

NOTE: In all cases, confidence of fit is a measure of how well the data fits the best fit curve for this equation with 100% being the best fit.

A plot of (1 + a) times the square root of shear stress versus (1 + a) times the square root of shear rate is displayed for this model.

Power Law

The Power Law equation is shown in Figure 4-43.

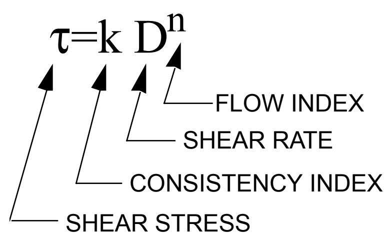


Figure 4-43: Power Law Equation

The calculated parameters for this model are:

- Flow Index (no units)
- Consistency Index (cP or mPa·s)
- Confidence of fit (%)

NOTE: In all cases, confidence of fit is a measure of how well the data fits the best fit curve for this equation with 100% being the best fit.

A plot of the LOG of shear stress versus the LOG of shear rate is displayed for this model.

NOTE: In accordance with common usage, k is displayed in cP or mPa·s units in lieu of those obtained from data insertion in the formula shown in Figure 4-: CGS units, dyne-sec^n/cm^2, SI units, newton-sec^n/cm^2. Numerical values in these units are smaller than these shown by the factors: 100 (CGS units), 1000 (SI units).

IPC Paste

The IPC Paste Analysis method is based on the power law equation and is intended to calculate the Shear Sensitivity Factor (pseudo plasticity) of pastes. A prime example of its use is in the solder paste industry, thus the name IPC (Institute for Interconnecting and Packaging Electronic Circuits). The Paste equation is shown in Figure 4-44.

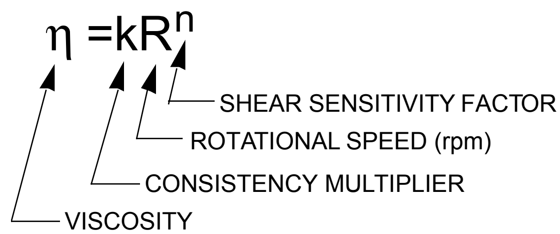


Figure 4-44: IPC Paste Analysis Calculation

The calculated parameters for this model are:

- Shear Sensitivity Factor (slope of line; no units)
- Viscosity (cP or mPa·s)
- Confidence of fit (%)

NOTE: In all cases, confidence of fit is a measure of how well the data fits the best fit curve for this equation with 100% being the best fit.

A plot of the LOG of viscosity versus the LOG of speed (rpm) is displayed for this model.

Calculate

The Calculate button updates the results box and the graph using the data and model type selected.

Equation

The Equation box displays the equation and variables for the model selected.

Herschel Bulkley

The Herschel-Bulkley equation is $\tau = \tau^{\circ} + kD^{n}$ where

t = shear stress
to = yield stress (shear stress at zero shear rate)
D = shear rate
k = consistency index (cP)
n = flow index

The calculated parameters for this model are:
Flow Index (no units)
Consistency Index (cP or mPa•s)
Yield Stress (Dynes/cm^2 or N/m^2)
Confidence of fit (%)

A plot of the LOG of (shear stress - yield stress) versus the LOG of shear rate is displayed for this model.

CUSTOM PAGE

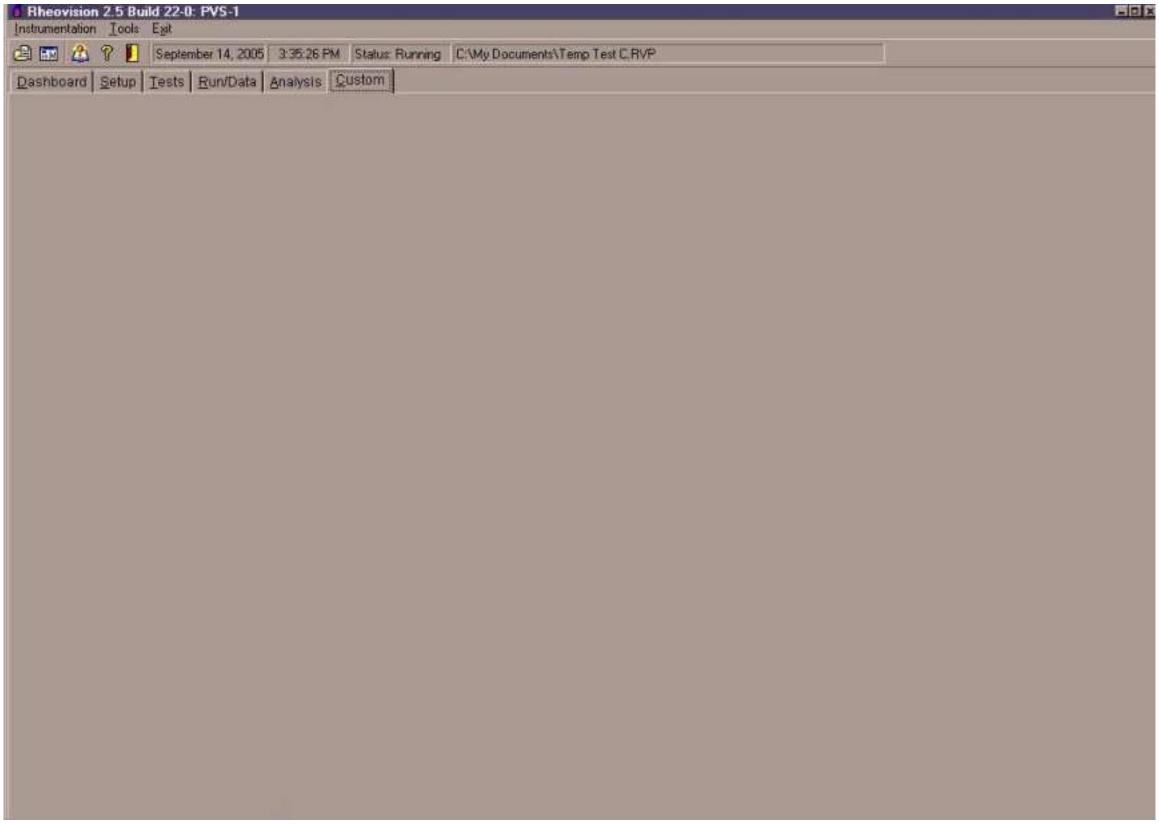


Figure 4-45: Custom Page Blank

Selecting the Custom Tab will open the above Blank Screen. The operator can create a custom screen that will move windows from other screens and have them all displayed on one Custom Screen. Selecting “Tools” then selecting “Save User Settings” can save any additions to the Custom Screen. The following pages detail setting up a Custom Screen.

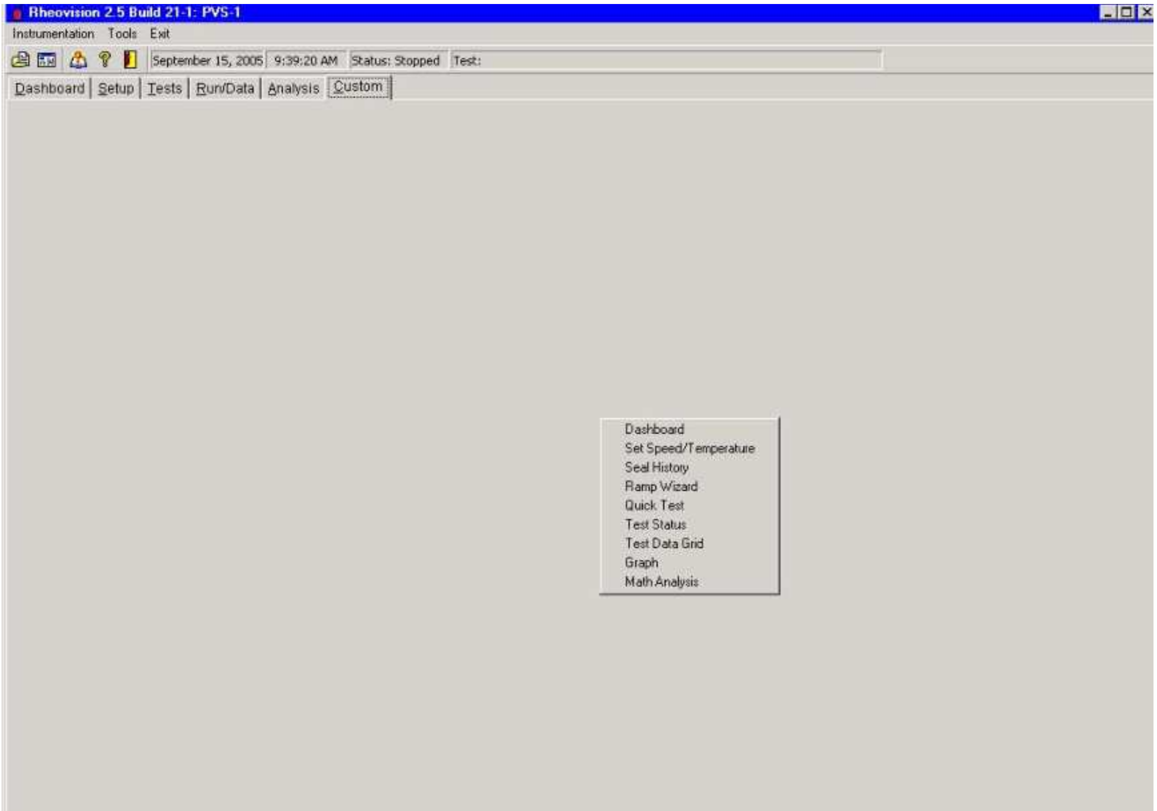


Figure 4-46: Custom Page Selection

Placing the Cursor inside the blank screen & right clicking will open up the selection box shown above. By selecting the desired item, that item will be moved to the Custom Screen. Each item may be resized or moved by placing the cursor over the drag bar of the window and double clicking when the cursor changes shape. After resizing or moving the window, double clicking in the title box on the top of the item will save the changes and return the item to its regular status. When all items have been selected & moved/resized, Select “Tools” then select “Save User Settings”. All changes will then be saved and when Rheovision is opened again the changes will be reflected. Changes can also be saved on normal exit from Rheovision.

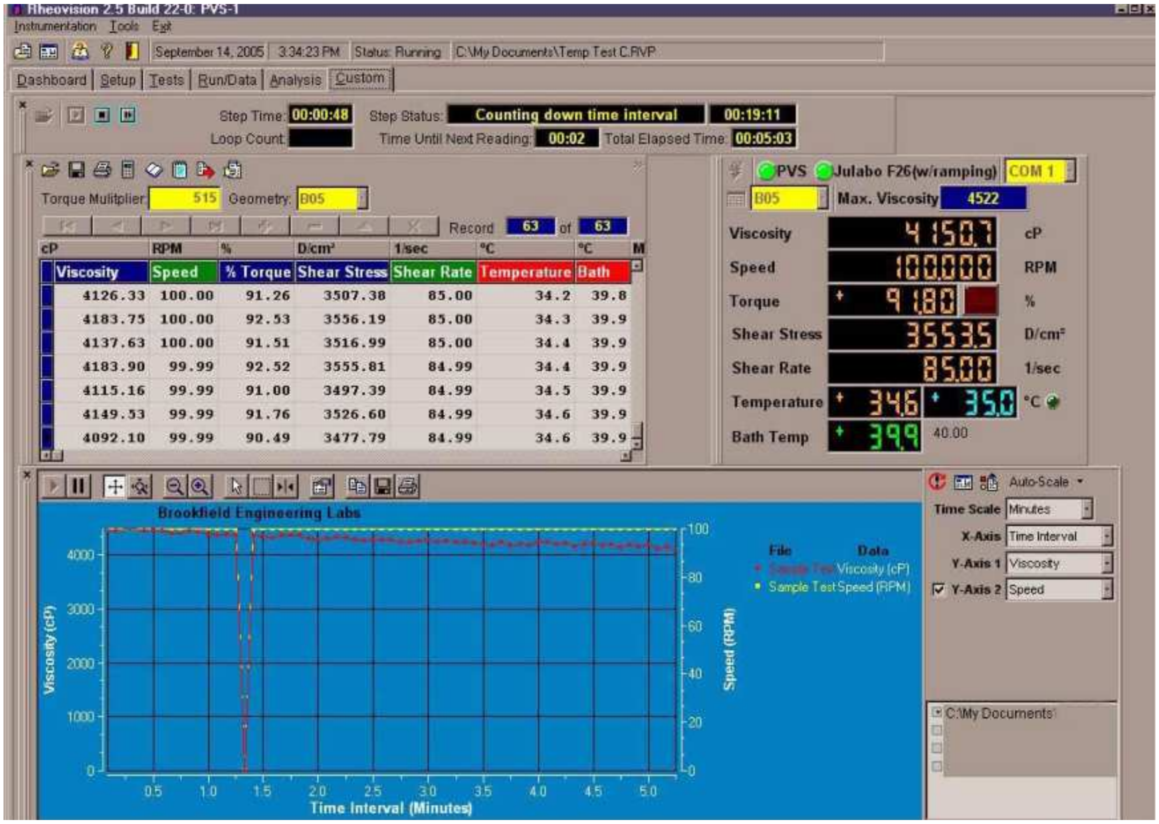


Figure 4-47: Custom Screen Filled

Example of a Custom Screen with imported items.

Section 5 - B.E.A.V.I.S. Programs

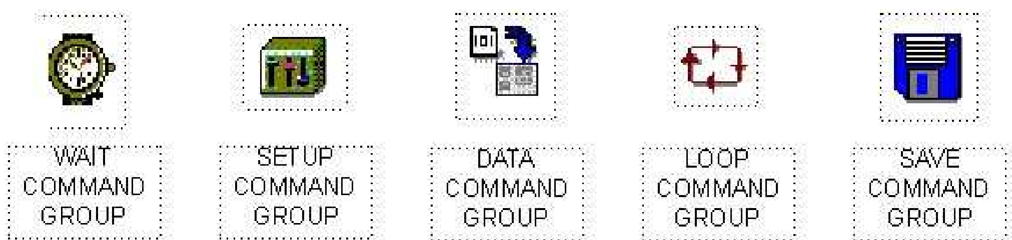
What is a B.E.A.V.I.S. Program?

B.E.A.V.I.S. Brookfield Engineering Advanced Viscometer Instruction Set is a command language developed at Brookfield Engineering Labs that allows control of Brookfield viscometers/rheometers and associated accessories (i.e. temperature controllers). The commands allow the creation of both simple and complex test programs that provide maximum flexibility in completely unattended data gathering.

B.E.A.V.I.S. Commands

Command Groups

Commands are grouped into functional groups which are identified by the graphic to the left of the command. Icons for each group are shown in Figure 5-1.



Wait Command Group

Wait Commands wait for a certain condition to be reached. The time to reach the condition is displayed as Step Time on the Program page.

Setup Command Group

Setup Commands set program parameters (i.e. speed or temperature).

Data Command Group

Data Commands dictate the manner in which data is collected.

Loop Commands Group

Loop Commands mark the beginning and end of a loop (i.e. commands between the loop start and end are repeated).

Save Data Commands Group

Save Data Commands save or append data to a disk file.

Table 5-1: B.E.A.V.I.S. Commands used in Rheovision

Command	Function	Description
WTI	Wait for time	Remains at the step until the specified time interval (HH:MM:SS) has elapsed.
WPT	Wait for % torque	Remains at the step until the specified % torque value is reached.
WTP	Wait for temperature	Remains at the step until the specified temperature value is reached.
WTS	Wait for set point temperature	Remains at the step until the temperature reaches the set point value in the associated temperature controller ± the specified value.
WDP	Wait for data points	Remains at the step until the specified number of data points are collected from the time this command is issued.
SSN	Set speed	Run the rheometer at the specified speed.
STM	Set temperature	Set the temperature controller set point to the specified value and control to this temperature.
SZR	Reset zero	Record the current % Torque value and subtract it from all future torque readings (zero the torque).
DCI	Data collection interval	Begin collecting data at the specified time interval (HH:MM:SS). Data is collected at this interval until a DSD command is issued.
DSP	Collect a single data point	Immediately collect a single data point.
DSD	Stop data collection	Terminate any DCI already in progress.
LSC	Start count loop	Marks the start of a loop. Perform all commands starting after this one up to the next LEC (loop end) the number of times specified.

Table 5-1: B.E.A.V.I.S. Commands used in Rheovision (continued)

Command	Function	Description
LEC	End count loop	Marks the end of a loop. Perform all commands before this one back to the most recent LSC the number of times stated in the LSC.
FSA	Append to data file	Append any data in the capture buffer at the end of the file specified in the first parameter. If a file is specified in the second parameter, perform the appropriate add-on module calculations (for example: API Power Law) on only the data being appended and add the calculation to the end of the second file. The report is then displayed in the dialog box showing all calculations. **NOTE**: If a full path name is not specified, the file is saved in the current directory. If the files specified do not exist, then they are created. **NOTE**: Refer to Add-On Modules in Section 4 - Rheovision Software for more information.
FSO	Save data to disk file	Save any data in the capture buffer to the file specified in the first parameter over-writing any data that was already in the file. If a file is specified in the second parameter, perform the appropiate add-on module calculations (for example: API Power Law) on only the data being appended and add that calculation to the end of the second file. The report is then displayed in the dialog box showing all calculations. **NOTE**: If a full path name is not specified, the file is saved in the current directory. If the files specified do not exist, then they are created. **NOTE**: Refer to Add-On Modules in Section 4 - Rheovision Software for more information.

Section 6 - Troubleshooting

Introduction

The information in Section 6 will help you troubleshoot problems when they occur. The problems presented in Table 6-1 are followed by possible causes and corrective actions listed in their order of probability of occurrence.

Table 6-1: PVS Rheometer Troubleshooting Procedures

Problem	Possible Cause	Corrective Action
Dashboard temperature display is erratic or incorrect.	Poor contact between mounting tube pins and stator receptacles.	Refer to Cleaning of Wetted Parts in Section 3.
	Shorted or open RTD wiring.	Refer to Appendix A and contact Brookfield for assistance.
No torque response.	Cable from PVS Rheometer head to base is disconnected.	Refer to Figure 2-2 and connect the cable.
	Foreign matter beetween mounting tube and stops.	Refer to Cleaning of Wetted Parts in Section 3.
	Bent torsion element.	Refer to Appendix A and contact Brookfield for assistance.
	Open field coil wiring.	Refer to Appendix A and contact Brookfield for assistance.

Table 6-1: PVS Rheometer Troubleshooting Procedures (Continued)

Problem	Possible Cause	Corrective Action
No communication to PVS Rheometer.	PVS Rheometer power OFF. Loose or disconnected RS-232 cable. Software /PC communication error.	Refer to Turning Power On in Section 3. Refer to Figure 2-2 and check RS-232 cable connections. Refer to Communication Problems within this section.
No communication to PVS Bath.	Power OFF. Loose or disconnected RS-232 cable.	Refer to Turning Power ON in Section 3. Refer to Figure 2-2 and check RS-232 cable connections. Refer to Communication Problems within this section.
Dashboard window display indicates dashes upon startup indicating a value less than 10%.	Zero Offset calibation incorrect.	Refer to Appendix A and contact Brookfield for assistance.
Cannot install stator/bob.	Mis-aligned stator/bob or lack of lubrication on stator/bob O-ring. Broken/bent element.	Refer to Sample Cup, Stator/Bob and Baffle Installation in Section 3. Refer to Appendix A and contact Brookfield for assistance.
Stator cannot be removed.	Mis-aligned stator/bob or lack of lubrication on stator/bob O-ring. Broken/bent element.	Refer to Sample Cup, Stator/Bob and Baffle Installation in Section 3. Refer to Appendix A and contact Brookfield for assistance.

Table 6-1: PVS Rheometer Troubleshooting Procedures (Continued)

Problem	Possible Cause	Corrective Action
Fluid inside of stator/bob.	Sample foaming and climbing on stator/bob or too much sample in cup.	Reduce the sample fluid level and refer to Cleaning of Wetted Parts in Section 3.
PVS Rheometer will not retain pressure.	Damaged lip seal or other sealing components. Broken torsion element.	Refer to Appendix A and contact Brookfield for assistance.
Sample cup wobbles.	Loose knurled ring or sample cup not installed properly on hub.	Refer to Sample Cup, Stator/Bob and Baffle Installation in Section 3.
Sample cup cannot be removed. Knurled ring will not turn.	Residual pressure inside sample cup.	Refer to Sample Cup Removal in Section 3.
Sample cup cannot be removed. Knurled ring turns.	Sample cup O-ring is binding between cup and hub.	Refer to Appendix A and contact Brookfield for assistance.
Torque hang-up (Zero point return from the positive direction is different from the negative direction by more than 0.3%).	Friction in the torque sensor assembly.	Refer to Appendix A and contact Brookfield for assistance.
Spikes in the torque readings.	Solids bridging measuring annulus. Cup contacting stator/bob.	Refer to Cleaning of Wetted Parts in Section 3. Refer to Appendix A and contact Brookfield for assistance.

Communication Problems

If the warning shown in Figure 6-1 is displayed for either the rheometer or the temperature controller, use the troubleshooting procedures in this section to resolve the problem.

Figure 6-1: Communications Warning Pop-up Window

Instrumentation Setup

1. Ensure that the rheometer or temperature controller (or both) have the appropriate communications cable connected to them and that the opposite end of the cable is connected to a valid COM (serial) port on the host PC.

2. Ensure the rheometer, temperature controller, or both are powered ON.

NOTE: For any optional temperature bath, check the bath's operation manual for RS-232 communication information.

3. If communication problems still exist, perform one of the following procedures based the computer operating system being used.

Windows NT/XP/2000

1. Select the START button.

2. Select SETTINGS then CONTROL PANEL.

3. Select the SYSTEM icon.

4. Select the HARDWARE tab, then click the DEVICE MANAGER button.

5. Select PORTS. Highlight the COM port in use and select the PROPERTIES button (or double click the COM port in use).

6. Select PORT SETTINGS then ADVANCED.

7. Make sure the check box labeled USE FIFO BUFFERS (requires 16550 compatible UART) is checked. Make sure the sliders for the RECEIVE BUFFER and the TRANSMIT BUFFER are both set all the way to the left (Low).

8. Select the OK buttons to accept the changes and get back to the desktop.

9. If there is still a communication problem, follow the above procedure, but this time, remove the check from the box labeled labeled USE FIFO BUFFERS (REQUIRES 16550 COMPATIBLE UART).

10. Select the OK buttons to accept the changes and get back to the desktop.

11. If communication problems still exist, refer to Appendix A and contact Brookfield Engineering, Inc. technical support.

Section 7 -
PVS Sensing Stack Replacement

Tools Required

- Medium slotted screwdriver
- Small slotted screwdriver
- Phillips head screwdriver
- Armature wrench (P/N TT-100-1T)
- Retaining ring pliers (45 degree angle tips)
- 7/64 hex wrench
- 5/32 hex wrench
- 5/64 hex wrench
- 9/32 open end wrench

NOTE: Refer to Figures 7-1 and 7-2 throughout this section for parts identification.

Disassembly

1. Power down the PVS base and disconnect the PVS head cord from the PVS base and disconnect any pressure connections.

> **CAUTION**
>
> Never disconnect the PVS head power cord from the PVS base when the base power switch is in the on position. Damage could occur to the motor drive electronics.

2. Remove the sample cup and stator. Remove the baffle by loosening the (2) hex socket cap screws with a 5/64 hex wrench.

CAUTION

Throughout this section be careful when handling the sensing stack assembly and always protect the mounting tube assembly/torque sensor assembly with the gray PVC guard (PVS-80) when possible.

3. Invert the PVS head on the upright rod of the base so the underneath of the head is accessible by loosening the two hex socket cap screws located on the clamp with a 7/64 hex wrench, which secure the head to the upright rod. Then remove the head from the rod and turn the head upside down, install it back onto the rod and tighten the (2) hex socket cap screws to secure the head to the rod.

CAUTION

Extend the upright rod to the highest position before loosening the clamp screws to prevent the rod from springing upward. Support the PVS head so that the head will not slip down the upright rod when loose and become damaged.

4. Remove the lip seal and retainer assembly (PVS-194Y) by removing the (4) phillips head screws. Two of the holes which the (4) phillips head screws were in are tapped with a 6-32 thread and (1) 6-32 x 1” screw should be installed into each of the two 6-32 tapped holes, turning each screw clockwise 1/4 turn at a time until the lip seal is released.

5. Remove the O-ring (PVS-195) and backup ring (PVS-192). There are three small holes provided in the backup ring for inserting a tool to lift out the backup ring. Once the backup ring is lifted it can be removed with a pair of tweezers.

6. Remove the retaining ring (PVS-36) using a pair of retaining ring pliers with tips positioned at a 45 degree angle.

7. Loosen the clamp screws again and return the PVS head to the normal operating position on the upright rod. Tighten the clamp screws to secure the head to rod.

8. Remove the pressure connections and hardware from the side of the head and remove the (4) slotted screws located on the back of the cover, which secure the cover to the head. Once the screws are removed lift upward on the cover until it is free of the head.

9. Remove the (2) hex socket cap screw with a 5/64 hex wrench, which secure the fan to the PVS head back panel and set aside the fan assembly then remove the strain relief fitting from the side of the sensing stack assembly. Remove the (2) slotted screws, which secure the sensing stack cover and ring terminal to the sensing stack. Remove the sensing stack cover by gently pulling upwards until free.

CAUTION

Do not disconnect the wire ends from the sockets in the microsyn field assembly located under the cover.

10. Remove the two slotted screws and washers that secure the microsyn field assembly to the microsyn housing w/jewel (PVS-204Y). Once the microsyn field is removed the cover, wire and microsyn field can hang off to the side together while finishing the section.

11. The violet and yellow wires which come through the sensing stack assembly must be disconnected from the wires that they are connected to (yellow to black and red, violet to black and white).

CAUTION

Do not cut the wires, try and unsolder them from the other wires to maintain the length for future repair.

12. Remove the Armature assembly using the TT-100-1T armature wrench and 9/32 wrench. Install the armature wrench so that the fingers on the end of the tool fit gently into the cutouts of the armature to hold the armature in place while using the 9/32 wrench to loosen the brass nut of the armature assembly in a counter clockwise direction. Once the nut is loosened sufficiently the remainder of the armature assembly must be pulled gently up and straight off the wire it is attached to.

13. Using a 5/32 hex wrench loosen and remove the (4) hex socket cap screws (10-32x1”) which secure the sensing stack to the base plate using a 5/32 hex wrench. Once the screws are removed the sensing stack assembly can be carefully pulled upward to release it from the Drive hub assembly (PVS-190PY). Make sure to remove the wave spring (PVS-37) and preload spacer (PVS-14) from under the sensing stack, as you will need these during the rebuilding section.

14. Package the old sensing stack assembly and return to Brookfield Engineering Labs, Inc. for refurbishing.

Reassembly

1. Carefully remove the shipping tubes from the new sensing stack assembly.

> **CAUTION**
>
> Be careful not to damage the sensing stack assembly when removing the shipping tubes as damage to the assembly could occur.

2. Place the preload washer (PVS-14) onto the Drive hub assembly with the extended I.D. going into the hub assembly. Place the wave disc spring (PVS-37) onto the preload washer.

3. Carefully install the new sensing stack assembly through the base plate, wave disc and preload spacer into the Drive Hub assembly (PVS-190PY) without applying force to the mounting tube assembly/torque sensor assembly. Once the new sensing stack is resting on the base plate rotate the assembly until the (4) 10-32x1 " can be installed through the torsion element into the base plate and semi tighten the (4) screws using a 5/32 hex wrench. Pull the drive hub assembly forward to put tension onto the motor belt and tighten the (4) 10-32x1" in place ensuring tension on the belt. Install the gray PVC guard (PVS-80) to protect the mounting tube assembly from damage.

NOTE: The screw locations in the base are asymmetrical, so the sensing stack may be installed in one orientation only.

4. Install the armature assembly (armature, clamp and nut) onto the wire, which extend through the microsyn housing w/ jewel until the armature is resting on the jewel in the housing. Once the armature is resting on the jewel the nut should be hand tightened just enough to allow it to secure the armature assembly to the wire yet loose enough to allow the assembly to be slid up and down on the wire. Slide the armature down the wire until it contacts the jewel then pull up slightly so that the bottom of the armature will not rub on the jewel, then the nut should be tightened to the wire using the TT-100-1T wrench and 9/32 wrench so that it is secure.

> **CAUTION**
>
> Do not bend the wire when tightening the armature nut as damage to the jewel or torsion element may occur.

5. Support the head while loosening the (2) hex socket cap screws, which clamp the head to the upright rod. Once the screws are loose and the head is free remove the head and reinstall on the rod upside down so that the bottom of the head is accessible and tighten the (2) hex socket cap screws to hold the head secure onto the rod. With the head mounted on the rod upside down remove the guard and install the retaining ring (PVS-36) into the groove on the drive mounting sleeve by compressing downward on the drive hub assembly until the groove is exposed.

CAUTION

Be careful not to damage the mounting tube assembly while turning the head upside down on the rod and when installing the retaining ring as serious damage to the torsion element could occur.

6. Once the retaining ring is installed place the backup ring (PVS-192) on top of the retaining ring and install the o-ring (PVS-195). The lip seal in its retainer should be lubricated with Krytox grease (PVS-256) prior to installation. Once lubricated the lip seal & retainer assembly should be carefully installed over the mounting tube assembly and secured into place with the (4) 4-40 phillips head screws. The torsion element guard (PVS-80) should be screwed onto the drive hub assembly to protect the torsion element.

7. Loosen the (2) clamp screws while supporting the head, remove the head from the rod, reinstall the head upright onto the rod and secure by tightening the (2) clamp screws.

8. Carefully replace the microsyn field assembly in to the microsyn housing w/jewel and replace the two slotted screws and washers, and secure it to the housing finger tight. Secure the ring connector and wire onto the microsyn housing with (1) of the slotted screws which, hold the sensing stack cover onto the sensing stack. Do not at this time install the sensing stack cover until the next steps are completed.

CAUTION

Be sure to secure the ring connector and wire to the microsyn housing or step 11 will be difficult to complete.

9. Reconnect the violet and yellow RTD wires (violet to white/black and yellow to red/black). Solder the wires together to ensure proper contact and cover with shrink tubing to eliminate the possibility of shorting out under the sensing stack cover.

10. Replace one of the screws which hold the fan in place and position so that when the fan operates that the fan blades will not come into contact with anything. Reconnect the PVS head to the base and the CPU to the base.

11. Power up the CPU, PVS base and remove the gray PVC torsion element protector (PVS-80). Open the Rheovision software and click on the dashboard tab. The % torque display should indicate four dashes. Slowly rotate the microsyn field assembly until between –1% and –2%a torque is shown in the % torque display. Tighten the (2) slotted screws, which secure the microsyn field assembly into the microsyn housing w/jewel ensuring that the -1% and -2 % torque is maintained. Once this is done gently apply torque to the mounting tube assembly with your hand from right to left when looking at the PVS from the front to ensure that the % torque readings increase to a positive number. Should the % torque value decrease to more negative number while applying torque, then a resetting of the microsyn field assembly will be required because the phase orientation of the microsyn needs to be changed. Should the phase need to be reoriented you must repeat step 11 and find a different position for the microsyn to be secured to give the negative 1-2 % of torque. Once a positive torque is attained by gently applying torque by hand to the mounting tube (right to left) the % torque reading should increase to a positive % torque and return to the original value +/- .05 % torque.

NOTE: There are 45 degrees between each phase position. Torque response alternates direction as each successive position is reached.

CAUTION

When the PVS is powered up the fan will be rotating so be careful, as there are not guards in place to prevent injury with the cover to the PVS head is off.

12. Install the baffle onto the drive mounting sleeve by carefully sliding the baffle up the mounting tube (PVS-125Y) and tightening the (2) hex socket cap screws with a 5/64 hex wrench, captivating the baffle onto the drive mounting sleeve.

13. Remove the slotted screw that secures the ring connector and wire to the microsyn housing. Reinstall the sensing stack cover and secure with the (2) slotted screws with the ring connector and wire secure under one of the screws. Carefully replace the shielded cable into the sensing stack cover using the strain relief connector.

14. Secure the other end of the fan to the back panel of the head and make sure both screws are tightened. Replace the PVS cover onto the head and secure with the (4) cover screws. Reconnect pressure fittings, install stator, and sample cup.

15. Before running, a test calibration should be preformed using a sample with a known centipoise value.

CALIBRATION

Calibration must be performed with the B5 or B1 bob and PVS-30 sample cup. From the Dashboard page of the Rheovision software, click on the geometry table button and set the torque multiplier to a value of 500. Highlight the bob you have decided to use during the calibration, either B01 or B05 on the geometry page of the Rheovision program. Click on the Programs tab in the Rheovision software. Write a program controlling the calibration fluid at the proper fluid calibration temperature using a temperature bath. Take data points at 100, 50, 25 and 10 rpm (allow 30 seconds of wait time for each rpm setting before each data point is taken to ensure proper calibration). Introduce calibration fluid into the PVS-30 sample cup: 2000 cp or higher for calibration using a B5 bob and 1000 cP or higher using a B1 bob. Tighten the sample cup with fluid onto the PVS and run the program you created with the four 4 rpm settings.

NOTE: Shear rates above 200 sec-1 could add error during calibration and data with % torque values below 10% of scale should be disregarded.

Once the program has run, plot the data onto a graph, viscosity vs. rpm. The plotted viscosity of the fluid may be higher or lower than the actual value of the fluid. Should the plotted value of the fluid be lower than the actual value of the fluid, then increase the value of the torque multiplier and rerun the program until the plotted viscosity line is at the actual value of the fluid being measured. Should the plotted value of the fluid be higher than the actual value of the fluid, then decrease the value of the torque multiplier and rerun the program until the plotted viscosity line is at the actual value of the fluid being measured. The torque multiplier can be set from a value of 450-550 for calibration purposes. Should you find that in order to calibrate that the multiplier must be set outside of the 450-550 value, then contact Brookfield Engineering, Process Service Department.

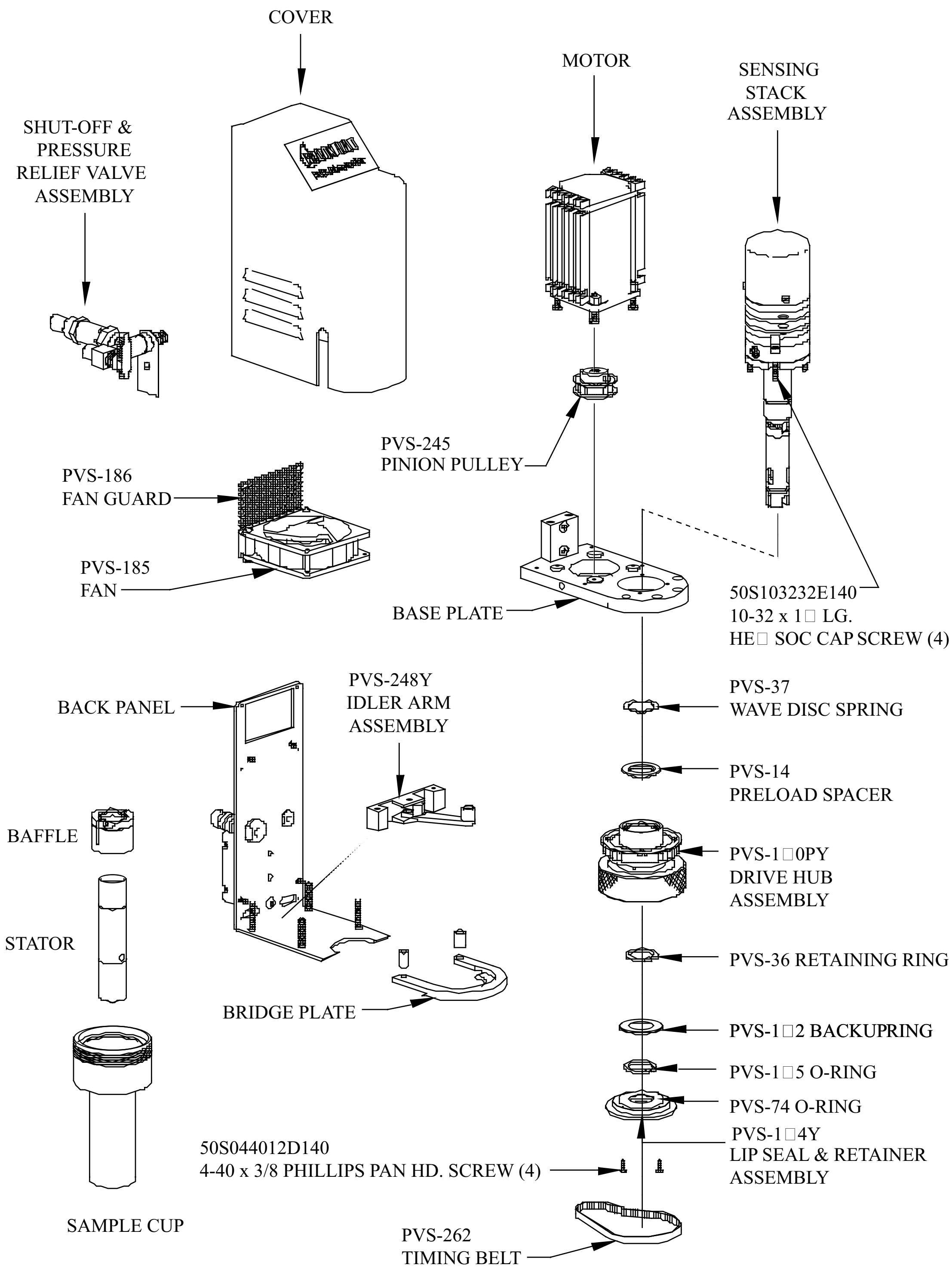


Figure 7-1: PVS Rheometer Component Identification

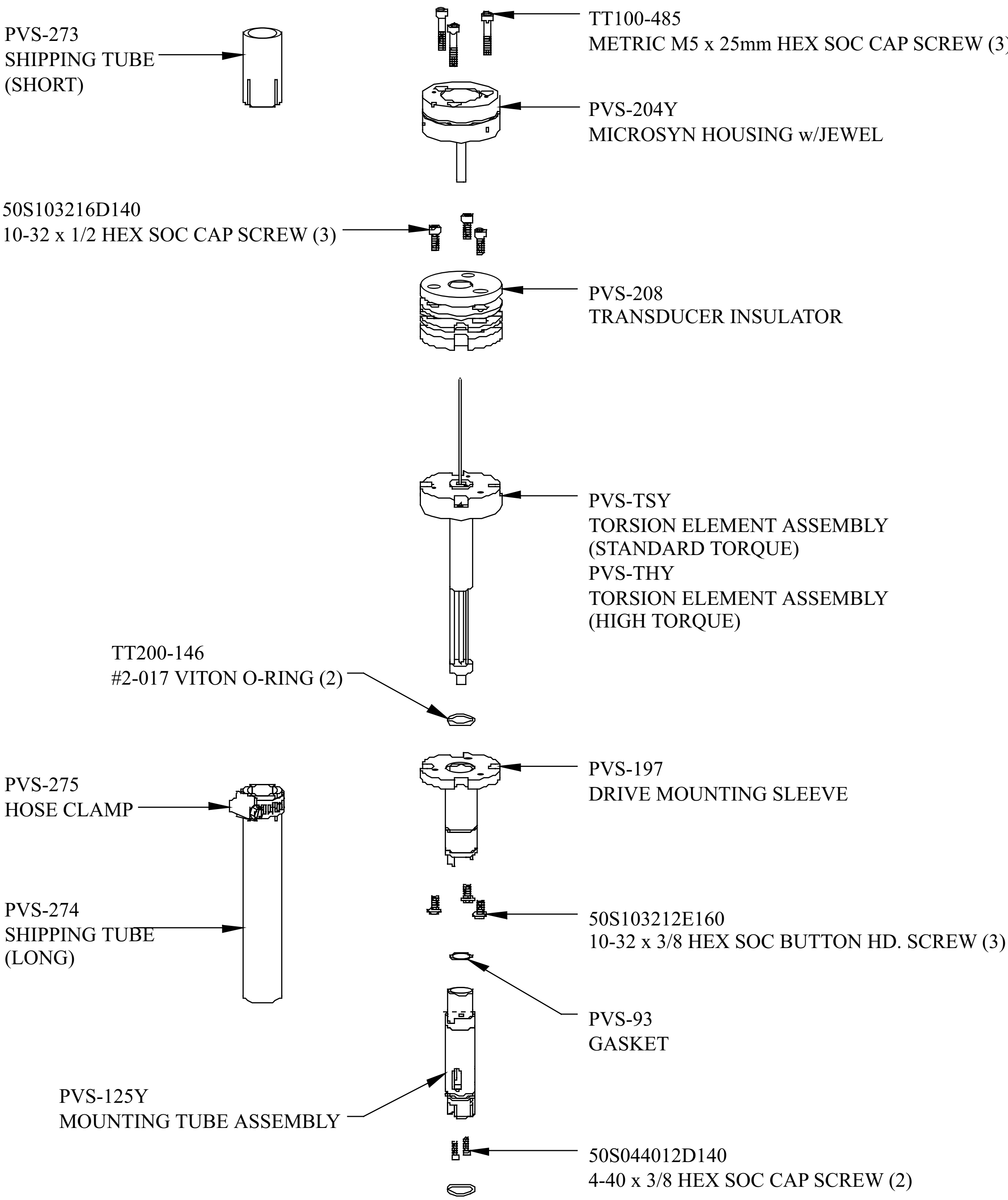


Figure 7-2: PVS Sensing Stack (Exploded View)

Appendix A - Customer Support

Introduction

Use the following information to Contact Brookfield Engineering Laboratories, Inc. for technical assistance or service:

Brookfield Engineering Laboratories, Inc.
11 Commerce Boulevard
Middleboro, Massachusetts 02346 U.S.A.
TEL: 508-946-6200
800-628-8139 (USA only - excluding MA)
FAX: 508-946-6262

Please have the following information available when calling so that we may assist you:

- Product Part Number
- Product Serial Number
- Product Application
- Specific Problem Area
- Hours of Operation
- Equipment Type

NOTE: Contact Brookfield to obtain a Return Material Authorization number before returning any equipment. The instrument must be cleaned prior to shipment and an MSDS must be provided for the materials being handled.

Appendix B - Drawings

RS-232 Cables, Part No. DVP-80

Use the information in Figure B-1 to test or to make your own RS-232 communication cable.

NOTE: Your computer may use either a standard 9-pin or 25-pin (male or female) D-type connector.

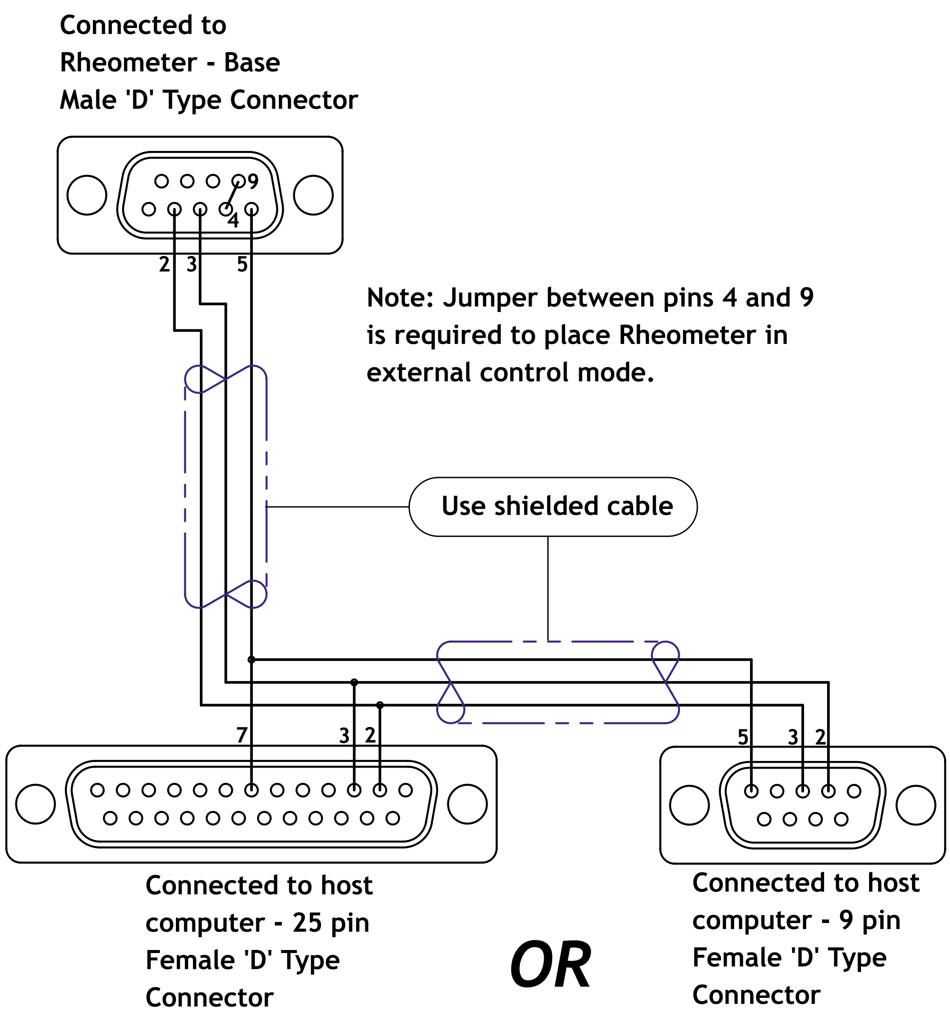


Figure B-1: RS-232 Cable Drawing

Appendix C – Calculations

Geometry (Stator) Factors

Each measurement geometry is made up of a stator (sometimes referred to as a bob) and a cup with optional inserts in between the two. The purpose of having multiple geometries is to increase the measurement range of the instrument.

Each geometry has two constants used to calculate viscosity, shear stress, and shear rate. The Geometry Torque Constant (SMC) is used in viscosity and shear stress calculations. The Shear Rate Constant (SRC) is used in viscosity and shear rate calculations.

The particulars for each of the geometries is as follows:

Table C-1: Geometry (Spindle) Factors

Bob (Spindle)	Annulus	SRC	SMC	Recommended Sample Size (ml)
B01	0.046	1.703	1700.0	23.0
B02	0.242	0.377	730.0	53.0
B05	0.096	0.850	1340.0	40.0
TA1	0.46	1.0	9750.0	150.0
4C	0.110	1.161	2500.0	120.0
TA5	0.096	0.850	8900.0	175.0
TC5*	0.590	0.285	1430.0	250.0

*TC5 geometry set uses the triple annulus cup (only) and the B5 stator (only).
Neither stator shroud or cup insert are used.

NOTE: The Annulus refers to the gap between the outer diameter of the spindle and the inner diameter of the surrounding cup or sleeve.

Torque Multiplier

The Torque Multiplier is an instrument calibration parameter. The Torque Multiplier for a Standard PVS (PVS002) should be between 450 and 550. The Torque Multiplier for a High Torque PVS (PVS003) should be between 900 and 1100. The Torque Multiplier is strictly related to the properties of the sensor (torsion element) and not the geometry in use.

NOTE: Refer to Torque Multiplier in Section 4 - Rheovision Software for more information

Viscosity Calculation

The viscosity for any rheometer model and geometry may be calculated using the equation:

Viscosity [cP] = (TM * %torque * 10,000)/(rpm * SMC * SRC)

Where:
TM = Torque Multiplier
SMC = Geometry Torque Constant
SRC = Shear Rate Constant

Shear Stress Calculation

The shear stress for any rheometer model and geometry may be calculated using the equation:

Shear Stress [dyne/cm^2] = (TM * %torque* 100)/SMC

Where:
TM = Torque Multiplier
SMC = Geometry Torque Constant

Shear Rate Calculation

The shear rate for any geometry may be calculated using the equation:

Shear Rate [1/sec^1] = rpm * SRC

Where:
SRC = Shear Rate Constant

NOTE: All the above constants can be found in the Geometry Table dialog box.

Appendix D - Spare Parts List

Tables D-1 through D-3 provide part numbers and a description of commonly used replacement parts. Refer to Appendix A and contact Brookfield or your Brookfield agent for price and delivery information.

Table D-1: Bob/Stator Spare Parts

Part Number	Description
PVS-221HC	Hastelloy C B1 bob (1.358 inches OD) for use with PVS-B1-D-HC set
PVS-222HC	Hastelloy C B2 bob (0.968 inches OD) for use with PVS-B2-D-HC set
PVS-223HC	Hastelloy C B5 bob (1.260 inches OD) for use with PVS-B1-D-HC or PVS-TA5B5-D-HC sets

Table D-2: Cup and Baffle Spare Parts

Part Number	Description
PVS-30HC	Hastelloy C Cup (1.450 inch ID) for use with any stator/bob
PVS-211HC	Hastelloy C Cup (2.440 inch ID) for use with PVS-TA5B5-D-HC triple annulus set
PVS-27HC	Hastelloy C baffle for use with any bob/stator

Table D-3: Miscellaneous Spare Parts

Part Number	Description
PVS-125Y	Mounting tube assembly
PVS-93	Gasket, mounting tube to torsion element
PVS-194Y	Lip seal and retainer assembly
PVS-193	Lip seal
PVS-195	O-ring, 2-029, Viton lip seal retainer
PVS-252YHC	Hastelloy C sample cup insert, 1.450 inch ID, 1.776 inch OD, for use with PVS-TA5B5-D-HC set
PVS-253YHC	Hastelloy C stator skirt, 2.042 inch ID, 2.122 inch OD, for use with PVS-TA5B5-D-HC set
TT200-146	O-ring, 2-017, Viton (bob/stator to mounting tube or torsion element)
PVS-74	O-ring, 2-140 Viton (sample cup)
PVS-THY	Torsion element, high torque
PVS-TSY	Torsion element, standard torque
PVS-34	Bearing
PVS-90	Protector, PVC, torsion element
PVS-123	Stator gasket (B1 or B5 bob/stator)
PVS-217	Stator gasket (B2 bob/stator)
PVS-105Y	Insulating disc assembly (B1, B5 only, includes RTD)
PVS-244	Pressure relief valve
PVS-268	Carrying case
PVS-126Y	Mounting tube spring replacement kit
PVS-SK	PVS head service tool kit
PVS-SSY-S	Complete torque sensor assembly