

BROOKFIELD MODEL VTE250
ELECTRIC VISCOSEL PROCESS VISCOMETER

Installation, Operation, and Maintenance Instructions

Manual No. M06-512



SPECIALISTS IN THE
MEASUREMENT AND
CONTROL OF VISCOSITY

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Section 1 - VTE250 Process Viscometer Description

Introduction

The Brookfield VTE250 Process Viscometer is a highly sensitive versatile instrument that measures process fluid viscosity at given shear rates. Viscosity is a measure of a fluid's resistance to flow. Refer to Appendix A and contact Brookfield Engineering Laboratories' to request More Solutions To Sticky Problems, a detailed guide of viscosity mathematics.

Features and Benefits

The Brookfield VTE250 Process Viscometer incorporates the following features:

- Simplified Installation and Operation
- Easy To Read Digital Display - User's choice of % Torque or Engineering Units
- Reduced Space Requirement
- 4 - 20 mA Output Signal
- Continuous Sensing
- Low Maintenance
- $\pm 1\%$ Full Scale Accuracy, 0.2% Full Scale Repeatability
- Low Cost
- Relay Control Selectable by User
- Direct RS232 output for connection to PC

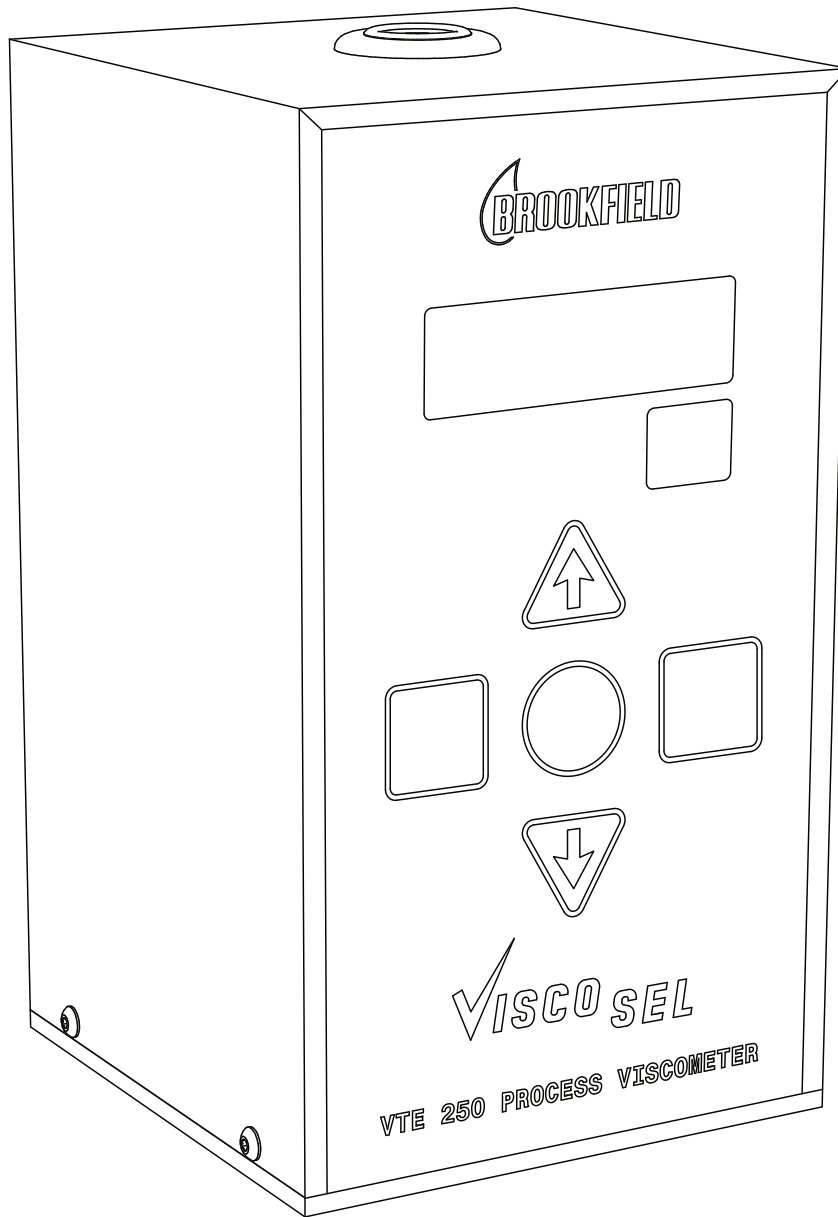


Figure 1-1: Typical VTE250 Process Viscometer

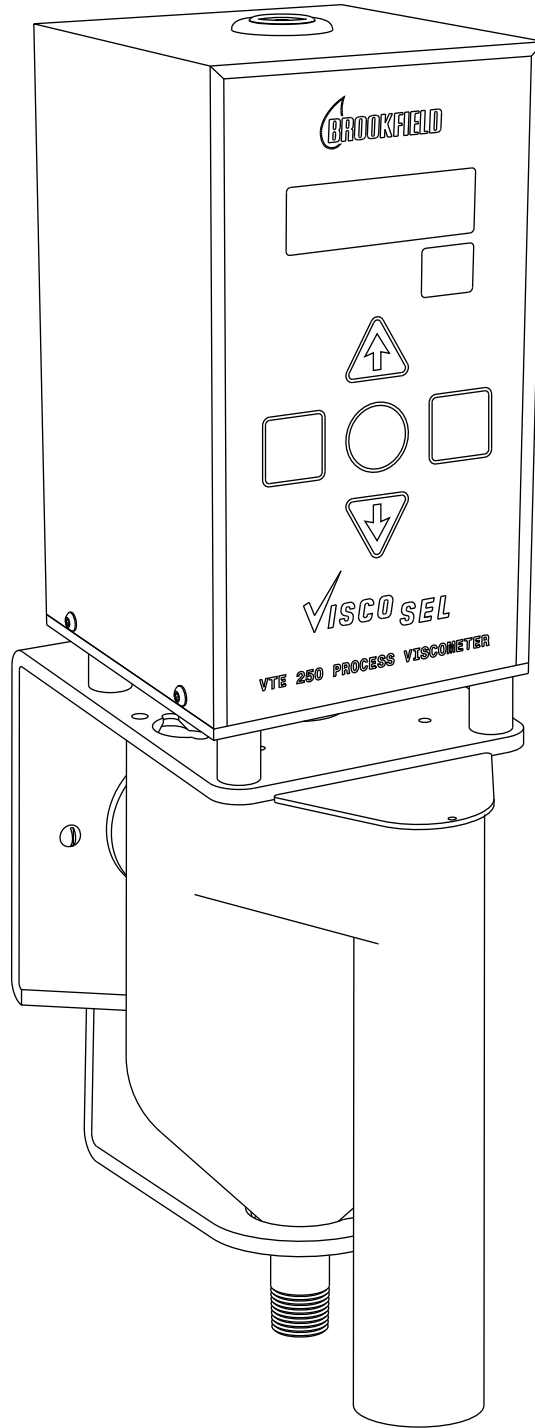


Figure 1-2: VTE250 Process Viscometer (with optional Measuring Chamber)

Theory of Operation

The principle of operation of the VTE250 Process Viscometer is to rotate a spindle, which is immersed in a process fluid, through a calibrated spring. The viscous drag of the fluid against the spindle is measured by the spring deflection. Spring deflection is measured with a rotary transducer which provides a torque signal.

The measurement range of the VTE250 Process Viscometer (in centipoise or milli-pascal seconds) is determined by the rotational speed of the spindle, the size and shape of the spindle, the container in which the spindle is rotating, and the full scale torque of the calibrated spring.

Brookfield Engineering Laboratories, Inc. offers a four spring torque series as listed in Table 1-1. The higher the spring torque as designated by (1/8, 1/4, 1/2), the higher the measurement range. The viscosity measurement range for each spring may be found in Appendix C.

Table 1-1: Spring Torque Series

Viscosel Model	Dyne-cm	milli-Newton meter
1/8 RVVTE	896	0.0896
1/4 RVVTE	1792	0.1792
1/2 RVVTE	3593	0.3593
RVVTE	7187	0.7187

NOTE: The higher the spring torque value, the higher the measurement range. (see Table C).

All units of measurement are displayed as either percent of torque, or in engineering units.

The VTE250 Process Viscometer is equipped with a process control relay that can be turned ON or OFF by setting Controller High and Low limits. The relay can be used to turn process equipment ON or OFF depending upon the process fluid viscosity. When the High limit has been reached, the relay is energized. When the Low limit has been reached, the relay is de-energized. Refer to Section 3 - Calibration and Operation for additional information.

The measuring range can be varied by changing the spindle as specified in Tables C-1 - C-4. Refer to Appendix C for more information.

Correlation with other Measurements

There may be a difference between laboratory and process viscosity measurements depending upon shear conditions existing pursuant to the measurement.

Viscosity measurements are unique among common types of fluid measurement in that, for most fluids, numerical values that are generated are dependent upon flow conditions in the fluid being measured (shear rate or velocity gradient). Other factors such as temperature change, turbulence, and pH among the most prominent, also affect the readings.

Frequently it may become necessary to correlate readings provided by your on-line viscometer to those factors which influence viscosity obtained by other methods. The correlation consists of holding the viscosity dependent factors constant, as mentioned above, and plotting the on-line viscosity value against the other reading as shown in Figure 1-3. A successful empirical correlation will assure the process operator that an on-line reading can be matched to a viscosity value derived by the other method. The correlation of these readings may be instrumental in educating process operators how the process stream relates to bench-top derived viscosity measurements.

Many factors beyond those noted above, which are more difficult to control in an on-line situation as opposed to a laboratory environment, can potentially affect your correlation. Refer to Appendix A and contact Brookfield Engineering Laboratories, Inc. for assistance in generating an empirical correlation.

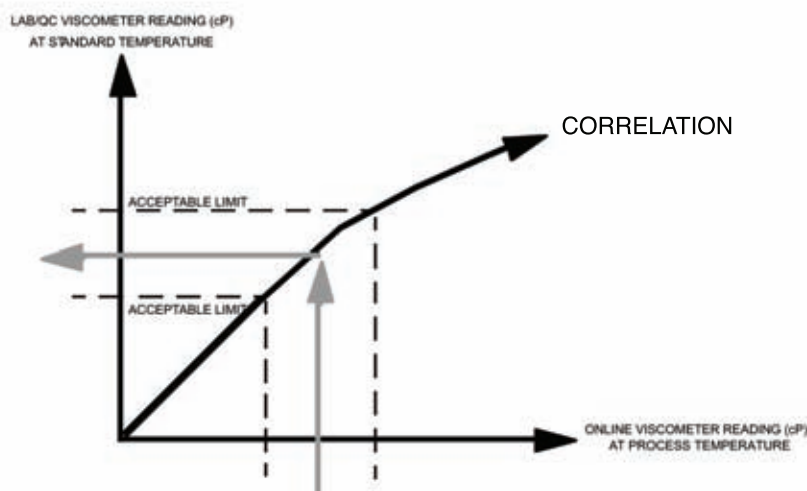


Figure 1-3: VTE250 Process Viscometer Correlation with Other Measurement Techniques

Specifications

The VTE250 Process Viscometer is designed to operate at the specifications listed in Table 1-2.

Table 1-2: VTE250 Process Viscometer Specifications

Parameter	Value
Speeds	20, 30, 50, 60, or 100 rpm
Accuracy	±1.0% of Full Scale Range
Repeatability	±0.2% of Full Scale Range
Output Signal	4 - 20 mA @ 1200 ohms max. and RS232
Weight	20 lbs. (9 kg)
Relay Rating	250 VAC, 3 Amp max.
Dimensions	Refer to Figures B-1 or B-2

Required Utilities

The VTE250 Process Viscometer requires the utility connections listed in Table 1-3 to operate.

Table 1-3: Utility Requirements

Parameter	Value
Supply Voltage	90 - 264 VAC
Line Frequency	47 - 63 Hz
Power	20 Watts

Options

Measuring Chamber

The VTE250 Process Viscometer can be used with an optional measuring chamber in which the spindle is placed to measure process fluid viscosity. Refer to Appendix A and contact Brookfield Engineering Laboratories, Inc. for more information.

Measuring Chamber Insert

The Measuring Chamber Insert can be used for non-turbulent process fluid measurement below 10 cP. For example, a VTE250 Process Viscometer calibrated to 1/8 RV and operating @ 20 RPM, equipped with a Measuring Chamber and Insert, and a VTA-SP-35 spindle, will have a range of 0 - 12 cP. Refer to Appendix A and contact Brookfield Engineering Laboratories, Inc. for more information.

Component Identification

The following paragraphs provide a brief description of each VTE250 Process Viscometer component. Refer to Figure 1-5 for component location.

Bubble Level

The Bubble Level, mounted on top of the VTE250 Process Viscometer, provides the installer with a built-in reference so the viscometer can be installed in a level position.

CAUTION

The VTE250 Process Viscometer must be installed in a level position to ensure accurate process fluid viscosity readings.

Digital Display

The Digital Display is primarily used to provide process fluid viscosity readings during normal operation. The display also indicates various information during the VTE250 Process Viscometer calibration. An LED indicator in the upper right corner of the display is illuminated when the process control relay is energized as shown in Figure 1-4. The firmware version number can also be displayed. Refer to Section 3 - Calibration and Operation for more information.

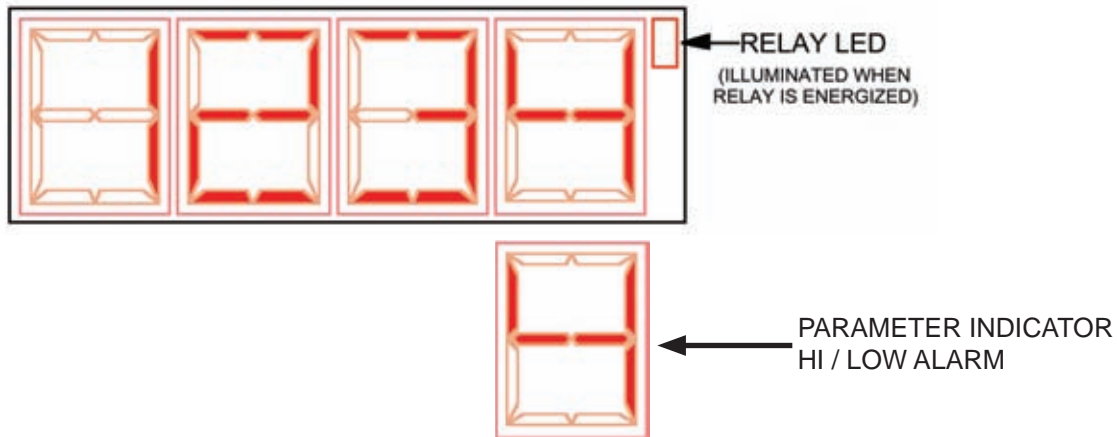


Figure 1-4: Digital Display and Relay LED Indicator

Power Switch

The Power Switch, which is mounted on the VTE250 Process Viscometer rear panel, is used to apply or remove power from the VTE250 Process Viscometer.

Process Signal Connector

The Process Signal Connector, which is mounted on the VTE250 Process Viscometer rear panel, provides the 4 - 20 mA signal that is proportional to the process fluid viscosity. This signal can be sent to the process fluid control system. Refer to Section 2 - Installation for more information.

Power Cord Receptacle

The Power Cord Receptacle, which is mounted on the VTE250 Process Viscometer rear panel, is used to connect the AC power cord to the VTE250 Process Viscometer. Refer to Table 1-3 for the appropriate power specifications.

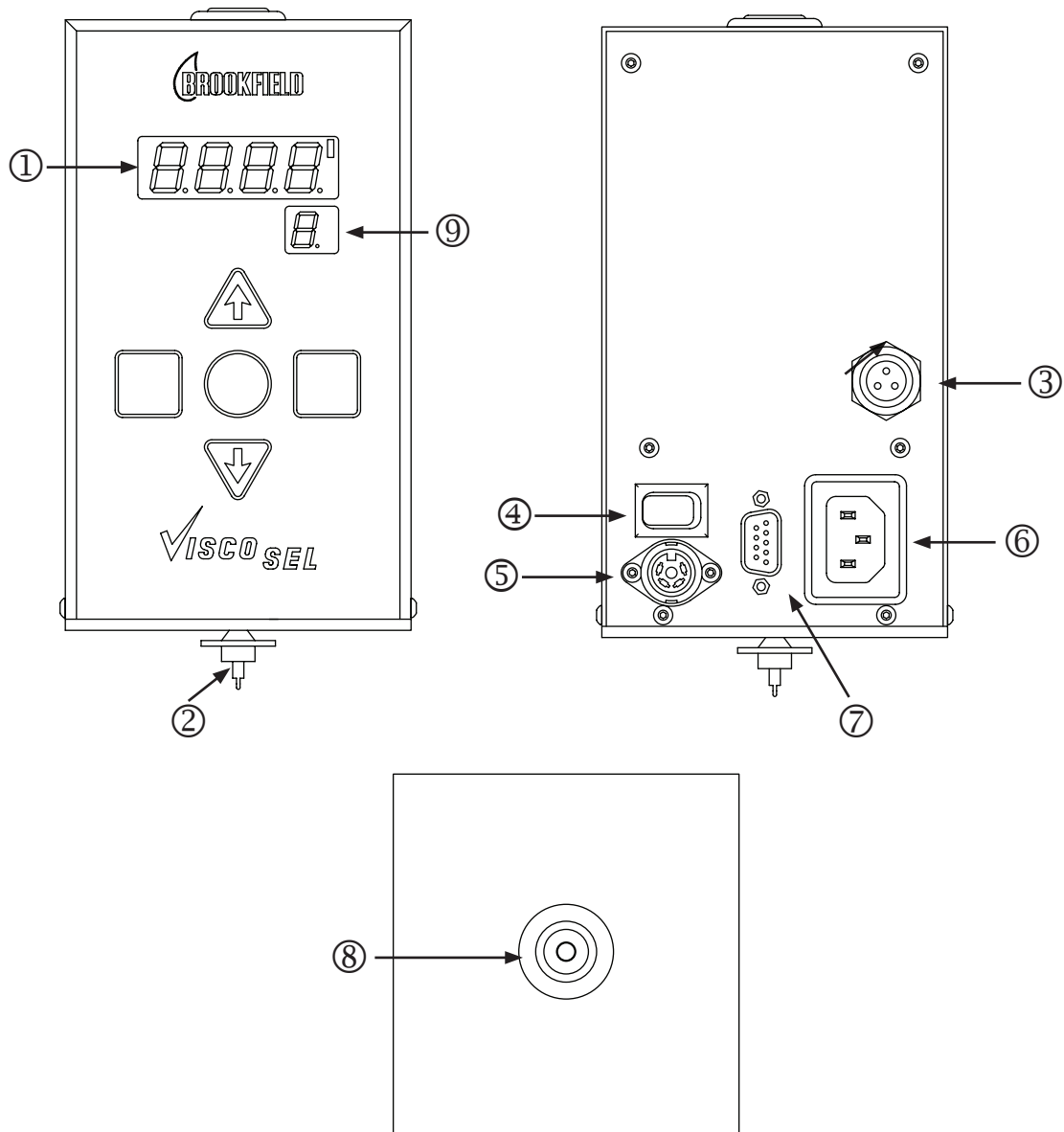
Process Control Relay Connector

The VTE250 Process Viscometer is equipped with a process control relay that can be turned ON or OFF by setting Controller Upper and Lower limits. The relay can be used to turn process equipment ON or OFF depending upon the process fluid viscosity setpoints. When the Upper limit setpoint has been reached, the relay is energized and the LED will be illuminated. When the Lower limit setpoint has been reached, the relay is de-energized and the relay LED is OFF. Refer to Section 2 - Installation and Section 3 - Calibration and Operation for additional information.

RS232 Connector

The RS232 Connector, which is mounted on the process viscometer rear panel, will output an information string through the RS232 port. The port runs at 9600 baud, 8 bits, no parity, 1 stop bit. The string is formatted as shown below, with one space between each entry. The field length of each data item is noted, includes the decimal point, and is padded with spaces:

- h% Torque (5)
- Motor Speed (3)
- Scaled % Torque (5)
- Hi Alarm Value (5)
- Low Alarm Value (5)
- Zero offset Value (5)
- Scaled Setpoint Value (5)



LEGEND

- 1. 4 DIGIT DISPLAY
- 2. DEFLECTOR HUB
- 3. PROCESS CONTROL RELAY CONNECTOR
- 4. POWER SWITCH
- 5. PROCESS SIGNAL CONNECTOR (4 - 20 mA)
- 6. POWER CORD CONNECTOR
- 7. RS232 CONNECTOR
- 8. BUBBLE LEVEL
- 9. 1 DIGIT DISPLAY

Figure 1-5: Typical VTE250 Process Viscometer Component Identification

Section 2 - Installation

Unpacking and Inspection

Once the shipping carton has been opened, please make sure that you have received the components listed in Table 2-1. Notify the shipping company if there is any shipping damage. Refer to Appendix A and notify Brookfield Engineering Laboratories, Inc. immediately if there are missing or damaged components.

Table 2-1: Shipping Carton Contents

Item	Quantity
VTE250 Process Viscometer	1
Power Receptacle Plug	1
Signal Cable and Connector	1
Instruction Manual	1
Process Control Relay Connector	1

VTE250 Process Viscometer Installation



WARNING

Make sure power, as specified in Table 1-3, is available for the VTE250 Process Viscometer before installation. Connecting the viscometer to power other than what is specified in Table 1-3 will damage the unit.

1. Install the VTE250 Process Viscometer on the process equipment. Adjust the mounting hardware until the bubble level on top of the VTE250 Process Viscometer indicates it is level.
2. Install the spindle on the VTE250 Process Viscometer.

NOTE: If the optional Brookfield Engineering Laboratories' measuring chamber is being installed, proceed with step 3. If the measuring chamber is not being used, proceed with step 4.

3. Install the measuring chamber according to the Installation Instructions that came with the measuring chamber.
4. Locate the spindle in the process fluid as follows:
 - a. Insert the spindle in representative process fluid.
 - b. Make sure the spindle is two inches away from any chamber wall and completely submerged at all times.
 - c. Make sure there are no obstructions in the area of the spindle.
 - d. Make sure there are no vortices in the process fluid in the area of the spindle.

NOTE: Verify the VTE250 Process Viscometer output signal as specified in Table 1-2 matches the recording or controlling equipment being used.

5. If a recording or controlling device is being used, perform the following steps:
 - a. Connect the provided signal cable to the 4 pin-DIN connector, as shown in Figure 1-5 item 5, on the rear panel of the VTE250 Process Viscometer. Lock the connector ring.

- b. Connect the red (+) wire from the signal cable to the positive lead of the recorder or controlling device.
- c. Connect the black (-) wire from the signal cable to the negative lead of the recorder or controlling device.

NOTE: This is a 4-20 mA signal.

6. If applicable, connect the process control relay cable to the connector on the rear panel as shown in Figure 1-5 item 3, of the VTE250 Process Viscometer.
7. Connect the process control relay cable to the process system as shown in Figure 2-1.

NOTE: If the VTE 250 Process Viscometer control output is to be used for actuating a device to add solvent due to evaporation loss, use pins 1 and 2 as shown in Figure 2-1. Connect an appropriate device power source to the pin 2 terminal and connect pin 1 to the device.

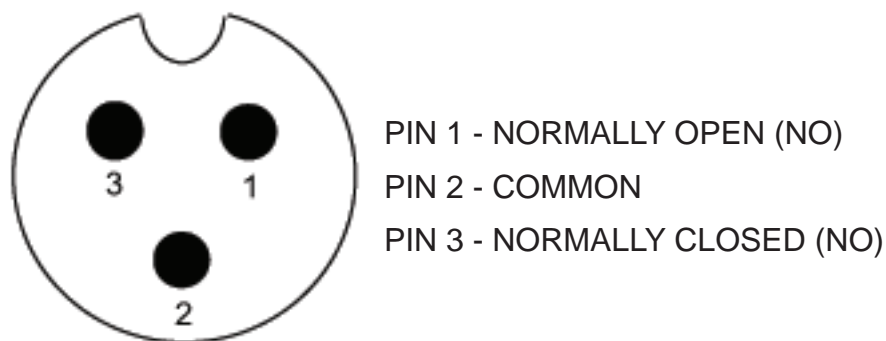


Figure 2-1: Process Control Relay Cable Connector Pin Identification

8. Connect the power cord to the a grounded AC power source as specified in Table 1-3.
9. Refer to Section 3 - Calibration and Operation.

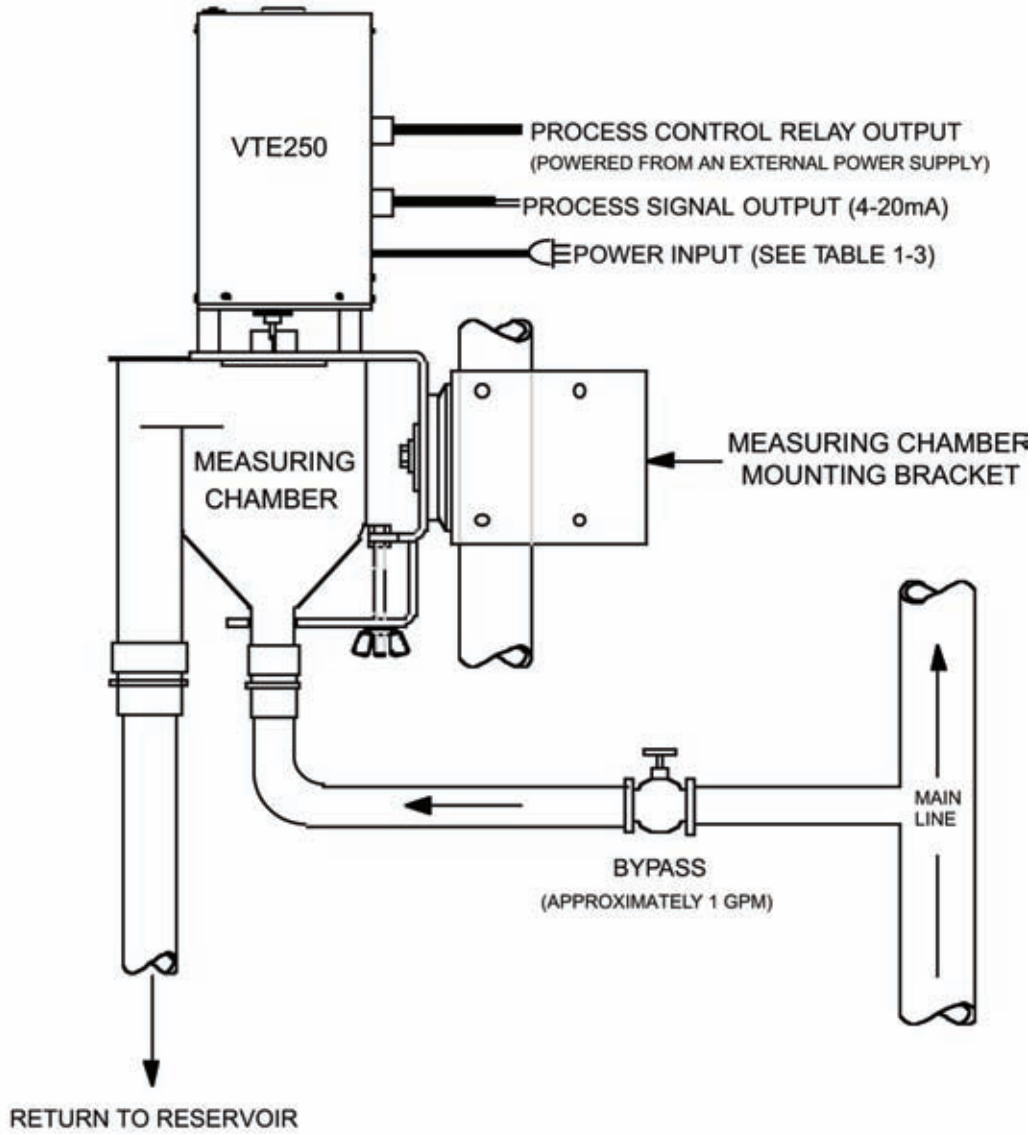


Figure 2-2: Typical VTE250 Process Viscometer Installation

Section 3 - Calibration and Operation

Introduction

The VTE250 Process Viscometer is calibrated at the factory and shipped ready for service. However, Brookfield Engineering Laboratories, Inc. recommends that the viscometer calibration be verified after the following events have occurred:

- Installation
- Disassembly and Cleaning
- Component Replacement

Calibration Setup

Once the viscometer has been installed, cleaned, or a component has been replaced, it must be calibrated. The calibration test cable must be connected.

1. Make sure the following has been completed before proceeding with calibration:
 - a. The viscometer is installed in a level position as described in Section 2 - Installation.
 - b. There is no load applied to the spindle.
2. Connect the calibration test cable 4-pin DIN plug to the connector on the viscometer rear panel as shown in Figure 1-5 item 5.
3. Connect the positive (+) lead of an ammeter to the red wire (pin 1) on the calibration test cable.
4. Connect the negative (-) lead of an ammeter to the black wire (pin 2) on the calibration test cable.
5. Connect the viscometer power cord into the power connector on the rear panel and then to the power supply.
6. Proceed with VTE250 Process Viscometer Calibration.

VTE250 Process Viscometer Calibration

During Calibration the Firmware moves to the next calibration parameter when the “INDEX” Key is pressed. Once Parameters have been calibrated, turn the viscometer Power OFF and then back ON to return to normal operation or press the ON/OFF Key on the Keypad.

Parameters as indicated by the number on the small one digit display:

0. Setpoint
1. Hi Alarm
2. Low Alarm
3. Relay Control Window
4. Relay Control On/Off
5. Dose Time
6. Motor Speed
7. Spindle Calibration
8. 100% Torque Reading Value
9. Zero Offset
 - a. 4ma adjust
 - b. 20ma adjust

The parameter entry procedure follows:

1. Remove the spindle from the instrument. Turn power on. The display will show “ZERO”. The one digit display will show a “-”.
 - Pressing the ON/OFF key will begin the **Autozero** routine. The “ZERO” on the display will blink, indicating that the Autozero is being performed. Autozero will run the motor at 50 RPM for 30 seconds, resulting in 25 revolutions. The last four readings, taken during the last revolution, will be used in the Autozero calculations.
 - Pressing the INDEX key will bypass the Autozero routine and cause the unit to display the last accessed parameter. The parameter entry process will begin at that point. To resume operation without parameter changes, press ON/OFF key.

NOTE: Do not autozero with spindle in the process fluid.

2. At the end of the Autozero routine, the display will show “0000”. Replace the spindle. Push the “INDEX” key. Until the digit display shows “0”, and the four-digit display will flash with the current **Setpoint** value. The range of Setpoint values is 0 to 100 %, with a default value of 0%. To modify the parameter value:
 - Use the UP and DOWN keys to move the decimal point to the right (UP) or the left (DOWN). Use the SET key to accept the position of the decimal point. The left most digit will begin to flash.
 - Use the UP and DOWN keys to adjust the value of the flashing digit. Use the SET key to accept the value of this digit. The next digit to the right will begin flashing. After the last digit has been adjusted, use the SET key to accept the



- value of that digit. The entire four-digit display will now be flashing.
- Pressing the UP or DOWN key will return the operator to the decimal point adjustment.
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.
 - If a value greater than the maximum range is entered, the display will continually flash “ERR1”. Pressing the SET key will return the operator to the decimal point adjustment.
3. Push INDEX. The one digit display shows “1”, and the four-digit display will flash with the current **Hi Alarm** value. The range of Hi Alarm values is 0 to 100 %, with a default value of 100%. To modify the parameter value:
- Use the UP and DOWN keys to move the decimal point to the right (UP) or the left (DOWN). Use the SET key to accept the position of the decimal point. The left most digit will begin to flash.
 - Use the UP and DOWN keys to adjust the value of the flashing digit. Use the SET key to accept the value of this digit. The next digit to the right will begin flashing. After the last digit has been adjusted, use the SET key to accept the value of that digit. The entire four-digit display will now be flashing.
 - Pressing the UP or DOWN key will return the operator to the decimal point adjustment
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.
 - If a value greater than the maximum range is entered, the display will continually flash “ERR1”. Pressing the SET key will return the operator to the decimal point adjustment.
 - If a value is entered for the High Alarm that is less than that already programmed for the Low Alarm, the display will continually flash “ERR2”. Pressing the SET key will return the operator to the decimal point adjustment.
4. Push INDEX. The one digit display shows “2”, and the four-digit display will flash with the current **Low Alarm** value. The range of Low Alarm values is 0 to 100 %, with a default value of 0%. To modify the parameter value:



- Use the UP and DOWN keys to move the decimal point to the right (UP) or the left (DOWN). Use the SET key to accept the position of the decimal point. The left most digit will begin to flash.
 - Use the UP and DOWN keys to adjust the value of the flashing digit. Use the SET key to accept the value of this digit. The next digit to the right will begin flashing. After the last digit has been adjusted, use the SET key to accept the value of that digit. The entire four-digit display will now be flashing.
 - Pressing the UP or DOWN key will return the operator to the decimal point adjustment.
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.
 - If a value greater than the maximum range is entered, the display will continually flash “ERR1”. Pressing the SET key will return the operator to the decimal point adjustment.
 - If a value is entered for the Low Alarm that is greater than that already programmed for the High Alarm, the display will continually flash “ERR2”. Pressing the SET key will return the operator to the decimal point adjustment
5. Push INDEX. The one digit display shows “3”, and the four-digit display will flash with the current **Relay Control Window** value. This value sets a % torque window $\frac{1}{2}$ above and below the setpoint value. The range of Relay Control Window value is 0 to 200 %, with a default value of 2%. To modify the parameter value:
- Use the UP and DOWN keys to move the decimal point to the right (UP) or the left (DOWN). Use the SET key to accept the position of the decimal point. The left most digit will begin to flash.
 - Use the UP and DOWN keys to adjust the value of the flashing digit. Use the SET key to accept the value of this digit. The next digit to the right will begin flashing. After the last digit has been adjusted, use the SET key to accept the value of that digit. The entire four-digit display will now be flashing.
 - Pressing the UP or DOWN key will return the operator to the decimal point adjustment.
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.



- If a value greater than the maximum range is entered, the display will continually flash “ERR1”. Pressing the SET key will return the operator to the decimal point adjustment.
6. Push INDEX. The one digit display shows “4”, and the four-digit display will flash with the current **Relay Control On/Off** value. The four-digit display will show “ON” or “OFF”. The default value is off. To modify the parameter value:
 - Use the UP and DOWN keys to toggle between ON and OFF.
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.
 7. Push INDEX. The one digit display shows “5”, and the four-digit display will flash with the current **Dose Time** value (the left most digit will be blank). The range of Dose Time values is 0 to 100 seconds, with a default value of 0 seconds. To modify the parameter value:
 - Use the UP and DOWN keys to adjust the value of the left most digit. Note that this digit can only be a ‘1’ or a ‘0’. Use the SET key to accept the value of this digit. The next digit to the right will begin flashing. After the last digit has been adjusted, use the SET key to accept the value of that digit. The entire four-digit display will now be flashing.
 - Pressing the UP or DOWN key will return the operator to the left most digit adjustment.
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing. If the value is greater than 100, the unit will automatically return the operator to the left most digit adjustment.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.
 - If a value greater than the maximum range is entered, the display will continually flash “ERR1”. Pressing the SET key will return the operator to the left most digit adjustment.
 8. Push INDEX. The one digit display shows “6”, and the four-digit display will flash with the current **Motor Speed** value. The preset Motor Speed values are 20, 30, 50, 60, and 100 RPM, with a default value of 50 RPM. To modify the parameter value:
 - Use the UP and DOWN keys to increment or decrement though the motor speed values.



- Pressing the SET key will accept the new motor speed value, and the four-digit display will stop flashing.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.
9. Push INDEX. The one digit display shows “7”, and the four digit display will flash four dashes (----), and the unit will enter the **Spindle Calibration**. Immerse the spindle in a temperature controlled calibration fluid of known viscosity. Push SET. The instrument will run at the selected Speed parameter, and will flash a live percent torque reading. Push the UP / DOWN arrows until the display matches the known torque value of the calibration fluid relative to 100% of the full-scale range. Push SET to accept the calibration value and stop the motor. The display will stop flashing and show the last read percent torque reading.
- At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.
10. Push INDEX. The one digit display shows “8”, and the four-digit display will flash with the current **100% Torque Reading** value. The range of 100% Torque Reading values is 0 to 9999, with a default value of 100. To modify the parameter value:
- Use the UP and DOWN keys to move the decimal point to the right (UP) or the left (DOWN). Use the SET key to accept the position of the decimal point. The left most digit will begin to flash.
 - Use the UP and DOWN keys to adjust the value of the flashing digit. Use the SET key to accept the value of this digit. The next digit to the right will begin flashing. After the last digit has been adjusted, use the SET key to accept the value of that digit. The entire four-digit display will now be flashing.
 - Pressing the UP or DOWN key will return the operator to the decimal point adjustment.
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.

11. Push INDEX. The one digit display shows “9”, and the four-digit display will flash with the current **Zero Offset** value. Note that both positive and negative values are allowed. The range of Zero Offset values is -999 to 9999, with a default value of 0. To modify the parameter value:
 - Use the UP and DOWN keys to move the decimal point to the right (UP) or the left (DOWN). Use the SET key to accept the position of the decimal point. The left most digit will begin to flash.
 - Use the UP and DOWN keys to adjust the value of the flashing digit. The left most digit can be a value of 0 to 9, and ‘-’. Use the SET key to accept the value of this digit. The next digit to the right will begin flashing. After the last digit has been adjusted, use the SET key to accept the value of that digit. The entire four-digit display will now be flashing.
 - Pressing the UP or DOWN key will return the operator to the decimal point adjustment.
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.

12. Push INDEX. The one digit display shows “A”, and the four-digit display will flash with the current **4 ma Adjust** value, displayed in hexadecimal. The range of 4 ma Adjust values is 0000 to FFFF, with a default value of 29EA. To modify the parameter value:
 - Pressing the UP button will cause the left most digit to increment. This digit will continue to flash while the other 3 digits stop flashing.
 - Pressing the DOWN button will cause the left most digit to decrement. This digit will continue to flash while the other 3 digits stop flashing.
 - Pressing the SET button will accept the left most digit. The next digit to the right will start to flash, while the others stop flashing.
 - Use the UP and DOWN keys to adjust the value of whichever digit is flashing. Values go from 0 to 9, then from a to f. Observe the milliamp reading of the 4-20 ma output. Adjust the values of all the digits on the display for a reading of 4 ma. The digits on the left will have a larger affect on the 4-20ma reading. Use the SET key to accept the value of each digit as it is adjusted. The next digit to the right will begin flashing. After the last digit has been adjusted, use the SET key to accept the value of that digit. The entire four-digit display will now be flashing.
 - Pressing the UP or DOWN key will return the operator to the adjustment of the left most digit.
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing.



- At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.
13. Push INDEX. The one digit display shows “b”, and the four-digit display will flash with the current **20 ma Adjust** value, displayed in hexadecimal. The range of 4 ma Adjust values is 0000 to FFFF, with a default value of D202. To modify the parameter value:
- Pressing the UP button will cause the left most digit to increment. This digit will continue to flash while the other 3 digits stop flashing.
 - Pressing the DOWN button will cause the left most digit to decrement. This digit will continue to flash while the other 3 digits stop flashing.
 - Pressing the SET button will accept the left most digit. The next digit to the right will start to flash, while the others stop flashing.
 - Use the UP and DOWN keys to adjust the value of whichever digit is flashing. Values go from 0 to 9, then from a to f. Observe the milliamp reading of the 4-20 ma output. Adjust the values of all the digits on the display for a reading of 4 ma. The digits on the left will have a larger affect on the 4-20ma reading. Use the SET key to accept the value of each digit as it is adjusted. The next digit to the right will begin flashing. After the last digit has been adjusted, use the SET key to accept the value of that digit. The entire four-digit display will now be flashing.
 - Pressing the UP or DOWN key will return the operator to the adjustment of the left most digit.
 - Pressing the SET key will accept the new parameter value, and the four-digit display will stop flashing.
 - At any time during parameter adjustment, pressing the INDEX button exits the parameter the user is in and moves to the next parameter. Any adjustment that had not been accepted using the SET button will not be saved.
 - At any time during parameter adjustment, pressing the ON/OFF button returns the system to the normal operating screen. Any adjustment that had not been accepted using the SET button will not be saved.

Additional Parameter entry information:

- A flashing display, individual LED digit, or decimal point means that that item is in adjustment mode and can be altered or set.
- A non-flashing display means:
 - The adjustments have been accepted and user can INDEX to next parameter
 - User is at the normal operating display



— User can exit (ON/OFF) to the normal operating display

- To further change a parameter that has been set, the user must press INDEX until that parameter is displayed again and is flashing.
- All parameters are saved on power down, including the last parameter number accessed, as displayed by the one digit display.
- The one digit display always retains and displays the last parameter number accessed, and when the INDEX key is pushed, the parameter value referenced by the number in the one digit display is the one flashing for adjustment. On power up, the last accessed parameter number is retained and shown on the one digit display.

Normal Operating Mode

The normal operating mode can be entered from the Parameter Input mode by pressing the On / Off key.

Information presented in the Normal Operating mode is as follows:

Four Digit Display

- Displays a live, scaled percent torque reading.
- A flashing display indicates that the unit is in an alarm condition (scaled percent torque reading is above or below the alarm parameter values) or that the selected parameter is in adjustment mode.

One Digit Display

- Displays the last accessed Parameter number.
- If the unit is in an alarm condition, the one digit display will show an 'H' for a High Alarm, or an 'L' for a Low Alarm condition.

Small LED

- Located immediately to the right of the Four Digit Display.
- Illuminated whenever the relay is energized.

Keypad operation in the Normal Operating mode is as follows:

ON / OFF Key

When the motor is off, pressing the ON / OFF key will:

- Turn the motor on.
- Enable Alarms.
- Enable Relay Control (if Relay Control On / Off parameter is set to ON).

When the motor is on, pressing the ON / OFF key will:

- Turn the motor off.
- Disable Alarms.
- Disable Relay Control (if Relay Control On / Off parameter is set to ON).
- Turn relay off and clear out Dose timer.
- Display the last accessed Parameter number on the one digit display.

Index Key

The Index Key is active whether the motor is on or off. Pressing the Index Key will put the unit in the Parameter Entry Mode. This mode will operate as described above with the following exceptions:

- If the unit is actively dosing when the Index Key is pressed, during the time the unit is in Parameter entry mode, the relay will continue to be turned on and off per the programmed dose time. However, the unit will not be comparing the torque reading to the Relay Control Window. When the Parameter entry mode is exited and the unit is returned to normal operating mode, control monitoring will be restored. Care should be taken not to leave the unit in Parameter Entry mode when the motor is running.
- Alarm status will not be show as the small display is used to show the current parameter being adjusted. The unit will not be comparing the torque reading to the Hi and Low alarm values, so if an alarm condition occurs, it will not be noted until the unit is returned to normal operating mode. Care should be taken not to leave the unit in Parameter Entry mode when the motor is running.
- The unit will stop transmitting the data string.

Up Arrow Key

The Up Arrow key is inactive until the Index key is pressed, accessing the Parameter Entry Mode. The key will then operate as described above in the Parameter Entry section.

Down Arrow Key

The Down Arrow key is inactive until the Index key is pressed, accessing the Parameter Entry Mode. The key will then operate as described above in the Parameter Entry section.

Set Key

If the motor is running, pressing the SET Key causes the currently display scaled value to become the new Setpoint. If the displayed value includes a Zero Offset, the Setpoint is determined without using the Zero Offset. This new Setpoint value is saved to EEPROM and will be the Setpoint from that time forward. After the Setpoint is determined, the Zero Offset is factored back in.

If the motor is not running, the Set key is inactive until the Index key is pressed, accessing the Parameter Entry Mode.



RS232 String

If the motor is running, the unit will output an information string through the RS232 port. The port runs at 9600 baud, 8 bits, no parity, 1 stop bit. The string is formatted as shown below, with one space between each entry. The field length of each data item is noted, includes the decimal point, and is padded with spaces:

- % Torque (5)
- Motor Speed (3)
- Scaled % Torque (5)
- Hi Alarm Value (5)
- Low Alarm Value (5)
- Zero offset Value (5)
- Scaled Setpoint Value (5)



Parameter Definition

Setpoint

The Setpoint is a % torque value around which the operator wants to control his process. The Setpoint can be entered in the Parameter Entry mode or by using the SET key while the unit is actively running. The value displayed when the SET key is pressed is calculated without the Upper Torque Reading and Zero Offset value and becomes the new % torque Setpoint value.

Range: 0 to 100 % torque

Default: 0 %

Hi Alarm

The Hi Alarm value is a percentage of the scaled % torque above which the scaled % torque will cause a visual indication on the front panel. When in a Hi Alarm condition, the visual indication will be:

- Four digit display flashes the scaled % torque value
- One digit display shows “H” (not flashing)

Range: 0 to 100 % of scaled torque. Scaled torque is determined by the 100% Torque Reading (span) and the Zero Offset values.

Default: 100 %

Low Alarm

The Low Alarm value is a percentage of the scaled % torque below which the scaled % torque will cause a visual indication on the front panel. When in a Low Alarm condition, the visual indication will be:

- Four digit display flashes the scaled % torque value
- One digit display shows “L” (not flashing)

Range: 0 to 100 % of scaled torque. Scaled torque is determined by the 100% Torque Reading (span) and the Zero Offset values.

Default: 0 %

Relay Control Window

This value creates a % torque window centered around the Setpoint. It is used along with Relay Control On/Off and the Dose Time to create the control area for the process. See “Dose Time” below for more information.

Range: 0 to 200 % torque

Default: 2 % (+ or – 1 % around the Setpoint)

Relay Control On/Off

This parameter enables and disables the relay dosing. If control is set to ON, the unit will compare the measured % torque to the Relay Control Window, and will energize or de-energize the relay in accordance with the Dose Time to maintain the torque reading in the control area. If control is set to OFF, the relay will remain de-energized and the unit will not be controlling the process. See Dose Time below for more information.

Range: ON, OFF

Default: OFF

Dose Time

The Dose Time is the amount of time during a 100 second span that the relay will be energized when dosing is called for.

Range: 0 to 100 seconds

Default: 0

The Dose Time function, along with Relay Enable On/Off and the Relay Control Window, is as follows:

The unit must be running with the Relay Enable “ON”.

If the measured % torque goes above the setpoint by a value of $\frac{1}{2}$ the Relay Control Window, the relay will be energized and a 100 second timer will start.

The relay will remain energized until one of the following happens:

- Dose time expires:
 - Relay is de-energized.
 - 100 second timer continues to count down to zero.
- Measured % torque goes below the setpoint by a value of $\frac{1}{2}$ the Relay Control Window:
 - Relay is de-energized.
 - 100 second timer stops counting and is cleared.
- ON/OFF key is pressed:
 - Relay is de-energized.
 - 100 second timer stops counting and is cleared

If the 100 second timer counts down to zero, and the measured % torque has not dropped below the setpoint by a value of $\frac{1}{2}$ the Relay Control Window, the relay will be energized and the 100 second timer will start again.

This cycle will continue until the measured % torque has dropped below the setpoint by a value of $\frac{1}{2}$ the Relay Control Window.



If the operator goes into the Parameter Entry mode while the unit is running and in a dosing cycle, the relay will continue to be energized and de-energized per the dose time, but the unit will not be comparing the torque reading to the Relay Control Window to determine when the dosing should stop. When the operator leaves the Parameter Entry mode and returns to the Normal Operating mode, the unit will resume comparing the torque reading to the Relay Control Window and control the dosing cycle.

Motor Speed

The unit is capable of running at 20, 30, 50, 60 or 100 RPM.

Range: 20, 30, 50, 60, and 100

Default: 50

Spindle Calibration

Spindle Calibration is performed to give the unit data it uses to calculate % torque. See #9 in the Parameter Entry mode above.

100% Torque Reading

The 100% Torque Reading is the value that will be displayed when the measured torque is 100% and the Zero Offset is 0. The 100% Torque Reading can be considered the “span” when calculating the Scaled % Torque. Scaled % Torque is calculated by multiplying the measured % torque by the 100% Torque Reading, and then adding in the Zero Offset to that result. For example if the measured % torque is 50, the 100% Torque Reading is 400, and the Zero Offset is 0, then the Scaled % Torque would be 200 $((.5 * 400) + 0)$.

Range: 0 to 9999

Default: 100

Zero Offset

The Zero Offset is added to the product of the measured % torque and the 100% Torque Reading to modify the Scaled % Torque reading shown on the units display. For example if the measured % torque is 50, the 100% Torque Reading is 400, and the Zero Offset is 0, then the Scaled % Torque would be 200 $((.5 * 400) + 0)$. If the Zero Offset were changed to -110, then the Scaled % Torque would be 90 $((.5 * 400) + - 110)$.

Range: -999 to 9999

Default: 0



4ma Adjust Value

This is the number (in hex) that is written to the DAC to yield an output of 4ma on the current loop output. It is used to represent 0% torque.

Range: 0 to FFFF
Default: 29EA

20ma Adjust Value

This is the number (in hex) that is written to the DAC to yield an output of 20ma on the current loop output. It is used to represent 100% torque.

Range: 0 to FFFF
Default: D202

Section 5 - Troubleshooting

Introduction

Refer to Table 5-1 for troubleshooting common problems that may occur with the VTE250 Process Viscometer. If the procedures in Table 5-1 do not fix the problem you are experiencing, then refer to Appendix A and call Brookfield Engineering Laboratories, Inc. for assistance.

Table 5-1: Troubleshooting Procedures

Problem	Possible Cause	Corrective Action
Spindle does not rotate	Drive motor not energized	Turn power switch ON
Spindle rotates eccentrically	<ol style="list-style-type: none"> 1. VTE250 is not level 2. Dirt on spindle, extension, or coupling 	<ol style="list-style-type: none"> 1. Adjust mounting hardware until the bubble is centered in the level. 2. Refer to Section 5 and clean the spindle, extension or coupling.
Display indicates EEEE	<ol style="list-style-type: none"> 1. Spindle turning too quickly 2. Spindle interference 3. Spindle range too low (above 100% of scale) 	<ol style="list-style-type: none"> 1. Refer to Section 3 and perform the Calibration Setup and VTE250 Viscosel Calibration procedures. 2. Turn VTE250 motor OFF by keypad display, remove the spindle, turn motor ON. Display should indicate 0% torque. If not, refer to Appendix A and contact Brookfield Engineering Laboratories, Inc. 3. Spindle out of range. Refer to Appendix A and contact Brookfield Engineering Laboratories, Inc.



Table 5-1: Troubleshooting Procedures (continued)

Problem	Possible Cause	Corrective Action
Display indicates 00.0 and will not respond to viscosity measurements	1. Spindle not installed 2. Internal viscometer problem	1. Install spindle 2. Refer to Appendix A and contact Brookfield Engineering Laboratories, Inc.

Section 4 - Maintenance

Introduction

The VTE250 Process Viscometer is a low maintenance device that requires periodic cleaning of the spindle, deflector hub, base, spindle extensions and optional measuring chamber. The frequency of cleaning is dependent upon the process application.

Special Tools


Refer to Table 4-1 for the special tools required for maintaining the VTE250 Process Viscometer. Refer to Appendix A and call Brookfield Engineering Laboratories, Inc. for assistance in obtaining the tools.

Table 4-1: Special Tools

Tool Description	Part Number
4-40 Bristol Wrench	AT-2

Cleaning Without Optional Measuring Chamber

WARNING



Make sure electrical power is turned OFF before cleaning the VTE250 Process Viscometer.

1. Set the VTE250 Process Viscometer power switch to the OFF position.
2. Disconnect the power cord from the power source.
3. Close the valve on the process fluid supply line.
4. Drain the process fluid from the chamber.
5. Remove the spindle and spindle extensions as shown in Figure 4-1.

NOTE: Record the axial position of the deflector assembly before removing it from the viscometer.

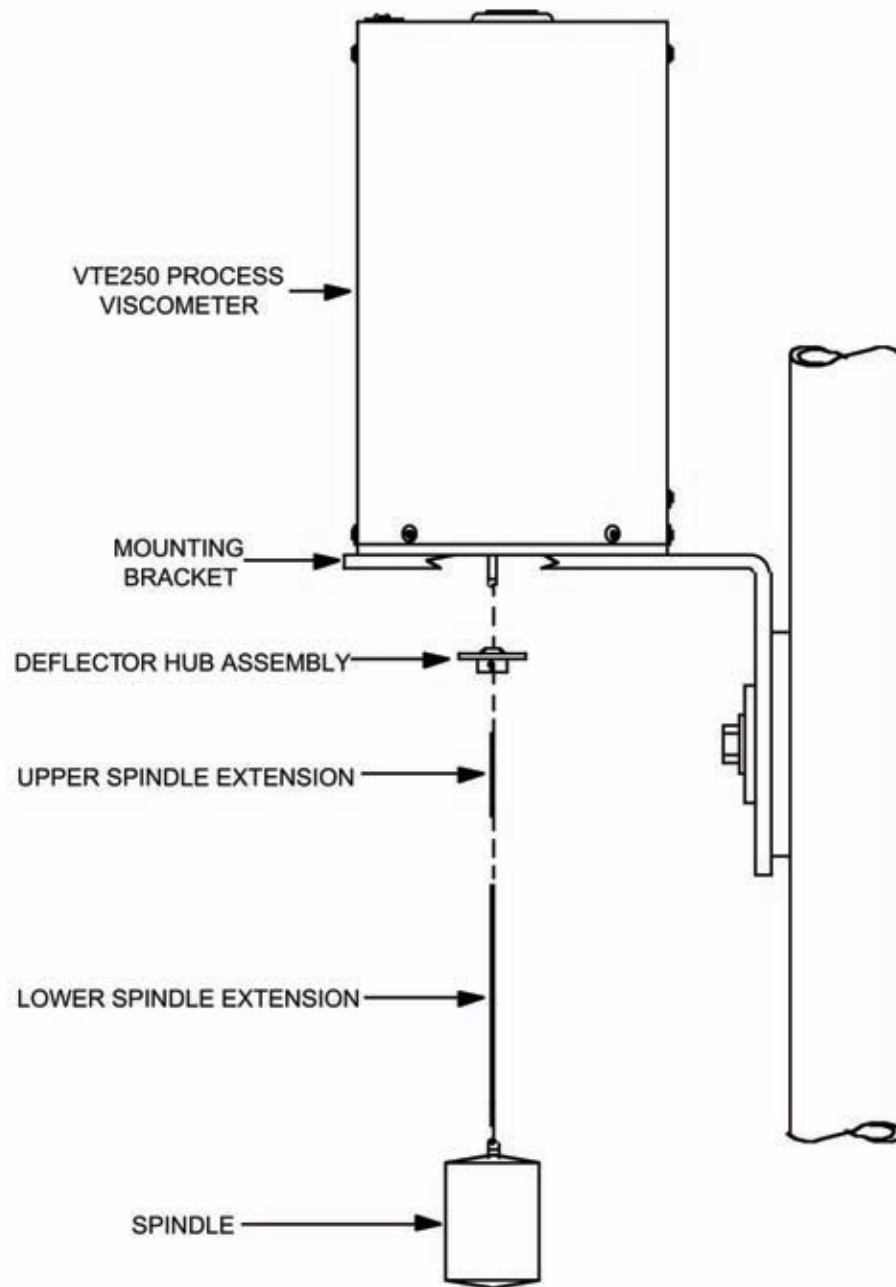
6. Using a 4-40 Bristol wrench, loosen the deflector assembly set screw and gently remove the deflector assembly from the shaft as shown in Figure 4-1.

NOTE: The solvent used for cleaning the VTE250 Process Viscometer is dependent upon the process fluid being measured.

7. Using an appropriate solvent, gently clean the viscometer base, deflector assembly, spindle and extensions until all process fluid build-up has been removed.
8. Install the deflector assembly in its original position and tighten the set screw.
9. Install the spindle extension(s).
10. Install the spindle.
11. Connect the power cord to the power source.


NOTE: Do not open the process fluid supply valve until instructed to do so in Section 3 - Calibration.

12. Refer to Section 3 - Calibration and perform Calibration Setup.



*Figure 4-1: VTE250 Process Viscometer Disassembly
(without Optional Measuring Chamber)*

Cleaning With Optional Measuring Chamber

	WARNING
	Make sure electrical power is turned OFF before cleaning the VTE250 Process Viscometer.

1. Set the VTE250 Process Viscometer power switch to the OFF position.
2. Disconnect the power cord from the power source.
3. Close the valve on the process fluid supply line.
4. Drain the process fluid from the measuring chamber.
5. Disconnect the process fluid supply and return lines from the measuring chamber.
6. Refer to Figure 4-2 and loosen the wing nut and swing the bracket clamp out of the way. Remove the measuring chamber and baffle plug.
7. Remove the lower spindle extension (SXV-13, 1 5/8 inches) and the spindle from the viscometer.

CAUTION
Be careful not to damage the deflector hub assembly when removing the viscometer from the mounting bracket.

8. Remove the viscometer from the mounting bracket as follows and as shown in Figure 4-2.:
 - a. Remove the four bracket mounting screws.
 - b. Remove the viscometer from the bracket and carefully place the viscometer on its side on a workbench.
 - c. Retain the stand-offs and screws for reassembly.
 - d. Remove the upper spindle extension (SXV-08, 1 inch).

9. Using a 4-40 Bristol wrench, loosen the deflector assembly set screw and gently remove the deflector assembly from the shaft as shown in Figure 4-2.

NOTE: The solvent used for cleaning the VTE250 Process Viscometer is dependent upon the process fluid being measured.

10. Using an appropriate solvent, gently clean the viscometer base, deflector assembly, measuring chamber, spindle and extensions and baffle plug until all process fluid build-up has been removed.
11. Install the upper spindle extension.
12. Install the deflector assembly in its original position and tighten the set screw.
13. Place the stand-offs on top of the mounting bracket and install the viscometer on the mounting bracket. Secure the viscometer in place using the mounting screws.
14. Install the lower spindle extension and the spindle.
15. Install the measuring chamber and baffle plug and swing the bracket in place under the chamber. Tighten the wing nut.
16. Connect the process fluid supply and return lines to the measuring chamber.
17. Connect the power cord to the power source.

NOTE: Do not open the process fluid supply valve until instructed to do so in Section 3 - Calibration.

18. Refer to Section 3 - Calibration and perform Calibration Setup.

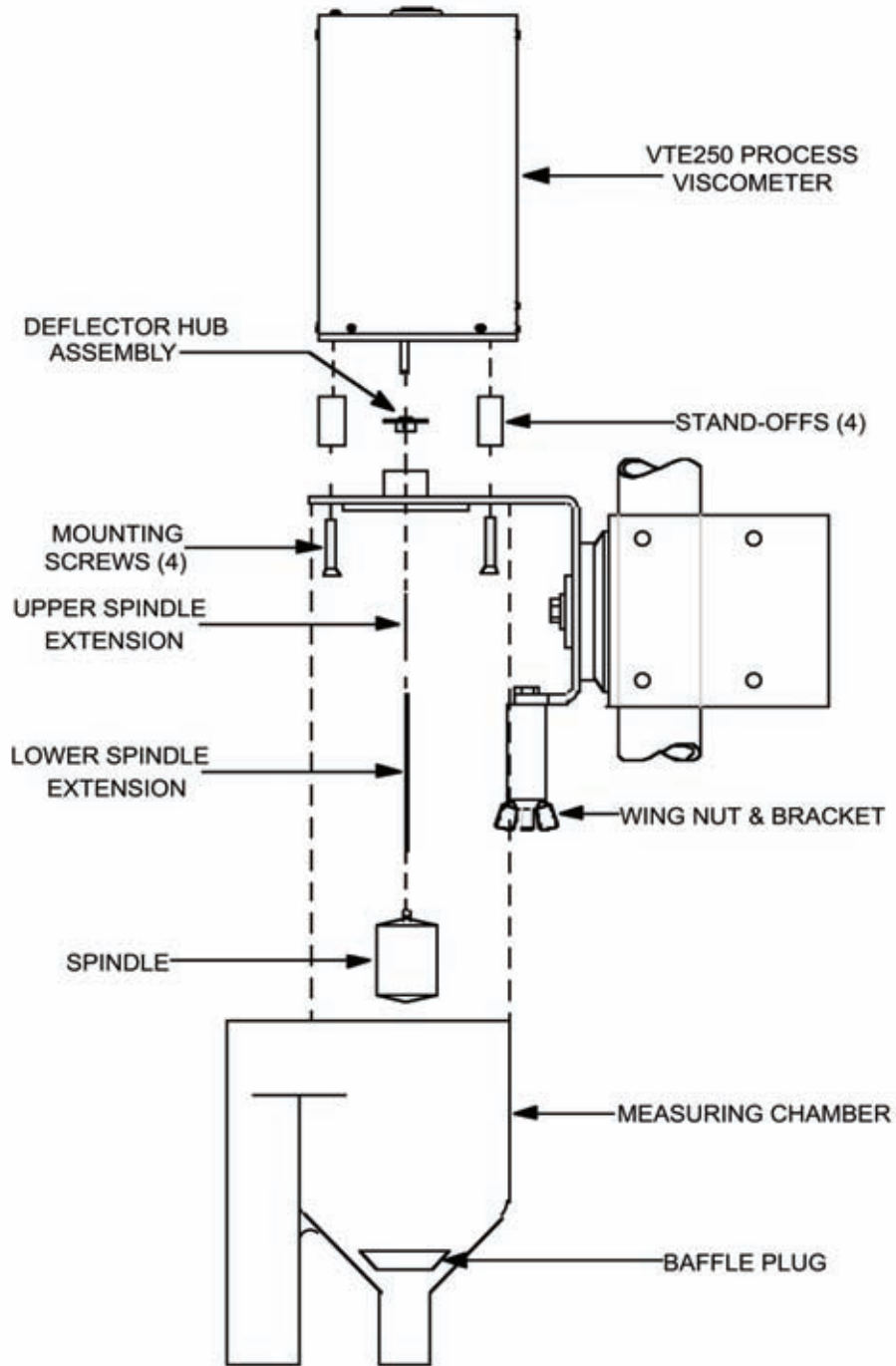


Figure 4-2: VTE250 Process Viscometer Disassembly (with Optional Measuring Chamber)



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

Instrument Repair Procedure and Guidelines

In the event that your Process Viscometer should require factory maintenance, Brookfield Engineering has provided the following guidelines and recommendations to follow to ensure a prompt turn around time for all repaired items.

Before returning any Brookfield Process Viscometer, please contact our Process Service/Sales Department to obtain a **Return Materials Authorization Number** (RMA #). This will ensure that your instrument is routed to the proper Repair Department when received. Unnecessary delays result when “unannounced” repairs arrive at our facility and have to be sorted and routed outside standard procedures. To contact the Process Service/Sales Department, please call **508-946-6200** or **800-628-8139**; or you may prefer to email us at service@brookfieldengineering.com.

Please be sure to follow these guidelines when returning your instrument:

1. The RMA form received from us is completely filled out with the correct information.



2. Ensure that the MSDS section of the RMA is completed and any applicable MSDS sheets are also included with your instrument to be repaired. Failure to comply with MSDS regulations may result in delays to your repair.
3. Including a Purchase Order Number with your RMA will allow us to complete repairs to a specified dollar amount determined by the product type, and thereby, bypassing the need to complete an “Estimate of Repair” to submit for your approval. If you wish to be informed of repair cost before proceeding, please specify on the RMA form.
4. Our method of return shipment is via UPS. Should you prefer a different method or wish to charge to your carrier account number, be sure to include this information.

Appendix B - Drawings

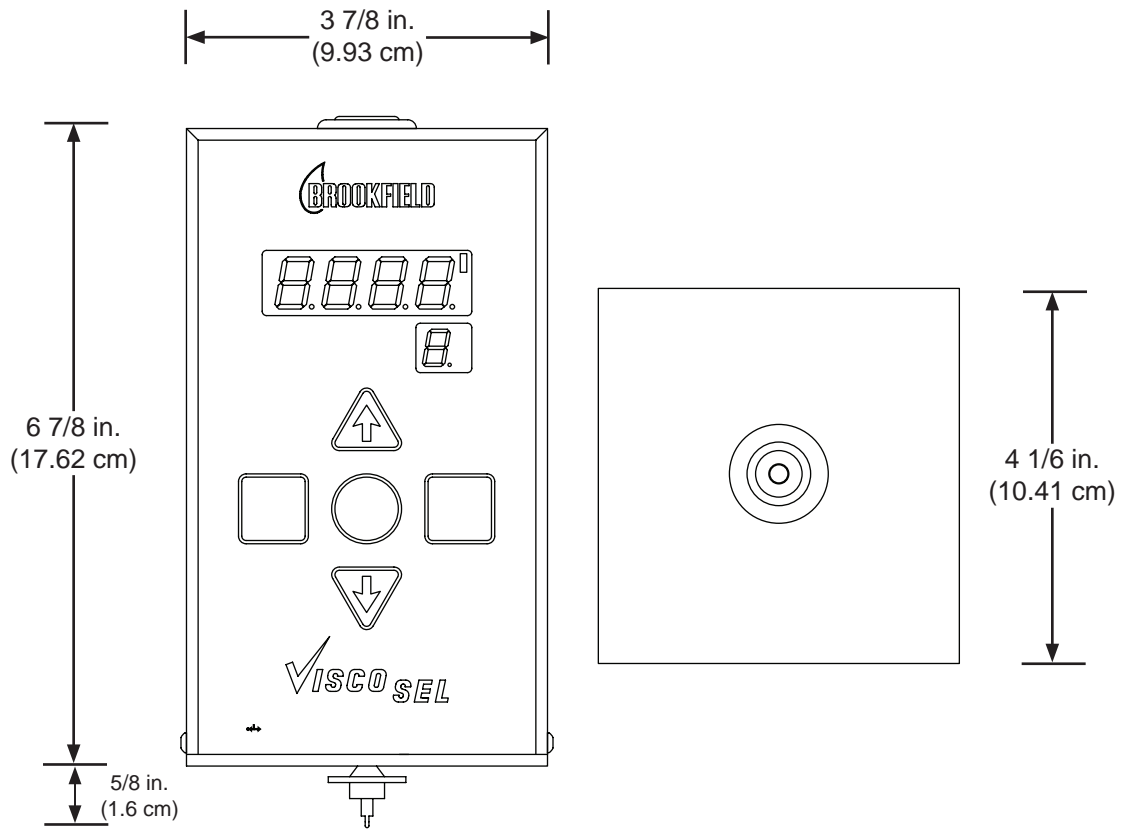


Figure B-1: VTE250 Process Viscometer Dimensions

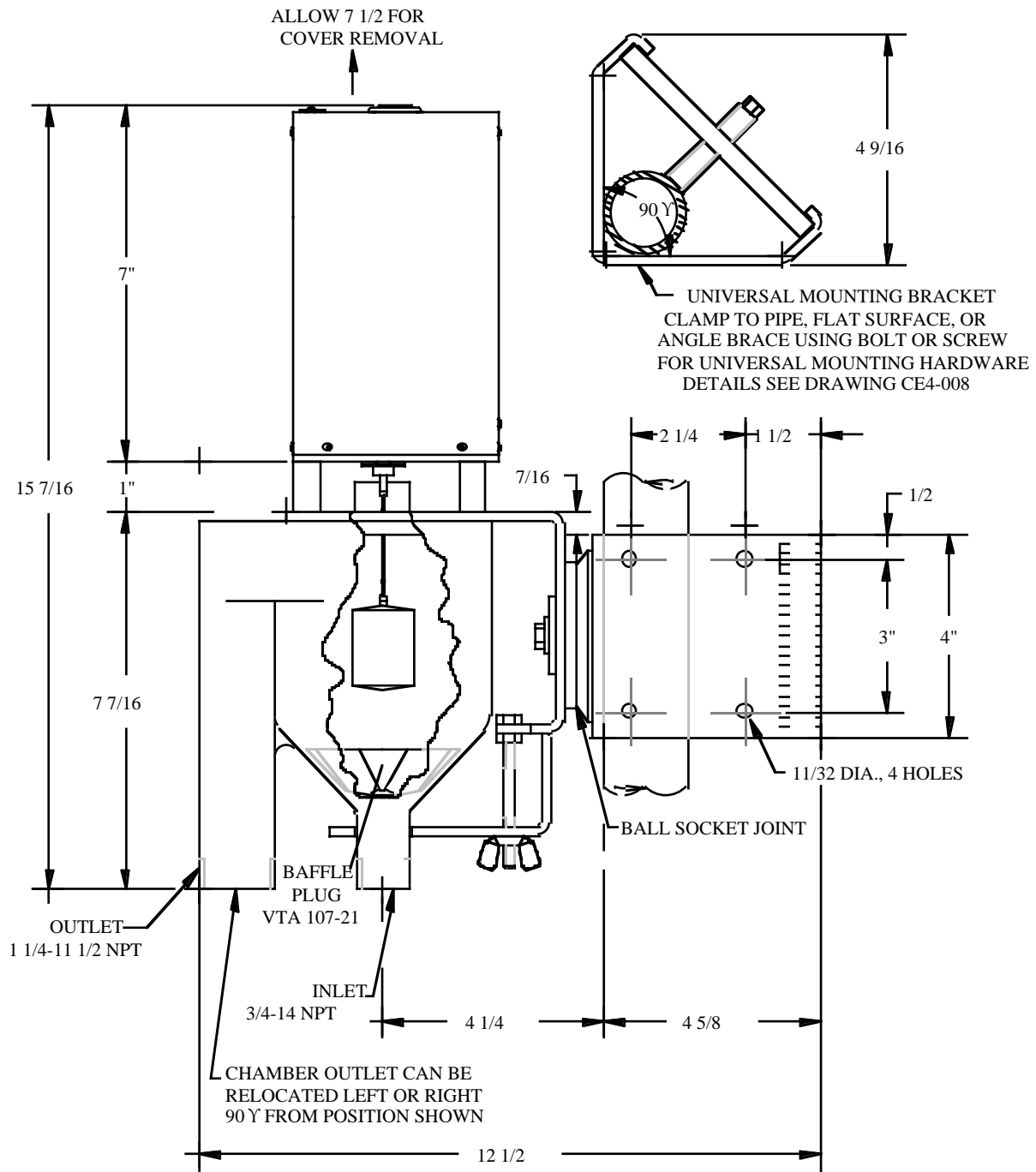


Figure B-2: VTE250 Process Viscometer Dimensions (with Optional Measuring Chamber)

Appendix C - Spindle Ranges

Introduction

The spindles listed in Tables C-1 - C4 can be attached to the VTE250 Process Viscometer. Refer to Figure C-1 for the shape and measurement definitions of each spindle type.

The full scale range information in Tables C-1 - C-4 provides the ENGINEERING RANGE HIGH LIMIT required for viscometer calibration for the most common torque ratings and the most frequently used spindle speeds of 20, 50, 60 and 100 RPM.

Table C-1: VTE250 Spindle Ranges @ 50 RPM

Spindle Number	Full Scale Range (cP) @ 50 RPM 1/8 RV	Full Scale Range (cP) @ 50 RPM 1/4 RV	Full Scale Range (cP) @ 50 RPM 1/2 RV	Full Scale Range (cP) @ 50 RPM RV	Spindle Diameter (inches)	Spindle Length (inches)	Spindle Type
VTA SP-35	15*	35*	100	200	1.887	1.600	Hollow Cylindrical
VTA SP-100	50	100	200	400	1.475	1.900	Closed Conical
VTA SP-200	100	200	400	800	1.2	1.485	Closed Conical
VTA SP-300	150	300	600	1200	1.075	1.229	Closed Conical
VTA SP-400	200	400	800	1600	0.992	1.060	Closed Conical
VTA SP-500	250	500	1000	2000	0.953	0.892	Closed Conical
VTA SP-1000	500	1000	2000	4000	0.718	0.855	Closed Conical

NOTE: For values above 50 cP, viscosity range will vary directly proportional to the torque rating and inversely proportional to speed.

*NOTE: Operation of SP-35 spindle above 30 RPM may produce measurements in turbulence.



Table C-2: VTE250 Spindle Ranges @ 20 RPM

Spindle Number	Full Scale Range (cP) @ 20 RPM 1/8 RV	Full Scale Range (cP) @ 20 RPM 1/4 RV	Full Scale Range (cP) @ 20 RPM 1/2 RV	Full Scale Range (cP) @ 20 RPM RV	Spindle Diameter (inches)	Spindle Length (inches)	Spindle Type
VTA SP-35	63	125	250	500	1.887	1.600	Hollow Cylindrical
VTA SP-100	125	250	500	1000	1.475	1.900	Closed Conical
VTA SP-200	250	500	1000	2000	1.2	1.485	Closed Conical
VTA SP-300	375	750	1500	3000	1.075	1.229	Closed Conical
VTA SP-400	500	1000	2000	4000	0.992	1.060	Closed Conical
VTA SP-500	625	1250	2500	5000	0.953	0.892	Closed Conical
VTA SP-1000	1250	2500	5000	10,000	0.718	0.855	Closed Conical

NOTE: Adequate flow through the sample chamber with fluid viscosities in excess of 2000 cP may not be possible. Refer to Appendix A and call Brookfield Engineering Laboratories, Inc. for assistance with higher viscosity fluids.

Table C-3: VTE250 Spindle Ranges @ 60 RPM

Spindle Number	Full Scale Range (cP) @ 60 RPM 1/8 RV	Full Scale Range (cP) @ 60 RPM 1/4 RV	Full Scale Range (cP) @ 60 RPM 1/2 RV	Full Scale Range (cP) @ 60 RPM RV	Spindle Diameter (inches)	Spindle Length (inches)	Spindle Type
VTA SP-35	12*	28*	83	167	1.887	1.600	Hollow Cylindrical
VTA SP-100	41	83	167	333	1.475	1.900	Closed Conical
VTA SP-200	83	167	333	667	1.2	1.485	Closed Conical
VTA SP-300	125	250	500	1,000	1.075	1.229	Closed Conical
VTA SP-400	167	333	667	1,333	0.992	1.060	Closed Conical
VTA SP-500	208	417	833	1,667	0.953	0.892	Closed Conical
VTA SP-1000	417	833	1,667	3,333	0.718	0.855	Closed Conical

NOTE: Adequate flow through the sample chamber with fluid viscosities in excess of 2000 cP may not be possible. Refer to Appendix A and call Brookfield Engineering Laboratories, Inc. for assistance with higher viscosity fluids.



Table C-4: VTE250 Spindle Ranges @ 100 RPM

Spindle Number	Full Scale Range (cP) @ 100 RPM 1/8 RV	Full Scale Range (cP) @ 100 RPM 1/4 RV	Full Scale Range (cP) @ 100 RPM 1/2 RV	Full Scale Range (cP) @ 100 RPM RV	Spindle Diameter (inches)	Spindle Length (inches)	Spindle Type
VTA SP-35	7*	13*	40	100	1.887	1.600	Hollow Cylindrical
VTA SP-100	22	48	100	200	1.475	1.900	Closed Conical
VTA SP-200	48	100	200	400	1.2	1.485	Closed Conical
VTA SP-300	75	150	300	600	1.075	1.229	Closed Conical
VTA SP-400	100	200	400	800	0.992	1.060	Closed Conical
VTA SP-500	125	250	500	1,000	0.953	0.892	Closed Conical
VTA SP-1000	250	500	1,000	2,000	0.718	0.855	Closed Conical

NOTE: Adequate flow through the sample chamber with fluid viscosities in excess of 2000 cP may not be possible. Refer to Appendix A and call Brookfield Engineering Laboratories, Inc. for assistance with higher viscosity fluids.

Table C-5: VTE250 Spindle Ranges @ 30 RPM

Spindle Number	Full Scale Range (cP) @ 30 RPM 1/8 RV	Full Scale Range (cP) @ 30 RPM 1/4 RV	Full Scale Range (cP) @ 30 RPM 1/2 RV	Full Scale Range (cP) @ 30 RPM RV	Spindle Diameter (inches)	Spindle Length (inches)	Spindle Type
VTA SP-35	42	83	166	334	1.887	1.600	Hollow Cylindrical
VTA SP-100	83	166	334	666	1.475	1.900	Closed Conical
VTA SP-200	166	334	666	1334	1.2	1.485	Closed Conical
VTA SP-300	250	500	1,000	2,000	1.075	1.229	Closed Conical
VTA SP-400	334	666	1,334	2,666	0.992	1.060	Closed Conical
VTA SP-500	416	834	1,666	3,334	0.953	0.892	Closed Conical
VTA SP-1000	834	1,666	3,334	6,666	0.718	0.855	Closed Conical

NOTE: Adequate flow through the sample chamber with fluid viscosities in excess of 2000 cP may not be possible. Refer to Appendix A and call Brookfield Engineering Laboratories, Inc. for assistance with higher viscosity fluids.



Appendix D - Warranty Information

Guarantee

We hereby guarantee this Brookfield Viscometer to be free from defects in workmanship and materials. If found to be defective in workmanship or materials upon being returned, within one year from the date of purchase to our factory, it will be repaired or replaced at the factory without charges. Transportation charges shall be at the owner's expense.

However, if upon being so returned and after inspection, we determine that the instrument has been subjected to tampering, careless handling, improper or faulty application or installation, the above guarantee shall not be applicable and we shall have the right in any such case to make a charge to cover the cost of repairs or servicing. Brookfield Engineering Laboratories, Inc. assumes and shall have no liability for consequential damages resulting from the use or misuse of the instrument.

The foregoing guarantee is in lieu of all other guarantees or warranties, expressed or implied, and of all other obligations or liabilities, contractual or otherwise, either to the original purchaser of said instrument or to any other person whomsoever.

Glossary

Control High and Low Limits

The measured values, expressed in engineering units, which cause control output to change.

Centipoise/milli-pascal-seconds

Units of absolute viscosity. The viscosity of water at room temperature is 1 centipoise or 1 milli-pascal-second.

Correlation

A relationship, usually shown as a graph, between one measurement and another. When correlating two viscosity measurements, it must be shown that a particular value from one measurement always corresponds to a particular value in the other. The conditions (method, temperature, amount of rotations, etc.) should remain constant to obtain this correlation.

Cup Seconds

The amount of time required for a given fluid to flow completely from an efflux cup through its chamber and accurately machined bottom orifice.

Dyne-centimeter/milli-Newton-meter

Units of torque that is measured as a force acting at a distance from a reference point, such as the axis of rotation of an object.

Engineering Units

Units of viscosity as displayed on the readout panel of a viscometer. These units may be in centipoise, or other units which relate to absolute viscosity, such as cup seconds.

Full Scale

The upper limit, in engineering units, of a viscometer. For Brookfield Process Viscometers, this value must be calculated from the torque capacity, rotational speed, and the spindle design of the instrument.

Laboratory Measurements

Viscosity measurements made off-line by a different instrument, usually for purposes of quality control. Due to the unique nature of viscosity measurement, the numerical value of this measurement may not agree with that measured by Brookfield Process Viscometers.

Laminar Flow

Flow which occurs when layers of fluid move uniformly with respect to one another, without mixing between elements.

Measuring Chamber

The container through which a fluid is caused to flow, in laminar flow conditions, and where its viscosity is measured.

Repeatability

The ability of an instrument to measure the same value whenever identical conditions of viscosity are presented to it. For Brookfield Process Viscometers, deviation is expressed as a percentage of full scale.

Shear Rate

The speed at which layers of fluid move with respect to one another. Also known as velocity gradient.

Shear Stress

The force per unit area required to move layers of fluid with respect to one another.

Spindle

The cylindrical object which is rotated in the fluid by the viscometer. Its motion in the fluid causes a resistance called viscous drag which is measured by the instrument as % torque. Its rotation causes fluid shearing to occur.

Turbulent Flow

Flow which occurs when fluid moves randomly with respect to other elements of fluid, with mixing between elements.

Viscous Drag

The resistance to rotation produced by an object such as a spindle when it is rotated in a fluid.

Viscosity

A measure of the internal resistance within a fluid to resist flow. Mathematically defined as shear stress divided by shear rate. Sometimes called absolute viscosity.

4-20 mA Signal

The continuous electrical output produced by a viscometer which is proportional to the % torque being measured and also proportional to the scale. For Brookfield Process Viscometers, 4 mA = 0 cP, 12 mA = half of full scale, and 20 mA = full scale, linear between 0cP and full scale.

% Torque

Brookfield Process Viscometers function as a rotating torque meter, whose response is linear with respect to viscosity. A % torque measurement displays the proportion of full scale which a measured fluid produces. This factor is applied to full scale in order to give a measurement in engineering units.

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