TCV 300 Viscometer

User Manual

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Contents

Overview

The TCV300 Laboratory Viscometer is a self contained device which will enable rapid and accurate measurement of fluid viscosity off line.

It requires only a very small one milliliter sample, which speeds thermal stabilization and measurement time, greatly reduces waste, and virtually eliminates disposal costs. There is no need for lengthy delays while large samples temperature equilibrate.

The data obtained will agree with data obtained in-line using our process viscometers, so it is an invaluable tool for incoming QC, a low cost instrument for measuring process fluids that require only occas-sional test, and an important "sanity test" for continuously operating in-line instruments.

To measure viscosity simply 1) dial in the appropriate range, 2) set the calibration coefficient, 3) fill the measurement chamber with 1 ml of fluid, 4) insert the measurement piston, 5) cap the chamber,and 6) record the data when it is stable (typically 60 seconds).

Our unique electronic temperature control enables quick and easy adjustments in the measurement temperature, which is impossible with bulky constant-temperature baths. By increasing or decreasing the temperature a few degrees the observed viscosity changes can be used to determine Viscosity Index, another important fluid characteristic.

The force imparted on the piston during measurement can be varied, which means quantitative data can be obtained with regard to shear rate sensitivity of non-Newtonian fluids like paint.

Principle of Operation

Viscosity Measurement

The TCV300 Laboratory Viscometer employs the accurate and reliable forced-piston principle which is also used in our process viscometers. Two electromagnetic coils drive an internal piston up and down inside a measurement chamber filled with test fluid. Magnetic force on the piston is resisted by viscous flow of the fluid around the piston. Gravitational effects are eliminated by measuring round trip travel time. Measurement time is electronically converted into absolute viscosity (centipoise).

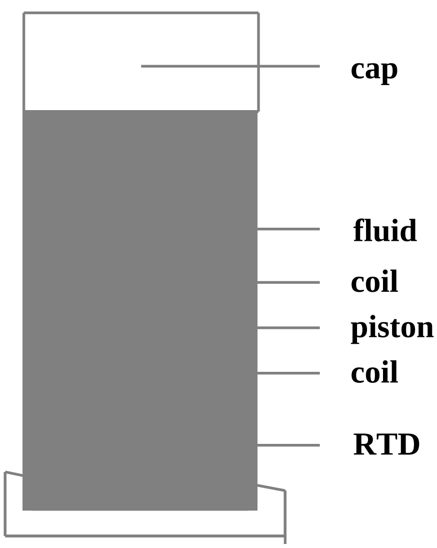

Figure 1: Cut away view of the sensor

Temperature Measurement

Temperature is measured at the base of the measurement chamber using a platinum Resistance Thermal Detector (RTD). Platinum has a thermal coefficient of about .38 percent per degree Celsius. Its resistance is 100 ohms at 0 deg Celsius. Increases in temperature result in increased resistance which is measured and converted to temperature.

Temperature Control

The body of the sensor is 316L stainless steel, which is very corosion resistant. At the base of the measurement section there is a resistance heater that is used to increase the temperature of the measurement chamber by conduction through an inner aluminum sleeve. Using the internal temperature detector as a reference, heat is added to assure the measurement chamber is at the reference temperature set point. The "**DATA READY**" green light is a visual indication that the set point temperature and actual temperature are within ±0.15 degree.

> **Note: Temperature control will be fast, accurate, and very stable unless the instrument is operated in gusty conditions. If you are working in gusty conditions, use the high temperature thermal shield.**

Operating the System

Setting the Measurement Temperature

Under the cover of the calibration well there are four multiturn adjustment knobs, shown below. The top knob is used to set the reference temperature. To set a new temperature simply 1) press and hold the "**READ SET TEMP**" button on the face of the instrument, then 2) adjust the **temperature reference set** knob until the desired temperature is displayed.

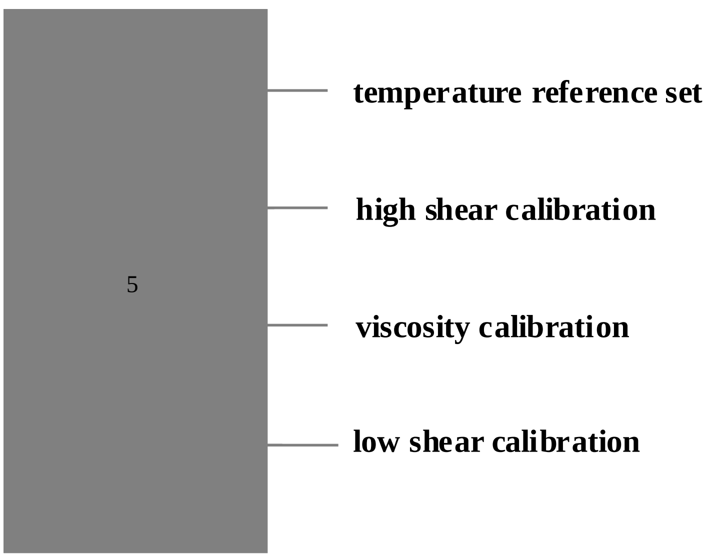

Figure 2: Adjustments inside the calibration well.

Note: To get acurate and quick temperature control the set temperature must be at least ten degrees Celsius greater than the ambient temperature.

Cleaning the Sensor and Piston

After completing a measurement, remove and clean the cap with a lint-free wipe, and set it aside.

Remove the piston using a pair of long nose pliers or forceps pulling on the nob on the piston. Clean the piston and put it in the storage carousel for safekeeping.

> **Note: Good surface finish on the piston and inside the sensor is important. Be careful not to scratch or abuse them.**

If the viscosity of the fluid in the sensor is more than 100cp it may be helpful to add about 0.5ml of solvent prior to cleaning. In either case, rotate the sensor forward to drain the majority of the fluid out, catching the waste in a towel, bucket, or drain tray. With a lint-free wipe wound tighhtly around the tip of the forceps, swab the inside until it is "squeeky" clean, then return the sensor to its near-vertical position against the mechanical stop.

> **Note: to clean volatile fluids, rinse with a solvent or damp swab and repeat the cleaning process until all interior film is removed. Consult factory for suggestions with difficult materials.**

Selecting and Setting the Measurement Range

There are four measurement ranges available, 1-10cp, 10-100cp, 100-1,000cp, and 10-100poise. Each range has its own piston and its own calibration coefficient.

If you have no knowledge of the viscosity of your fluid, compare it to each of the calibration fluids provided to select a range.

Once the measurement range is selected:

1. Set the measurement range on the front panel

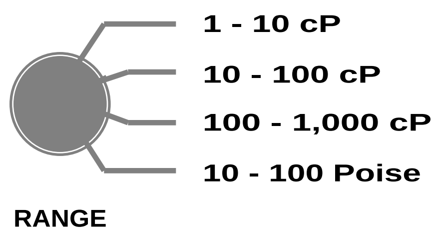

Figure 3: Range Selector Switch.

> **Note: the Range Selector Switch will properly position the decimal point in the display, but it will <u>not</u> automatically enter the correct calibration coefficient.**

2. Enter the correct calibration coefficient.

To enter a calibration coefficient lift the cover on the the calibration well and adjust the third knob until the appropriate coefficient appears on the knob's counter dial (see figure 2, page 3-1). Coefficients are listed in the appendix.

Measuring Viscosity

1. Gradually draw a 1 ml sample of fluid into a pipette and slowly introduce it into the measurement chamber near the bottom with the tip of the pipette touching the near wall.

   Note: If the sample is too rapidly drawn or dispensed, air may be injested into the sample. Separation of the air may take several minutes.

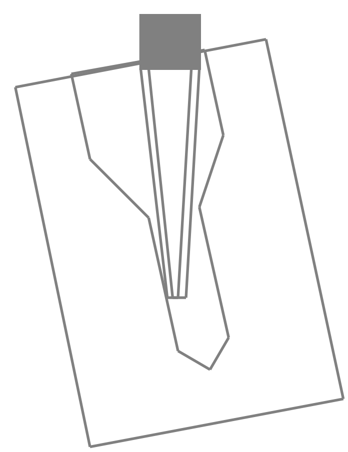

Figure 4: Inserting a sample into the measurement chamber.

2. Select an appropriate piston from the carousel, clean it with a lint-free cloth, and insert it into the measurement chamber with the nob end up.

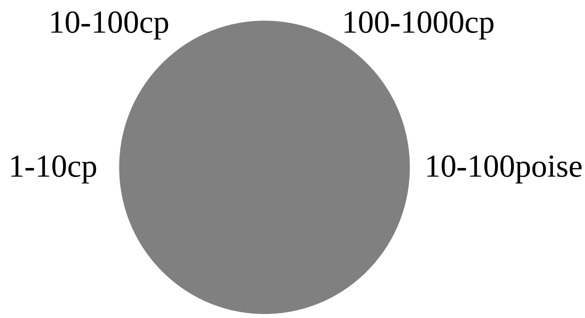

Figure 5: The piston carousel.

3. Gently seat the piston on the bottom of the measurement chamber using the pipette tip or a similar soft instrument.

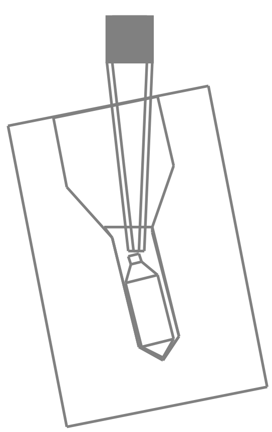

Figure 6: Seating the piston in the measurement chamber.

4. Cap the measurement chamber.

5. Wait for the green "**DATA READY**" light to go ON and the red "**OUT OF RANGE**" light to go OFF then, when the data is stable, record the displayed viscosity.

   Note: Each time the green "PISTON DIRECTION" light is ON, the data displayed is a new measurement.

Calculating Shear Rate

What is shear rate?

If two parallel plates are separated by a gap which is filled with fluid and the plates are moved parallel to one another (sheared), the shear rate induced in the fluid is defined as the ratio of the shear velocity (speed of one plate vis-a-vis the other) divided by the gap. It has the dimensions of velocity divided by distance, or 1/time. The units are inverse seconds (sec^{-1}).

How is it determined with a translating piston device?

The TCV300 viscometer imparts a constant magnetic force to the piston which results in a two-way motion which is accurately known. Knowing the piston geometry, displacement, and travel time, the shear velocity and shear rate can be calculated. In a given range the lower the viscosity the faster the piston motion and the greater the shear rate.

To calculate the shear rate in the "NORMAL" setting simply divide the displayed viscosity into the number listed in the following chart. For example, if the viscosity displayed is 50 cp with a measurement range of 10-100cp, the shear rate is 16,600/50 = 332 inverse seconds. The shear rate with a "HIGH SHEAR" setting will be about 30 percent higher. Similarly, in the "LOW SHEAR" setting the shear rate will be about 30 percent lower than the "NORMAL" shear given by the calculation below. The exact coefficient to be used in the "HIGH", "NORMAL", and "LOW" shear settings are listed in the appendix.

Range	"NORMAL" Shear Rate Coefficient
1-10 cp	9,000
10-100cp	17,000
100-1,000cp	27,000
10-100poise	330

Calibration

Normal Shear-Rate Calibration

Calibration of the TCV300 is quite simple. There are four reference fluids provided with the unit for this purpose. Each fluid has a known viscosity which is listed in the appendix for several test temperatures.

Follow the procedures for measurement of a sample using the appropriate calibration fluid. For example, if you are calibrating the 10-100cp range at 40 deg Celsius, K60 would be the appropriate fluid. The goal is to use a fluid which is in the upper half of the measurement range, e.g. 50-100 cp on a 10-100cp range.

> **Note: There are small differences between calibration coefficients at different temperatures, so calibrate at the temperature at which you intend to make your measurements.**

After achieving stability of the data, compare the indicated viscosity to the value listed in the appendix for the reference fluid used. If the values agree, the system is in calibration. If they do not:

1. Open the calibration cover plate.

2. Push the "PRESS TO CALIBRATE" button on the face of the instrument while adjusting the VISCOSITY CALIBRATION (third) knob in the calibration well until the displayed viscosity reading agrees with the published value for the reference fluid.

3. Record the knob setting (calibration coefficient) for future reference.

4. If HIGH and LOW shear rate calibration will not be attempted, close the cover to the calibration well.

High- and Low-Shear Rate Calibration

After the system is calibrated in the NORMAL setting, as described above, if you want to calibrate the HIGH SHEAR setting, place the front panel switch in the HIGH SHEAR setting then wait several minutes for the data to stabilize. The calibration fluid is Newtonian, so the displayed viscosity should be independent of shear rate. After the data has stabilized adjust the HIGH SHEAR (second) knob in the calibration well until the displayed viscosity agrees with the known value, then record the knob setting.

> **Note: When changing the shear rate the sensor temperature may change enough to extinguish the DATA READY light for a minute or so. Be sure to let it restabilize.**

To calibrate the LOW shear rate, set the selector switch to LOW SHEAR and after stabilization adjust the LOW SHEAR (bottom) knob in the calibration well until the displayed viscosity agrees with the published values, then record the knob setting.

> **Note: The HIGH and LOW SHEAR calibration knobs are enabled only when the front panel shear rate switch is set to HIGH or LOW shear respectively.**

After completing calibration, secure the cover to the calibration well to prevent inadvertent adjustment of the settings.

Reference Materials

Certificate of Calibration

Customer ____

System Serial Number __________________________________

Viscosity Calibration Coefficients
(Dial Settings)

Range	Gain 40ºC	RP3 40ºC	Gain ___ºC	RP3 ___ºC
1-10cp	_____	____kΩ	_____	___kΩ
10-100cp	_____	____kΩ	_____	___kΩ
100-1,000cp	_____	____kΩ	_____	___kΩ
10-100poise	_____	____kΩ	_____	___kΩ

Shear Rate Coefficient

Range	LOW	NORMAL	HIGH
1-10cp	_____	9,000	_____
10-100cp	_____	17,000	_____
100-1,000cp	_____	27,000	_____
10-100poise	_____	330	_____

Signature: ______________________ Date:______________________

Reference Fluid Viscosities
(Values in centipoise)

	Reference Temperature						
Fluid	35C	40C	45C	50C	60C	80C	100C
K6 lot#94102	5.63	4.86	4.25	3.74	2.96	1.99	1.44
Q60E lot#94501	58.8	46.0	36.5	29.4	19.8	10.4	6.19
K600 lot#94301	648	461	335	248	144	58.1	28.3
Q8000 lot#93202	90.4p	60.7p	41.0p	28.4p	14.4p	45.1p	17.4poise

Notes