

# **HERCULES**

## **HI-SHEAR VISCOMETER**

**Model TS-9**

KALTEC SCIENTIFIC, INC.  
22425 Heslip Drive  
Novi, Michigan 48375-4138  
U. S. A.

## **Hercules® Hi-Shear Viscometer**

**Model TS-9**

**User's Guide**

# Guaranty and Certificate of Quality

---

All Hercules® Hi-Shear Viscometers are guaranteed against defects in materials and workmanship for one year providing:

1. The defective unit has been operated within published electrical specifications;
2. The unit has not been damaged by misuse, improper operation, or accident;
3. The unit has not been modified or altered; and
4. All costs of transportation of the unit to Kaltec Scientific, Inc. are prepaid by the original purchaser.

VISCOMETERS MUST BE RETURNED DIRECTLY TO THE FACTORY, NOT TO THE DISTRIBUTOR OR AGENT FROM WHICH THEY WERE PURCHASED.

Kaltec Scientific, Inc. limits its obligation under this warranty solely to the repair or replacement of any unit returned during the period covered by the warranty. No other obligations or liabilities are implied or expressed. This form serves as a certificate of quality.

Kaltec Scientific, Inc.

## Description and Features

---

The TS-9 is specifically designed for research and development work. This model is devoted to rendering high accuracy and excellent repeatability to viscometric measurements.

The versatile features a comprehensive control panel and a Hewlett-Packard ColorPro Plotter. Its torque transducer provides expanded full-scale accuracy and excellent resolution on low viscosity samples.

The TS-9 has the unique ability to plot viscosity (shear stress) as a function of time, at constant or varying shear rates.

# Table of Contents

---

	Page
Guaranty and Certificate of Quality	i
Description and Features	ii
Section One — Viscometer Setup	1-1
Unpacking the Viscometer	1-2
General Assembly	1-3
Viscometer Accessories	1-4
Section Two — The Viscometer	2-1
Control Panel	2-2
Digital Displays	2-2
Push Buttons	2-2
Torque and RPM Dials	2-7
How the Viscometer Works	2-8
Section Three — Output Device	3-1
Plotter	3-2
Section Four — Calibration	4-1
TS-9 Calibration Program	4-2
Variable RPM Calibration	4-3
Section Five — Viscometer Maintenance	5-1
Lubricating the Viscometer	5-2
Preventative Maintenance	5-2
Cleaning the Viscometer	5-4
Returning the Viscometer for Service	5-4
General Troubleshooting	5-7

# Viscometer

## Setup

## Unpacking the Viscometer:

Your viscometer and its components were inspected and in good working order before leaving Kaltec Scientific. Carefully unpack the viscometer by following the instructions listed below.

**CAUTION:** Do not pry the crate apart. The viscometer is bolted to the crate. Prying may damage the instrument and its components.

*SUGGESTION: The technician responsible for the instrument's operation should supervise the unpacking and assembly of the viscometer.*

1. Remove the four screws from the bottom of both side panels of the crate.
2. Lift the outer box straight up to clear the viscometer. NOTE: Two people are recommended for this step.
3. Turn the outer box upside down.
4. Remove the three screws from the compartment marked "ADDITIONAL PARTS INSIDE," inside the outer box. This compartment contains a corrugated box which holds the accessories.
5. Elevate the base to remove the four bolts fastened to the body of the viscometer. (1/2" wrench or socket required.)
6. Carefully remove the unit from the base of the crate and place it on a sturdy table or bench.

*SUGGESTION: Save the crate and packing materials for future shipping.*

## General Assembly:

Except for a few small components, the unit was shipped preassembled. The small components include the following:

4 - Leveling Mounts	6 - Bobs (A, B, C, D, E, & FF)	1 - Camlock Cup
1 - Bob Box	1 - Electrical Cord	2 - Pinion Levers
1 - Calibration Cable	1 - Data Communication Cable	

1. Screw the four rubber Leveling Mounts into the extended feet of the main casting. Adjust the leveling mounts until the unit stands firmly on the table or bench. (Precision leveling is not required.)
2. Screw the Pinion Levers into the Pinion located on the right side of the Spindle Housing.
3. Connect the unit to the properly rated and grounded electrical outlet (Refer to the specification plated affixed to the rear of the unit).

4. Connect the Data Communication cable to the back of the viscometer and to the plotter.

### **Viscometer Accessories:**

The accessories listed below were shipped with the viscometer.

**CUP** (Part Number: 10042): Insert the Cup carefully into the Cup Holder. Align the Cup's key with the Cup Holer's key. Carefully lower the Cup to the bottom. Turn the Cup slightly counter-clockwise until the Cup locks into place. **CAUTION: If the Cup is difficult to remove from the Cup Holder, do not force the Cup out. Forcing the Cup will either damage the Cup or the Cup Holder. To remove the Cup, gently tap the Cup with your hand. Lift the Cup straight up. Refer to page 5-7 for possible causes and how to correct the problem.**

**Bobs** (Part Numbers: 10020 - 10031): Screw the Bob clockwise no more than finger tight onto the lower, threaded end of the Drive Spindle. **NOTE:** Hold the Drive Spindle only by the flats at the top, using the Spindle Wrench provided.

**Bob Box** (Part Number: 10035): The Bob Box was specifically designed to hold Bobs A, B, C, D, E, and FF. The box prevents the Bobs from being damaged while not in use.

**Fluid Depth Gauge** (Part Number: 10310): The line closest to the letter represents the amount of sample necessary for a particular Bob. To use: Insert the gauge (ball end up) in the Cup. Hold the gauge straight up with the end resting on the bottom of the Cup. Pour the sample into the center of the Cup until it reaches the line on the gauge for the Bob you will be using.

**Splash Shield** (Part Number: 12101): The shield is a safety precaution. It also prevents possible splattering of test material. This shield must be in place while spindle is rotating.

# The Viscometer

### CONTROL PANEL:

#### Digital Displays

- **TIME** displays the time elapsed from the start of a cycle to the point at which it achieve its maximum rpm speed. The **TIMER** retains this readout of elapsed time during deceleration cycle or when **RETURN**, **HOLD**, or **SET RPM** functions are activated. Press the **STOP** button to reset **TIMER** to zero.
- **RPM** indicates maximum Bob rpm speeds attained in **AUTO**, **TRACE**, **SET RPM**, and **HOLD** functions. During **AUTO** and **TRACE** cycles, the display will follow the acceleration but not the deceleration of the Bob rpm speed. Use the actual rpm value retained in the display when calculating viscosity.

#### Push Buttons

**STOP:** Primarily for terminating a measurement, but may be used to interrupt an operation for any reason. Activation brings the Bob and the plotter pen to rest within one second and resets the **DIGITAL TIMER** and **DIGITAL RPM** displays. When the **FUNCTION** light is off, the **STOP** button can be used to pick up the pen to prepare for a test.

**TRACE:** Bob accelerates from zero rpm to a selected rpm speed in a fixed 20.4 seconds and then automatically enters **HOLD** mode (unless the **HOLD** button is pressed before selected speed is attained), retaining that speed until the **STOP** or **RETURN** button is activated. The moment that selected rpm speed is attained, the **DIGITAL TIMER** activates, and the plotter pen stops. If torque results reach full scale (18 cm) during a test before reaching maximum rpm the viscometer will automatically switch to **RETURN** mode plotting the return data.

**HOLD:** For use with **TRACE** operation. Pressing the **HOLD** button during **TRACE** cycle halts the Bob's acceleration and maintains constant rpm speed from that

point on. At the same time, the recorder is halted and the **DIGITAL TIMER** is activated. Once **HOLD** is activated, the Bob speed can only be decelerated.

**RETURN:** Decelerates the rotation speed of the Bob and reverses the pen's direction. During a **TRACE** or **HOLD** operation, pressing the **RETURN** button decelerates Bob and pen movement to zero at the same rate as that of the previous acceleration. During **SET RPM** operation, pressing the **RETURN** button decelerates the speed of the Bob (but not the plotter) to zero within one second. This is the preferred way to stop a Bob during **SET RPM** operation.

**SET RPM:** Used for precise pre-selection of maximum rpm for a specific measurement cycle. Bob accelerates to selected maximum rpm for a specific measurement cycle. Bob accelerates to selected maximum rpm within one second and then runs at this speed until stopped. Actual speed may be read at **DIGITAL RPM** indicator and may be adjusted (if variant) during operation at the **VARIABLE RPM DIAL** (with the **RPM SELECTOR** set at "V x 1" or "V x 10"). Either the Bob or the Cup must be removed during this operation. We recommend that both be removed.

**AUTO:** Activates a standard, fully reproducible measurement cycle. The Bob will accelerate from zero rpm to a pre-selected maximum in a fixed duration of 20.4 seconds and then will decelerate to zero rpm in the next 20.4 seconds. The plotter is automatically driven up and down with the Bob's direction to generate the Y-axis of the rheogram. The actual maximum rpm achieved will remain until the display is reset by pressing the **STOP** button. If torque results reach full scale (18 cm) during a test before reaching maximum **RPM** the viscometer will automatically terminate the test cycle. Test results will be reported at the last point before termination.

**FUNCTION:** The **FUNCTION** button controls the plotter. When the switch is illuminated the plotter will draw the complete rheogram on a blank sheet of paper. When the switch is not illuminated the plotter will plot the results of the test on a preprinted graph paper with a grid of 18 cm x 22 cm. **NOTE: When designing your pre-printed graph paper, the right and bottom margin must be a minimum of 3/4" (2 cm).**

### Torque and RPM Dials

#### Torque Kilodynes-cm:

The torque range is 25,000 to 1,000,000 kilodynes-cm. Rotate the knob to the desired torque before the test. Do NOT change torque during a test.

#### Variable Speed:

Selects Bob rpm speed when **MAXIMUM SPEED (RPM)** selector is set at "V x 1" or "V x 10." May be used to set maximum Bob rpm speeds for **AUTO** operation or to set constant Bob rpm speeds for **TRACE** operation.

#### Maximum Speed (RPM):

For use with **TRACE**, **AUTO**, and **SET RPM** functions. Selects maximum Bob rpm speeds. The "V x 1" setting selects a speed roughly equal to that indicated on **VARIABLE RPM DIAL** — from 0 to 1000 rpm. The "V x 10" setting selects a speed roughly ten times that shown on the **VARIABLE RPM DIAL** — 0 to 5500 rpm. The remaining four select speeds are pre-set to the designated rpm. Do NOT change the rpm during a test.

### **How the Viscometer Works:**

The Hercules® Hi-Shear Viscometer is a coaxial cylinder viscometer that uses a Searle sensor system. It produces the rheograms (speed vs. torque or shear stress vs. shear rate) at a wide range of shear rates using a cup and bob configuration.

The sample being tested is confined between two coaxial cylinders and the inner cylinder (bob) is rotated. The viscous drag of the sample induces rotational force to the outside cylinder (cup) which is sensed by a torque sensor. The torque and bob speed are recorded throughout the test and used for all calculations and plot displays.

**Output**

**Device**

### Plotter:

The Hewlett-Packard ColorPro Plotter, Model 7440A, is supplied with the Hercules® Hi-Shear Viscometer, Model TS-9, for plotting graphs in real time. As of January 1, 1996, all plotters shipped with the TS-9 are reconditioned. These plotters have the same warranty as a new one.

For technical and operation procedures, please refer to the manufacturer's manual that is enclosed.

### Points to remember:

- Before running a test, make sure the plotter is on and the paper and pens are loaded. As the test is running the plotter will draw the results in real time.
- To print the graph and results, the **FUNCTION** light must be "ON." To plot the results only, the **FUNCTION** light must be "OFF."
- When using preprinted graph paper, margins of 3/4" (2 cm) are required on the right and bottom edge of a standard letter-size paper (8-1/2" x 11").
- To set the initial zero point, follow this sequence:
  1. Turn the ColorPro Plotter ON.
  2. Turn the TS-9 ON.
  3. Turn the **FUNCTION** light off.
  4. Press **STOP** to check the zero position.

The plotter will go the last stored zero setting. The zero position can be adjusted with the plotter arrow buttons. If the **STOP** button is pressed again, the pen will move to the old stored position. When **AUTO** is pressed to start a test, the current position of the pen becomes the stored position.

- When the plotter is not in use for a long period of time, remember to put the caps back on the plotter pens to prevent them from drying.

- Keep viscometer and plotter clean. Avoid getting dust and sample residue on either of them. Contaminants inside the plotter can cause the unit to malfunction, which is not covered under warranty.

# **Calibration**

### TS-9 Calibration Program

To run this program you must have a 286 computer system or greater.

1. Connect the calibration cable to the viscometer and to the serial port on the computer.
2. Install the calibration program on your computer by typing:

```
A:INSTALL
```

3. Run the calibration program by typing the following at the C:\ prompt:

```
CD\KALTEC <enter>  
KALCAL <enter>
```

4. Condition the Cup, "A" Bob, and the test fluid to 25°C. Kaltec recommends taking several readings to assure the temperature is exactly 25°C.
5. Select the **CALIBRATE** option from the pull down menu.
6. The program will show the default values preset for the following:

```
Set RPM:      1100   RPM Increment:      100  
Ramp Time:   10     Y Viscosity Increment:  10     Bob Size:   A
```

7. Fill in the desired calibration viscosity in poise in the space provided.
8. Start test.
9. When the viscometer reaches its maximum RPM, press (G) to set the gain. This tells the viscometer to remember the torque value.
10. When the program asks you (save gain Y/N?) enter "Y," if you were satisfied with the calibration, or "N," if you wish to re-calibrate.
11. Exit program.

### Variable RPM Calibration

To calibrate and pre-select maximum rpm speeds, other than the four pre-set speeds, set **MAXIMUM SPEED (RPM)** to "Vx1" or "Vx10" setting, press **SET RPM** button, and adjust the **VARIABLE SPEED** dial until desired value is shown on the **RPM** display. The "Vx1" setting results should roughly equal to that displayed on the **VARIABLE SPEED** dial; the "Vx10" setting results should roughly equal ten times that displayed on **VARIABLE SPEED** dial. Press **STOP** to terminate operation and to reset displays.

**Viscometer**  
**Maintenance**

### **Lubricating the Viscometer:**

**Bi-Monthly.** Clean and lubricate the four areas of the Dovetail Slide that contact the Spindle Housing and the top half of the Drive Spindle that slides through the Drive Pulley. Use a heavy lithium grease to do the lubrication. Kaltec recommends that you apply the grease while in both the raised and lowered positions of the spindle housing.

**Never.** DO NOT lubricate bearings (except for the components mentioned above). All other bearings are permanently sealed and do not require lubrication. Especially DO NOT lubricate Cup Holder bearings; they are designed for "dry" operation, and any lubrication whatsoever will adversely affect measurement accuracy.

### **Preventive Maintenance:**

Your Hercules® TS-9 Hi-Shear Viscometer has been ruggedly designed and has been operated for 50 hours before shipment. Like all fine instruments, however, it is vulnerable to misuse or neglect. Observing the following rules and tips will ensure many years of trouble-free and effective use.

Be especially careful when handling the Cup Holder, and try to protect it from any undue pressures or shocks. Abuse may result in the Cup Holder shaft becoming bent or damage to the torque sensor.

Never force the Cup in or out of the Cup Holder. If insertion or removal ever becomes more difficult than usual, check under the cam slot for a recently formed bur. Such a bur should be filed and polished away to prevent interference with the Cup's normal outer dimension.

Keep unit clean. Sample spills and other contaminants can permanently damage some components, especially the Cup Holder bearings.

Never lubricate the Cup Holder bearings.

Clean and lubricate the Dovetail Slide and upper Drive Spindle regularly. **See Lubricating the Viscometer.**

Major problems such as Bob and Cup misalignment, bent shafts, or electronic malfunction should be serviced only by qualified technicians.

### **Cleaning the Viscometer:**

Unplug the viscometer and the plotter from the AC power outlet before cleaning. Clean the viscometer after every test. If the sample spills on the viscometer, wipe it off before it dries. The sample could damage the Cup Holder bearings or other small components.

When washing, use a damp sponge. Water should not run inside the viscometer. This could create an electronic malfunction and cause a shock hazard. Water or cleaning solution should NEVER be poured directly on the viscometer. This could cause more damage to the viscometer. ONLY clean the exterior of the viscometer.

### **Returning the Viscometer for Service:**

If you need to ship your viscometer in for service, pack it in its original crate. If needed, a shipping crate may be obtained from Kaltec. In-transit damage is not covered by the warranty. We suggest that you always insure shipments.

You can help assure effective servicing of your viscometer by following these guidelines:

- Follow the instructions in this manual to make certain the malfunction is in your viscometer and not the result of an interface error. If possible, identify the defective area or function.
- If you determine that repair is required, please include the following items when you return your viscometer for service:
  - All Bobs, Cups, & Cup Holders
  - Electrical Cord (1)
  - Data Communication Cable
  - Calibration Cable
  - Leveling Mounts (4)
  - Pinion Levers (2)
  - Hewlett-Packard Plotter
  - All Plotter Accessories

- Include the following paperwork:
  - A brief description of the symptoms.
  - A graph from a test using Kaltec Test Fluid, if possible.
  - A graph from a test using your sample, if possible.
  - Contact name, address, and a phone number where you can be reached during the day.
  - A purchase order number for evaluation of the instrument.
- When shipping the instrument in, you must pay for all freight. Kaltec will ship the viscometer back to you "Prepaid" and then add it to the invoice. If any shipments are sent to Kaltec "Collect," a service charge of \$10.00 plus the amount of the freight bill will be added to your bill.

Ship to:       **Kaltec Scientific, Inc.**  
                  **22425 Heslip Drive**  
                  **Novi, Michigan 48375**  
                  **U.S.A.**

- On your Bill of Lading list the instrument as follows:

**Crate Machinery**  
**NMFC Item #133300, Sub 3**  
**Class 85**

- For international shipments, the schedule B number for the instrument is:

**9026.80.0000**

- After Kaltec has received and inspected your unit, a representative from Kaltec will call with the cost of repairs. If you decide to have the repairs done, the evaluation charge will be credited towards the repair. A purchase order number will be required for repairs to be made. If you decide not to have the repairs completed, an evaluation charge of \$280.00 will be invoiced.

## General Troubleshooting

SYMPTOM	LIKELY CAUSE	SOLUTION
Cup resists attachment and detachment from Cup Holder.	<ul style="list-style-type: none"> <li>• Dried sample material in and around Cup Holder.</li> <li>• A bur has formed on Cup's camlock groove.</li> <li>• Cup is bent</li> </ul>	<ul style="list-style-type: none"> <li>• Clean thoroughly with steel wool.</li> <li>• File bur off.</li> <li>• Replace with a new cup immediately</li> </ul>
Spindle Housing tracks poorly.	<ul style="list-style-type: none"> <li>• Sample material on Slide.</li> <li>• A bur has formed on the Slide.</li> </ul>	<ul style="list-style-type: none"> <li>• Clean thoroughly with stiff brush.</li> <li>• Use fine sandpaper or emery cloth to remove bur and lubricate.</li> </ul>
Bob does not rotate when unit is in AUTO or TRACE mode.	<ul style="list-style-type: none"> <li>• DC fuse (located in back of unit) has blown.</li> </ul>	<ul style="list-style-type: none"> <li>• Replace with AGC 20 fuse only.</li> </ul>
Power switch indicator or displays do not light up when the power is turned on.	<ul style="list-style-type: none"> <li>• AC fuse is blown.</li> <li>• The unit is not plugged in.</li> </ul>	<ul style="list-style-type: none"> <li>• Contact Kaltec's Service Department before replacing.</li> </ul>