



# TE-DPV<sup>®</sup> Asphalt

Thermoelectric Rotational  
Paddle Viscometer



*Operation  
Manual*

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## Contact

Address: Cannon Instrument Company  
2139 High Tech Road  
State College PA 16803, USA

Phone: 814-353-8000 | 800-676-6232

Fax: 814-353-8007

Website: [CannonInstrument.com](http://CannonInstrument.com)

Email:

Sales: [sales@CannonInstrument.com](mailto:sales@CannonInstrument.com)

Service: [service@CannonInstrument.com](mailto:service@CannonInstrument.com)



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## Overview

The TE-DPV Asphalt (TE-DPV) is an automated, thermoelectrically cooled, rotational digital paddle viscometer for measuring the dynamic viscosity of non-homogenous materials such as emulsified asphalts, marine fuels, residual oils, slurries, and foods at 25 °C, 40 °C, 50 °C, 60 °C and 70 °C. The TE-DPV provides an affordable and automated alternative to older, labor-intensive, and less precise methods.

### Theory of Operation

The CANNON TE-DPV is designed to measure viscosity of asphalt emulsions, residual oils, slurries, paints, marine fuels, and other similar materials between 30 and 3000 mPa·s (cP) at temperatures of 25 °C, 40 °C, 50 °C, 60 °C, and 70 °C. The TE-DPV can also be used for other applications consistent with its temperature control and viscosity measurement capabilities, including the ASTM D244 consistency test. The TE-DPV can determine the viscosity of lubricating oils, marine fuels, and other liquids; it yields results with an accuracy of 5% or better for most materials.

Microprocessor circuitry, functioning in tandem with twin temperature probes and sophisticated internal electronic sensors, detect and analyze temperature and viscosity data as a rotor immersed in the test oil is turned at a fixed rate.

Viscosity test results are continuously updated on a digital display screen located on the front panel of the head unit. Results are displayed in centipoise [mPa·s (cP)] or centistokes [mm<sup>2</sup>/s (cSt)] if a density value has been entered. When the test is complete, data is sent to the 9-pin serial output port for (optional) printing.

### Related Documents

Refer to Table 1 for documents of related ASTM and AASHTO methods.

**Table 1: Related documents**

Title	Reference Number
Standard Test Methods and Practices for Emulsified Asphalts	ASTM D244
Test Method for Determining the Viscosity of Emulsified Asphalts Using a Rotational Paddle Viscometer	ASTM D7226
Standard Specification for Cationic Emulsified Asphalt	ASTM D2397
Standard Specification for Emulsified Asphalt	ASTM D977
Determining the Viscosity of Emulsified Asphalt by a Rotational Paddle Viscometer	AASHTO T 382

## Specifications/Compliances

Table 2 provides specifications and compliances for the TE-DPV.

**Table 2: Specifications and Compliances**

Specifications	Details
Model	Thermoelectric Rotational Paddle Viscometer
Methodology	ASTM D7226, ASTM D2397, ASTM D977 and AASHTO T 382
Applications	Emulsified asphalts, marine fuels, suspensions, slurries, foods, paints, and residual oils
Dimensions (W × D × H)	23.5 cm × 27.3 cm × 41.5 cm (9.3 in × 10.8 in × 17.8 in) 15 cm (6 in) rear clearance required
Weight	10.0 kg (22.0 lb)
Shipping dimensions (W × D × H)	38.1 cm × 40.6 cm × 53.3 cm (15.0 in × 16.0 in × 21.0 in)
Shipping weight (with all items)	16.3 kg (36.0 lb)
Maximum throughput	4 samples per hour
Automated sample capacity	1 sample
Viscosity range and accuracy	30 mPa·s (cP) to 3000 mPa·s (cP) ± 5%
Test temperatures and accuracy	25 °C, 40 °C, 50 °C, 60 °C, 70 °C ± 0.1 °C
Minimum sample volume	135 mL per test
Electrical specifications	100 to 240 VAC, 47 to 63 Hz, 120 watts power consumption
Operating conditions	15 °C to 30 °C, 10% to 75% relative humidity (non-condensing), Installation Category II, Pollution Degree 2
Compliance	CE Mark; EMC Directive (2004/108/EC); Low Voltage Directive (2006/95/EC); HI-POT (1900 V <sub>DC</sub> , 60 sec.); ROHS
Data output	RS-232C

## Notes/Cautions/Warnings

Notes, caution, and warnings are used in the manual to call an operator's attention to important details prior to performing a procedure or step. Read and follow these important instructions. Failure to observe these instructions may void warranties, compromise operator safety, and/or result in damage to the TE-DPV.



**Note:** *Provides more information about the content that follows.*



**Caution:** *Alerts the operator to conditions that may damage equipment.*



**Warning:** *Alerts the operator to conditions that may cause injury.*

## Safety Precautions

Please observe the following general safety precautions for proper and safe operation of the Thermoelectric Rotational Paddle Viscometer.

- Only qualified personnel should operate the TE-DPV.
- Use appropriate safety precautions for working with high-temperature liquids/equipment.
- Make sure that you read and understand all operating instructions and safety precautions listed in this manual before installing or operating your unit. If you have questions regarding instrument operation or documentation, contact Cannon Instrument Company.
- Do not deviate from the installation, operation, or maintenance procedures described in this manual. Improper use of the TE-DPV may result in a hazardous situation and may void the manufacturer's warranty.
- Handle and transport the unit with care. Sudden jolts or impacts may cause damage to components.
- Avoid spilling liquids on the viscometer head or electric cables and connectors. If spillage occurs, remove power from the unit immediately
- Observe all warning labels. Never remove warning labels.
- Never operate damaged or leaking equipment.
- Unless procedures specify otherwise, always turn off the unit and disconnect the **MAINS AC** power cable from the power source before performing service or maintenance procedures, or before moving the unit.
- Do not position power cords so that they are likely to be walked on or pinched by items placed on or against them.

- If the TE-DPV will not be used for an extended period, unplug the power cord from the wall outlet. To disconnect the power cord, pull it out by the plug. Never pull the cord itself.
- Refer all service and repairs to qualified personnel.

The **~MAINS** symbol indicates the connections for the **AC** power input. The **AC** power input must match the electrical specifications of the instrument.

**~MAINS** Never operate the equipment with a damaged **MAINS AC** power cable. Use only the manufacturer-supplied **MAINS AC** power cable. This cable must be inserted into a receptacle with a protective earth ground.

**(O)** The **(O)** symbol indicates the **OFF** position for the electrical switches for your unit.





## Unpacking and Assembly

### Unpacking and Inspecting

Unpack and inspect the CANNON® TE-DPV and all accessories as soon as they are received.



**Caution:** Many components are fragile. Use caution when moving and handling the TE-DPV and accessories.

1. Carefully unpack the entire contents of the shipment.
2. Referring to the packing list, verify that all materials were received.
3. Inspect materials for defects and shipping damage. Contact your CANNON representative to resolve any issues.

**Table 3: Packing list**

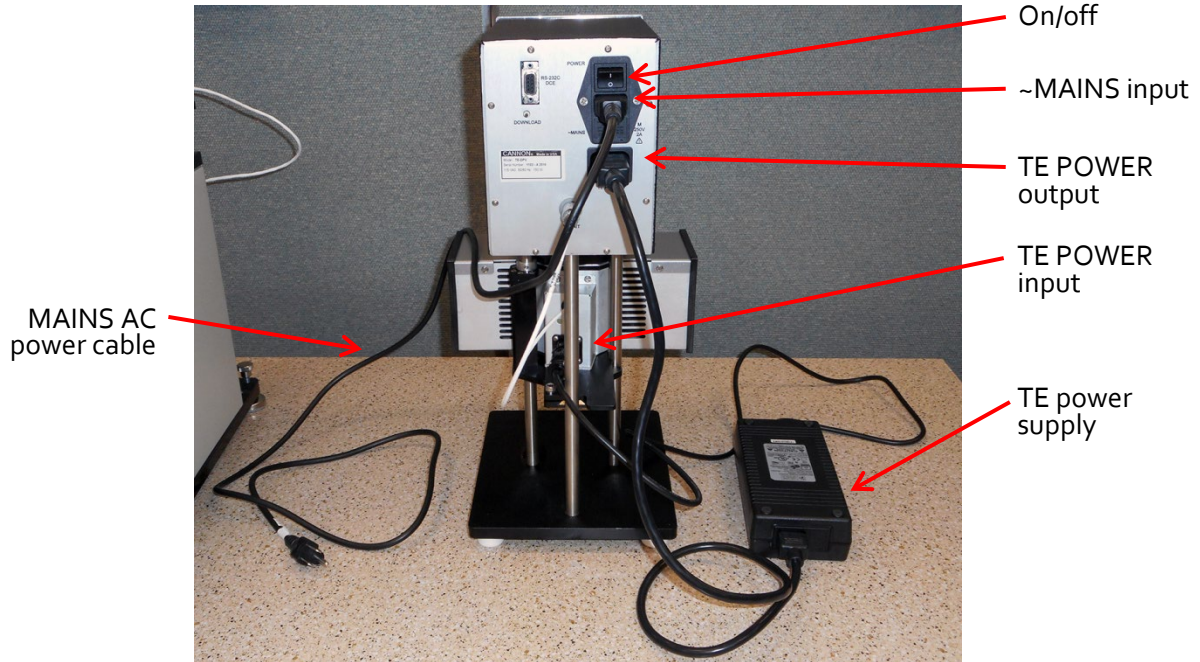
Description	Part Number
TE-DPV base unit	17.4165
TE block	17.4160
TE power supply	17.5173
MAINS AC power cable	74.2110 (U.S. standard)
Sample cup	17.4003
Sample lid (2)	17.4079
Low range paddle (2)	17.4004
Gapping washer, flat $\frac{3}{8}$ " stainless steel	01.0394
Viscosity reference standard N750 (500 ml)	9727-C51.016
TE-DPV Operation Manual	17.5140
TE-DPV Quick Reference Card	17.5095

### Assembling the TE-DPV

Assemble the TE-DPV on a secure, level surface (refer to Figure 1 and Figure 2).

1. Verify the TE-DPV power switch is off.
2. Connect the **MAINS AC** power cable to the **~MAINS** input on the back of the TE-DPV.
3. Connect the **TE power supply** to the **TE POWER** output on the back of the TE-DPV.

4. Connect the **TE power supply** to the DC power input on the back of the thermoelectric cooler (round plug).
5. Verify that the **TE control cable** (white cable) is plugged into the **TE UNIT** connector.
6. (Optional) Connect the optional printer to the **RS-232C** connector.
7. Plug the **MAINS AC** power cable into a **MAINS AC** receptacle.



**Figure 1: Assembled TE-DPV**



**Figure 2: TE-DPV Close Up of Back**

## Connecting (optional) Printer

A compact dot matrix printer is available from CANNON (P/N: 82.0067).



**Note:** *Serial data output: 9600 baud/19.2K/38.4K/76.8K, 8 data bits, no parity, one stop bit; RS-232C DCE with x-on, x-off flow control. Contact CANNON for instructions on changing the serial port communication speed. The default speed is 9600 baud.*



**Note:** *The printer must be turned on and in an active, receiving mode when a sample test finishes in order for the results to print. The data stream is transmitted directly to the serial port. No feature exists to print/re-print an already completed sample test.*

When a sample test finishes, the TE-DPV transmits a simple ASCII stream to the DB-9 connector/RS-232 serial port on the back of the TE-DPV. A printer can be connected to this serial port. The printer output includes temperature and viscosity. No density value (even when set) is printed. Follow instructions provided with the printer to set it up.



## Operating the TE-DPV

This procedure runs dynamic viscosity tests designed to meet methods ASTM D7226, ASTM D2397, ASTM D977, and AASHTO TP121.

### Front Panel Operation

The unit is controlled by the front panel display. See Figure 3 and Table 4 for a description of the front panel buttons and their action.



**Note:** To cancel an action, press the key used to start the action, e.g., to cancel temperature selection, press **SET TEMP**



Figure 3: TE-DPV front panel

Table 4: Front panel operation

Button	Action
<b>RUN TEST</b>	Start a test
<b>SET TEMP</b>	Select the target test temperature
<b>SET DENS</b>	Enter sample density to display viscosity in cSt (mm <sup>2</sup> /s)
<b>MENU</b>	Select measurement units and access to temperature and viscosity calibration
<b>ENTER</b>	Confirm entry of a parameter

## Starting the TE-DPV



**Note:** *On start-up, the TE-DPV is set to the last used temperature.*

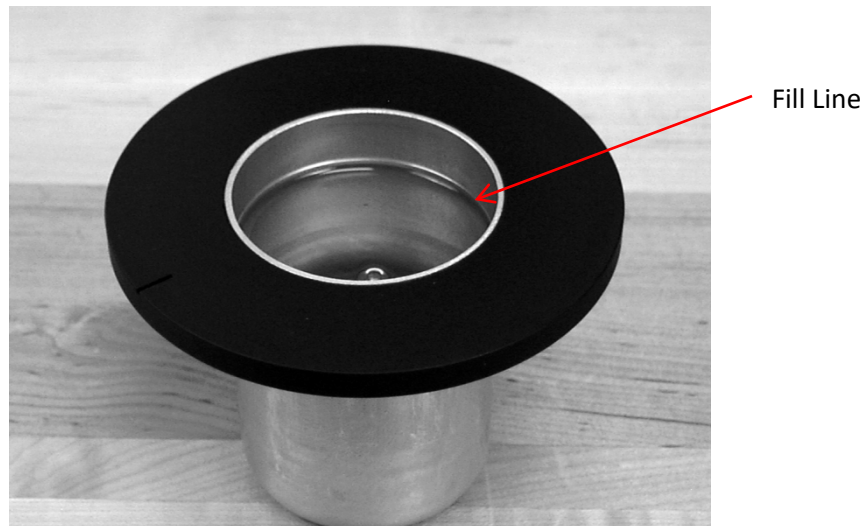
1. Turn on TE-DPV. The instrument will issue a series of short beeps.

## Loading a Sample



**Note:** *In addition to these instructions, the user should follow the instructions of the related ASTM or AASHTO method.*

1. Fill a clean sample cup to the fill line with the test sample. The fill line is circumscribed around the inside of the sample cup approximately  $\frac{1}{2}$ " (12 mm) below the top of the cup (~ 135 mL), see to Figure 4.



**Figure 4: Sample cup with liquid level at fill line**

2. Slide the TE block tray out on its rails until it is clear of the paddle.



**Note:** *When seated properly, the bottom of the sample cup is flush with the top of the TE block.*

3. Place the sample cup into the TE block and slowly rotate the sample cup until the notch is facing forward and the pin on the sample cup is seated in the hole in the TE block.
4. Push the TE block tray back until it clicks into position.
5. Loosen the knob on the front of the sample tray by turning it counterclockwise.
6. Raise the tray until the bearing contact the stop collar on the rail.
7. Lock the tray into position by turning the knob clockwise until the tray is secure.
8. Carefully place the sample cover over the cup. This is required for good temperature control.

## Running a test

Once a test is started, all testing functions of the TE-DPV are automatic. The instrument heats the sample to the test temperature. The current and target test temperatures display on the front panel. When the TE-DPV temperature probe senses that the sample temperature is within one-tenth of a degree of the target temperature, the instrument begins timing the test run and sampling of viscosity. After the instrument completes the analysis sequence, the calculated viscosity is displayed on the digital display and transmitted via the serial port.

The TE-DPV displays dynamic viscosity in mP·s (cP) if the sample density is not provided. To display kinematic viscosity in mm<sup>2</sup>/s (cSt), sample density must be entered before a test is run. Both values cannot be displayed at the same time.

1. To set density in order to display kinematic viscosity:
  - a. Press **SET DENS**, and then enter the sample density. A value must be entered for every character, e.g., a density of “.9” must be entered as “0.9000”.
  - b. Press **ENTER** to commit the selection.
2. To change the displayed viscosity units:
  - a. Press **MENU**.
  - b. Press **1) Configure Units**.
  - c. Press **ENTER**.
  - d. Select the desired units. See Table 5.

**Table 5: Viscosity units**

	cGs	SI
w/o density	cP	mPa
with density	cSt	mm <sup>2</sup> /s

- e. Press **ENTER**.
3. To change the test temperature:
  - f. Press **SET TEMP**.
  - g. Select the appropriate test temperature.
  - h. Press **ENTER**.
4. If a printer is connected, turn it on and verify that it is in active mode, e.g., for a Citizen Model CBM-910 dot matrix printer, the green **SEL** light must be lit.
5. Press **RUN TEST** to start a test cycle.

## Cleaning the Instrument



**Warning:** *Use appropriate precautions if handling a hot sample cup!*

Clean the sample cup, paddle, and sample cover after each test to ensure accurate viscosity reading.

1. Allow the sample and sample cup to cool to a safe handling temperature.
2. Remove the sample cover.
3. Wipe off any sample with an absorbent towel.
4. Lower the TE block tray and remove the paddle from the magnetic coupling.
5. Wipe any sample residue from the paddle. Use solvent if necessary.
6. Empty the used sample from the sample cup into an appropriate waste container.
7. Wipe out the cup with an absorbent towel. If necessary, use an appropriate solvent to completely clean the cup.



## Maintenance and Service

Do not attempt to service the TE-DPV beyond the basic instructions provided in this manual.

The TE-DPV is factory calibrated to ensure accurate temperature and viscosity reading. If results cannot be verified with a viscosity standard, recalibration may be required. Contact Cannon Instrument Company for further information.

### Adjusting the Stop Collar

The stop collar on the right-hand rail of the TE-DPV was adjusted during factory calibration to ensure that the paddle is positioned correctly in the sample cup when the TE block is raised into position for a test.

1. Use a  $\frac{5}{64}$ " (#8) or 2 mm Allen wrench to loosen the stop collar set screws until it slides freely on the rail.
2. Place the gapping washer in the bottom center of an empty sample cup.
3. Place the sample cup into the TE block and slowly rotate the sample cup until the notch is facing forward and the pin on the sample cup is seated in the hole in the TE block.
4. Push the TE block tray back until it clicks into position.
5. Loosen the knob on the front of the sample tray by turning it counterclockwise.
6. Raise the tray until the paddle touches the washer.
7. Lock the tray into position by turning the knob clockwise until the tray is secure.
8. Slide the stop collar down until it touches the top of the TE block and tighten the stop collar set screws

### Menu options

The Menu selection button on the TE-DPV provides access to three sub-menus:

1. **1) Configure Units:** use this option to change the display and printout between cGs and SI unit. Refer to *Running a test* section of this manual for more information.
2. **2) Condition Motor:** use this option to auto zero the motor. Follow the instructions on the screen.
3. **3) Advanced Options:** this option provides access to temperature and viscosity calibration and changing the serial port speed. Contact CANNON for more information





## Warranty

### Products Limited Warranty

In addition to other manufacturers' warranties, Cannon Instrument Company ("the Company") warrants all products (other than reagents and chemicals) delivered to and retained by their original purchasers to be free from defect in material and workmanship for one year from the date of the Company's invoice to the purchaser. For a period of one year from the date of such invoice, the Company will correct, either by repair or replacement at the Company's sole discretion, any defect in material or workmanship (not including defects due to misuse, abuse, abnormal conditions or operation, accident or acts of God, or to service or modification of the product without prior authorization of the Company) without charge for parts and labor. The determination of whether any product has been subject to misuse or abuse will be made solely by the Company. For repairs and service of the Brookfield DV2T Head Unit and associated accessories, contact Brookfield Engineering.

The Company shall not be liable for any special, incidental, or consequential damages, or any damage to plant, personnel, equipment, or products, directly or indirectly resulting from the use or misuse of any product. Representations and warranties made by any person, including dealers and representatives of the Company, which are inconsistent, in conflict with, or in excess of the terms of this warranty shall not be binding upon the Company unless placed in writing and approved by an officer of the Company.

### Reagent and Chemical Warranty

Cannon Instrument Company ("the Company") warrants all reagents and chemicals sold by the Company and delivered to and retained by their original purchasers to conform to the weight, specifications and standards stated on the package. The Company will, at its sole discretion, either replace or refund the price (net of freight, handling charges and taxes), of any reagent or chemical sold by the Company which does not conform to such weight, specifications, and standards upon the prompt return of the unused portion. Except for replacement or refund of the net price, the Company shall not be liable for any damages occurring as a consequence of the failure of any reagent or chemical sold by the Company to conform to the weight, specifications and standards stated on the package.

### Returning a Product to CANNON

Before returning a CANNON product for repair or service, make every attempt to identify the problem. If, after careful checking, the problem remains unidentified or unsolved, telephone Cannon Instrument Company (or the local service agent) to consult with a product specialist. If the specialist cannot recommend a simple solution or repair, CANNON will authorize the return of the product through the issuance of a Return Authorization number (RA).

CANNON Telephone Number: 814-353-800

Products returned to CANNON must be carefully packed. Ship prepaid to the following address:

CANNON Instrument Company  
ATTN: Return Authorization # \_\_\_\_\_  
2139 High Tech Road  
State College, PA 16803 USA

The following information must be included with the return shipment.

### ***Required Information***

- The Return Authorization number (RA).
- The name and telephone number of the person at your company to contact regarding the product.
- Shipping and billing instructions for the return of the product to your location.
- A detailed explanation of the reason for the return. If the product is not covered by warranty, the customer will be provided with an estimate of the repair costs and asked for approval before any repairs are made. The customer will be required to issue a purchase order for the cost of the repairs.

### ***Hazardous Materials***

Please contact CANNON before returning a product that could possibly contain hazardous material.

### ***Shipping Notification***

Products returned without CANNON's prior authorization, will not be accepted. The customer may be billed a testing fee if a product is returned to CANNON and found to be working properly.



**CANNON INSTRUMENT COMPANY®**

2139 High Tech Road | State College, PA 16803 | USA  
800-676-6232 | 814-343-8000 | Fax: 814-353-8007  
sales@cannoninstrument.com | [www.cannoninstrument.com](http://www.cannoninstrument.com)