



# Viscosity of Bitumen

ASTM D2170, EN 12595, ASTM D2171, IP 222, EN 12596,  
AASHTOT 202

Rev 1.09



**Tamson Instruments**



## CONTENT OF PRESENTATION

- What is Bitumen?
- Viscosity of Bitumen Today
- Standards
- The Method
- Manual Viscosity baths
- TV2000 & TV4000 (Main Characteristics)
- Set-up for ASTM D2170
- Set-up for ASTM D2171
- Unit Installation and Preparing



## WHAT IS BITUMEN?

- Bitumen is an oil based substance.
- Hydrocarbon product, originating from crude oil, refrained from lighter fractions.
- Refined it is a stable, semi-solid substance, at ambient temperatures.
- In Europe it is named bitumen, while in North America it is named asphalt cement or asphalt.
- Usually, “asphalt” is the term used for a mixture of small stones, sand, filler and bitumen, which is used as a road paving material. This asphalt mixture contains approximately 5% bitumen.



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Viscosity of Bitumen today

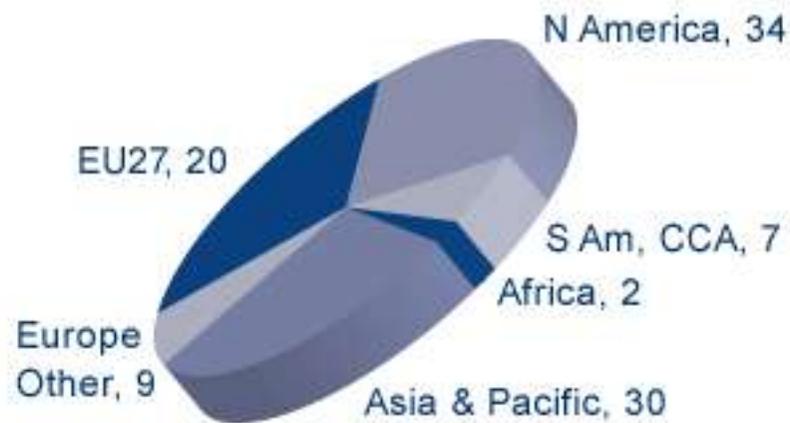


# Importance

## VISCOSITY OF BITUMEN TODAY

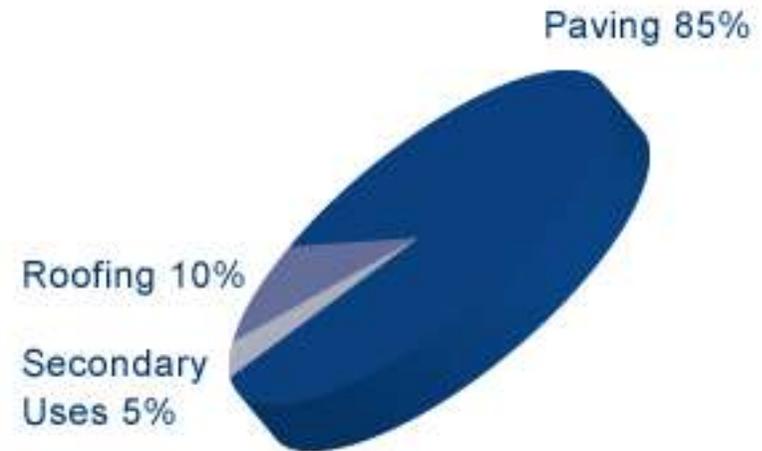
### Global Bitumen Use

(million metric tonnes per year)



Total: 102 MT per year

### Bitumen Applications





# Importance

## VISCOSITY OF BITUMEN TODAY

### **Bitumen is a quality product with distinct properties:**

- Viscosity grade of bitumen have a thermoplastic property which causes the material to become liquid at high temperatures and to harden at ambient temperatures.
- This unique temperature/viscosity relationship is important when determining the performance parameters such as the adhesion, rheology, durability and application temperatures of bitumen.
- Therefore, accurate viscosity analysis of bitumen at different temperatures has become an important test.



# Standards

## KINEMATIC VISCOSITY OF BITUMEN

- Test methods: ASTM D2170 and EN 12595.
- The standard describes the manual determination of kinematic viscosity.
- A viscosity bath is used.
- The time is measured for a fixed volume of liquid to flow under gravity through the capillary of a calibrated **reverse flow** viscometer at a closely controlled and known temperature.
- The kinematic viscosity (determined value) is the product of the measured flow time and the calibration constant of the viscometer. Two such determinations are needed from which to calculate a kinematic viscosity result that is the average of two acceptable determined.



# Standards

## VISCOSITY OF BITUMEN BY VACUUM CAPILLARY VISCOMETER

- Test methods: ASTM D2171, IP 222, EN 12596, AASHTOT 202.
- The standard describes the manual determination of dynamic viscosity.
- A viscosity bath is used.
- The time is measured for a fixed volume of liquid to flow under precise vacuum ( $300 \text{ mm HG} \pm 0.5 \text{ mm HG}$ ) through the capillary of a calibrated vacuum viscometer at a closely controlled and known temperature.
- The viscosity in Pascal-seconds is calculated by multiplying the flow time in seconds by the viscometer calibration factor.



## Manual baths

### BATH TEMPERATURE

- Use a bath with a constant temperature.
- Temperature tolerance max.  $\pm 0.01^{\circ}\text{C}$  for ASTM D2170 @  $60^{\circ}\text{C}$  and  $\pm 0.03^{\circ}\text{C}$  for both ASTM D2170 and D2171 @  $135^{\circ}\text{C}$ .
- The temperature measuring device is a calibrated glass thermometer, accuracy  $\pm 0.02^{\circ}\text{C}$  or better. Or a Digital Contact Thermometer (DCT) is allowed. We recommend our TT3B DCT thermometer with temp. range from  $-40^{\circ}\text{C}$  to  $+140^{\circ}\text{C}$  (P/N 10T6094), see next slide.
- Since October 2017, mercury in LIG thermometers are forbidden within the EU and the market has to change to DCTs.



# Manual baths

## BATH TEMPERATURE

### Tamson TT3B Thermometer

Complies to ASTM D445 / D8278

- Sensor element PT100
- Display resolution 0.01 or 0.001°C
- Accuracy better than  $\pm 0.02^\circ\text{C}$
- Linearity  $\pm 0.01^\circ\text{C}$
- Fast response time 6 sec
- Annual drift  $< \pm 0.001^\circ\text{C}$

(Thermistor or PT100)  
(0.01°C)  
( $\pm 0.02^\circ\text{C}$ )  
( $\pm 0.01^\circ\text{C}$ )  
( $< 8$  sec)  
( $< \pm 0.02^\circ\text{C}$ )

Requirements  
ASTM D445 /  
D8278



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Tamson TT3B DCT

Now available!



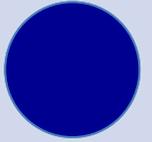
# Manual baths

## CAPILLARIES

- The viscometer is a calibrated glass capillary, the size depends on the sample being tested.
- Flow times between 200 and 900 seconds are recommended.
- ASTM D2170 prescribes reverse flow viscometers.
- ASTM D2171 prescribes vacuum viscometers.
- The viscometer has to be suspended in a vertical position. This is possible with the special design of the covers used in the Tamson viscosity baths and the Tamson stainless steel viscometer holders. These are available for most viscometers, please see [www.tamson.com](http://www.tamson.com) for further information.



# Manual Baths



## TIMING DEVICE

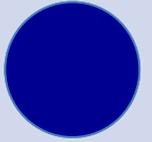
- The manual timing device must allow readings with a tolerance of 0.1 second or better. **Accuracy  $\pm 0.07\%$ .**
- Electrical timing devices can be used if an accuracy of  **$\pm 0.05\%$  or better** is reached.



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# Manual Baths



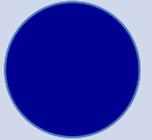
## TIMING DEVICE



- Tamson timer (P/N 10T6090) uses a crystal which has a maximum deviation of 20 ppm (parts per million).
- On one second that is  $(1 / 1000.000) * 20 = 0.00002$  sec.
- One hour has  $60*60*0.00002 = 0.072$  seconds.
- Human reaction time is 0.2 second (200 mS).
- So, fault of Tamson timer when measuring one hour is three times less than human error (viscosity flow time is between 200 and 900 seconds).



# TV2000 & TV4000



## MAIN UNIQUE FEATURES

- ✓ Standard Worldwide
- ✓ Temperature Range
- ✓ Ultra High Stability
- ✓ Three or Seven Places
- ✓ LED Lights Background
- ✓ Detachable Front Window
- ✓ Bath Drain & Bath Overflow
- ✓ PID Digital Controller



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# TV2000 & TV4000



## WORLDWIDE STANDARD

- ✓ TV2000 & TV4000 introduced in late 1980s. New design and electronics since 2010.
- ✓ Since introduction, thousands installed.
- ✓ In every continent and most of the countries worldwide you can find a TV2000 or TV4000.
- ✓ Dominant standard in petrochemical labs.



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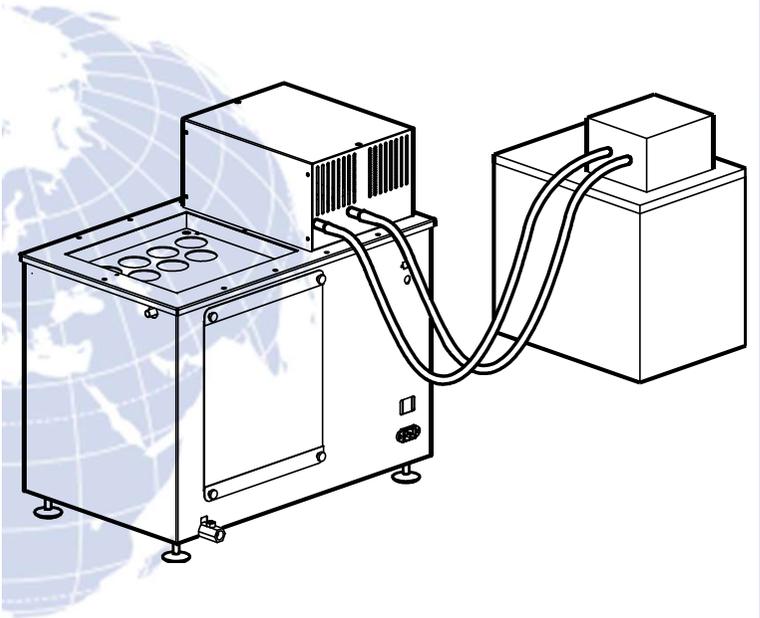


# TV2000 & TV4000



## TEMPERATURE RANGE

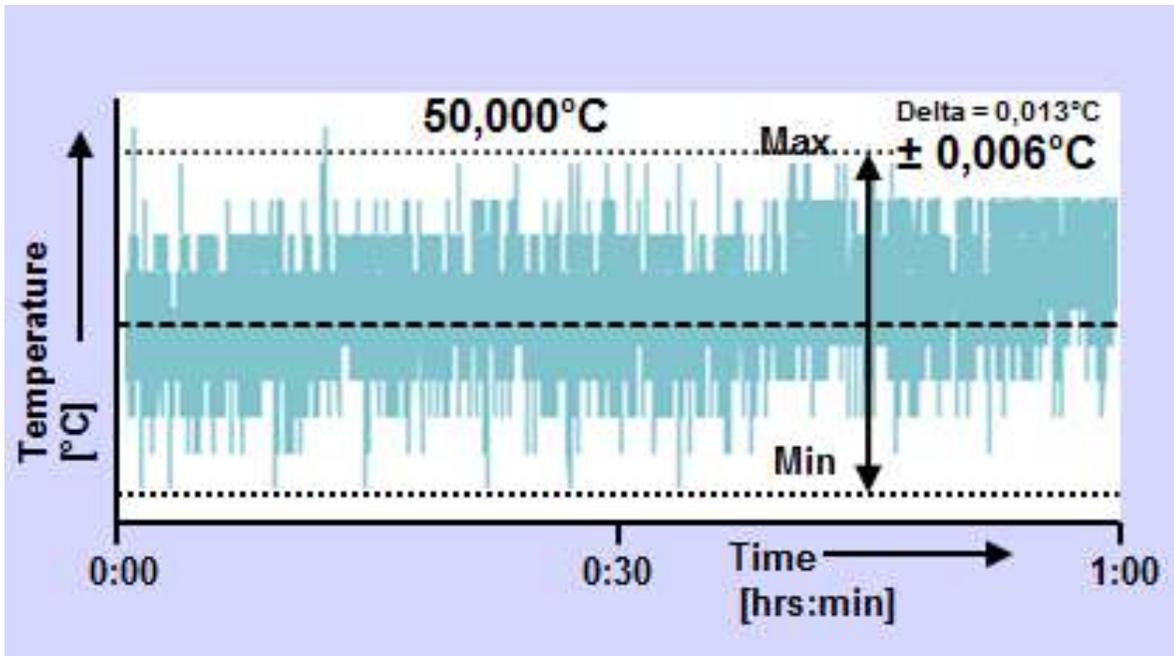
- Standard range from ambient to +230°C.
- TV2000 & TV4000 is standard equipped with a cooling coil.
- When connecting to tap water or an external cooler, sub ambient temperatures can be reached.





# TV2000 & TV4000

## HIGH TEMPERATURE STABILITY



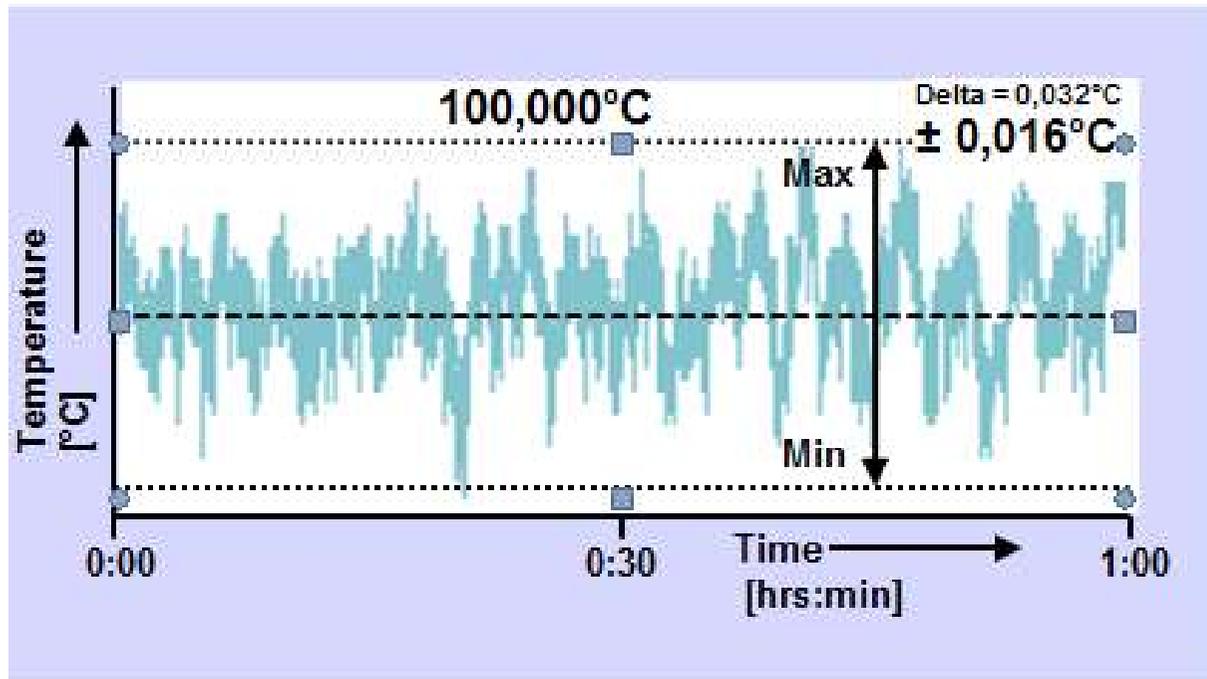
ASTM D2171  
requirement:  
temperature tolerance  
max.  $\pm 0.03^{\circ}\text{C}$ . ASTM  
D2170 max.  $\pm 0.03^{\circ}\text{C}$

This is the real  
difference between the  
minimum and  
maximum temperature  
for 60 minutes. Some  
competitors just state  
the standard deviation  
of the mean or  
mention the stability  
for a few minutes.



# TV2000 & TV4000

HIGH TEMPERATURE STABILITY



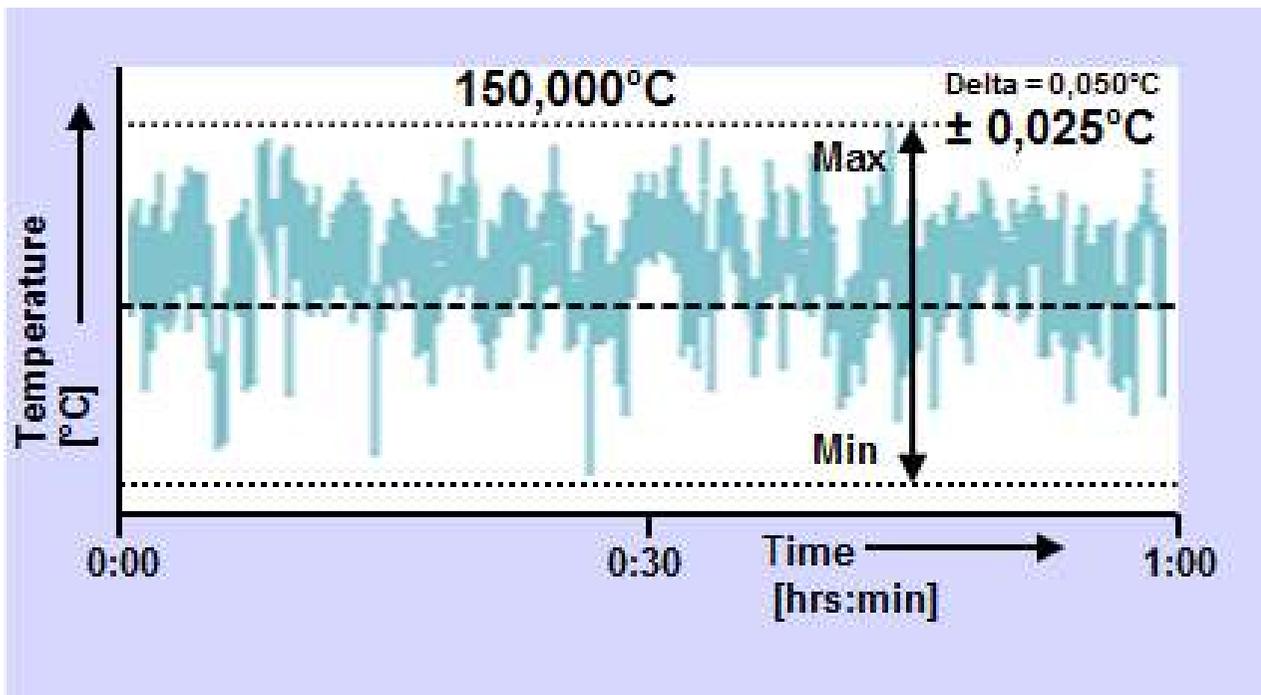
ASTM D2171  
requirement:  
temperature  
tolerance max.  $\pm$   
0.03°C.



# TV2000 & TV4000

## HIGH TEMPERATURE STABILITY

ASTM D2170 /  
ASTM D2171  
requirement:  
temperature  
tolerance max.  $\pm$   
**0.03°C.**





# TV2000 & TV4000

## HIGH TEMPERATURE STABILITY

As you can read in the ASTM D2170 & ASTM D2171, the standard methods allow quite a temperature instability. **But what is the consequence for the viscosity result if the bath temperature is varying by  $0.02^{\circ}\text{C}$  ( $\pm 0.01^{\circ}\text{C}$ )?**

|   | Sample                           | 1      | 2      | 3      | 4      | 5      | 6      |
|---|----------------------------------|--------|--------|--------|--------|--------|--------|
| 2 | Time [sec.]                      | 132.43 | 132.69 | 131.81 | 131.76 | 132.79 | 132.14 |
| 3 | Min. Temp. $^{\circ}\text{C}$    | 49.166 | 49.177 | 49.172 | 49.173 | 49.177 | 49.162 |
| 4 | Max. Temp. $^{\circ}\text{C}$    | 49.193 | 49.204 | 49.200 | 49.202 | 49.201 | 49.198 |
| 5 | Delta ( $\pm$ )                  | -0.027 | -0.027 | -0.028 | -0.029 | -0.024 | -0.036 |
| 6 | Average temp. $^{\circ}\text{C}$ | 49.178 | 49.185 | 49.190 | 49.184 | 49.192 | 49.171 |

We have tested six samples using a Ubbelohde viscometer with a constant of 0.009021. The results of the six tests are mentioned in the table.

Row 2 gives the duration of a measurement in seconds, where the time is measured via two optical infra red sensors.

Rows 3 and 4 show the minimum and maximum temperature during a test.

Row 5 demonstrates the difference between the maximum and minimum temperature.

Row 6 gives the average temperature of the bath during a test.



# TV2000 & TV4000



## ULTRA HIGH STABILITY

The table shows the kinematic viscosity. For sample 2 it is calculated as follows:

$$v = C \times t$$

$$v = 0.009021 \times 132.43$$

$$v = 1.194651$$

You are allowed to delete one test result, so we have deleted the result of sample 4.

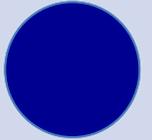
The average in the table is taken from the five other samples.

The deviation is calculated by dividing the  $v$  by the average of the five samples. This result has been multiplied by 100%.

|         | mm <sup>2</sup> /s | Deviation | Temp °C | Deviation |
|---------|--------------------|-----------|---------|-----------|
|         | 1.188607           | 99.538%   | 49.184  | 100.002%  |
|         | 1.194651           | 100.044%  | 49.178  | 99.990%   |
|         | 1.196996           | 100.240%  | 49.185  | 100.003%  |
|         | 1.189058           | 99.575%   | 49.190  | 100.014%  |
|         | 1.197899           | 100.316%  | 49.192  | 100.017%  |
|         | 1.192035           | 99.825%   | 49.171  | 99.976%   |
| Average | 1.194128           |           | 49.183  |           |



# TV2000 & TV4000



## ULTRA HIGH STABILITY

This table is a part of previous table. The delta in temperature is  $49.192^{\circ}\text{C} - 49.171^{\circ}\text{C} = 0.021^{\circ}\text{C}$ . And the deviation in the measuring result is  $100.316\% - 99.825\% = 0.491\%$ ! Based on this experiment, we can conclude that a slight temperature variation by only  $0.02^{\circ}\text{C}$  -can cause a 0.5% deviation in the viscosity result.

Conclusion: it is not just important that the TV2000 & TV4000 are conform to the ASTM D2170 and D2171 methods. It is also very important that the bath temperature is as stable as possible in order to get the most accurate results.

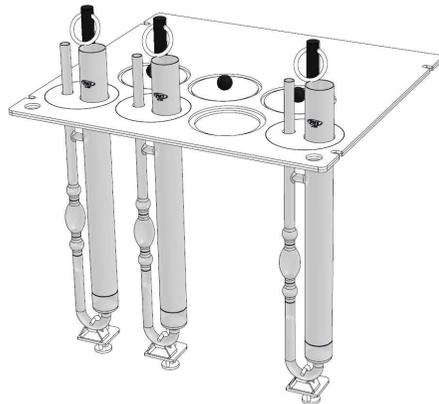
| mm <sup>2</sup> /s | Deviation | Temp °C | Deviation |
|--------------------|-----------|---------|-----------|
| 1.192035           | 100.316%  | 49.171  | 100.017%  |
| 1.197899           | 99.825%   | 49.192  | 99.976%   |





# TV2000 & TV4000

## COVER WITH 3 & 7 POSITIONS

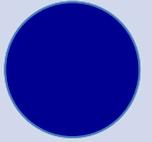


- The cover of the bath has round 51 Ø mm openings with lids, for suspending glass capillary glass viscometers in viscometer holders.
- Cover has standard two openings 12.5 mm ø for ASTM thermometers.
- Cover of TV2000 offers three openings (four optional).
- Cover of TV4000 offers seven openings (eight optional).



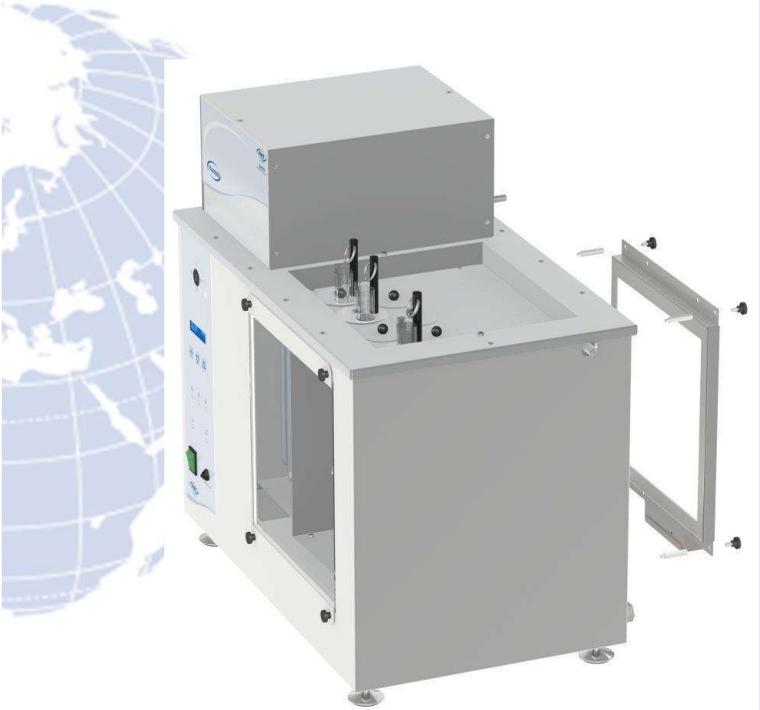


# TV2000 & TV4000



## EXTERNAL LED LIGHT

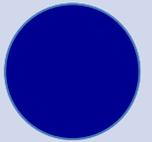
- Tamson has introduced a new design using LED technology which can be mounted on the TV2000 & TV4000 as a back panel resulting in excellent visibility in the bath.
- It is highly energy efficient (6 Watts).
- It has a wide range inputs from 85V up to 250V/ 50~60Hz
- The LED panel has a much longer expected lifetime than a TL bulb which is used by competitors.



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# TV2000 & TV4000



## DETACHABLE FRONT WINDOW

The bath is fitted with a double window of which the front pane is detachable for cleaning purposes (after some years of usage, a vapour on the inner windows can reduce the visibility, cleaning of the inner windows is very easy).

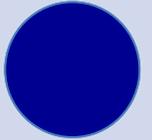
Outside window pane can be removed by unscrewing the four black screws.



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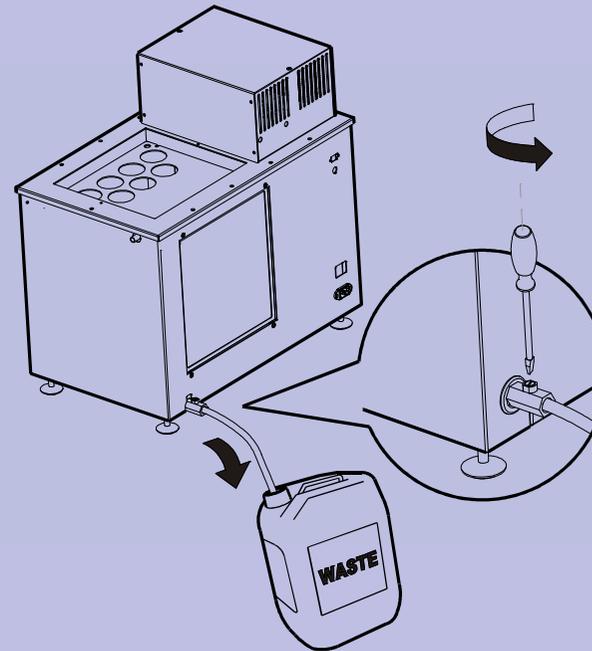


# TV2000 & TV4000



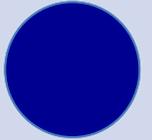
## BATH DRAIN & OVERFLOW OUTLET

- The TV2000 & TV4000 can be emptied via the drain tap located at the backside of the apparatus.
- For safety reasons the tap can only be opened by using a screwdriver.
- The thread inside the tap is 3/8" BSP.



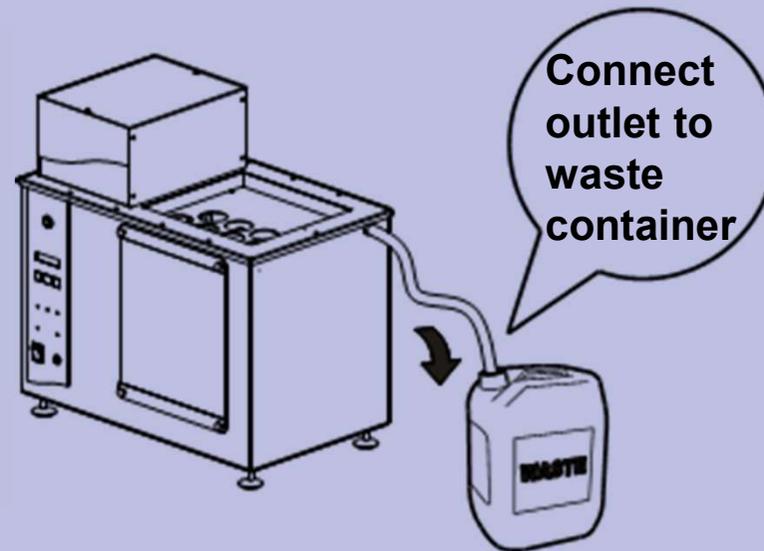


# TV2000 & TV4000



## BATH DRAIN & OVERFLOW OUTLET

- If the fluid level is too high, it will leave the bath via the overflow outlet
- Prevent fluid from the overflow outlet entering the side of the bath.
- For this reason the overflow outlet must be connected to a waste container.





## TV2000 & TV4000

### DIGITAL CONTROLLER

- One of the reasons for the unique bath stability is that we use our own Tamson Microprocessor controller (TMC70) board. This circuit board offers several nice features:
  - ✓ Two decimal readout
  - ✓ Offset
  - ✓ Percentage heating is shown in display, maximum percentage can be programmed
  - ✓ PID settings (automatic and manually)
  - ✓ RS232 communication

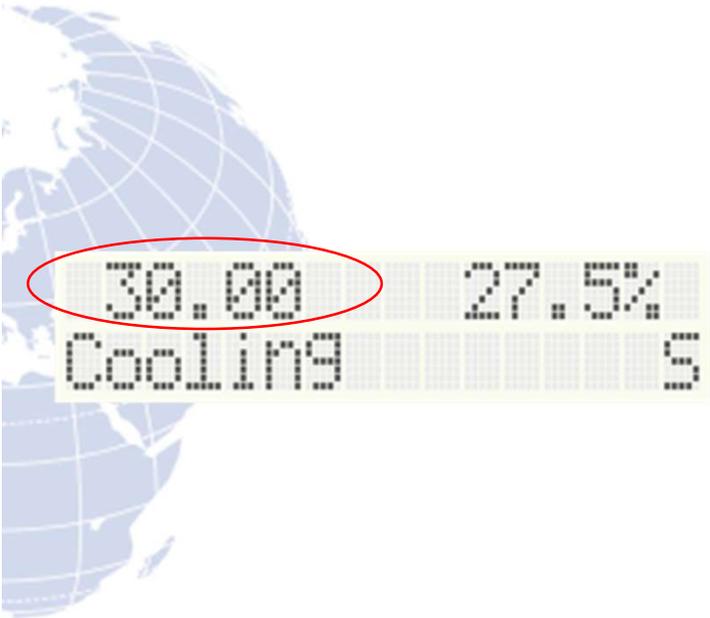


# TV2000 & TV4000



## DIGITAL CONTROLLER – TWO DECIMAL READ

- Temperature stability is very important for ASTM D2170 & D2171. Therefore, we show a two decimal readout in the display. **Optional is a three decimal readout.**
- It is doubtful to use a viscosity bath with an analog controller or a digital controller offering one decimal readout for ASTM D2170 or ASTM D2171 tests.



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## TV2000 & TV4000

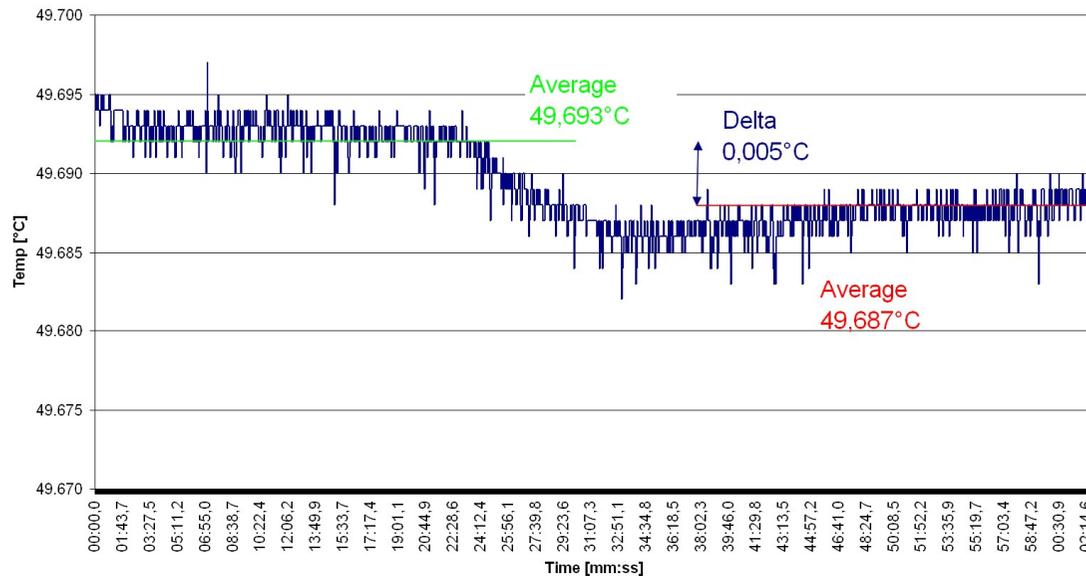
### DIGITAL CONTROLLER - OFFSET

- The temperature displayed can be increased or decreased with an offset ranging from  $+5.00^{\circ}\text{C}$  down to  $-5.00^{\circ}\text{C}$  in steps of  $0.01^{\circ}\text{C}$ . This way the temperature reading on the display can be synchronised with an independent and calibrated thermometer.
- **N.B. an offset is essential for your viscosity bath.**



# TV2000 & TV4000

## DIGITAL CONTROLLER - OFFSET



Also, we offer standard an additional  $0.005^{\circ}\text{C}$  offset.

This is very important when temp is e.g  $39.995^{\circ}\text{C}$ . With a  $0.01^{\circ}\text{C}$  offset you can only reach  $40.005^{\circ}\text{C}$ .

With the additional  $0.005^{\circ}\text{C}$  offset option you can reach exactly  $40.000^{\circ}\text{C}$  in the bath.



# TV2000 & TV4000

## DIGITAL CONTROLLER – PERCENTAGE HEATING

Display

30.00 27.5%  
Cooling S

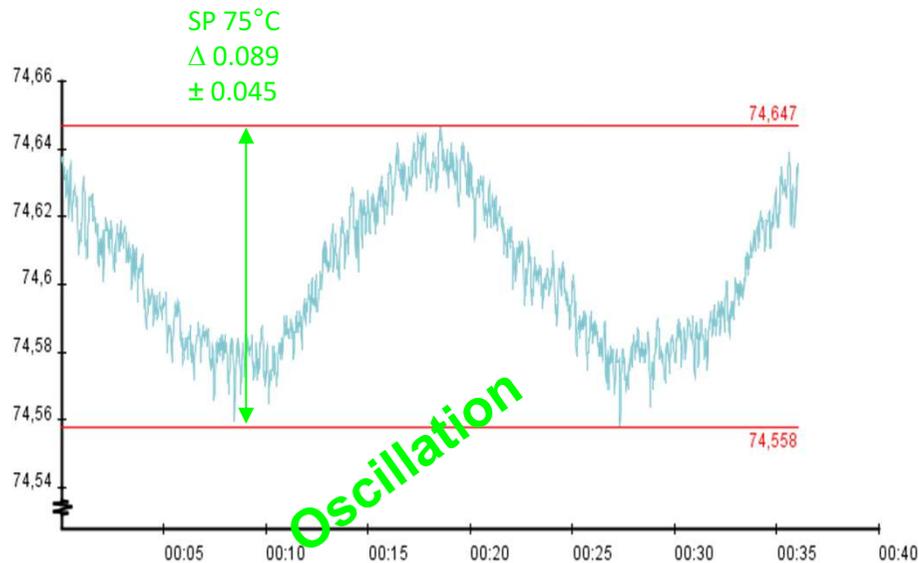
- Maximum percentage of heating can be selected in the menu. This maximum power can be selected to prevent overshoot or burning of bath fluids. Four stages are available: 25%, 50%, 75%, and 100%
- The controller continually calculates the amount of power which should be applied for stable control. The value is displayed with a resolution of 0.1% and ranges from 0% to 99.9%.
- If this percentage is lower than 10%, additional cooling is needed to get precise temperature stability. This is a good explanation as to why the bath temperature is not stable. Other brands don't give you this information.



# TV2000 & TV4000

## DIGITAL CONTROLLER – PID SETTINGS

|                         |             |
|-------------------------|-------------|
| Temperature:            | 75°C        |
| Proportional band (Pb): | 100         |
| Integrator:             | 16          |
| Differentiator:         | 0           |
| Min/max:                | $\pm 0.045$ |



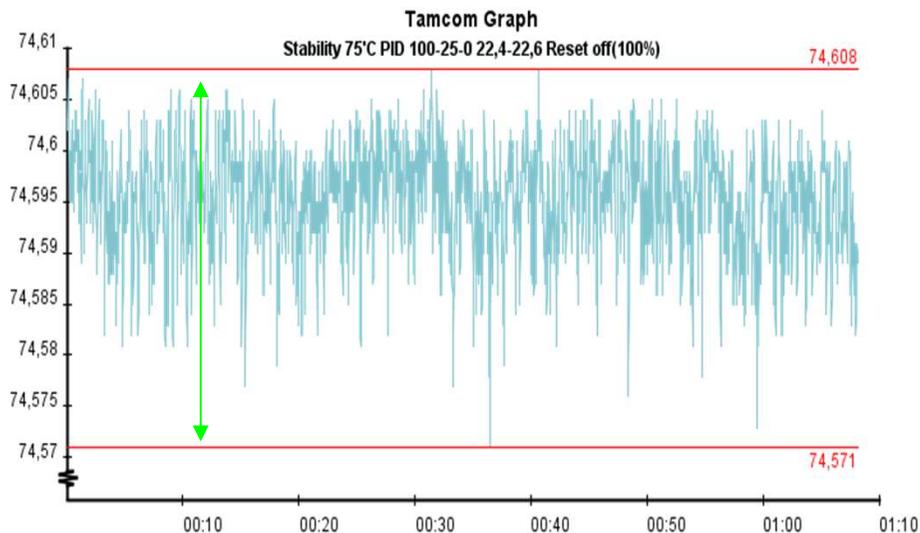
Controller is equipped with PID settings. If necessary, the PID settings can be manually adjusted to get the best optimum. As an example, we show below a graph off an unstable bath.



# TV2000 & TV4000

## DIGITAL CONTROLLER – PID SETTINGS

Temperature: 75°C  
Proportional band (Pb): 50  
Integrator: 16  
Differentiator: 0  
Min/max:  $\pm 0.018$



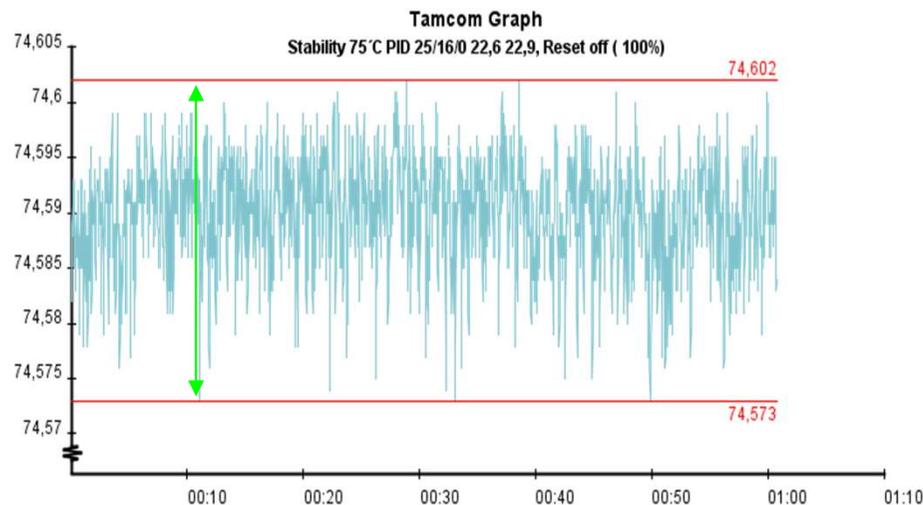
By changing the 'P' from '100' to '50', stability is becoming better. All other variables stay the same.



# TV2000 & TV4000

## DIGITAL CONTROLLER – PID SETTINGS

Temperature: 75°C  
Proportional band (Pb): 25  
Integrator: 16  
Differentiator: 0  
Min/max:  $\pm 0.015$

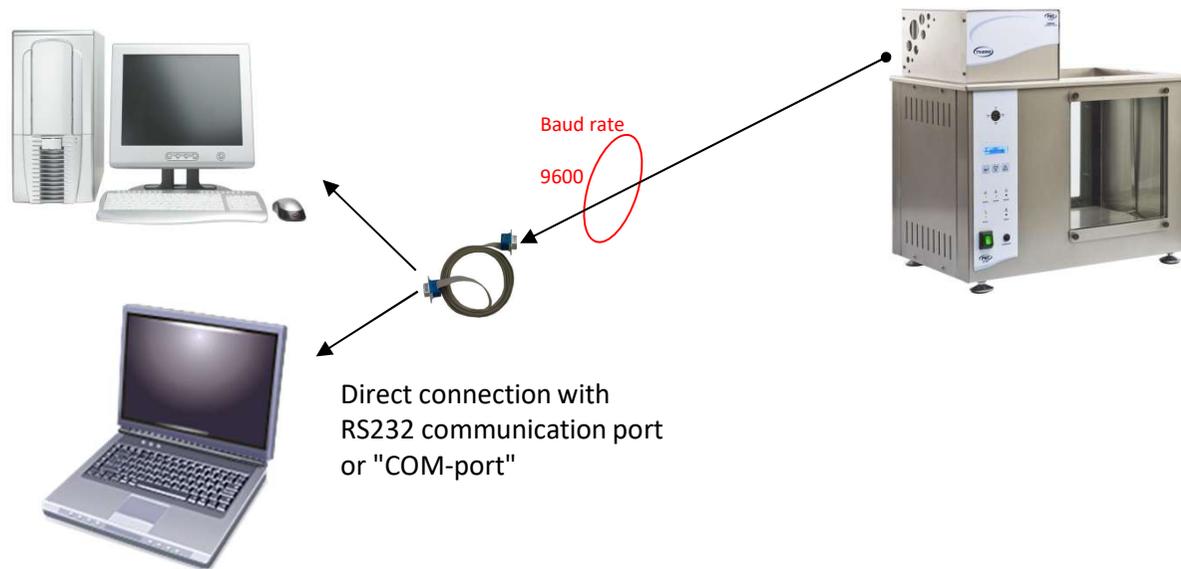


By changing the 'P' from '50' to '25', the temperature stability even improves further.



# TV2000 & TV4000

## DIGITAL CONTROLLER – RS232 COMMUNICATION



- ✓ Equipment is standard equipped with RS232 communication.
- ✓ By using the RS232 communication port, the controller can be controlled remotely using the Tamson software, or a serial terminal, or your own software.



# TV2000 & TV4000

## DIGITAL CONTROLLER – RS232 COMMUNICATION

The Tamcom software can do following:

- ✓ Logging data into a file (CSV)
- ✓ Programming a Set Point curve via simple data in a file
- ✓ Display process value and set point temperature in a graph
- ✓ Actual values
- ✓ Change set point temperature
- ✓ Show Process value
- ✓ Set Offset
- ✓ Set PID values.



# TV2000 & TV4000

## DIGITAL CONTROLLER – RS232 COMMUNICATION

Easy setting of important parameters, click and alter

Actual process value (PV) and set point (SP)

Curve displays PV and SP. Time stamp is hh:mm:ss

Tamcom 2.4.1

Tamson Instruments by <http://www.tamson.com/> **PMT** est. 1978

Process Value: **31.221 °C**

low: 27.594 high: 31.221  **High Limit**

Δ: 3.627

Setpoint: **30.00 °C**

PB: 25 Offset: 0.00

TI: 16 Schedule: « none »

TD: 0 Firmware: V1.30

Tamcom Graph  
project description

31.5  
31  
30.5  
30  
29.5  
29  
28.5  
28  
27.5

00:00:05 00:00:10 00:00:15 00:00:20 00:00:25 00:00:30 00:00:35 00:00:40

Min and max values during run. Toggle red marker lines on or off

Alter PID values, offset or import setpoint curve file

Print or export graph as PNG(word) or CSV(Excel)

Reminder text or project description for header log file



## VISCOSITY BATH



# ASTM D2170 Set-Up

- ✓ Three position TV2000 or seven position TV4000
- ✓ Backlight LED Illuminator (P/N 00T0908)
- ✓ Silicon oil (P/N 08T0001)



# ASTM D2170 Set-Up

## VISCOMETERS



- ✓ Reverse flow viscometers, selection can be made between:
  - ✓ Cannon Fenske Opaque (CFO)
  - ✓ Zeifuchs Cross-Arm (ZCA)
  - ✓ BS/IP/RF U-tube
  - ✓ (Lantz-Zeifuchs cannot be used in a TV2000 or TV4000)
- ✓ Rubber stopper for viscometer CFO and ZCA (P/N 06T1724)
- ✓ Filling tube and stopcock for BS/IP/RF U-tube viscometer (P/N 25T1069)
- ✓ ZCA and BS/IP/RF viscometers have the same constant at different temperatures and are therefore preferred, especially when using them @135°C.



est. 1878

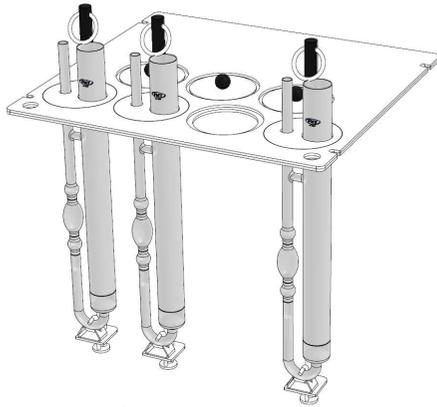
**Tamson Instruments**

Wide range of viscometers available!



# ASTM D2170 Set-Up

## VISCOMETERS HOLDERS



- TV2000 & TV4000 cover consists of two plates. The bottom plate has the standardized 51 Ø mm openings as prescribed by ASTM D445 and related test methods and the top plate has wider openings to accommodate our stainless steel holders.
- Viscometer holders also have a cover consisting of two plates which fit perfectly in the covers of the Tamson viscosity baths.
- In the picture, you can see an example of our TV4000 cover.



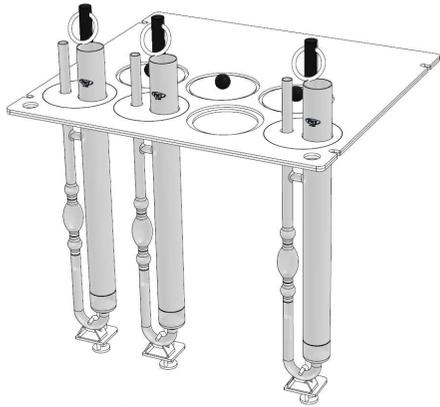
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# ASTM D2170 Set-Up

## VISCOMETERS HOLDERS



- ✓ Tamson stainless steel holders will fit into the openings of the covers used in our viscosity baths perfectly.
- ✓ Prevent the holders from shifting position when, for example, silicon tubing is connected to the viscometers in order to apply vacuum.
- ✓ Viscometer tubes will not move due to the bath fluid circulating inside the viscosity bath.
- ✓ Tamson can guarantee that the viscometer in its stainless steel holder is aligned at a 90 degree angle to the cover as prescribed in ASTM D445 (kinematic viscosity is determined using gravity as a driving force).
- ✓ The Tamson stainless steel holders are widely used and popular among users due to a robust design. The insulated handle makes it easy and safer to remove the viscometer even at high working temperatures.
- ✓ Another advantage of the Tamson holder is the clamp at the bottom of the holder, which makes it impossible for the viscometer to fall out of the holder. Breakage of the glass viscometers can easily happen with the rubber and plastic holders available on the market currently.





# ASTM D2170 Set-Up

## VISCOMETERS HOLDERS



- ✓ Stainless steel holders:
  - ✓ Cannon Fenske Opaque (P/N 10T6071)
  - ✓ BS/IP/RF U-tube (P/N 10T6050)
  - ✓ Zeitfuchs Cross-Arm (P/N 10T6327)
- ✓ Insulated handle, easy to grab at high working temperatures
- ✓ Stainless steel
- ✓ Viscometer will not move when applying vacuum
- ✓ Ring to hang out



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Wide range of viscometers available!



# ASTM D2170 Set-Up

## OTHER ACCESSORIES

- ✓ Viscohanger (P/N 10T6066)
- ✓ Timer (P/N 10T6090)
- ✓ ASTM thermometer
  - ✓ @ 60°C (P/N 25T0940BW)
  - ✓ @ 135°C (P/N 25T0981BW)
  - ✓ Alternative TT3B DCT (P/N 10T6094)
- ✓ General Purpose Viscosity Standards
- ✓ Spill tray for TV2000 or TV4000



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Great accessories to optimize your  
product



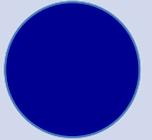
# ASTM D2171 Set-up

COMPLETE SET-UP D2171





# ASTM D2171



## VISCOSITY BATH

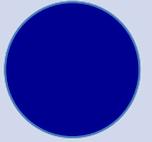
- ✓ Seven position TV4000
- ✓ Backlight LED Illuminator (P/N 00T0908)
- ✓ Silicon oil (P/N 08T0001) if working at temperatures  $> 80^{\circ}\text{C}$



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# ASTM D2171



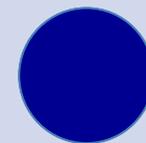
## TAMSON VACUUM SYSTEM



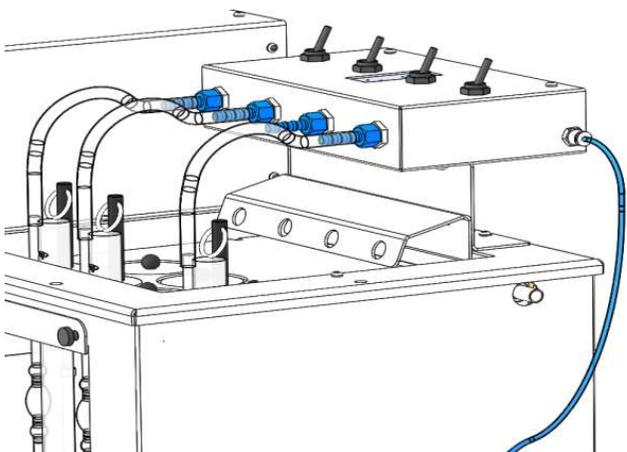
- ✓ Extremely small footprint
- ✓ Wide input range (85-265V)
- ✓ 20 to 320 mm HG (negative pressure)
- ✓ Stability  $\pm 0.5$  mm Hg
- ✓ Readout selectable in mm HG, PSI or mBAR
- ✓ Very quiet
- ✓ Internal pump can be switched-off between tests to increase life time of pump.
- ✓ Easy calibration
- ✓ Fluid traps to prevent fluid being sucked into system



# ASTM D2171



## TAMSON VACUUM MANIFOLD (TVM)



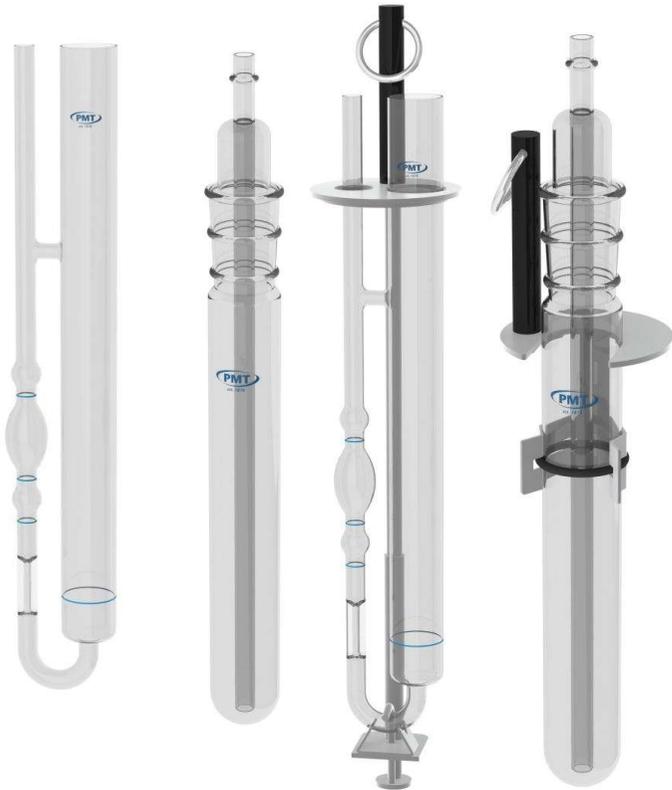
- ✓ Four position manifold
- ✓ Can be easily mounted on the TV4000 using the holes in top plate
- ✓ Delivered with blue silicon tubing to connect TVM with TVS
- ✓ Strong and robust switches



# ASTM D2171



## VISCOMETERS AND VISCOMETER HOLDERS



- ✓ Vacuum Viscometers:
  - ✓ Cannon-Manning
  - ✓ Asphalt Institute
  - ✓ Modified Koppers
- ✓ Stainless steel holders vacuum viscometers:
  - ✓ Cannon-Manning and Asphalt Institute (P/N 10T6052)
  - ✓ Modified Koppers (P/N 10T6053)



# ASTM D2171 Set-Up

## OTHER ACCESSORIES

- ✓ Viscohanger (P/N 10T6066)
- ✓ Timer (P/N 10T6090)
- ✓ ASTM Thermometer
  - ✓ @ 60°C (P/N 25T0940BW)
  - ✓ @ 135°C (P/N 25T0981BW)
  - ✓ Alternative TT3B TT3B (P/N 10T6094)
- ✓ General Purpose Viscosity Standards
- ✓ Spill tray for TV2000 or TV4000



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Great accessories to optimize your  
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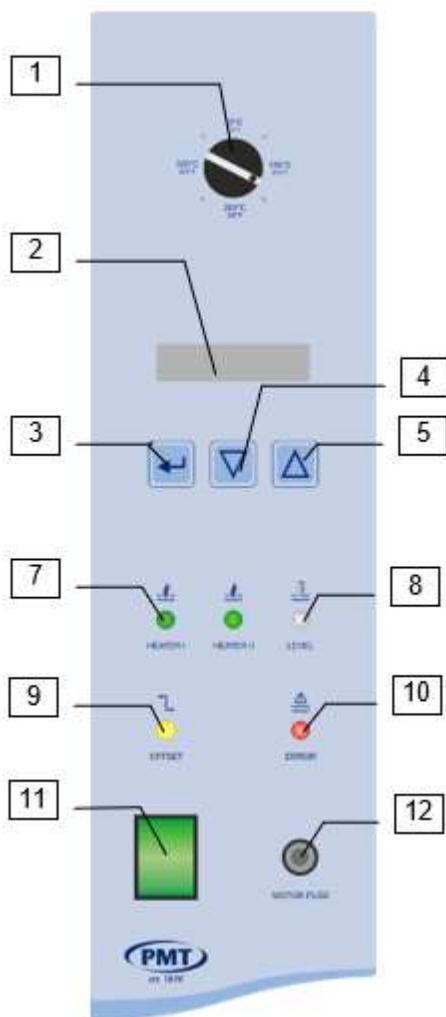
## EASY INSTALLATION

- ✓ Bath is completely assembled and tested at factory (some manufacturers ask their dealers to assemble the bath).
- ✓ Remove bath from packaging material.
- ✓ Clean inner bath thoroughly of any loose packing materials, etc.
- ✓ Place the bath spirit level. The four supporting feet can be turned in and outwards for exact adjustment.
- ✓ Use a mains supply that is well earthed and clean of interference and can carry the load of the bath. Be sure to check the power requirements (230V/50-60Hz, 115V/60Hz) marked on the tag plate at the back side of the bath.
- ✓ Check operating voltage (230V/50-60Hz, 115V/60Hz) and connect the bath to appropriate mains supply. The bath has to be filled with a liquid suitable for operating temperature.



# Preparing

## PREPARING - FOIL



- 1 Thermostat (Over-temperature protection)
- 2 Display (Shows bath parameters (see sheet digital controller))
- 3 Switch (Enter in Menu)
- 4 Switch (Down in Menu)
- 5 Switch (Up in Menu)
- 7 LED (Heater I or II On/Off indicator )
- 8 LED (Float)
- 9 LED (Offset entered)
- 10 LED (System – Error)
- 11 Switch (Mains switch)
- 12 Fuse (Protects stirrer motor)



# Preparing

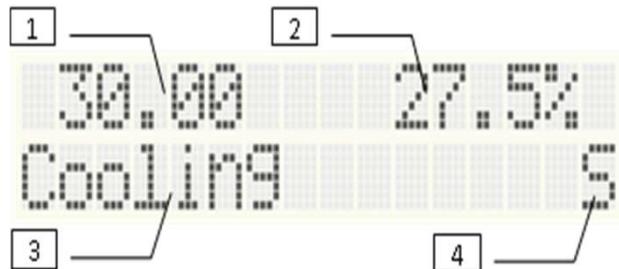
## MENU OPTIONS

- ✓ Set point
- ✓ Offset (press: <-5.00 .. +5.00°C resolution 0.01°C)
- ✓ Max Power (press: low 25, med, hi, max)
- ✓ Boost heater (press on / off)
- ✓ Time const (press: fast, medium slow, precise)
- ✓ Stirrer (Inactive for TV2000 & TV4000)
- ✓ Low alarm
- ✓ High alarm
- ✓ PID parameter
- ✓ Backlight (Inactive for TV2000 & TV4000)
- ✓ Temp units
- ✓ Baudrate
- ✓ SP Offset
- ✓ Restart



# Preparing

## DISPLAY



- **1 Temperature readout**  
When the controller starts or is restarted, the displayed value increases to a stable readout appears after a few seconds.
- **2 Applied percentage of power**  
The controller calculates every second the amount of power which should be applied for stable control. The value is displayed with a resolution of 0.1% and ranges from 0% to 99.9%. To have a stable bath heating percentage should be higher than 10% at working temperature.
- **3 Operating mode**
  - Boost Bath is heating to set point using boost heater
  - Heating Bath is heating to set point, boost heater is off
  - Cooling Bath is cooling down to set point
  - Tuning Ratio Bath is tuning for power needed at set point, first step
  - Tuning SA Bath is tuning, second step
  - PID SP=25.00 Bath is controlling, set point is 25.00°C
- **4 Indicator, alarm high, alarm low, control stable**  
Bath control is stable



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The end

TAMSON D2171 APPARATUS IS THE BEST SOLUTION IN THE MARKET

