MANUAL
TV2000 AKV

Automated
Kinematic
Viscosity

Safety and Warnings

Make sure you read and understand all instructions and safety precautions listed in this manual, before installing or operating the equipment. If there are any questions concerning the operation of the equipment or about the information in this manual please contact your local dealer or Tamson Instruments sales department first.

Performance of installation, operation, or maintenance other than those described in this manual may result in a hazardous situation and may void the manufacturers warranty.

Never operate equipment that is not correctly installed. Unqualified personnel must not operate the equipment. Avoid causing damage to the equipment or its accessories through incorrect operation.

Important:
- When performing service, maintenance or moving the apparatus, always disconnect the line cord of the apparatus,
- Only well skilled and trained personnel are allowed to operate this equipment,
- Take notice of warning labels and do not remove them,
- Refer service and repairs to qualified technician,
- If a problem persists, call your supplier or Tamson Instruments B.V.

Warranty

Tamson Instruments B.V. warrants that all equipment manufactured by it shall be free from defects, in material and workmanship, which might impair its usefulness. Tamson Instruments B.V. does not warrant that the equipment is fit for any particular use. The manufacturer is only responsible for the security, reliability and performance of the equipment, if the unit is operated in accordance with the operating instructions, extensions, adjustments, changes and/or repair is only performed by Tamson Instruments B.V. or authorized persons. All equipment and materials are further subject to tolerances and variations consistent with the usage of the trade.

Contents

Tamson Instruments B.V.
van 't Hoffstraat 12
2665 JL Bleiswijk
The Netherlands

We wish to thank you for the purchase of this Tamson Thermostatic Bath. For a fast settlement of the one-year warranty, please return this warranty certificate as soon as possible to the following fax number +31 10 522 43 73 or the above mentioned address.

Model Thermostatic bath : …….

Name of your company : …….

Name of user : …….

Address : …….

……..…….

……..…….

……..…….

Tel. nr. : ……..…….

Serial number : ……

Mains voltage: …….. Mains Freq.: ……Hz

Date of delivery : ……..

Name of dealer: ……..…….

……..…….

……..…….

Signature: …...……

EC declaration of conformity thermostatic bath T-Series

Manufacturer: **Tamson Instruments B.V.**
van 't Hoffstraat
2665 JL Bleiswijk
The Netherlands

Product: **Thermostatic bath**

Model: **TV2000 - AKV**

The products to which this statement relates, is manufactured and dully carried out in compliance with the provisions of Directive 89/392/EEC, 91/368, 93/44 EEG and 93/68 EEG on the approximation of the laws of the Member States relating to electromagnetic compatibility.

The products are in conformity with the following specification:

EN 50081-1 : 1992
EN 50082-2 : 1995
EN 61000-3-2 : 1995

1 January 1996, Tamson Instruments bv, The Netherlands

Ing. R.C. van Hall
Director

Delivery checklist

Bath parameters:				
Date				
Operator				
Bath type	TV2000 - AKV			
Serial No				
Power supply	230V	115V	50Hz	60Hz
Test Parameters:				
Testing liquid				
Testing Temperature				°C
Reading with calibrated Thermometer (F250)				°C
Offset used for correcting bath				°C
Checklist:				
Viscometer bath				
Stability bath				
Motorfuse tested				
Fuses placed				
Condition motor				
Stirrer mechanism				
Baffle plates				
LED Board				
Micro Processor print				
Power supply board				
Display print				
Safety thermostat				
Serial interface				
AKV Module				
Display print				
Mains socket for vacuum pump				
Vacuum valves				
Printer				
Measuring head				
Tube connection(s)				
Sensitivity				

(For test result please see the separately added calibration certificate.)

Precautions and hazards

Read all parts of this manual carefully to insure smooth operation and avoiding damage to the equipment or its accessories. If a malfunction occurs, consult chapter "Trouble shooting". If a problem persists, call your supplier or TAMSON INSTRUMENTS b.v. Never operate the equipment if not correctly installed. Qualified personnel must operate the equipment.

Introduction to the TV-series

The TAMSON model TV-baths are designed to perform a variety of accurate temperature control required for general laboratory use or as a constant temperature bath. The TV-series is intended for temperature control of applications requiring a high degree of stability over a broad temperature range. The robust construction incluiding advanced safety features give the bath a range of wide application.

Intended use

The AKV system replicates the manual kinematic viscosity measurement method as described in ASTM D445. In the AKV system both Ubbelohde tube or Cannon Fenske(CF) tubes can be used. Two measuring heads are available. The procedure handles as follows:

- Choose Ubbelohde or CF tube (routine) in the range of the expected visosity.
- Fill the tube with sample.
- Pre heat measuring head and sample.
- Start measurement:
  - Sample is drawn up by vacuum into the Ubbelohde or CF tube,
  - When vacuum stops, gravity will pull the fluid down again,
  - The miniscus of the fluid is observed by the optical system,
  - The time the miniscus needs to lower over an calibrated distance is than measured,
  - From the tube constant and time follows the kinematic viscosity.

With some dark fluids a residue may remain on the inside of the glass capillary, which hides the samples' miniscus. If such is the case with the sample, the D445 method and routine flow tubes can not be used to perform methods for these types of samples. Instead reverse flow tubes should be used. These unfortunately are not available for the AKV system. A sample can always be send to Tamson instruments to make sure the unit can be used for these specific samples.

The AKV is capable of testing the same sample multiple times in a so called run. This makes calculation of repeatability an easy job.

Due to it's accuracy measuring times can be shortenend by choosing larger glass capliary. Measurement times thus can be shortened drastically. However be aware that this does not comply to ASTM D445. Also pre heating times of sample (15 minutes) have to taken into acount for every new sample.

General

The heat input is controlled by a microprocessor system. A special optimized electronic temperature measurement circuit ensures an extremely high degree of accuracy and reproducibility of operation conditions. The baths feature as standard a RS232C interface for connection to a computer, data logger or terminal. The baths have an integrated cooling coil as standard, for rapidly reducing bath temperature alternatively for working at or below ambient temperature.

Construction

The system contains a thermostatic bath and measuring unit. The bath can be operated from the front panel left from the bath window. The measuring system is located in the top of the apparatus and contains a microprocessor controller board, a printer, an alpha-numeric LCD, a key panel with numeric and function key, and the connections for the AKV measuring head.

The TAMSON baths are constructed entirely from corrosion-resistant materials – stainless steel and PTFE – entirely. A thick layer of glass wool between the inner bath and outher casing ensure effective insulation

against heat loss, resulting in relatively cool external at high operating temps. The central microprocessor within the control module manages and controlls, the functions for temperature measuring regulation, program storage, safety control and error coding. A circulation stirrer is built-in for uniform temperature distribution within the bath.

Temperature control and setting
The bath temperature is regulated using a Pt-100 temperature probe Class A connected to a microprocessor module. The advanced electronic control system continually computes the energy input required for optimal temperature accuracy and stability. The controller will activate the heaters partially or in full, taking into account the difference between actual bath temperature and set point taking into account the type of bath fluid used and working conditions. This process does not interfere electrically with other equipment since all heating elements are switched in zero-cross mode. Through the application of an especially developed inlet circuit for the temperature probe, the sensitivity to external interference has been reduced to a minimum. The required temperature is set by means of membrane switches on the front panel. Read-out is on a 2-line times 16-character display. An absolute temperature offset is provided with a resolution of 0.01°C. This fine-tuning can be carried out at any time during operation of the bath.

Safety systems
A number of precautions are provided to ensure a safe working of the bath and to protect the equipment, the bath fluid, the samples immersed and the workplace. A mechanical excess-temperature thermostat will automatically switch-off the entire bath when its maximum value is exceeded. The maximum temperature can be manually adjusted from 50°C up to 270°C.

A thermal protection of the stirrer mechanism will switch off the motor in case of malfunction. Both thermostat and motor-fuse can easily be accessed and reset on the front panel.

A large number of integral electronic safety checks will cause the bath to shut-down in case of electronic or electrical error. Any kind of activated safety system will be attended with an acoustic and visible alarm. On the front display operating faults or component failures, are reported as numbered ’errors’. In this way there is a continual check of the proper functioning of the bath.

Installation

Important

TAMSON INSTRUMENTS b.v. is not responsible in any way for consequential damage or harm caused by using this bath.

1) Whilst cleaning, servicing or repairing always disconnect the bath from the mains (by unplugging the power cord).
2) Well-trained and authorized persons may only carry out repairs on the electrical system of the bath.

Unpacking and connecting

Before leaving the factory Tamson baths are adequately packed to prevent damage during normal transportation. Check the packing for external damage and make a note on the shipping documents if any damage is found. Always retain the cartons and packing material until the bath has been tested and found in good condition. (Transport companies generally will not honor a claim for damage if the respective packing material is not available for examination).

The shipment contains at least the bath as mentioned in the delivery checklist. Further the consignment might contain one or more viscometers, individually packed in small boxes with the calibration certificate included in the box, as well as ASTM thermometers, thermometer holders etc. Please see packing list for details concerning total contents of consignment.

Level the bath by using the adjustable feet.

In order to avoid bath reporting erro or shutting down ensure a well earthed mains supply which is clear of interference and able to carry the full load of the bath.

Remove any remaining packing material from its interior before filling the bath. The interior of the bath can be accessed by unscrewing the lid. Now the bath has to be filled with a liquid suitable for the maximum operating temperature. It is very important to select a liquid with a viscosity of less than 20 cSt at the operating temperature and a flash point which is well above the operating temperature.

Caution

When operating at high temperatures the lid (of the bath), top plate and the window section of the bath become very hot. Always use heat protective gloves. Care must be taken when placing or removing material from the bath.

When changing the bath fluid from water to oil for operating at temperatures above 80°C, completely remove all the water from the bath. Small drops of water may result in hazardous occuringwhile reheating the bath with oil.

Water and oil must at all times be kept separate within the bath
Never mix oil and water in or around the bath

Bath liquids

When the bath has been installed it must be filled with an appropriate liquid. When working with water the bath should be filled to 1 cm below the lid. For oil the bath should be filled to not more than 5 cm below the

lid. Depending on the operating temperature the liquid level in the bath should be observed and excessive fluid should be removed. Take care when removing hot fluid:

- Never empty hot oil in a plastic container.
- Use heat protective clothing and wear safety glasses.
- Do not spill water in hot oil.
- Do not mix hot oil in water.

The liquid level should be maintained between 1 and 3 cm below the lid during normal operation.
A lower level than 5 cm below the lid will damage the heaters.
When selecting a bath fluid it is very important that the viscosity of the fluid at the operating temperature is not more than 20 cSt preferably less (e.g. 10 cSt).
We recommend the use of the following liquids for the respective ranges:

Recommended bath fluids		
Range	Ordering code	Description
Ambient to 80°C/176°F	N.A.	Clean tap water (preferably decarbonized) **NOT DISTILLED OR DEMINERALIZED**
80..150°C / 176..302°F	00T0220 (20 litres)	Tamson mineral oil 150. Transparent, 11cSt @ 80°C/176°F; 3cSt @ 150°C/302°F; F.P. 200°C/392°F.
80..160°C / 176..320°F	00T0226 (25 Kg)	Silicon oil 50DC200, transparent. 100cSt @ 25°C/77°F;10cSt @ 150°C/301°F. F.P. 315°C/599°F. When not polluted lifetime is unrestricted.
80..160°C / 176..320°F	00T0229 (25 Kg)	silicon oil 100DC200, transparent. 100cSt @ 25°C/77°F; 18cSt @ 150°C/301°F. F.P. 315°C/599°F. When not polluted lifetime is unrestricted.
80..180°C / 176..356°F	00T0222 (20 litres)	Mineral oil Calflo HTF. 9.4cSt @ 80°C/176°F; 2,8 cSt @ 150°C/302°F. F.P. 212°C/413,6°F.

The oil used has a limited lifetime. The type, brand and operating temperature mainly determines lifetime. Spilling of sample may also reduce lifetime,in some cases can start chemical reactions. Silicon oil has the tendency to form gel, for this reason silicon oil has to be replaced as soon as visible changes are noticed like string forming. Within a few hours silicon oil can transform itself into solid gel, which is very difficult to remove. When not totally cleaned, very small pieces of left over gel will catalyse new oil to form gel!

The use of other liquids is allowed as long as the viscosity of the fluid is low enough at the operating temperature. The viscosity must be approximately 10 cSt, but may definitively not exceed 20 cSt. High viscosity will result in poor stability as well as poor uniformity of the bath.

The fluid flashpoint must be well above the maximum operating temperature. Fluid must not be aggressive when in contact with stainless steel 304, 316, glass or PTFE and silicon sealing.

Please note following:

- Do not use distilled or demineralized water. This will cause serious corrosion.
- Only use water as a bath fluid below 80°C /175°F. Working for a longer period with water at temperatures above 80°C will damage the stirrer bearings.
- When working at temperatures below 10°C / 50°F ethylene-glycol should be added to the water. For example in the volume proportion of 50 / 50%.
- Using the bath for long periods at low temperatures will cause condensation on the glass window resulting in complete invisibility of material placed in the bath.

Cooling
The bath is provided with an integral cooling coil. Because of the friction-heat generated by the stirrer mechanism the bath will slowly heat-up. The lowest operating temperature at which the bath can be controlled depends on the fluid used and the ambient temperature. As an indication, when operating with water as a bath fluid the lowest achievable temperature without cooling is approx. 30°C / 86°F. When operating at lower temperatures it is therefore necessary to pass a small amount of tap water through the

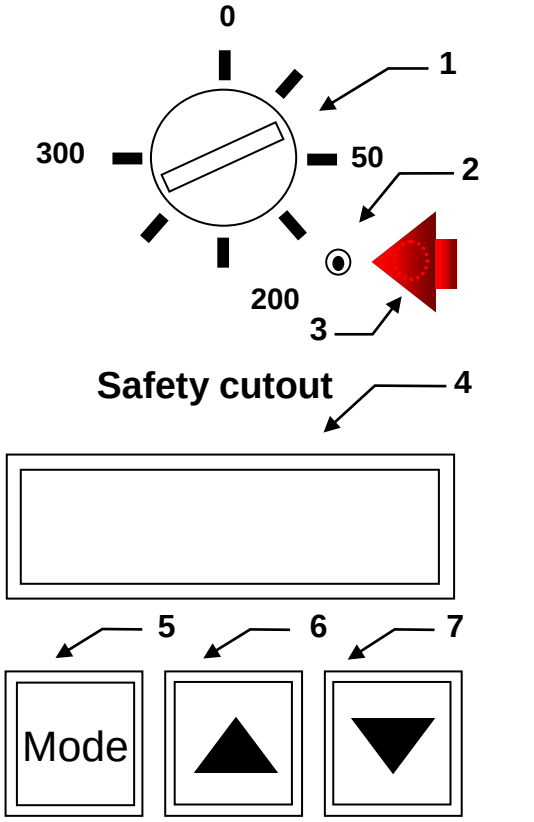


Figure 2 Front panel layout

cooling coil. Generally the temperature of the cooling coil water should be 5 °degrees (or more) below the operating temperature of the bath. To operate at 40°C / 104°F with an ambient temperature of 21°C / 70 °F and a cooling water temperature of approx. 16°C / 60,8°F an amount of 100 to 200 ml/min. is sufficient. When the set point is achieved and the first heater blinks short every second, the amount of cooling water is sufficient. It is not advisable to pass much more cooling water through the coil than necessary.

Front panel layout		
Item	**Description**	**Function**
1	Thermostat	Safety feature
2	Reset pin	Press to reset thermostat(1)
3	Lamp	Indicates that bath temperature exceeded thermostat(1) value
4	Display	Shows bath parameters
5	Switch	Press to show menu-item
6	Switch	Next value
7	Switch	Previous value
8	LED	Heater 200 Watt
9	LED	Heater 1000 Watt
10	LED	Heater 1500 Watt
11	Switch	Mains switch
12	Fuse	Protects stirrer motor

Figure 1 Cooling apparatus TLC10 and TLC15

Operating the bath

Before plugging into a mains socket (use a ground well connected to the earth), make sure the voltage of the bath corresponds to the local voltage. Also see "Installation page 10"

When the bath is ready for use it can be switched on by pressing the mains switch. Because the bath is equiped with an automatic calibration facility, the microprocessor controller first calibrates the analogous part of the controller. The display of the bath will indicate the text **"calibrating bath".**

The controller will automatically recalibrate the analogous part several times during heating. To guarantee stable working of the analogous electronics, this part of the board is kept at 45°C. It takes approximately 15 minutes before the analogous section is at this operating temperature and the display gives accurate reading.

The electronics are suited for both 50 and 60 Hz. The mains frequency is checked during start up. The frequency is displayed with an accuracy of 1 Hz. Due to this it is possible that the display shows e.g. 49 or 51 Hz when connected to a 50 Hz power supply. After a few seconds the display will show the actual bath temperature, the heating power installed by the controller and the calibration offset.

When the electronics detect an error during the start or heating the display will show an error. For an explanation of these error reports please see the chapter "Bath error messages".

The controller of the bath is equipped with a so called **"scroll menu",** which means that all parameters are accessible by using only one key. This is the **MODE** key which, by pressing it, show you:

- BACKLICHT
- CALIBRATE BATH
- CONTRAST
- LOG TIME
- MAX. POWER
- OFFSET
- PASSWORD
- SET POINT
- TEMPERATURE
- MODE
- TIME CONSTANT

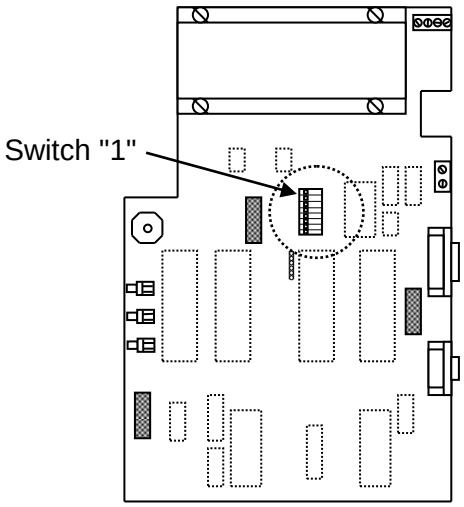


Figure 2 Location of DIP-Switch

Password
The controller has the possibility to enter a password to prevent the value of the parameters to be changed by unauthorized staff. To enter a password select **Enter security code** with the mode key. By pressing the **"UP"** and **"DOWN"** keys it is possible to enter a value between 1 and 9999. Entering **"0"** will disable the password function. During the first 100 seconds after entering the password it will not be active. During this time all parameters can be accessed and altered. If the **MODE** key is pressed after 100 seconds the display will message to enter the password first. When this value is not correct a message appears **"Illegal value".** When the value is correct all menu items will be visible by pressing the **MODE** key.

Changing the password can be done by selecting **"Enter security code"** again. Entering **"0"** will disable the password function.

Adjusting set point
When switched on the set point temperature will be set on the previous temperature setting. To change the working temperature select **"Set point"** with the **"MODE"** key and change the value **"UP"** or **"DOWN".** The desired temperature can be set with a setting accuracy of 0.1 degree. To check the actual temperature setting just select **"Set Point"** together with the temperature set and the unit **Celsius** or **Fahrenheit.**

When there is no power limit entered and the new set point is more than 1 degree but less than 2 degrees above the bath temperature the bath will switch-on 50% of the heating power. When the new set point is more than 2 degrees above the bath temperature all available heating power (which can be limited with the option **POWER LIMIT**) will be used to reach the new working temperature.

- Only well skilled staff should perform this operation. -

If the password is forgotten or unknown the controller has to be reset. In this procedure the mains can be contacted. Be very careful.

Switch off the power and remove the mains cable from the power plug. Remove the left side panel of the bath. Switch the DIP-switch NR. 1 on the large printed circuit board to ON (see figure 2). (In this situation the bath must be started after placing the plug in the wall socket). Be carful with the next step. Whilst the bath is running and the display shows the actual temperature switch DIP-switch 1 back to "off-position" again. (All bath parameters will be reset when the switch is not reset to off position) Now switch off the bath, remove power, and close the left panel.

Setting offset
The absolute accuracy of the calibration of the controller is 0.01K at -100°C / -148°F and 0.1K at +250°C / +482 °F. The sensor used in the bath is a Class A Pt-100 in 4-wire connection which is the most accurate temperature sensing system obtainable. Nevertheless when all inaccuracies are added, the total temperature inaccuracy may be unacceptable thogh.For this reason the bath is equipped with an option which allows fine tuning of the temperature with an offset of 0.01 degree.
///''''''
Select **"Offset"** and use the **"UP"** and **"DOWN"** keys to adjust the temperature. The temperature reading can be adjusted in the range of -1.99°C up to +1.99 °C(-3.58°F up to +3.58°F). As soon as an offset is introduced and accepted by the controller the **CALIBRATED** – LED will light up.

Due to non-linearity of the PT100 temperature sensor, the offset is only valid for the actual set point temperature. When changing the set point a recalibration at this new set point has to be done for maximum accuracy or when working according to ATSM D445 / IP71.

Switching Celsius/Fahrenheit
The controller of the bath is suitable to operate in the °C as well as in the °F mode. To switch from the Celsius mode to the Fahrenheit mode or reverse you have to press the **MODE** key several times until the display shows the text **Temp. mode.** By using the **"UP"** or **"DOWN"** key it is possible to toggle between these two modes. The displayed temperature, set point as well as the offset will be converted to the new unit. Switching between Celsius and Fahrenheit may result in a small drift of the bath temperature. Also the reading may change max. 0.1 degree for the temperature and 0.01 degree for the offset. This is due to the round off in the calculations carried out by the microprocessor and is inevitable. Therefore it is advisable to

select the temperature unit first and after that to set the desired temperature and if necessary the offset.

Setting power limit
The bath has an option to limit the maximum heating power that can be installed by the microprocessor control led. Effective power is limited by not switching on every half sign in the mains. If the temperature of the bath fluctuates strong due to external influences like placing cold material in the bath, overshoot of the temperature can be reduced by lowering the power limit, stabilizing the bath much quicker.

To install a power limit, choose the option **"Max Power"**, by pressing the **MODE** key. Edit the limit with the **"UP"** or **"DOWN"** key. A changed power limit will become effective when the entering mode on the display is left. The bath is equipped with *3* heaters of respectively 200, 1000 and 1500 Watts. When setting power limit you do not have to take in account the individual value of the heaters. To prevent the third heater from being used simply enter a power limit of 1200W or less.

Time constant
This parameter fixes the time within the microprocessor controller will not be able to change the installed power of the heaters as long as the difference between the measured temperature and the temperature setting is less than 0.1°K. When the difference is more than O.1°K the time constant is half the value set with this option. The change in power by the controller will never exceed the value set with the parameter Max. power.

Press the **"MODE"** key until the option **"TIME"** constant is displayed. Change the time by pressing the **"UP"** and **"DOWN"** key to select the desired value. The value to be chosen depends on the application of the bath and the fluid used. A disadvantage of a short time constant generally is the decrease of the controller accuracy. When a bath is used for an application where it needs almost no power long time constant will have a negative effect on the stability of the bath. Available time constants are:

- 50 seconds
- 100 seconds
- 150 seconds
- 200 seconds

The default time constant is 100 seconds.

Recalibrating controller
From the moment the bath is switched-on, until the moment that the controller is stable the analogous part of the controller is automatically recalibrated at regular time intervals. The necessary calibration reference is included in the analogous part of the microprocessor board.

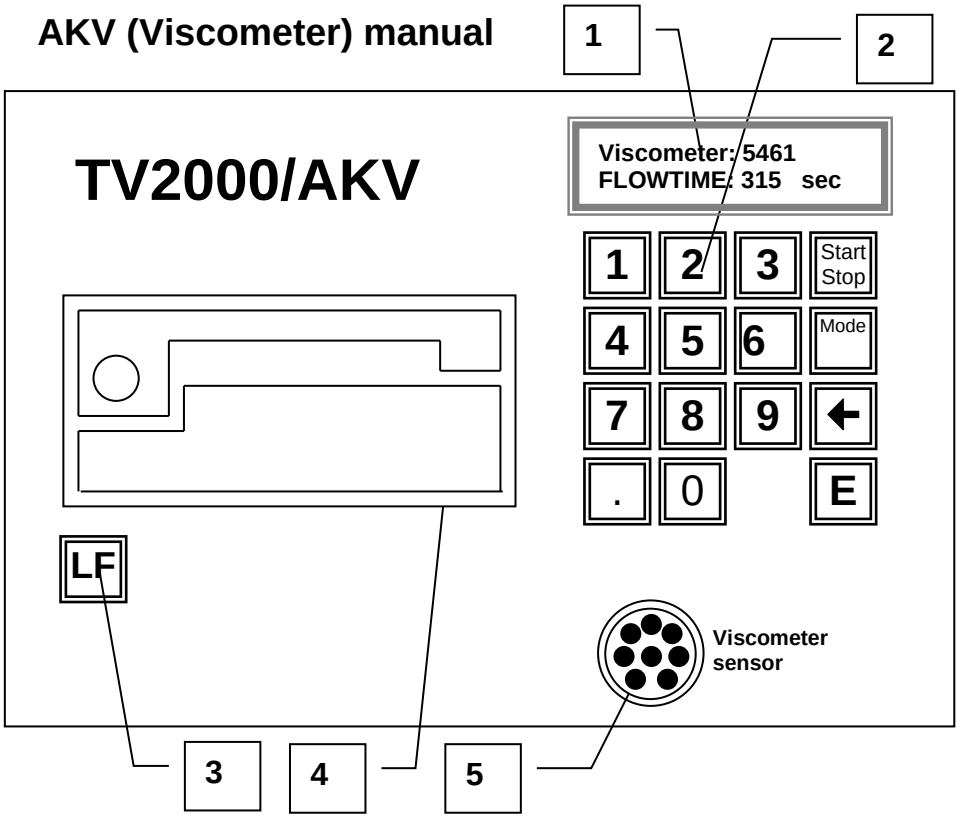
The time interval between 2 recalibrations also depends on the time constant installed. As soon as the controller is stable, which is shown on the display by the word STABLE in the lower right corner, the controller will be recalibrated a last time. The operator can manually recalibrate the controller during operation. Select by pressing the **"MODE"** the option **"Calibrate bath"** and press the **"UP"** and **"DOWN"** key simultaneously. After a few seconds the display will show the text **Calibrating bath.** If only one of the keys is pressed it will not result in a recalibration of the controller.

During the recalibration of the controller all heaters should be switched-off. It is possible that after the recalibration of the controller the temperature of the bath will deviate a little from before. After the calibration procedure is completed the display automatically returns to normal operation.

Contrast
The display used in this bath is an LCD-display with an adjustable contrast. One of the properties of an LCD-display is that the contrast of the display defines the viewing angle under which the display can be

observed conveniently. As the bath can be used at different viewing angles, depending on the application of the bath the contrast of the display is adjustable To adjust the contrast of the display press the **MODE** key until the option “Contrast” is displayed and can be adapted in 16 steps (0..15) by pressing the **”UP”** and **”DOWN”** keys.

Backlight
The display used in this bath is an LCD-display which is equipped with an adjustable backlight. To adjust the intensity of the backlight select the option **Backlight** with the **“MODE”** key. Using the **”UP”** and **”DOWN”** keys to adapt the intensity of the backlight in 16 steps (0 .. 15).



AKV - Module	
Item	Description
1	Display
2	Numerical keys
3	Paper line feed printer
4	Printer
5	Connector viscometer head

Setting up the viscometer unit

After initiation of the controller the display will show:

VISCO: 3964
START, E or MODE

The next step is to adjust the vacuum for drawing-up the sample into the viscometer.

Therefore press the **"Mode"** key until the display shows:

DISPLAY VACUUM
START, E or MODE

After pressing the **"E"** key the display shows two options:
- Relative pressure indication,
- Absolute pressure indication.

0=REL 1=ABS

When option either option **"0"** or **"1"** is selected the wall socket at the back of the bath will be activated. When a vacuum pump is connected to this socket the pump will start to run. The display now shows the actual vacuum pressure.

Vacuum -xxx hPc
START, E or MODE

The vacuum pressure can be regulated by turning the vacuum nozzle screw located at the rear side of the bath. A vacuum set too strong will result in a fountain

of liquid coming out of the capillary when drawing-up the sample. This will cause false triggering of the optical detection system. For this reason the vacuum pressure should be set in the region of –40 and –200 hPc. The vacuum setting depends on the kind of fluid to be measured.

DISPLAY VACUUM
START, E or MODE

After adjusting the pressure press the **"E"** key and the display will return. To go back to the main menu press the **"Start/Stop"** key again. The system is now ready for use.

The AKV menu structure

The AKV contains a menu, which can be scrolled using the **"Mode"**-key. The menu contains following items:

AKV Menu	
Item	**Description**
SELECT VISCO	Select a glass viscometer tube with programmed constant
ENTER VISCO	Enter new glass viscometer tube-constant in memory
DELETE VISCO	Delete a glass viscometer tube-constant tube from memory
ENTER SAMPLE NR	Modify counter for sample
PARAM OVERVIEW	Print glass viscometer tube-constants from memory
ENTER DELAY TIME	Enter pre-heating time
DISPLAY VACUUM	Display the pump vacuum
ENTER RUNS	Enter number of runs for repeat
SET SENSITIVITY	Adjust sensitivity of sensor (Transparent or opaque liquids)
SET CONTRAST	Set displays contrast
SET BACKLIGHT	Set intensity background
SET BAUDRATE	Set baudrate for external data logging
SET TIME&DATE	Set system time and date

These items are explained in detail in the following chapters.

How to select a viscometer

The non-volatile memory of the controller can store up to 25 different viscometers with their corresponding constants. Before you can start a test you must select the corresponding number of the viscometer you are using. If a wrong viscometer is selected for measurement this will result in a wrong calculation of the viscosity.

SELECT VISCO
START, E or MODE

When using a new glass viscometer tube for measurement its constant should be stored into the AKV memory first. Press the **"MODE"** key until the display reads:

VISCO NR: XXXX
E

Now press the **"E"** key and the display will show:

The cursor is blinking on the first figure. Enter a numerical value of max. 4 digits.

SELECT VISCO **START, E or MODE**	After entering press the **"E"** key. Now the display returns to: Press the **"Start"** key to return to the standard display mode. When a mistake is made during input (before confirming the number with **"E"** key), the backspace key "← " can be used to correct the false character. If the wrong value has been confirmed using the **"E"** key, the menu item "SELECT VISCO" has to be chosen again and the right value can be typed in again.
Number <> 0 **Press any key**	If **0000** has been entered the system will not accept this as a valid number and the display will show "Number <> 0"
Number <> 0 **Press any key**	If a number is chosen which is not in the systems memory the number will be accepted but it is not possible to start a test.

Store new viscometer parameters

The non-volatile memory of the controller can store up to 25 different viscometers with their corresponding constants. To add a new viscometer to the memory select the option **ENTER VISCO** using the **Mode** key.

ENTER VISCO **START, E or MODE**	When this option appears press the **"E"** key.
VISCO NR: XXXX **E**	The cursor now is blinking on the first digit. A numeric value of 4 digits can be entered. After completing this four-digit number, again press the **"E"** key.
Const: 00.000000	The tubes constant can now be entered. Confirm the value using the **"E"**. The entered value will be stored into the systems non-volatile memory.
Writing table	After completion of this operation the display automatically returns.

SELECT VISCO START, E or MODE

When a mistake has been made when entering the constant, it can be corrected using the **"←"** key. If the value has been confirmed using the **"E"** key just repeat the whole procedure and type in the correct value.

After a new viscometer is added to the memory an overview can be printed of all viscometers stored. This option can be found under menu item **"PARAM OVERVIEW"**.

The last entered viscometer will also be the selected viscometer.

Delete a viscometer from memory

Select the option **"DELETE VISCO"** using the **"Mode"** key. Press the **"E"** key and the display will show:

VISCO NR: xxxx E

The cursor is blinking on the first digit. The number of the viscometer to be used can now be entered. Confirm the number by pressing the **"E"** key.

Removing the viscometer from the memory also automatically removes the corresponding constant from the memory. Before confirming by pressing the **"E"** key one has to be absolutely sure that the viscometer has to be removed.

Writing table

The system removes the data from memory and the data table is re-organized and again written to the non-volatile memory.

DELETE VISCO START, E or MODE

To verify if the viscometer is deleted from the memory the option **"PARAM OVERVIEW"** can be selected.

When the deleted viscometer was the one used for measurement, a new viscometer tube has to be chosen for measurement under the option **"SELECT VISCOMETER"**

Entering a sample number

The controller unit has an internal counter, which automatically increases the sample number by 1 after a successful test.

Because this number consists of 4 digits the highest number is 9999. After this the counter is reset to 1 and starts counting from thereon. It is possible to set a different number for each sample. The number has to be a numerical value consisting of max 4 digits. When setting another sample number please keep in mind that after the test this number will automatically be increased by 1. To set a different sample number press the **"Mode"** key until the display reads:

ENTER SAMPLE Nr **START, E or MODE**

Press the **"E"** key the display shows:

Sample nr: xxxx

Enter the desired number by using the numerical keys and press the **"E"** key to enter the value to the memory. The display will return to the ENTER Sample nr. reading.

Use the **"Start/Stop"** key you return to the standard display.

Print the stored viscometer parameters

It is possible to get a printout of all viscometers together with the constants as well as the programmed number of runs, pre-heating time and date. Press the **"Mode"** key until the display reads:

PARAM. OVERVIEW **START, E or MODE**

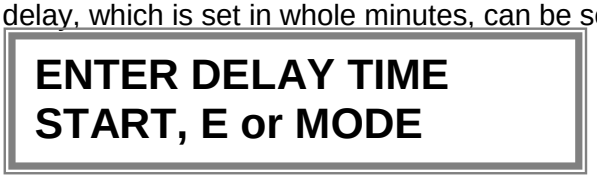
When pressing the **"E"** key the printer output an overview.

```
Parameter overview
TIME: 14:15
DATE: 26/09

Pre-heat time 0 min

No. of runs:       3

Viscometer table

Number             Constant
0012               00.090543
0459               01.123500
1429               00.001592
2863               00.300235
9433 s             00.304438
```

The **"s"** behind the viscometer number indicates the currently selected viscometer. After the printout is completed return by pressing the **"Start/Stop"** key.

Setting a pre-heating time

As the norms **ASTM D 445, IP 71** etc. prescribe that the viscometer with the sample should be in the bath for at least 15 minutes, before a test may be started the unit is equipped with an adjustable start delay. The delay, which is set in whole minutes, can be set between 0 and 59 minutes.



Press the **"Mode"** key until the display shows "ENTER DELAY TIME".

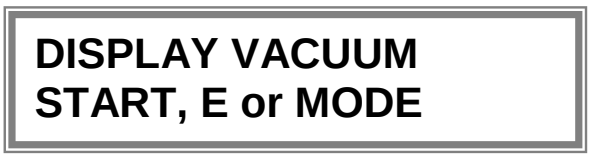
Press the **"E"** key to select

The cursor is blinking at the most left digit. Using the numerical keys to enter the delay value and confirm by pressing the **"E"** key. The display returns to the ENTER DELAY TIME reading.

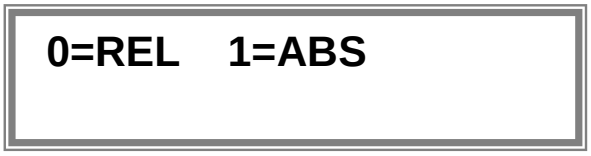
Press the **"Start/Stop"** key to return.

Setting the tube vacuum

The TV 2000/AKV is **not** equipped with a built-in vacuum source to draw the sample up into the viscometer. It has a vacuum connection to an external source, which commonly is supplied as accessories. The applied vacuum can be trimmed using the valve, which is located on the back of the apparatus. To read the vacuum pressure select the **"Mode"** key **"DISPLAY VACUUM"**



Now press the **"E"** key.



0 means the pressure reading is related to the atmospheric pressure (difference between atmospheric pressure and pressure in the system). **1** means the pressure reading is and absolute pressure, which is not related
to the atmospheric pressure.

Under normal conditions it is the best to select option **0**. After selecting **0** or **1** the main socket located at the back of the apparatus is switched on and a vacuum pump (if connected to this socket) will be activated. At the same time the vacuum valves will be activated and the actual vacuum will be displayed.

The pressure-reading unit is in hecto - Pascal (hPc) and equals to **mbar**.

When the option **0** is selected the minus(-) sign appears in front of the value. This to indicate that the value displayed is the differential value between the atmospherical pressure and the pressure in the system.

The vacuum can be adjusted by turning the screw of

the vacuum valve located at the left rear side of the bath. It is not advisable to set a vacuum pressure which exceeds 300 mBar. This might result in a fountain of liquid coming out of the capillary when drawing-up the sample. This could result in a false triggering of the detection system. We advise to set a pressure between – 40 and – 200 hPc, depending on the kind of fluid to be measured.

After pressing the **"E"** key, the vacuum pump (if connected) and the vacuum valves will be switched-off. Press the **"Start/Stop"** to get back to the standard reading.

Enter number of runs

It is possible to carry out more tests using the same sample, for example to obtain an average viscosity calculation. Select the option **ENTER RUNS** by pressing the **"Mode"** key until the display shows:

ENTER RUNS **START, E or MODE**

Use the numerical keys to enter a value between 1 and 10. A value of 00 will not be accepted and the system will automatically set the value to 1. Entering a value bigger than 10 is not accepted and the system will automatically set the value to 10. After entering the number of runs confirm by pressing the **"E"** key.

Nr. RUNS: xx **Range: 1 - 10**

Return to the standard reading by pressing the **"Start/Stop"** key. The programmed number of runs is stored in the non-volatile memory and will be applicable to each following sample as well.

Adjusting contrast

SET CONTRAST **START, E or MODE**

The readability of the LCD display depends on the viewing angle of the display. For this reason it might be necessary to adapt the contrast of the display. Select the option **CONTRAST** by pressing the **"Mode".** Press the **"E"** key after and enter a numerical value.

Contrast: 06 **Range: 0-15 E**

Enter a value between 0 and 15, using the numerical keys followed by **"E"**. The best setting will be between 3 and 8.

Do not enter a long value the first time, as because of tolerances in components it is possible that the display becomes unreadable.

Return to the main display by pressing the **"Start/Stop"** key.

Adjusting sensitivity

SET SENSITIVITY **START, E or MODE**

The system automatically selects its sensitivity. In some cases it can be necessary to adjust the sensitivity of the system. When a sample is very light or the

opposite very dark it can be necessary to adjust the sensitivity for proper working detection.

SENSITIVITY: 80 **Range: 0-100 E**

Select the option **SENSITIVITY** by pressing the **"Mode"**-key. Press the **"E"** key and enter a numerical value.

Enter a value between 0 and 99, using the numerical keys followed by **"E"**. Return to the main display by pressing the **"Start/Stop"** key.

Adjusting backlight

As the readability of the LCD display depends on ambient light circumstances the display is equipped with an adjustable illumination. To adjust the contrast of the display select the option **BACKLIGHT** by pressing the **"Mode"** key until the display shows:

SET BACKLIGHT **START, E or MODE**

Backlight: 15 **Range: 0 – 15 E**

After pressing the **"E"** key a numerical value between 0 and 15 can be entered again followed by **"E"**. Entering **0** means that the backlight is switched off. After you have changed the setting return to the main display by pressing the **"Start/Stop"** key.

Entering time and date

The AKV system is equipped with a real-time clock. This clock also operates when the bath is switched-off so it is not necessary to adjust the clock every time the bath is switched-on. To adjust the clock press the **"Mode"** key until the display shows:

SET TIME, DATE **START, E or MODE**

Time: 13 :12 **Date: 27/10 E**

Press the **"E"** key.

The cursor will blink on the first position. The new time and date can now be entered using the numerical keys. The first two figures of the time are the hours, according to the 24-hours system. So 3 p.m. is entered as 15 hours. After changing the hours press **"E"** to confirm and then change the minutes.

The first two figures of the date are the days of the month. After changing the days confirm the setting by pressing the **"E"** key. Now change the month. After you have changed all the settings return to the main menu by pressing the **"Start/Stop"** key.

Replacing paper and ink ribbon

To replace the paper of the printer remove the cover on top of the controller unit by unscrewing the two screws.
Lift out the holder pin for the paper roll and place it through the center hole of the new roll. Insert the roll into the holder and gently place the begin of the paper in the slot of the printer. Now press the **"LF"** key several

times until the paper comes out of the printer. Make sure that the paper is between the ink ribbon and the upper part of the ribbon holder. When the paper is below the ink ribbon the printer will not print the results.

To replace the ink ribbon of the printer the instrument has not to be opened. The ribbon is located at the front side of the printer in the upper part of it. Gently push against the right part of the ink ribbon as a result of which the left part is coming out of the printer. Remove the old ribbon and insert a new one. Make sure that the paper is between the ink ribbon and the upper part of the ribbon holder. When the paper is below the ink ribbon the printer will not print the results.

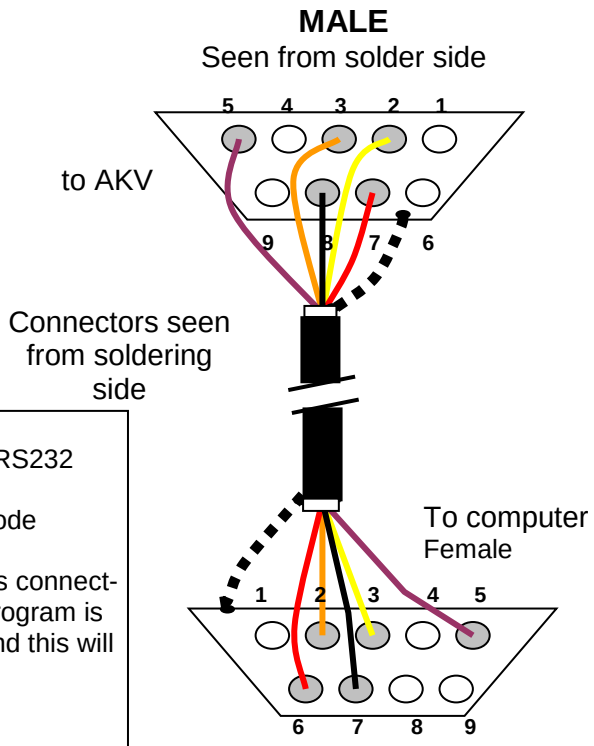
RS232 communication
The bath is equipped with an RS 232 C communication port, which makes it possible to communicate with a computer or a data logger. The transmission is defined to:

Baudrate	4800
Data bits	8
Parity	none
Stop bit	1
Flow control	Xon / Xoff

Be aware that high transmission speeds and long cables can mutilate the data send by the TV bath or computer. Cables longer than 2 meters should be shielded.

At the back side of the bath you will find a standardized 9-pins connector for the data cable. The pins have to be wired as follows (N.C. means not connected):

PEN 1 = N.C.
PEN 2= RX
PEN 3 = TX
PEN 4 = DTR
PEN 5 = COMMON
PEN 6 = N.C.
PEN 7 = RTS (always positive)
PEN 8 = CTS
PEN 9 = N.C.



The RS232 uses handshake:
1) When the RS232 cable is connected during during startup the RS232 monitor has to be connected and up and running
2) The cable can be connected when the AKV is in operational mode

Ad 1, 2 The handshake procedure detects connection. If a cable is connected to a PC the system will poll for communication. If no RS232 program is running to comunicate with the AKV, the systems keeps polling and this will locks the AKV for operation.

Solution
a) Start AKV system, and the AKV is operational, connect the cable,
b) Start the (RS232 monitor) program on the PC, Start AKV.

Only the "printerdata" is available. As the AKV systems is used to check bath parameters, the RS232 of the TV2000 bath is not available for control or read out of parameters i.e. like PV, SP etc.

Preparation for measurement

Precautions
Be aware of following:

- Read ASTM method D445 and D446 carefully,
- This manual is an assistance to get started, always respect the ASTM D445 and D446 method,
    - Measurement should only be performed by skilled and trained staff,
- Use clean viscometer tubes:
    - Viscometer tube must be absolutely free of sample or cleaning fluid,
    - Viscometer tube must be dry.
- Charge the viscometer tube with sample using a syringe.
- Place AKV system and measuring head holder spirit level.
- Before placing the viscometer tube remove condensate from holder first.
- Take all precautions to guarantee free detection of IR-sensors:
    - Remove water vapour bubbles when submerging the measuring head in water,
    - Align glass viscometer between IR-sensor (Cannon-Fenske tube).
- Take all safety precautions necessary:
    - Be aware of safety and health hazard,
    - Use protective clothing,
    - Use proper ventilation or fume cabinet.

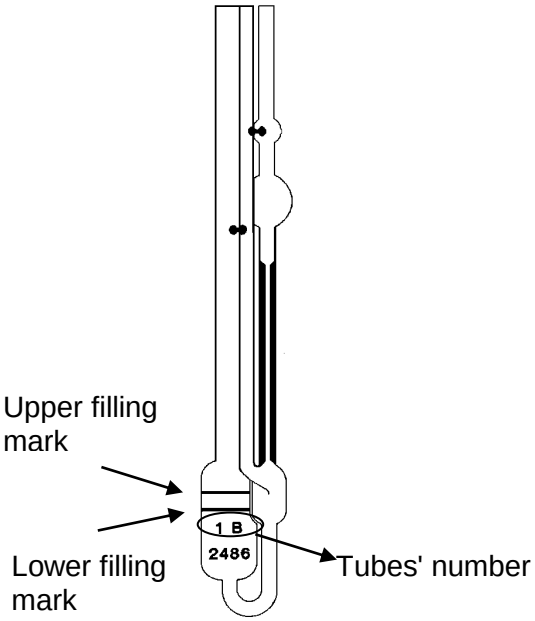
Causes for incorrect measurement
Some problems listed:

Cause	Test result	Check
Incorrect amount of sample	Fluctuating and incorrect	Sample volume
Incorrect cleaning viscometer tube	Fluctuating and incorrect	Check procedure and cleaning solvents
Condensate / moisture	Clogging, fluctuating and incorrect results	Pre heat sample, placing viscometer tube in holder, cleaning
Parts in sample	Clogging, fluctuating and incorrect results	Filter sample
No or short preheating	Fluctuating values	Time
Temperature instability		Bath fluid, pre heating time
Vacuum setting	Fluctuating values, vacuum error	Vacuum setting procedure
Optics	Fluctuating values, error	Positioning glass capillar, air bubbles.
Short measuring time	Short, fluctuating	Viscometer tube size
Leakage tube connectors	Short, fluctuating	Check for leakage
Silicone	Fluctuating, deviating	Keep tubes used for silicone sample separated

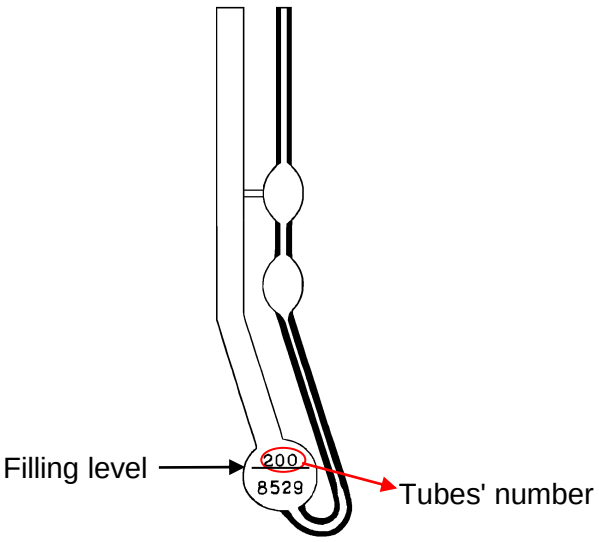
The type of viscometer tube
The TV2000-AKV system is developed for measuring kinematic viscosity following the ASTM D445 and D446 (Ubbelohde and Cannon Fenske - routine) method. Information in this manual is written to assist you in setting up the viscosity test and in any way is superseded by the directives found in the ASTM methods.

Two types of tubes are available for the TV2000-AKV. Please not that each type needs its specific measuring head. See page Spare parts list measuring head, page 60 for ordering codes. The two tubes which can be used are listed in the ASTM D-446 method.

Ubbelohde



Cannon Fenske



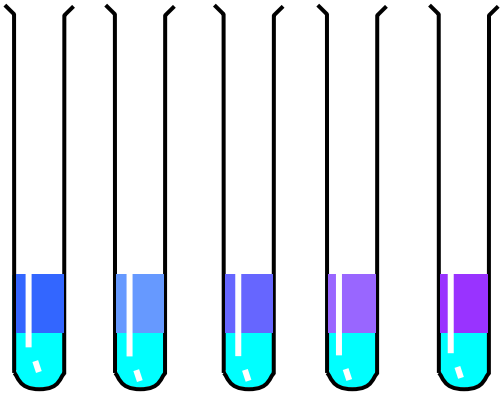
Cleaning of the glass viscometers
When cleaning the glass capillary make sure the cleaning solvent does mix with the sample. Use a simple test to choose the best solvent. Put different solvents in individual test tubes and mix each one of them with some sample. Use a stopper on the test tubes and shake them well. Observe in which solution the sample is best solved. Also hold the tube in and which mixture leaves fewest residue on the wall.

Do not use tubes used for silicone samples for non silicone samples. Tubes have to be fully dry. All moisture and cleaning solvent have to be fully removed. Tubes can be dried with warm air or nitrogen. A small flow of nitrogen trough the tube will remove moisture and remains of solvent. Be very careful with the pressurized air or nitrogen. It can damage the viscometer tube or cause accidents when solvent is sprayed around. Always wear protective clothing (gloves, eye protection etc.).

Test different solvents

Solvents are:
- White spirit
- Toluene
- Benzen
- Xylene
- Petroleum ether

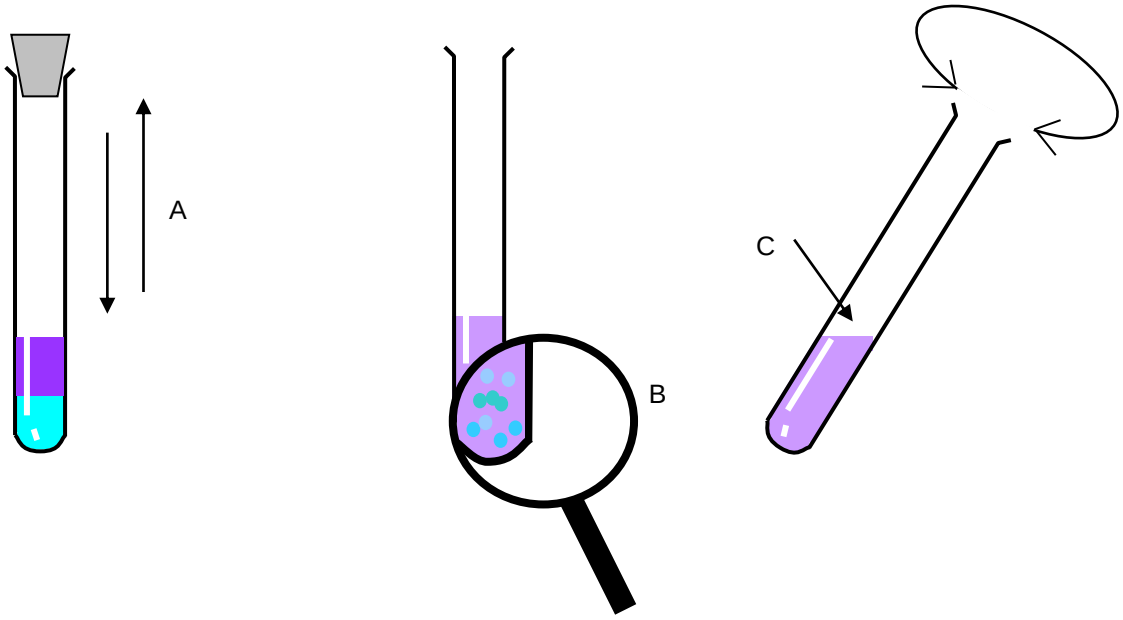
etc.



Be aware of hazards:
- health
- fire
- explosion

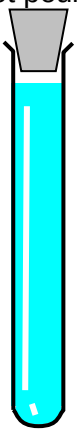
Use fume cabinet and ventilate well
Wear protective clothing

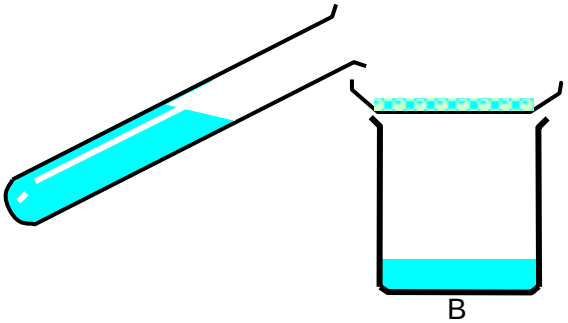
After shaking(A), observe in which solvent the sample has been solved best (B) + (C). When shaking the sample, use a stopper protecting the sample to from spilling around. Sample must be solved completely in the solvent. "B" therefore is incorrect and if separation between solvent and sample can be seen use different solvent. When tilting and turning the test tube(C), solvent must flow off the glass leaving no residue. If this is not the case, best is to use another solvent or remove these remains using a second solvent.

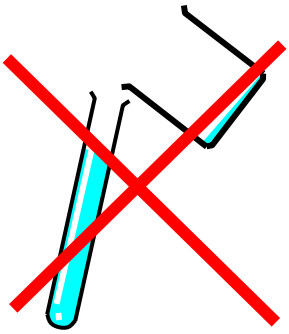


If after rejecting the cleaning solvent a residue is left in the capillary, a second solvent can be used for final cleaning. This can be a solvent with a lower boiling point fully removing all residue from sample and cleaning solution. Use warm dry air or nitrogen to remove any remains of the cleaning solvent or moisture.

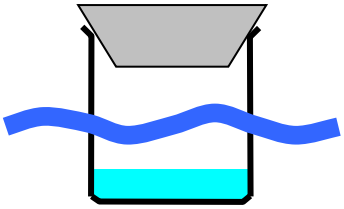
Preparation of the sample
Pre heat in water bath if necessary (viscous sample, prevent condensate),
Filter sample(A) from particles and other impurities to prevent clogging (B),
Do not pour sample from the viscometer tube back into sample container(C).
Use syringe to charge the viscometer tube, preferably use waste tip,
Make sure viscometer tube is dry,
Make sure viscometer tube is clean,
Make sure sample is at least at the same temperature or warmer than ambient and glass viscometer,
Do not pour sample from the viscometer tube back into sample container(B).


A

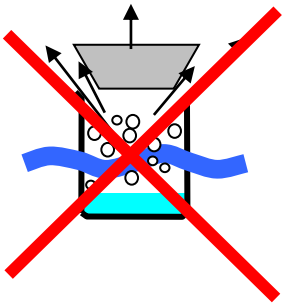

B


C

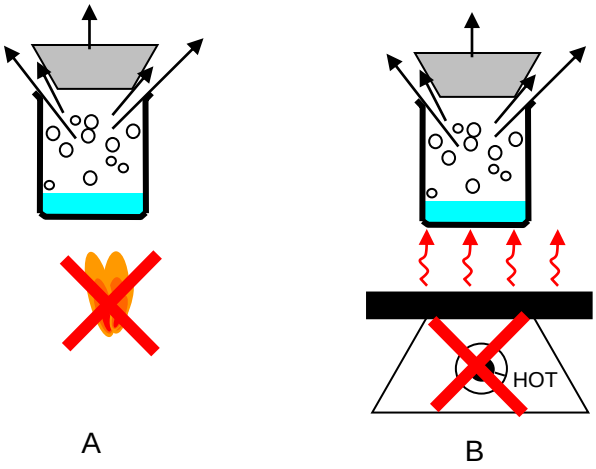
Charging the viscometer tube
To prevent build up of condensate, or lower the samples' viscosity, the sample can be pre-heated in a water bath. In any circumstances use a water-bath (see Tamson products TC6b, TC10b or TC20B) and **never** use an open flame or hot - plate to pre-heat. These will give serious explosion, burn and fire hazard. When closing the sample holder make sure cap can not be ejected by pressure building up during pre heating.



When pre-heating, prevent gas from building up pressure in the sample container.

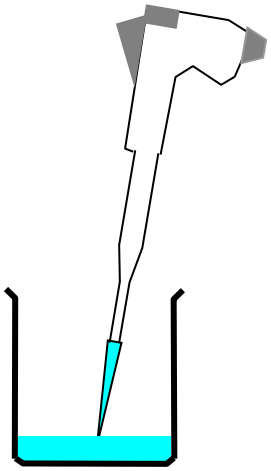


Do **NOT** use open fire(A) or hot plate(B) to pre-heat sample

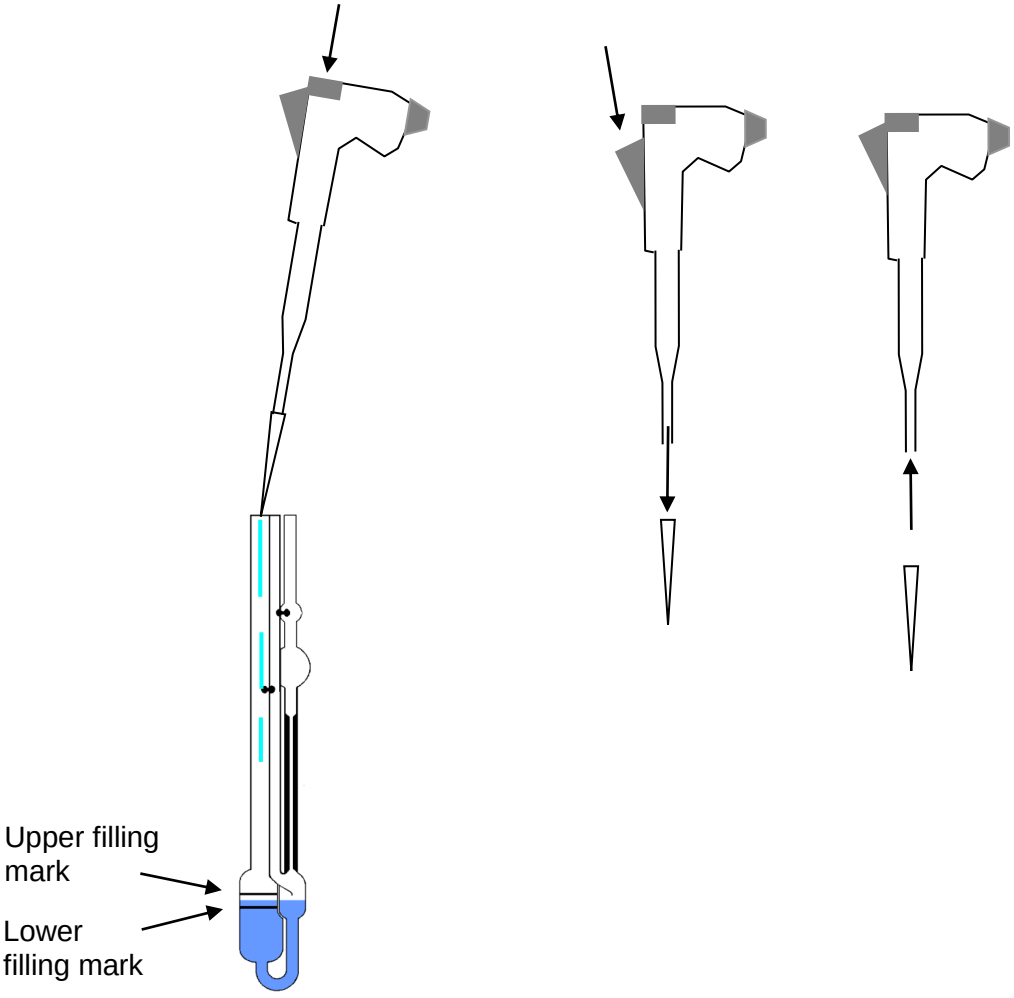


A B

Use syringe to take sample from the sample container and charge viscometer tube wit sample. Repeat procedure until appropriate level is reached.



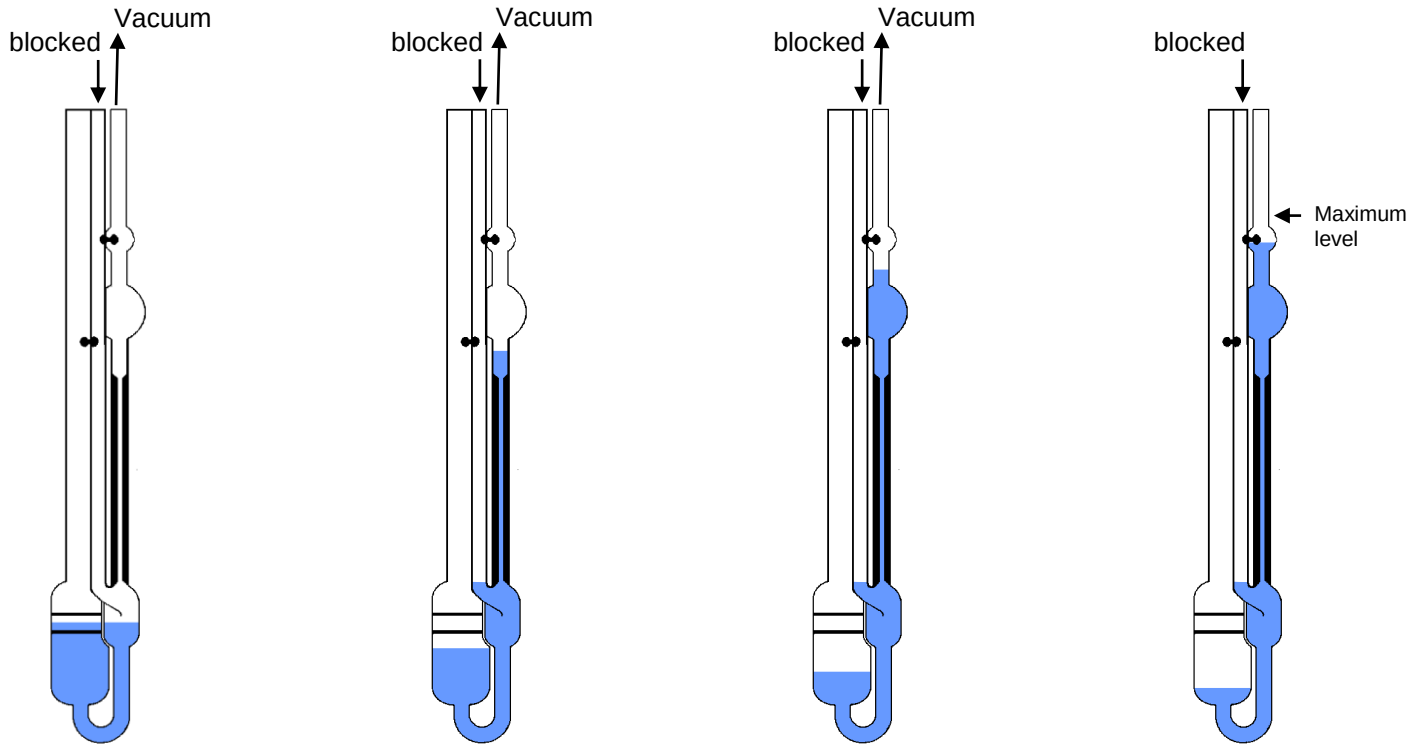
Charge the viscometer tube with sample, and repeat until appropriate level is reached.
Incorrectly filled viscometer tube will lead to error measurement. Reject syringe tip.
Mount new tip for next sample.



Measurement.
The viscometer tube must be clean and filled with sample.
The tube should be filled with sufficient sample,
Fill the tube until filling mark is reached
After the sample is heated (pre-heating time), the level may not exceed the uper filling mark
The measuring head, viscometer tube with sample has heat up in the bath. This may take between 15 and 30 minutes. When the system is stabilized measurement can start.

Measurement (A)

A) The bypass of the Ubbelohde tube is blocked and vacuum is started to suck the sample upwards.
B) The fluid should raise with ±1mm . . 3mm per second. If fluid is sucked up quickly bubbles may start to form causing problems with the optical detection. Fast raise of the fluid also will cause raise above the maximum level. Vacuum is set around 70 mBar and can be trimmed with the orifice on the back of the TV2000-AKV system.
C) Fluid passes 2nd timing mark.
D) Fluid passes 1st timing mark, IR detector is triggered and stops vacuum within a few seconds.



a: Ubbelohde filled with sample

b: Level passes 2nd timing mark

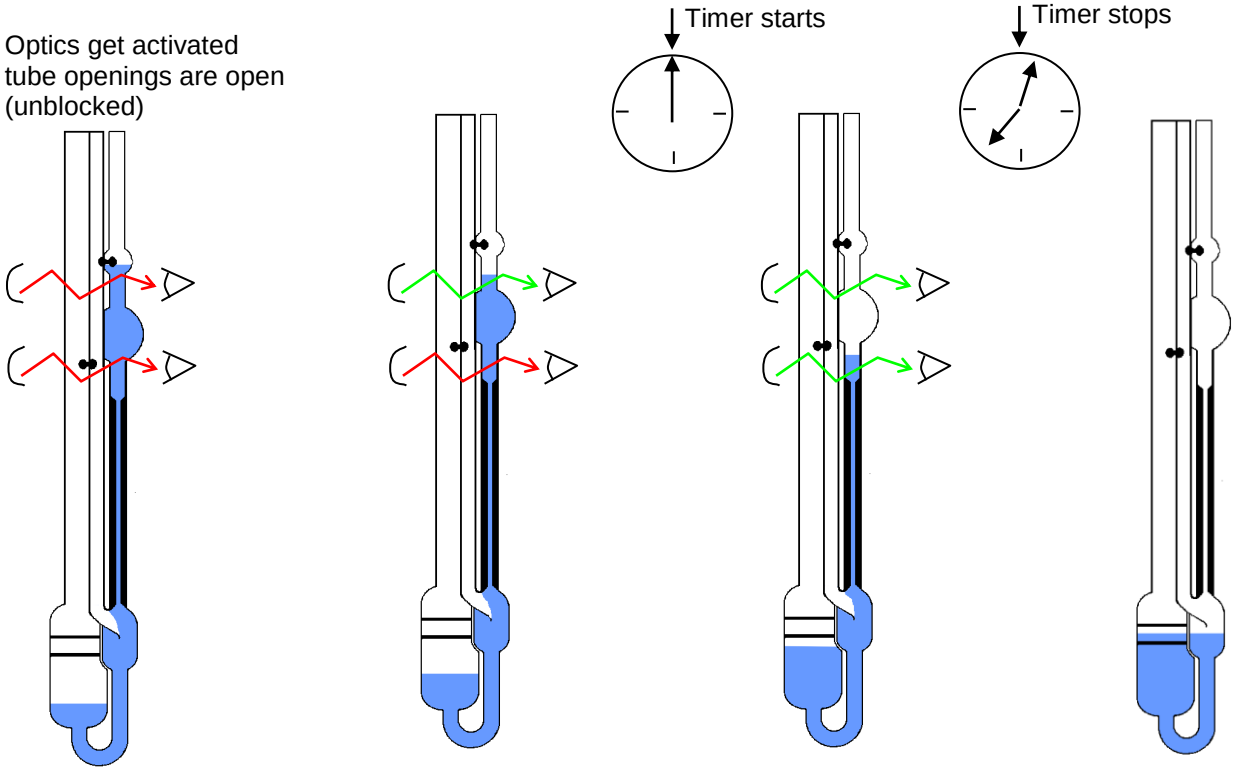
c: Level exceeds 1st timing mark

d: vacuum suction stops

Measurement(B)

When the fluid is below or has reached the maximum level in the glass capillary the vacuum stops.

A) Optics are active,
B) As soon as the fluid meniscus reaches the first optical detector the timer will start,
C) When the level is lowered to the second detector, the timer will stop. The measurement is completed and the viscosity is calculated, displayed and printed,
D) The system waits until the fluid is fully back in the tubes reservoir.



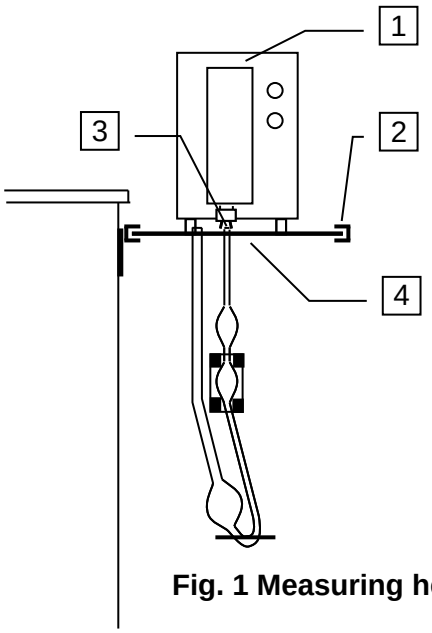
a: openings are unblocked, fluid drops

b: Miniscus passes 1st timing mark, timer starts.

c: Miniscus passes 2nd timing mark, timer stops. Result is calculated

d: Sample is at neutral level.

Connecting glass viscometer tube and measuring head

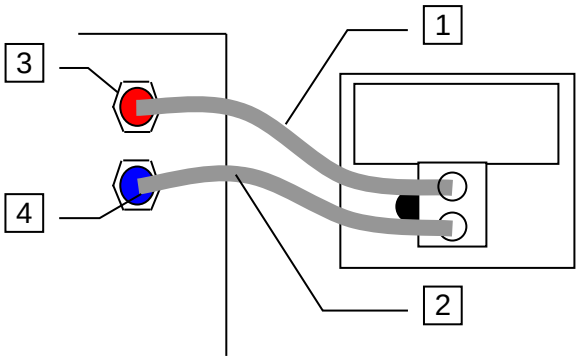


The measuring head can be placed inside the bath and in the bracket located at the right side of the bath.

The glass viscometer tube can be best placed / removed when the measuring head is placed in the bracket (2) located on the right side of the AKV system.

Before placing the glass viscometer tube, remove all condensate from the bottom of the measuring head (4) or silicon vacuum sealing (3).

Fig. 1 Measuring head and holder

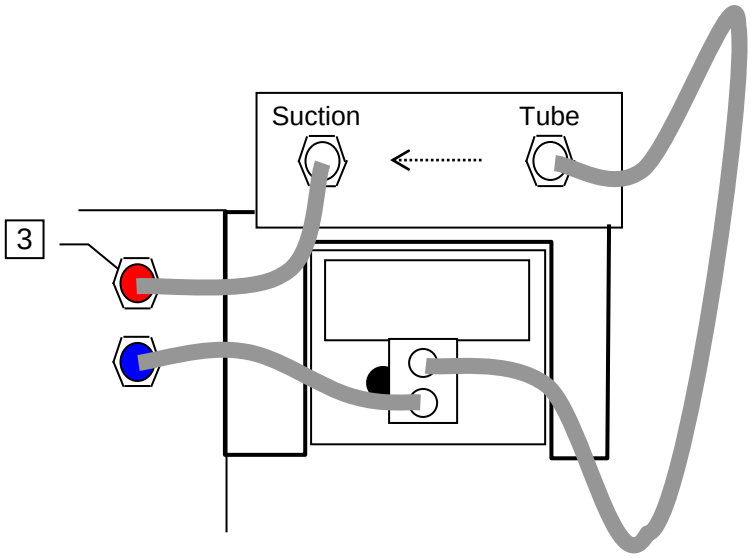


Connect the silicon vacuum tubes (1 + 2) onto the bath. When using the Cannon - Fenske tube, silicon tube (2) is not applicable. The connectors are colour coded. The vacuum connector (3) is red; The Ub-belohde connector (4) is blue.

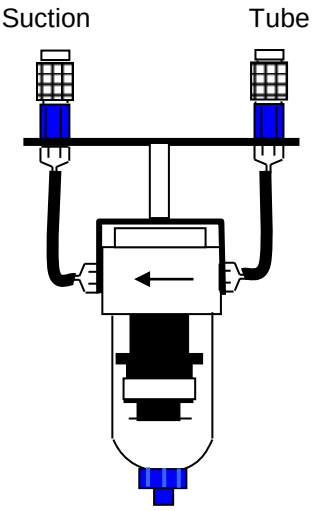
Fig. 2 Connecting tubes measuring head (Top view)

Fluid trap
Between the suction line (indicated red) a fluid trap can be placed. In some cases it is possible that fluid can be sucked directly into the system when this fluid trap is not placed. This might be the case with incorrect setting of the vacuum, incorrect filling of the capillary or problems with the optical detection. The supplied fluid trap must be placed in between the vacuum/suction line as indicated below.

See Spare partlist for fluid trap page 60 for specific spare parts.



Top view



Front view
(Measuring head not attached)

Adjustment of the AKV-system before performing a run.

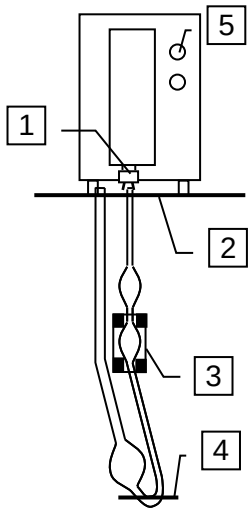


Fig. 3 Measuring head

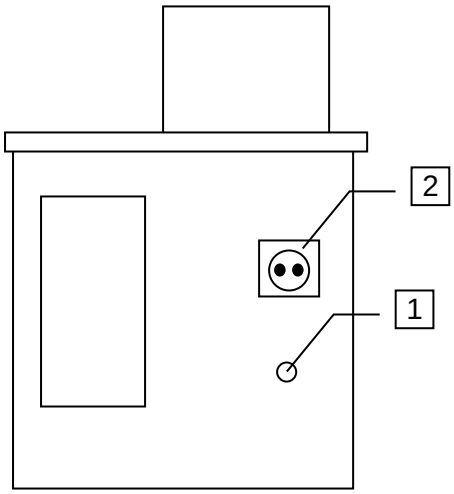


Fig. 4 Backside of TV2000 AKV

- Apply vacuum to the back of the system(1 - figure 4). When using constant vacuum -400 mbar will be sufficient. When using a small pump connect vacuum to connector located at the backside of the apparatus. Pump can be automatically powered by using connector at backside (2 - figure 4).
- Set number of runs to 1 see: Enter number of runs, page 23.
- Adjust set point temperature of bath (see page 14).
- Remove condensate from the bottom of the positioning lid (2).
- Fill the glass viscometer tube with sample.
- Place the glass viscometer tube gently in measuring head. Watch position of IR - sensors (3) and bottom plate (4). Place measuring head gently in the bath.
- Wait until bath shows "stable" on the display.
- Enter viscometer constant in AKV memory and select the glass viscometer tube (see: "Store new viscometer parameters", page 19 and "How to select a viscometer", page 18)
- Adjust vacuum, see also Setting the tube vacuum, page 22. Adjust vacuum value to 40 mBar (relative value (option 0). Turning the nozzle located at the backside of the AKV system can set the vacuum.
- Start the first measurement by pressing "**Start/Stop**" button on the AKV keypad.
- Observe the fluid being sucked upwards in the glass viscometer tube and adjust vacuum needle in such a way that the fluid level raises approximately 1mm per second. A vacuum set too high will cause bubbles in the fluid, which will lead to false detection.
- Observe the top-level detection. When the sensitivity is set incorrect the fluid will not be detected and will be sucked into the vacuum tube. When the top detection is not functioning press the "**Start/Stop**" button on the AKV keypad to stop the vacuum. The run will be aborted. Set the sensitivity 10% higher and wait until the sample is completely lowered in the viscometer tube. Press **"Start/Stop"** key again and repeat the above described procedure.

Start a single run

ENTER RUNS
START, E or MODE

Enter number of runs (page 23).

Adjust the set point temperature of bath (see Operating the bath chapter Adjusting set point page 14) when necessary.

Remove condensate from bottom of holder.

Always remove the glass viscometer tube from the measuring head very gently by lifting the glass viscometer tube a little bit. Bring the lower part of the viscometer just outside the bottom plate of the holder and press the bigger filling tube of the viscometer downward to remove the viscometer from the silicon connecting caps.

Fill glassware with sample, reference or calibrating oil.

If applicable remove any condensate from the bottom of the positioning lid of the measuring head and the silicon sealing before replacing the glass viscometer tube. Submerge the measuring head in the bath, making sure that the two holes in the positioning lid of the measuring head fit over the two pins on the top lid of the bath.

ENTER VISCO
START, E or MODE

Before using new glass viscometer tubes, the calibration constant has to be programmed into the AKV. Enter the viscometer constant in AKV memory and select a tube (see: Store new viscometer parameters, page 19 and How to select a viscometer, page 18)

SELECT VISCO
START, E or MODE

ENTER SAMPLE Nr
START, E or MODE

Select a sample number as reference for the measurement.

ENTER DELAY TIME
START, E or MODE

Both bath and sample have to pre-heat. Measurement must only be started after pre-heating and when the bath shows “Stable” on the bath display. The sample has to pre heat approximately 15 to 20 minutes. This can be done in two ways:

- Simply wait 15 to 20 minutes and press the “**Start/Stop**” button
- Set the AKV delay time. Press “**Start/Stop**” button. The system will wait until the entered time is passed before starting a run.

Resuming: before measurement the following applicable parameters have to be set:

- **SELECT VISCOMETER**
- **NUMBER OF RUNS**
- **SAMPLE NUMBER**
- **PRE HEATING TIME**

VISCO: 3964 **START, E or MODE**

After selecting and/or setting these parameters press the "**Start/Stop** key, after which the display shows:

Now press the **"Start/Stop"** key again to start the test.

If a viscometer number is selected which is not yet stored in the memory the system can be started but the test is not carried out and the display immediately returns to the standard display mode.

If a pre-heating time is programmed the display will show:

Pre-heating **time left: xx min**

The time left before the test is started is displayed in minutes. As soon as the programmed time has run down, the valves as well as the vacuum pump (if connected) are switched on to allow the system to draw-up the sample into the glass viscometer tube.

Draw sample up **measuring tube**

As soon as the sample is drawn-up into the measuring capillary of the viscometer, the vacuum pump as well as the valves are switched off

Waiting for timing mark 1

Sample nr.: 6
Time: xx.-- sec

At the moment the sample passes the upper sensor in the measuring head the timer is started. The display only shows the whole seconds but the timer counts with a resolution of 0.01 sec.

At the moment the sample passes the lower sensor the timer stops and shows the flow time with an accuracy of 0.01 sec.

At the same time the printer starts printing the result. At that moment the controller receives the information on the actual bath temperature from the controller of the bath.

If more than 1 run is programmed the system waits approx. 1 minute and after than the vacuum devices are switched-on again to draw the sample up into the measuring capillary.

Measurement examples

```
Sample nr:          44
TIME: 14:26
DATE: 26/09

Bath temp:          45.0°C
Viscometer nr:      3862
Constant:           0.094360

No. of runs:        1

Run:                1
Flow time:          445.10 sec
Visc:               41,9996 cSt
```

Example printout (single run).

```
Sample nr:          45
TIME: 14:45
DATE: 26/09

Bath temp:          45.0°C
Viscometer nr:      3862
Constant:           0.094360

No. of runs:        3

Run:                1
Flow time:          445.08 sec
Visc:               41,9977 cSt

Run:                2
Flow time:          445.05 sec
Visc:               41,9949 cSt

Run:                3
Flow time:          445.10 sec
Visc:               41,9996 cSt

Av, Visc:           41.9974 cSt
```

Example printout (three runs).

```
Sample nr:          46
TIME: 16:00
DATE: 26-okt

Bath temp:          60.0°C
Viscometer nr:      0003
Constant:           0.043790

No. of runs:  6

Run:                1
Flow time:          461.26 sec
Visc:               20,1985 cSt

Run:                2
Flow time:          461.15 sec
Visc:               20.1937 cSt

Run:                3
Flow time:          465.15 sec
Visc:               20.3689 cSt

Run:                4
Flow time:          461.38 sec
Visc:               20.2038 cSt

Run:                5
Flow time:          462.61 sec
Visc:               20.2576 cSt

Run:                6
Flow time:          461.31 sec
Visc:               20.2007 cSt

Av, Visc:           20.2372 cSt
```

Poor measuring results (bad repeatability) due to insufficient cleaning of glass viscometer tube

Aborting a run

```
Sample nr      :    46
TIME           :    15.15
DATE           :    26-okt

Bath temp      :    45.0°C
Viscometer nr  :    3862
Constant       :    0.094360

No. of runs    :    5

Run            :    1
Flow time      :    445.05 sec
Visc           :    41,9949 cSt

Run            :    2
Flow time      :    445.10 sec
Visc           :    41,9996 cSt

Run            :    3
Flow time      :    445.08 sec
Visc           :    41,9977 cSt

*********TEST ABORTED ********

Run            :    4
Flow time      :    10.45
Visc           :
```

As long as a test is running all keys of the viscometer section are disabled, with the exception of the **"Start/Stop"** key. If you want to stop a test you can press the **"Start/Stop"** key and the test will be aborted immediately.

If the test is aborted during the delay between two runs, nothing will be printed. If the test is aborted during a run the elapsed time and the report of the aborted test will be printed. Nevertheless the viscosity nor the average viscosity of any previous run(s) will be calculated nor printed.

Trouble shooting

Bath control
The bath controller is equipped with a number of safety devices, which can switch off the bath to prevent excessive temperature rise or malfunction. The safety devices can be divided into mechanical and electronic parts. The mechanical safety consists of an over temperature thermostat which can be reset and is located on the front panel of the bath. Turning the knob with a screwdriver or a coin can manually set the desired temperature at which the bath should be switched off.

When this thermostat is activated the entire bath will be switched-off and the red arrow shaped lamp and ERROR LED will light up. The display will show error **E1.** When the temperature of the bath has been lowered with approximately 20°K, pressing the reset pin can reset the thermostat.

Error messages			
E1	H 1 out of order	**E11**	A/D error
E2	H 1 wrongly on	**E12**	Overflow error
E3	H 2 out of order	**E13**	PV not valid
E4	H 2 wrongly on	**E14**	RAM 1 error
E5	H 3 out of order)	**E15**	RAM 2 error
E6	H 3 wrongly on	**E16**	RAM *3* error
E7	Illegal command	**E17**	Eprom CRC error
E8	Buffer overflow (RS232)	**E18**	Power Spikes !?
E9	Illegal data (RS232)	**E19**	Temp. offset error
E10	Illegal value (RS232)		

Adjust the safety thermostat as follows:
- Turn the thermostat fully clockwise.
- Heat the bath to its proper temperature. Be aware that the safety thermostat is now only functioning at 270 °C.
- Turn the thermostat gently counter clockwise, until the bath is switched off. Note this position and turn the knob approximately 30 to 50° clockwise. The reset pin can be activated, and the ERROR can be acknowledged by pressing any of the front panel keys. Turn the knob counter clockwise again and stop it just before the point where the bath was switched off previously.

Bath error messages
In almost all cases the bath will be switched off as soon as an error is reported. Pressing one of the keys on the front panel can reset the electronic error reports. However when the error still exists, the report will be repeated after resetting the system in approx. 3 minutes. The following error messages can be displayed:
- When the bath detects the errors **E 7** ”A/D error” and **E 19** ”Temp. offset err.” the controller recalibrates itself automatically.
- The error reports **E 18** ”Power spikes!?” and **E 19** ”Temp. offset err.” are not fatal and the display returns to normal operation after a few seconds or can be reset by pressing one of the keys. When these errors are detected the bath will not be switched-off.

ERROR 1: Heater 1 out of order
This error report appears when:
- The 200W heating element is malfunctioning
- The solid-state relays is out of order
- An operational amplifier on the power supply board has a defect.
- The power supply is too low and due to that the current detector is unable to operate correctly.

Besides the above, this error report appears if the microprocessor detects an undefined error during initializing the controller.

ERROR 2: Heater 1 wrongly on
This error report appears if:
- The solid-state of the first heater is not working properly.
- An operational amplifier on the power supply board is not working properly.

ERROR 3: Heater 2 out of order
This error report appears when:
- The 1000W heating element is malfunctioning
- The solid-state relay is out of order
- An operational amplifier on the power supply board has a defect.
- The power supply is too low and due to that the current detector is unable to operate correctly.

ERROR 4: Heater 2 wrongly on
This error report appears if:
- The solid-state of the first heater is not working properly.
- An operational amplifier on the power supply board is not working properly.

ERROR 5: Heater 3 out of order
This error report appears when:
- The 200W heating element is malfunctioning
- The solid-state relay is out of order
- An operational amplifier on the power supply board has a defect.
- The power supply is too low and due to that the current detector is unable to operate correctly.
- The bath is not equipped with a third heater but the DIP-switch 2 is set to ON.

ERROR 6: Heater 3 wrongly on
This error report appears if:
- The solid-state of the first heater is not working properly.
- An operational amplifier on the power supply board is not working properly.

ERROR 7: Illegal command
Error send by RS232 when a command forwarded by a computer connected via RS232 is not valid or recognized by the bath. The error is not fatal and the bath will continue to operate.

ERROR 8: Buffer overflow
This error is reported to a computer and appears on the screen as soon as a command or data string is sent to the bath, which is longer than the maximum defined length of 8 characters. The error is not fatal.

ERROR 9: Illegal data
This error appears on the screen of a computer as soon as a command or data is sent to the bath of which the format does not comply with the format mentioned in the manual. The error is not fatal.

ERROR 10: Illegal value
As soon as you try to send a value to the bath which is out of the range as defined in the manual the bath will transmit this error to the computer. The error is not fatal.

ERROR 11: A/D Error
This error can be reported both on the display as send by RS232 when using the command ER. This error indicates that during the analogous-digital conversion the microprocessor has detected a value, which is out

of range.

The first action of the microprocessor will be a recalibration of the temperature controller. The error is not fatal. In most cases it will be an indication that the analogous/digital converter on the microprocessor board is out of order. A repetitive error is serious and indicates an unreliable microprocessor board.

ERROR 12: Overflow error
Sending a data string to the bath, which is too long this error, will be reported. The command is not executed and the bath will continue to operate. The error is not fatal.

ERROR 13: PV NOT VALID
If you instruct the bath to transmit the actual bath temperature and the value is out of the limits the data will not be transferred to the computer. Instead this error is generated.

ERROR 14: RAM 1 ERROR
ERROR 15: RAM 2 ERROR
ERROR 16: RAM 3 ERROR
On the microprocessor board there are three integrated circuits 8155 which contain a volatile memory. If one of the volatile memories is damaged this will result in one of the before mentioned error reports. The error is fatal and the microprocessor board has to be repaired

ERROR 17: EPROM CRC error (program memory)
A checksum error is reported and the on-board EPROM needs replacement.

ERROR 18: Power spikes !?
If the controller detects a strongly fluctuating power supply or high frequency interference this report will be displayed. The error is not fatal and the bath will continue operating.

ERROR 19: Temp. Offset err.
As soon as the analogous/digital converter does not find a stable value the controller will report this error as an indication that the bath temperature fluctuates. A defect in the analogous/digital converter can also generate this error. If the error repeats after switching off and on the bath the microprocessor board has to be replaced.

ERROR 20: Bath not stable
If the “SP” command is send to the bath to check if the control of the bath temperature has become stable. the bath will answer with **”BATH NOT STABLE”.** The error is not fatal for the operation of the bath.

ERROR 21: Timeout error
If a command send to the bath by RS232 is not followed by a CR/LF within approx. 10 seconds, the command will be ignored and the bath will report this time-out error to the computer. The error is not fatal for the operation of the bath.

Bath temperature does not become stable
If the bath temperature does not become stable within approx. 45 minutes after the bath has reached its set point following might cause this problem:

- The operating temperature is around or below 30°C. To achieve stable bath temperature control at a set point temperature just above the ambient temperature it is necessary to apply cooling water to the cooling coil. If cooling liquid is already applied increase the flow of the cooling liquid or lower the cooling liquids’ temperature.

- If the operating temperature is far above the ambient temperature it is most likely that the viscosity

of the bath fluid used is too high. The maximum viscosity of the bath fluid lies below 20 cSt at the operating temperature but is preferably less than 10 cSt. If the viscosity of the bath fluid used is too high the circulating system of the bath will be no longer capable to mix thoroughly which results into poor stability.

- Check time constant of the bath. Standard time constant is 100 Seconds.
- Power limit has been set too low.
- Position of PT 100 has been changed. The tip of the PT 100 must be positioned just above the baffle plate.
- Position of the stirrer fan must be exactly in the center of the hole in the baffle plate (both in horizontal and vertical position).
- Check possible heat transfer from another apparatus near the bath i.e. oven or central heating.
- Check possible strong HF interference of non-CE apparatus. Interference can be caused via high frequency inducted by air or via mains supply.
- Check any possible strong magnetic field from other apparatus.
- Check overheating of electronics inside apparatus. All fans must be running.

Problems with measuring head: bad repeatability

The baths repeatability complies with the claims stated in the ASTM D445. If repeatability of the test does not comply use following points to fault find.

- Tube is not well cleaned
  - Do not use soap,
  - All residues must be removed,
  - All solvent must be removed.
- Glass viscometer tube was not dry when pouring the sample in the tube
  - Use dry air to clean the tube,
  - Remove solvents residues.
- Condensate dropped into the tube while placing viscometer tube in holder
  - Before placing the glass viscometer, remove condensate from the bottom of the mounting plate of the viscometer holder.
- Pre-heating time too short
  - Use enough time to pre heat the sample,
  - Determine the pre-heating time by trial and error, start with 25 or 30 minutes.
- Bath is not placed spirit level
  - Adjust leveling feet positioned under the bath.
- Bath fluid level too low
  - Adjust fluid level by filling the bath.

- Sample fluid level too low
    - Use enough sample to fill the glass viscometer sample reservoir so the sample fluid level is in between the two indicator lines.

- Sample is non - Newtonian fluid
    - When measuring non-Newtonian fluids like silicon oils, repeatability is usually very poor.

- Bath is placed in daughty / breezy environment
    - Keep away daught or wind to guarantee bath stability.

- Sample is sucked by vacuum too quickly
    - Adjust vacuum so the fluid rises with 1mm per second.

- Bath temperature does not become stable see page 45.

- Fluctuating flow time
    - If the flow time is fluctuating check following:
    - A leak in the vacuum system
        - A leak in the vacuum system or the connection of the glass viscometer and vacuum system might lead to air bubbles in the sample. These bubbles are often so small that they are sometimes difficult to detect with the eye. Nevertheless these air bubbles might be the cause unreliable measurements. Replace tubing or sealants when the show any form of leakage.

The following two measuring results show the difference between a well performed measurement and a measurement with bad repeatability which is caused by one of problems described above.

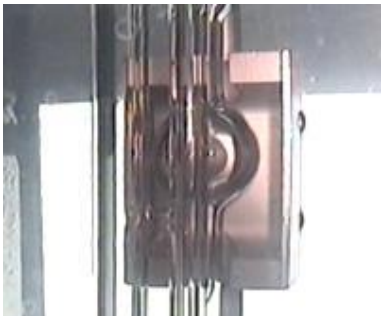
Poor result

```
Sample nr:          47
TIME: 12:00
DATE: 27-okt

Bath temp:          50.0°C
Viscometer nr:      0003
Constant:           0.043790

No. of runs:  6

Run:                1
Flow time:          102.23 sec
Visc:               04.4766 cSt

Run:                2
Flow time:          102.02 sec
Visc:               04.4674 cSt

Run:                3
Flow time:          102.26 sec
Visc:               04.4779 cSt

Run:                4
Flow time:          102.22 sec
Visc:               04.4762 cSt

Run:                5
Flow time:          103.95 sec
Visc:               04.5519 cSt

Run:                6
Flow time:          102.25 sec
Visc:               04.4775 cSt

Av, Visc:           04.4879 cSt
```

Normal result

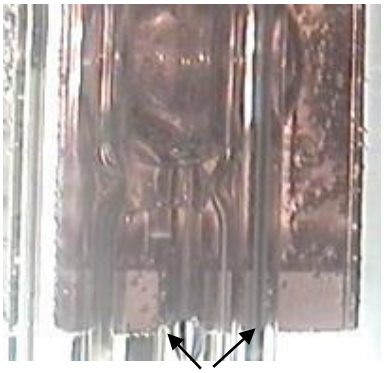
```
Sample nr:          48
TIME: 13:00
DATE: 27-okt

Bath temp:          50.0°C
Viscometer nr:      0003
Constant:           0.043790

No. of runs:  6

Run:                1
Flow time:          102.32 sec
Visc:               04.4805 cSt

Run:                2
Flow time:          102.32 sec
Visc:               04.4805 cSt

Run:                3
Flow time:          102.33 sec
Visc:               04.4810 cSt

Run:                4
Flow time:          102.35 sec
Visc:               04.4819 cSt

Run:                5
Flow time:          102.34 sec
Visc:               04.4814 cSt

Run:                6
Flow time:          102.33 sec
Visc:               04.4810 cSt

Av, Visc:           04.4811 cSt
```

Problems with measuring head: bad detection



Clear view IR sensors

- Viscometer tube not placed in center of IR detector
    - The IR-beam should cross the center of the capillary.
- Sample is sucked too quickly
    - Adjust vacuum in such a way that the fluid rises with approximately 1mm per second maximum.
- Water vapour or bubbles blocking IR detector
    - Lift the viscometer holder and submerge again in order to remove all bubbles around the IR detector.



Bubbles blocking IR detectors

- Glass viscometer tube was not empty.
    - Vacuum too high causing bubbles which remain in front of IR-sensor thus blocking or false triggering the detector.
- Sensitivity set too low
    - Increase sensitivity, see Adjusting sensitivity page 23.
- Level sample fluid too low
    - Use enough sample and fill the glass viscometer reservoir with enough sample so the level of the sample fluid is in between the two indicator lines.
- Sample too dark
    - With some dark fluids a residue may remain on the wall of the glass capillary and the meniscus can't be watched. If such is the case with the sample, the D445 method and routine flow tubes can not be used to perform methods for these types of samples. Instead reverse flow tubes should be used. These unfortunately are not available for the AKV system. A sample can always be sent to Tamson Instruments to make sure the unit can be used for specific samples. If the meniscus can be detected by eye, the AKV system will be able to detect and measure the flow times.

Errors on LC display

Displays locked, Error LED on
The bath temperature has exceeded the preset temperature of the safety thermostat. This has activated the thermostat and switched off the bath.

AKV Display shows "No vacuum"
If the display shows this message there is a problem with the vacuum. Check following:
- Is there a vacuum supplied (is vacuum pump working)
- Check tubing
- Check vacuum valve located on the back of the apparatus
- Check fuse next to mains-socket which provides power for the pump

AKV Display shows "Vacuum too low"
If this error is reported the vacuum supplied during drawing-up the sample the supplied vacuum pressure is too low. The vacuum should lay in between –40 and 200 hPc. Trimming the vacuum is described in chapter "Setting the tube vacuum" page 22.

Check also the placement of the glass capillary in the viscometer holder. The silicon sealing on top of the

glass viscometer should be airtight.

AKV Display shows “Visco not empty”
This error is reported when a measurement is started with the sample not flown back completely. This fault may occur after aborting a test and a quick restart of the test. Wait until the sample has flown back and then start a new measurement. If the problems persists check following:
- (a) Vacuum set too high. When the sample is sucked, vacuum must be adapted to realise a speed of less than 1mm / sec,
- (b) Fluid is very dark and leaves residue on capillary wall,
- (c) Glass capilary is not positioned in the middle of the infra-red detecors,
- (d) When using water as bath liquid, bubbles are formed around glass and infra-red detectors,
- (e) Connections on the glass capilary leak (bubbles are formed in sample when sucking up the sample),
- (f) Measuring head is defective.

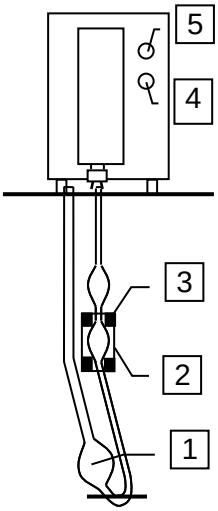
When the unit is in service mode (see below) the sucking of the sample, vacuum setting(speed of sample when sucked-up) and the detection of the infra-red detectors can be checked and observed. When the sample passes the IR sensors and the value on the top LCD changes, this indicates that the measuring head is OK, cause (F). If the infra-red detectors functions make sure all parameters indicated above all are ok.

AKV Display shows “Connect visco sensor”
When a test is started whilst the measuring head has not been connected the AKV system reports this error. When the measuring head is connected again the measurement will be started.

AKV Display shows permanently “Waiting for timing mark 1”
Following might cause this:
- A high vacuum pressure caused splashing of the sample when reaching the top and is false triggering the top sensor. Trimming the vacuum pressure can solve this. See chapter ”Setting the tube vacuum “ page 2.
- Using viscous sample and low vacuum pressure may cause false triggering of the top sensor. When drawing up the sample the sensor stays inactive for four seconds after detecting the sample during drawing up. These four seconds normally prevents false triggering caused by bubbles in the sample. Now when the sample flows back within four seconds thus passing the sensor again, it is obvious that when the sensor becomes active again it will not be triggered again. As with the previous fault trimming of the vacuum pressure should solve the problem.
- The sensitivity of the IR-detector is incorrect. Adapt the sensitivity for a proper detection of the fluid meniscus. See chapter “Adjusting sensitivity” on page 23.
- With some dark fluids a residue may remain on the wall of the glass capillary and the meniscus can't be watched. If such is the case with the sample, the D445 method and routine flow tubes can not be used to perform methods for these types of samples.

Trouble shooting the measuring head
To make sure the problem is not caused by the IR detection, measuring head and system can be tested in a special service mode. A single measurement can be performed manually using this service mode.

☞ **Service mode**
To get in this service mode switch of the AKV system. Connect the viscometer tube holder in the bracket sideways of the apparatus. (Do not leave the holder in the fluid and remove glass viscometer capillary/tube). Make sure the DIN-plug of the holder is connected onto the AKV system.



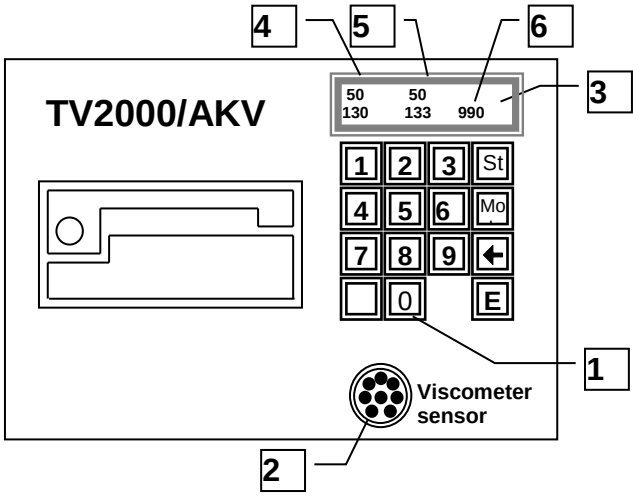
The AKV system can now be set to service mode by holding the "0" button down when switching on the AKV system. This "0" button is located on the numerical keypad of the AKV apparatus(1). The button must be pressed for approximately 1 minute until the top display(3) shows 5 numerical readings. The "0" key can be released now.

☞ **Test IR sensors:**
Remove viscometer from the holder. After pressing key "2" the IR sensors starts to "tune" and after several seconds new reading follows on the display. The left reading (4) is the bottom sensor, the right reading(5) is the top sensor. Reading indicated with (6) is the pressure sensor.

Block the bottom and top sensor with a piece of paper and wath the response. Note down all readings.

Press "3". The IR sensors will start to tune for a few seconds and after tuning block sensors and note all readings.

Fill the viscometer with sample and place the viscometer in the holder. Keep the holder outside the bath. The system must still be in service mode as described above. Press key "2" the IR sensors start to "tune" and after several seconds new reading follows on the display. Note down the reading. Press key "3" the IR sensors start to "tune" and after several seconds new reading follows on the display. Note down the reading.



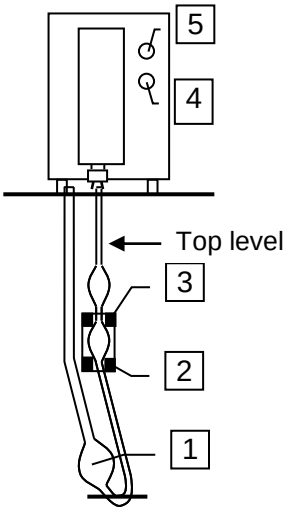
Top housing AKV system

☞**Simulate measurement:**
The viscometer with sample(1) should still be in the holder and the holder must still be outside the bath. The system must be in service mode as described above.

Use the "1" on the keypad to apply vacuum to the system. Press "0" to switch the vacuum off. Both buttons "1" and "0" can be used to draw up the sample and simulate a measurement. This way valves, vacuum and IR readings can be fully tested.

When the sample passes the IR detectors(2) and (3), the readings (4) + (5) must change on the LCD in the top housing. Indicator LED's (4) + (5) on the viscometer holder must blink in service mode. They do not show have a detection status.

Above performed tests mus show the source of the problem. If problems are caused by malfunctioning detection the measuring head needs to be checked. If the sample can't be raise to the top level the internal electrinics and pneumatics of the AKV must be checked.



Technical specifications

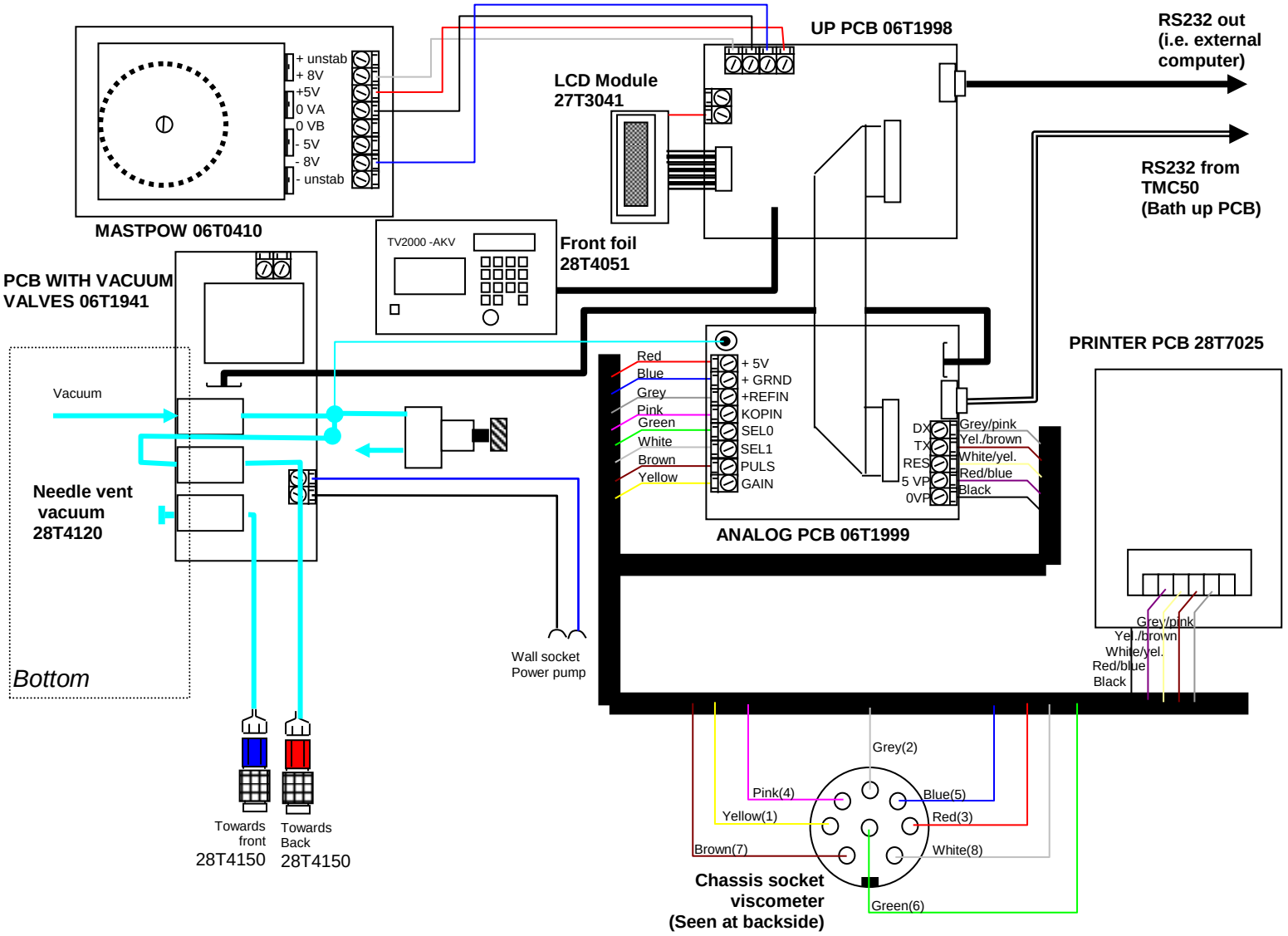
AKV-system

Temperature range	Ambient up to 125°C Lower temp than ambient possible when using an external cooler circulator (Beware for building of condensate)
Timer range	up to 9999.99 sec
Timer accuracy	± 0.01 sec
Viscosity range	0.3 up to 10.000 cSt
Detection system	opto - electronic, infrared
Color of sample	Transparent .. colored When measuring dark fluids sample residue may be left inside the glass capillary. If the lowering of the meniscus can be clearly watched, also dark fluids can be measured. If the residue makes the lowering of the meniscus badly visible, measurement will be un succesfull. It is always possible to send Tamson Instruments bv a sample to perform a test.
Intensity and gain control	automatic
Selectable parameters	viscometer number equilibrium time repeat runs
Adjustable parameters	- sample number - sensitivity - viscometer number - viscometer constant - pressure - backlight & contrast - date & time
Vacuum adjustment	manual with built-in valve
Vacuum system	external (optional)
Print out	- sample number - date & time - bath temperature (°C or °F) - viscometer no. and constant - number of runs - flow time in sec - viscosity in cSt - average value in cSt
Materials used	stainless steel 304 / 316 sillicon rubber PTFE (Teflon)
Excluded	- Measuring head (Ubbelohde) - Measuring head (Cannon Fenske) - Glass capillary - ASTM reference thermometer - Bath filling - Vacuum pump

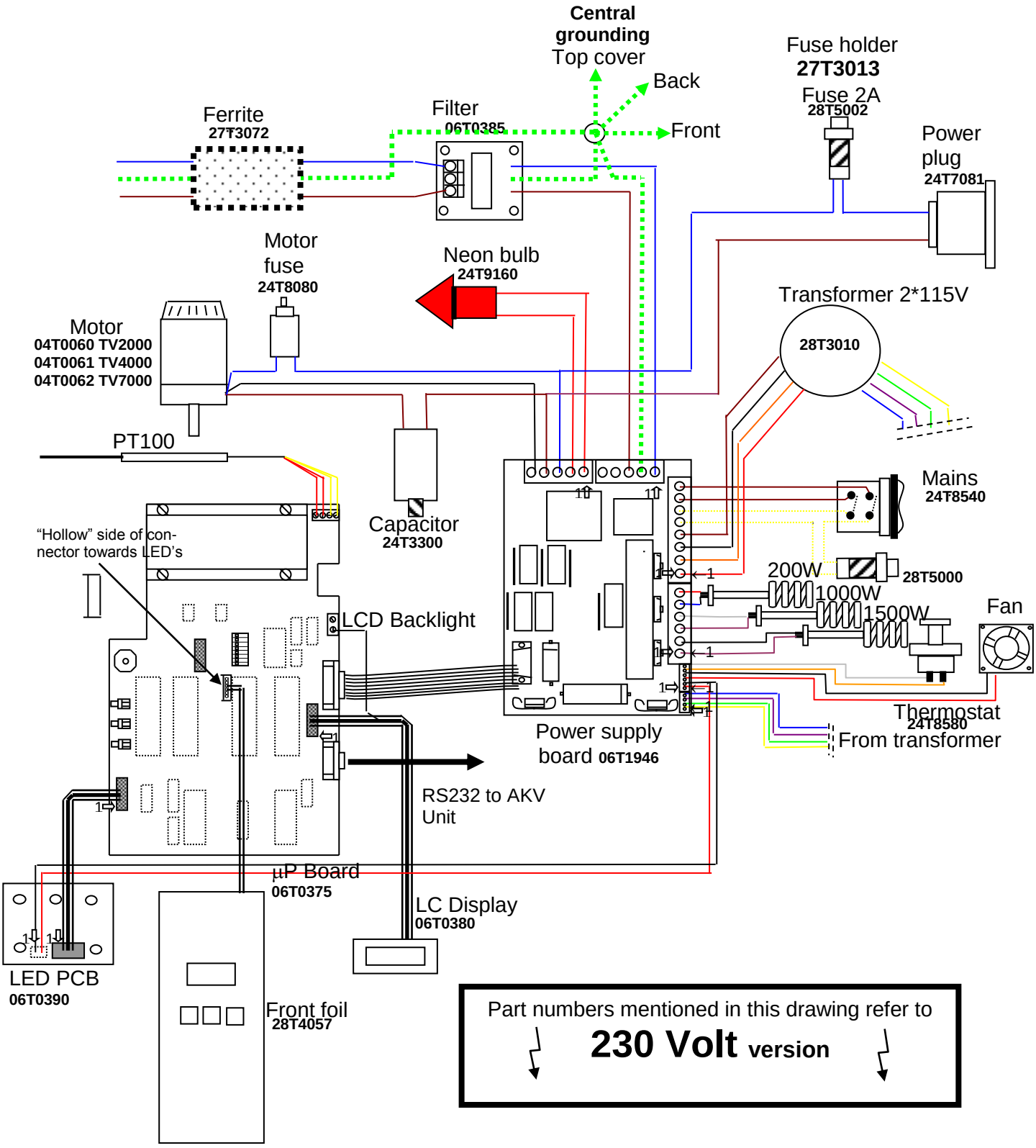
Specifications bath (TV2000)

Temperature range	Ambient up to 125°C Lower temp than ambient possible when using an external cooler circulator (Beware for building of condensate)
Setting accuracy	± 0.1°C or 0.1°F
Stability	± 0.01°C
Uniformity	± 0.01°C
Bath opening	130 * 165
Bath depth	300mm
Windows	140 * 285
Dimensions	width: 465mm height: 585 mm length: 285 mm
Heaters	200, 1000 and 1500 Watt
Power consumption	2800 Watts (Maximum during heating up)
Power supply	230V 50 or 60 Hz or 115V 50 or 60 Hz
Used material	stainless steel 304 / 316 silicon rubber
Include	- Cooling coil - Leveling feet - Communication port

Technical Drawing: AKV Unit



Technical Drawing: Thermostatic Bath



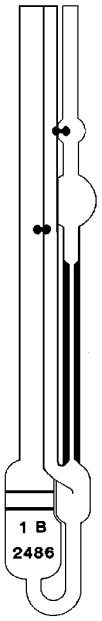
Accessories and spare parts

Viscometer tubes Ubbelohde and Cannon- Fenske
The AKV-system offers the choice to operate the instrument either with a Cannon-Fenske or Ubbelohde viscometer tube. To work with the Ubbelohde viscometer tubes the AKV-measuring head 00T0840 is needed. To work with Cannon Fenske tube AKV-measuring head 00T089 is needed.

The viscometers supplied for the AKV are completely according the ASTM D446 and IP 71, however the timing marks have been left of because of the electronic detection system. The tubes are further more precisely manufactured than the norm requires. This guarantees optimal measuring result. The tubes will be supplied with a factory calibration certificate, stating the viscometer number and constant of the viscometer.

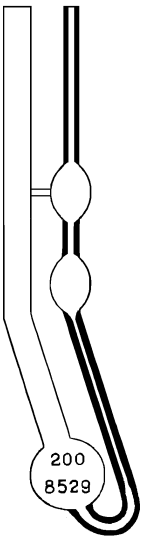
Ubbelohde viscometers available:

Ubbelohde				
Type	Ordering code	Size	Range [cSt]	Nominal constant
AKV/0	25T0766	0	0.3 – 1	0.001
AKV/0C	25T0767	0C	0.6 – 3	0.003
AKV/0B	25T0768	0B	1 – 5	0.005
AKV/1	25T0769	1	2 – 10	0.01
AKV/1C	25T0770	1C	6 – 30	0.03
AKV/1B	25T0771	1B	10 – 50	0.05
AKV/2	25T0772	2	20 – 100	0.1
AKV/2C	25T0773	2C	60 – 300	0.3
AKV/2B	25T0774	2B	100 – 500	0.5
AKV/3	25T0775	3	200 – 1000	1.0
AKV/3C	25T0776	3C	600 – 3000	3.0
AKV/3B	25T0777	3B	1000 – 5000	5.0
AKV/4	25T0778	4	2000 – 10000	10.0



Cannon Fenske viscometers available:

Cannon Fenske				
Type	Ordering code	Size	Range [cSt]	Nominal constant
AKV/25	25T0779	25	0.5 – 2	0.002
AKV/50	25T0780	50	0.8 – 4	0.004
AKV/75	25T0781	75	1.6 – 8	0.008
AKV/100	25T0782	100	3 – 15	0.015
AKV/150	25T0783	150	7 – 35	0.03
AKV/200	25T0784	200	20 –100	0.1
AKV/300	25T0785	300	50 – 250	0.25
AKV/350	25T0786	350	100 – 500	0.5
AKV/400	25T0787	400	240 – 1200	1.2
AKV/450	25T0788	450	500 – 2500	2.5
AKV/500	25T0789	500	1600 – 8000	8
AKV/600	on reqest.	600	4000 - 20000	20

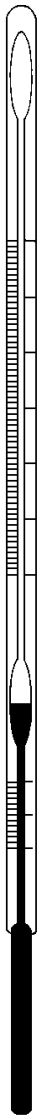


Indicating Thermometers

These thermometers comply with the ASTM D445 and E1. The glass thermometers are suitable for official calibration. All thermometers have a sub devision of 0.05°C (0.1°F) and are equipped with an ice-point scale. Following thermometers can be supplied

ASTM thermometer Range °C		
ASTM nr.	Ordering no.	Range°C
44C	25T0937	+18.5 … +21.5
46C	25T0938	+48,6 .. +51,4
120C	25T0990	+38.6 … +41.4
46C	25T0939	+48.6 … +51.4
47C	25T0940	+ 58.6 … +61.5
121C	25T0991	+98.6 … +101.4
Other ranges available on request		

ASTM thermometer Range °F		
ASTM nr.	Ordering no.	Range°F
44F	On request	+66.5 … +71.5
45F	On request	+74.5 … +79.5
118F	On request	+83.5 … +88.5
28F	On request	+97.5 … 102.5
46F	On request	+119.5 … +124.5
29F	On request	+127.5 … +132.5
47F	On request	+137.5 … +142.5
48F	On request	+177.5 … +182.5
30F	On request	+207.5 … +212.5
10F	On request	+272.5 … +277.5



To protect the thermometer for mechanical damage a stainless steel holders is available ordering code 00T0239.

Spare parts list bath

230 Volt	115 Volt	Description
Ordering code		
04T0061	04T0161	Stirrer complete
25T0170	25T0180	Heater 200/1000W
25T0210	25T0230	Heater 1500W
28T4021	28T4032	Heater 200/1000W
28T4022	28T4033	Heater 1500W
25T1290	25T1300	Motor for stirrer
24T3300		Capacitor 7uF
	24T3330	Capacitor 25uF
24T8080		Motorfuse 0.6 Amp.
	24T8090	Motorfuse 1.3 Amp.
24T8540		Mains switch
25T1242		Cooling fan
24T8580		Safety cut-out thermostat
24T9160	24T9170	Arrow shaped lamp
25T0210	25T0210	Heater 1500 Watts
06T1946	06T1946	Power supply board
28T3004		Relay for power supply board
28T5000		Fuse 250 mA
	28T5005	Fuse 500 mA
27T3050		Solid State Relay 8A
	27T3056	Solid State Relay 16A
27T8003		Error LED red
27T8002		Error LED green
28T4026		PT-100 sensor
28T3011		Ring-core transformer 2 * 110 V
06T0375		Microprocessor board TMC50, complete
06T0380		Display board, complete
06T0230		Eprom programmed
06T0380		Intelligent display
28T4057		Frontfoil with membrane switches
06T0385		PCB Net filter
06T0390		PCB LED
24T0051		Leveling foot
00T0232	00T0261	Vacuum Pump Valves Neoprene
00T0233	00T0263	Vacuum Pump valves Teflon
00T0262		Vacuum Pump valves Viton

Ordering code	
00T0840	Measuring head AKV Ubbelohde (Complete)
00T0890	Measuring head AKV Cannon-Fenske
24T0043	Silicon tubing 5*8mm
28T4160	Vacuum connector onto AKV-system
06T1723	Silicon sealing viscometer tube
06T1942	PCB measuring head
24T7937	DIN-connector electronic cable

Spare parts list AKV-system

230 Volt	115 Volt	Description
Ordering code		
06T1941		PCB with vacuum valves
06T0410/230V	06T0410/115V	PCB power supply AKV
06T1999		PCB analog
06T1998		PCB microprocessor
04T2180		Ax printer role
28T7000		Printer
28T7030		Printer ribbon
28T7035		Printer paper
28T7025		Printer PCB
27T3041		LC-display
24T0041		PVC vacuum tube blue (per meter)
28T4051		Frontfoil AKV unit
28T4120		Needle vent vacuum
28T4100		Vacuum valve (Located on PCB)
28T4150		Coupling vacuum system to viscometer head female

Spare parts list measuring head

Spare partlist for fluid trap

Ordering code	
28T4122	Filterpatrone Festo number* 51 62 97 LFP-D-MICRO-5M
28T4123	Filter housing Festo number* 51 63 17
28T4124	Internal replacement of filter (white + black parts) Festo number* 52 68 18
* Parts can be ordered lo0cally from festo under these codes	

DISCLAIMER

Information given herein is offered in good faith as accurate, but without guarantee. Conditions of use and suitability of the product for particular uses are beyond our control; all risks of use of the product are therefore assumed by the user.

We expressly disclaim all warranties of every kind and nature, including warranties of merchantability and fitness for a particular purpose in respect to the use or suitability of the product.

Nothing is intended as a recommendation for uses which infringe valid patents or as extending license under valid patents. Appropriate warnings and safe handling procedures should be provided to handlers and users. Alteration of this document is strictly prohibited. Except to the extent required by law, republication or retransmission of this document, in whole or in part, is not permitted. Tamson Instruments bv assume no responsibility for accuracy of information. Tamson Instruments neither represent nor warrant that the format, content or product formulas contained in this document comply with the laws of any other country except the Netherlands.