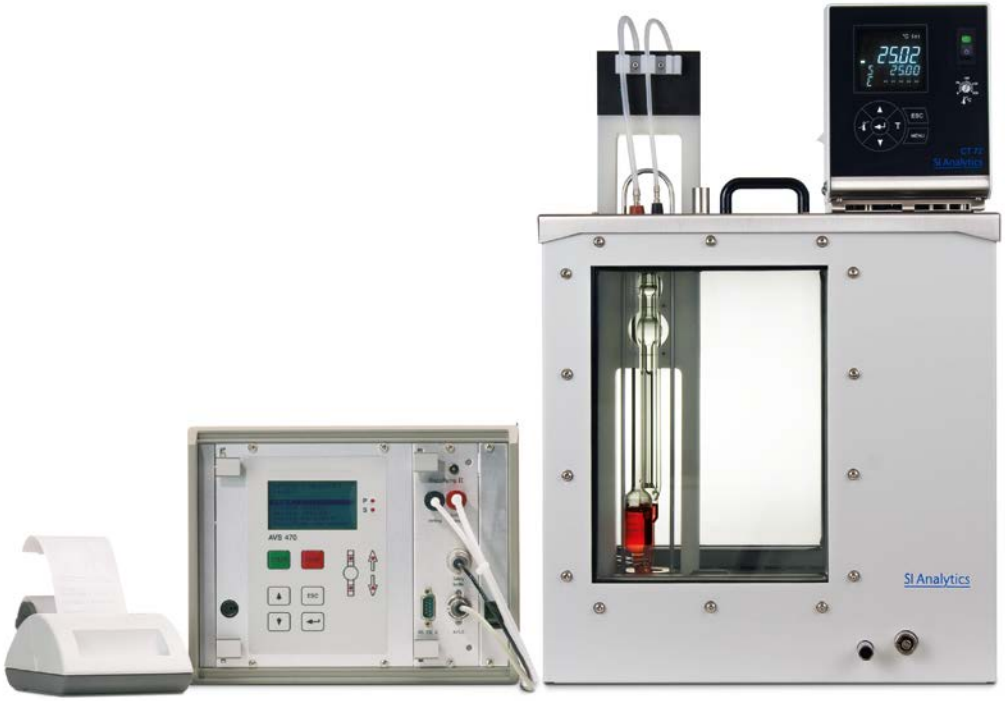
OPERATING INSTRUCTIONS




# AVS® 470

## VISCOSITY MEASURING DEVICE

SI Analytics

a xylem brand

**Wichtige Hinweise:** Die Gebrauchsanleitung vor der ersten Inbetriebnahme des Viskositätsmessgerätes AVS® 470 bitte sorgfältig lesen und beachten. Aus Sicherheitsgründen darf das Viskositätsmessgerät AVS® 470 ausschließlich nur für die in dieser Gebrauchsanleitung beschriebenen Zwecke eingesetzt werden.

Bitte beachten Sie auch die Gebrauchsanleitungen für die anzuschließenden Geräte.

Alle in dieser Gebrauchsanleitung enthaltenen Angaben sind zum Zeitpunkt der Drucklegung gültige Daten. Es können jedoch von SI Analytics sowohl aus technischen und kaufmännischen Gründen als auch aus der Notwendigkeit heraus, gesetzliche Bestimmungen der verschiedenen Länder zu berücksichtigen, Ergänzungen am Viskositätsmessgerät AVS® 470 vorgenommen werden, ohne dass die beschriebenen Eigenschaften beeinflusst werden.



**Important notes:** Before initial operation of the Viscosity Measuring Unit AVS® 470 please read and observe carefully the operating instructions. For safety reasons the Viscosity Measuring Unit AVS® 470 may only be used for the purposes described in these present operating instructions.

Please also observe the operating instructions for the units to be connected.

All specifications in this instruction manual are guidance values which are valid at the time of printing. However, for technical or commercial reasons or in the necessity to comply with the statuary stipulations of various countries, SI Analytics may perform additions to the Viscosity Measuring Unit AVS® 470 without changing the described properties.



**Remarques importantes :** Lire attentivement et respecter le mode d'emploi avant la première mise en route de l'appareil de mesure de la viscosité AVS® 470. Pour des raisons de sécurité, l'appareil de mesure de la viscosité AVS® 470 devra être utilisé exclusivement pour les usages décrits dans ce mode d'emploi.

Nous vous prions d'observer aussi les modes d'emploi pour les appareils à brancher.

Toutes les indications contenues dans ce mode d'emploi sont des données valables au moment de l'impression. Non seulement pour des raisons techniques et commerciales, mais aussi à cause de la nécessité de respecter des dispositions légales des différents pays, SI Analytics se réserve le droit de prévoir des mesures d'extension de l'appareil de mesure de la viscosité AVS® 470 sans que les caractéristiques décrites soient influencées.



**Nota importante:** Antes de la puesta en marcha del equipo medidor de viscosidad AVS® 470, Por favor lea y observe cuidadosamente el manual de instrucciones. Por razones de seguridad, el equipo medidor de viscosidad AVS® 470, solo se utilizara exclusivamente para los objetivos descritos en este manual de instrucciones.

Por favor, consulte también los manuales de instrucciones para las conexiones del equipo.

Todos los datos contenidos en este manual de instrucciones, son datos que están vigentes en el momento de la impresión. No obstante, por razones técnicas y comerciales, así como también por razones de las disposiciones legales existentes en los diferentes países, SI Analytics se reserva el derecho de efectuar los complementos concernientes al equipo medidor de viscosidad AVS® 470, sin influir en las características descritas.

SI Analytics

CONTENT PAGE



**Important information**: Please read the present operating instructions carefully before putting the AVS® 470 Viscosity Measuring Unit into operation. For safety reasons the unit must not be used for any purposes other than those described in the present operating instructions. This product is subject to a permanent adaptation to the latest state of the art. This implies that the present operating instructions may not fully describe the properties of this device despite the fact that utmost care was applied. In any cases of doubt, please contact the Technical Application department of our company.
Please note also the operating instructions of the devices to be connected.

Version 130809 US

SI Analytics

# 1 The AVS® 470 Viscosity Measuring Unit

The AVS® 470 is an measurement instrument for determining absolute and relative viscosity. It is operated using either the built-in membrane keyboard at the front or the TZ 2835 PS2 keyboard. Calculation of the results on the basis of the determined values is done by the built-in computing unit. The readings can be shown on the display or documented on the optional TZ 3460 printer.

## 1.1 Functioning of the device

The AVS® 470 Viscosity Measuring Unit is used to perform flow-time measurements in capillary viscometers. The available capillary viscometers enable viscosity measurements 0.35 of approx 5,000 mm²/s (cSt). This piece of information refers to the measurement temperature. For example, "heavy fuel oil" can have a viscosity greater than 50000 mm $^2$/s (cSt) at room temperature, with the result that a measurement cannot be performed. However, if the measurement temperature is increased to 100° C or more, the viscosity drops to the point where a measurement is now possible again.

The viscometer AVS® 470 is equipped with two options for the meniscus scan by using an appropriate ViscoPump II unit. The connection of TC viscometers on the ViscoPump VZ II 8512 module also allows the measurement of black and opaque liquids. Simple colorless and transparent liquids can also be detected with the TC viscometers. Alternatively, viscometers with meniscus scan can be used via photoelectric beam detectors in a measuring stand, such as AVS ®/S in conjunction with the optoelectronic module ViscoPump II VZ 8511.

Time recording extends up to 9999.99 seconds with a resolution of 0.01 s. The individual results of a measurement series can either be presented on the display, but it is also possible to document them on the printer which is available as an option.

Prior to the measurement as such, the liquid to be measured is sucked upwards inside the capillary viscometer though two measurement planes (N2 and N1) which are designed as light barriers or thermistor sensors, depending on the viscometer type (fig. 1 and 2).
The pumping pressure is controlled automatically by the AVS® 470 Viscosity Measuring Unit via the ViscoPump II module.

When using Ubbelohde viscometer, the design of the program ensures that the suspended spherical level will form prior to the start of the measurement.

The measured flow time is shown on the display. Up to 99 measurements of a measurement series (i.e. successive flow time readings taken one and the same viscometer) will be stored and evaluated.

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**Guarantee**

We provide guarantee for the meter described for two years from the date of purchase. This guarantee covers manufacturing faults being discovered within the mentioned period of two years. Claim under guarantee covers only the restoration of functionality, not any further claim for damages or financial loss.
Improper handling/use or illegitimate opening of the meter results in loss of the guarantee rights. The guarantee does not cover wear parts, as pumps, lobes, cylinders, valves and pipes including the thread connections as well as the breach of glass parts. To ascertain the guarantee liability, please return the instrument and proof of purchase together with the date of purchase freight paid or prepaid.

## 1.2 Capillary viscometry

Capillary viscometry is the most accurate method for the determination of the viscosity of liquids with a Newtonian flowing behaviour. The measurement as such consists in a time measurement. The time measured is that which a specific quantity of liquid requires to pass through a capillary having a defined width and length. Conventionally, this process is watched with the human eye, and the flow time is measured manually using a stop watch.
The viscometer AVS® 470 detects liquid meniscus in the measuring levels opto-electronically by means of photoelectric beam detectors or thermoresistively using thermistors as with all viscometers from SI Analytics.

## 1.3 Measurements principles

**Optoelectronic sensing of the liquid meniscus**

The near-infrared light which is generated in LEDs located in the upper section of the measurement stand is conducted through a glass-fibre light-conductor cable onto the measurement planes. The light shines through the viscometer before it arrives at another light-conductor cable located on the opposite side; inside this second cable, the light is conducted to a receiver in the upper section of the measurement stand. While the liquid meniscus passes through the measurement planes, the lens-like effect of the meniscus causes a short-term darkening of the light beam, followed by a magnification. This process generates a measurement signal which can be evaluated accurately.

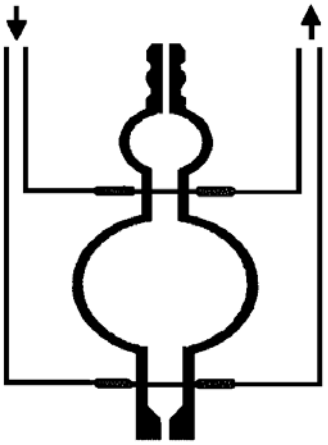


**Fig. 1** Viscometer for optoelectronic measurements

**Viscometer with thermistor sensors (TC viscometer)**

In the case of TC viscometers, glass-coated thermistors serving as sensors are molten in on the level of the measurement planes. While the meniscus passes through the measurement planes, the differences in the thermal conductivity properties of air and liquid lead to a change in the heat balance. The thermistors of the TC viscometers are molten hermetically tightly into the glass coating of the viscometer, so that the viscometers located inside are chemically resistant to all kinds of substances other than strong leaches, fluoric solutions, or concentrated hot phosphate solutions.
TC viscometers are protected under patent right by the German Design Patent no. 85 04 764.3 and US Patent no. 4 685 328.

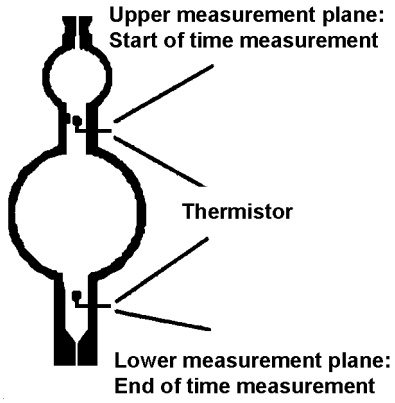



**Fig. 2** Viscometer for thermo-resistive measurements

## 1.4 Warning and safety information

For reasons of safety and functionality, the AVS® 470 Viscosity Measuring Unit must only be opened by authorized persons; this means, e.g., that work on electrical features must only be performed by qualified staff.
In the case of unauthorized intervention in the AVS® 470 Viscosity Measuring Unit as well as in the case of negligent or deliberate damage, the warranty will become void.

The AVS® 470 Viscosity Measuring Unit corresponds to Protection Class I. It was manufactured and tested according to DIN VDE 61010, Part 1, Protective Measures Applicable to Electronic Measurement Devices, and has left the factory in an impeccable condition as concerns safety technology. In order to maintain this condition and to ensure a safe operation, the user should observe the notes and warnings contained in the present operating instructions. Development and production are embedded within a system meeting the requirements of the DIN EN ISO 9001 standard.

Prior to switching the device on it has to be ensured that the operating voltage applied to the AVS® 470 Viscosity Measuring Unit matches the mains voltage. The operating voltage is indicated on the type plate. The mains plug is to be plugged to a socket equipped with a protective contact. The protective effect must not be eliminated by an extension cord without protective contact. Any interruption of the protective lead inside or outside the AVS® 470 Viscosity Measuring Unit, or any loosening of the protective-lead connector may render the AVS® 470 Viscosity Measuring Unit becoming hazardous. Intentional interruptions are inadmissible.

It has to be ensured that no fuses other than those of the specified type and with the nominal current strength are used. The use of mended fuses, or any short-circuiting of the fuse holder is inadmissible.

The built-in safety features must never be put out of operation.

If it has to be assumed that safe operation is no longer possible, the AVS® 470 Viscosity Measuring Unit has to be closed down and secured against inadvertent putting into operation.

Please switch the AVS® 470 Viscosity Measuring Unit off, remove the mains cable from the socket, remove the viscometry measuring unit, then call the service department of SI Analytics

Examples for the assumption that safe operation is no longer possible include the following:

- the AVS® 470 Viscosity Measuring Unit shows visible damages,
- the AVS® 470 Viscosity Measuring Unit does not function properly
- liquid has penetrated into the casing of the device,
- the package is damaged.

The AVS® 470 Viscosity Measuring Unit must not be operated or stored in rooms with a damp atmosphere.

For safety reasons the AVS® 470 Viscosity Measuring Unit must not be used for any range of application other than the one described in the present operating instructions.

⚠ **The relevant regulations regarding the handling of the substances used have to be observed:** The Decree on Hazardous Matters, the Chemicals Act, and the rules and information of the chemicals trade. It has to be ensured on the side of the user that the persons entrusted with the use of the viscometry measuring unit are experts in the handling of the substances used in the environment and in the viscometry measuring unit itself, or that they are supervised by specialised persons, respectively.

⚠ **Please wear protective glasses!** ⚠

Please note also the operating instructions of the devices to be connected.

## 1.5 Technical data Viscosity Measuring Unit AVS® 470

(Release 09. August 2013)

**CE sign:** CE EMC compatibility according to the Council Directive: 2004/108/EG;
applied harmonized standards: EN 61326-1:2006
Low-voltage directive according to the Council Directive 2006/95/EG
Testing basis EN 61 010, Part 1

**Country of origin**: Germany, Made in Germany

**Display:** LCD-Type (70x40mm)

**Measurement parameters:** Flow time in seconds [s]

**Capture of measurement value:** Flow time: Optoelectronic or thermo-resistive capture of the meniscus passage through the measurement planes of the viscometers

**Optional parameter:** To be selected at the AVS® 470 Viscosity Measuring Unit
Method: Absolute or relative viscosity
Viscometers: Ubbelohde viscometers (DIN, ASTM, micro); micro Ostwald; Cannon Fenskeroutine; TC Ubbelohde viscometers and dilute-solution viscometers.
ViscoPump: Pump parameters (ramp, pressure, waiting time, suck over N1)
Time for temperature adaptation: 0...20 min, to be selected in increments of 1 min
Number of measurements: 1...99 for each sample

**Measurement ranges:**
Time: 0.01 to 9999.99s, Resolution 0.01 s
Viscosity: "pressing" action 0.35 … 1.800 $mm^2/s$ (cSt) at measuring temperature
"sucking " action 0.35 … 5.000 $mm^2/s$ (cSt) at measuring temperature
Pumping pressure: Fully automatically controlled "sucking" action to approx. -160 mbar
Fully automatically controlled "pressing" action to approx. +160 mbar

**Measurement accuracy:** in accordance with DIN 51562, Part 1
Time measurement: ± 0.01 s / ± 1 digit; but not more accurate than 0.01%
measurement incertainty in the determination of absolute, kinematic viscosity furthermore depends on the incertainty of the numerical value of the viscometer constants and the measurement conditions, especially as concerns the measurement temperature.

**Data transfer parameters**
Data interface: Bi-directional serial interface according to EIA RS-232-C
Data format: Word length 7 bits, 2 stop bits, 4800 baud, no parity
for additional parameter sets view Chapter 4

**Connections:**
Back panel of the device:

| | |
|---|---|
| Data in- and output: | 1 serial RS-232-C interface: 9-channel sub-miniature D sockets for use with a serial data printer<br>1 device connector, round-plug connector with 7 channel DIN bayonet catch |
| Bath backlighting: | Circular connectors with bayonet lock DIN 5-pin, 24V, 350mA |
| Mains connector: | Device plug with safety interrupter according to VDE 0625, IEC 320/C14, EN 60320/C14, DIN 49 457 B |

**To be connected to the front panel of ViscoPump II modules:**

| | |
|---|---|
| Pneumatic connectors: | Pressure/suction venting, to be connected to viscometer. |

Overflow guard for VZ 8552 suction line:

| | |
|---|---|
| Capacitive sensor: | DIN round-plug connector, 4-channel (ViscoPump II module)<br>Screwed cap according to DIN 45321 |
| AVS® measuring stand: | Round-plug connector with bayonet catch, DIN 5 channels. |
| TC viscometer: | 4-channel DIN socket |
| **Power supply:** | Corresponds to Protection Class 1 according to DIN 57 411, Part 1 / VDE 0411, Part 1<br>Mains connection: 90 - 240 V, 50...60 Hz<br>Mains fuse: Fine-wire fuse 5 x 20 mm, 250 V~, 4 A, time-lag design<br>Power consumption: 100 VA |

**Materials:**

| | |
|---|---|
| Casing: | Steel/aluminium casing with chemically resistant two-component coating, stackable |
| Dimensions: | approx. 255 x 204 x 320 mm (WxHxD)<br>Weight: Approx. 5.34 kg with 1 ViscoPump II module |
| Front panel : | Polyethyleneterephtalate (PET) |
| **Ambient conditions:** | Ambient temperature: +10 ... +40°C for operation and storage<br>Air humidity according to EN 61 010, Part 1:<br>max. rel. hum. 80% for temperatures up to 31°C, linearly decreasing down to 50% rel. hum at a temperature of 40°C |

# 2 Initial operation

## 2.1 Unpacking

Please observe the operating voltage (90 to 240 V, 50…60Hz), it is indicated on the type plate. The device may be placed and operated on any plane surface. Placing it on the VZ 8571 panel. Up to two device may be stacked.

## 2.2 Connecting the devices

### 2.1.1 AVS® 470 connecting cables:

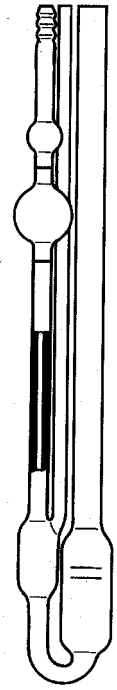
| **Description** | **Length** | **Connects:** | **to:** |
|---|---|---|---|
| Printer cable | 1 m | AVS® 470 | Serial printer |

### 2.2.2 Suitable viscometer types, racks and measurement stands

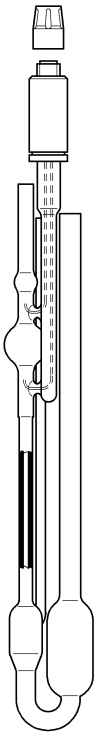
| **Viscometer** Type | | **Rack** Type no | **Measurement stand** Type no. | |
|---|---|---|---|---|
| Ubbelohde (DIN) | 532…<br>530…<br>501…<br>541… | 053 92 | AVS®/S | AVS®/SK |
| Ubbelohde (ASTM) | 525…<br>526…<br>527…<br>545… | 053 92 | AVS®/S | AVS®/SK |
| Micro Ubbelohde | 536…<br>537…<br>538… | 053 92 | AVS®/S | AVS®/SK |
| Ubbelohde for Dilution series | 531… | ---- | | |
| Cannon-Fenske Routine | 513…<br>520… | ---- | | AVS®/SK-CF |
| Micro-Ostwald | 517… | 053 97 | AVS®/S | AVS®/SK |
| Ubbelohde (TC) | 567…<br>568…<br>569 | 053 93 | ---- | |
| | 562…<br>563…<br>564… | 053 93 | | |
| Micro-Ubbelohde (TC) | 572…<br>573…<br>574… | 053 93 | ---- | |

⚠ When using viscometers with TC sensors, the ignition temperature of the media to be measured has to be taken into account.

It has to be higher than 250°C.



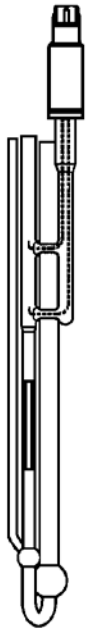
Ubbelohde-Viscometer
(DIN & ASTM)
Type 1 and 2



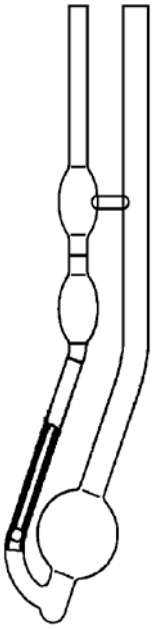
TC Ubbelohde – Viscometer
(acc. DIN )
Type 1

Mikro-Ubbelohde- Viscometer
( DIN )
Type 3

Mikro-Ostwald Viscometer
Type 5



Mikro-Ubbelohde- Viscometer
with TC-Sensors , Type 3



Canon-Fenske-Routine- Viscometer
(ASTM) Type 4

**Fig. 3** Suitable viscometer types: The respective viscometers are assigned type numbers to be entered when programming the AVS® 470 (see Section 5.6 and Chapter 9)

### 2.2.3 Applicable hose combinations

| Hose combinations Type No. | Description | Application |
|---|---|---|
| VZ 5505 | Silicone hose kit, oppressive, for Ubbelohde viscometers (3 legs), and Cannon-Fenske and Ostwald viscometers | Standard, but note: a sample can escape from the capillary tube at a malfunction |
| VZ 5505 + VZ 8526 | Silicone hose kit, suctioning, for Ubbelohde viscometers (3 legs) | Standard, safer as pressurized operation, since the sample cannot leak out of the capillary tube. Unsuitable for volatile samples. |
| VZ 5501 | PTFE hose kit, pressurizing, for Ubbelohde viscometers (3 legs) | For aggressive samples that attack silicone, e.g. sulfuric acid. However, note: a sample can escape from the capillary tube at a malfunction |
| VZ 8527 | PTFE hose kit, suctioning, with soda lime filter VZ 7215 for Ubbelohde viscometers (3 legs) | For aggressive samples whose vapors are absorbed by soda lime filters to protect the ViscoPump. Instead of soda lime filter VZ 7215, a charcoal filter VZ 7216 can be used depending on the sample. |
| VZ 8530 | PTFE hose kit, suctioning, with soda lime filter VZ 7215 for Ubbelohde viscometers (4 legs) | For Ubbelohde viscometers with an additional 4th tube for filling and cleaning |
| VZ 5606 | For TC viscometers: Silicone hose fittings with connecting cable. For pressing operation | For TC viscometers: Typical applications are measurements of oils. |

Note**:** The hose combinations to be used must be selected according to the required application.

## 2.3 Connecting the viscometers and other devices

The AVS® 470 Viscosity Measuring Unit allows the use of most various viscometer types:
DIN, ASTM, Ubbelohde and Micro Ubbelohde viscometers as well as Cannon-Fenske Routine, Micro TC and Micro Ostwald viscometers.
Owing to careful manufacture and quality-assurance procedures, all viscometers from SI Analytics meet the highest accuracy standards.
The K viscometer constant is determined individually by way of a calibration of each glass capillary viscometer. Owing to the use of high-quality measurement and testing equipment and the application of national standard gauges,SI Analytics guarantees an absolutely precisely reproducible calibration. For Ubbelohde viscometers having the same constant, the same correction seconds (Hagenbach-Couette correction) are valid.

In addition, it is also possible to connect or control other devices, such as a RS-232 data printer, AVS®24/26 rinsing unit, absorption traps, overflow guards etc. Depending on the intended use of the AVS® 470, it may be highly recommendable to connect these devices, please refer to the items below.

The AVS® 470 Viscosity Measuring Unit is not intended to be connected to any devices other than those mentioned above, e.g. to computers, piston burettes, or similarSI Analytics devices working according to the daisy-chain principle. If you wish to use a computer, please select the AVS® 370 Viscosity Measuring Unit fromSI Analytics; in case of need, please contactSI Analytics for the corresponding documentation. At the time the present operating instructions went to press, the connection of an external rinsing device was not yet possible.

In order to better follow the measurement process in the bath, the optionally available bath backlighting VZ 5405 on AVS® 470 must be connected. If two bath backlights are used, adapter cable VZ 5408 must be used.

### 2.3.1 TC viscometers with thermistor sensors

The ViscoPump II (VN 8512) module is required for TC viscometers when using TC viscometers.
Fill the viscometer (approx. 18 - 20 ml), then place it in the thermostat bath.
ometer (approx. 18 - 20 ml), then place it in the thermostat bath.

Connect the AVS® 470 Viscosity Measuring Unit and the TC viscometer using the hose/cable combination which comes with the device. To do so, place the device in the holders, then attach the quadruple plug of the cable to the viscometer and the ViscoPump II module (first plug, then screw); subsequently, make the screwed connections in accordance with the numbers indicated on the hoses and the rack. In the case of “pressing” operation, the capillary tube remains open, for “sucking” operation the filling tube is to be left open.

Please observe the colour codes (red = pressure/suction, black = venting) when connecting the pneumatic screwed connections to the ViscoPump II module for TC viscometers (VZ8512) of the AVS® 470 Viscosity Measuring Unit.

### 2.3.2 Viscometers using light-barrier sensing

The opto-electronic ViscoPump II (VZ 8511) module is required for measurements using photoelectric beam detector scanning. Use the hose/cable combination to make an electrical and pneumatic connection between the AVS® 470 Viscosity Measuring Unit and the measurement stand. The plugs are firmly connected to the sockets by rotating the union sleeve. Please observe the colour codes (red = pressure/sucking, black = venting) when screwing the threaded pneumatic connections into the ViscoPump II module.

Please insert the selected capillary viscometer into the fixating rack as is shown in fig 4., then fill it. Insert the fixating rack together with the viscometer into the measurement stand (with the cut-out at the bottom sheet pointing forwards). The cut-out will latch into the lug provided. Pressing the viscometer slightly against the fixating rack will latch it into the holding spring located on the measurement stand.

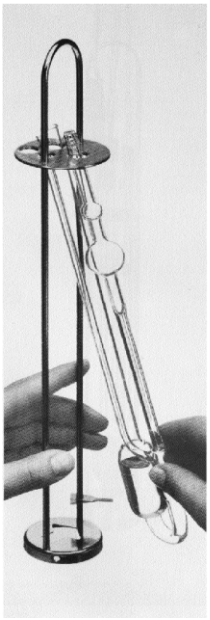


**Fig. 4** Inserting or replacing a viscometer with light-barrier sensing

### 2.3.3 Connection of VZ 7215 absorption traps

In the vacuum (vacuum) mode, volatile components can enter the ViscoPump II module. This is particularly problematic for corrosive solvents such as formic acid or dichloroacetic acid.

For these cases, a hose fitting "suctioning" VZ 8527 must be used, which includes the absorption traps VZ 7215 and appropriate connecting hoses.

In these absorption traps, soda lime is used as absorbent. The absorption traps which prevent contaminations from penetrating into the pneumatic system of the ViscoPump have to be inspected at regular intervals. If sodium lime is used as an absorption agent with acidic solvents, the colour condition of the indicator is to be checked on a daily basis. As soon as this condition has shifted to BLUE in the half of the absorber material, this is the very last moment to replace the material for safety reasons.

**Please note**: If such a colour shift will not be observed over an extended period of time, this may be attributable to the fact that an acidic over-saturation of the material has caused a de-colouration; this may then appear as “normal”, but it will definitely result in the destruction of the pneumatic system after some time. This situation is explicitly excluded from the warranty coverage!

For non-corrosive solvents and oils, which contain volatile constituents, absorption traps with activated carbon filling are available. When using activated carbon as an absorber material, the filling must be replaced approximately monthly depending on the load, which is caused by the volatility of the materials.

### 2.3.4 Connection of the VZ 8552 overflow guard

We urgently recommend the connection of the VZ 8552 overflow guard (available as an option) for the suction-mode operation of the ViscoPump II module. The connection of the VZ 8552 overflow guard (capacitive sensor for the safety bottle) excludes over-pumping in suction mode (contamination of the ViscoPump II module). The holder on the safety bottle accommodates the capacitive sensor.

When using the ViscoPump II module VZ 8511 (meniscus sensing by light barriers) the holder for the safety bottle is to be attached to the measurement stand, e.g. the AVS®/S.

When using the ViscoPump II module VZ 8512 (thermo-resistive measurement) the holder for the safety bottle is to be attached to the “viscometer gallows” provided for the TC viscometer 5932.

Should any liquid be over-pumped into the safety bottle, the safety sensor will trigger a stop. After emptying the safety bottle, the lateral LED on the capacitive sensor will go out. You may continue with the measurements.

The electrical connection of the VZ 8552 overflow guard is made using DIN plugs on the front side of the respective module of the ViscoPump II.

**Please note**: The sensitivity of the capacitive sensor has to be adapted to the medium being used. To do so, please use the enclosed screw driver to adjust the lateral set screw in such a manner that the capacitive sensor in the built-in condition (i.e. without medium) are just close from responding (i.e. the LED is off).

### 2.3.5 Transparent thermostats

Viscosity depends on the temperature of the sample liquid. This means that the viscometers must always be thermostated during the measurement. The measurement temperature has to be kept constant in order to achieve an accurate result.

This is possible on the AVS® 470 Viscosity Measuring Unit. The transparent thermostats fromSI Analytics which were developed especially for capillary viscometry meet the requirements imposed on precision and constancy. Th e 72/2 and CT 72/4 thermostats, for instance, guarantee a temperature constancy of ± 0.02 K at a command temperature in the range of 10° to 40°C, and a maximum fluctuation of the ambient temperature of ± 3 K. As a rule of thumb, you may suppose that the temperature deviation, expressed in degrees, multiplied with a factor of 10 will correspond to the deviation from the result in terms of %. This means that a deviation of 0.05 K corresponds to a possible error of 0.5%.

With the viscometer AVS® 470, basically two different transparent thermostats can be used: For measurements at various temperatures, the transparent thermostat CT 72/2 and CT 72/4 are available. These can be equipped with 2 or 4 viscometers including AVS®/S measuring stands. For measurements up to max. 60 °C, thermostat CT 72/ P of acrylic can be used.

Please read the separate operating instructions of the transparent thermostats as well.

### 2.3.6 Flow coolers

As was mentioned above, viscosity measurement is highly dependent on temperature constancy.
For reasons of control technology (self heating of the thermostat head), it is therefore necessary to use a CK 300 flow cooler as a counter cooler at bath temperatures exceeding 40°C.

Please read through the separate operating instructions of the CK 300 flow cooler as well.

### 2.3.7 ViscoPump II module

The ViscoPump II module controls the entire measurement process, including pre-heating the samples in viscometers, pumping up the liquid into the reservoir of the viscometers, measuring the flow time, etc.

Proceed as follows to replace the ViscoPump II module:

- Switch off the AVS® 470 and unplug the power plug from the socket.
- Remove the pneumatic and electrical connections from the front panel of the ViscoPump II module to be changed.
- Loosen the screws on the narrow sides of the front panel.
- Lift out the ViscoPump II module using the upper and lower inserting handle from its rear connector.
- Pull out the ViscoPump II module from the viscometer AVS® 470.
- After inserting the new ViscoPump II module, secure it again by using the front panel screws.
- Restore the electrical and pneumatic connections.

 After connecting, check whether the correct operating mode, "Suctioning" or "Pushing" is visibly set on the corresponding LED on the front panel. Changing the operating mode to the application is described in Section 5.6, Figure 23. Use the hose fittings designed for this purpose!

### 2.3.8 System expansion, connecting an AVS®24/26 rinsing unit

It is possible to replace various functional units of the AVS®470, including the viscometers, the measurement tripod, the ViscoPump II module and the optional **Z900** printer.
Connecting a rinsing unit of the AVS®24/26 type is possible if the back panel of the AVS®470 viscometer is equipped with a round-plug connector with a 7 channel DIN bayonet catch and if the software being used corresponds to the “12. Dec. 2005” (or later) version. In this configuration the power will be supplied through this round-plug connector on the back panel.
To do so, please screw the red threaded end of the pneumatic connection line (suction/pressure action) into the front panel of the ViscoPump, then connect it to a AVS®24 or AVS®26 rinsing unit. The electrical connection with the measurement tripod or TC viscometer on the ViscoPump should not be changed. Set the AVS®24 or AVS®26 rinsing unit to the “AUTO” automatic operating mode. As soon as the AVS®470 has completed a measurement series, the automatic start of the rinsing unit will be initiated following the printout of the result. As long as the AVS®24 or AVS®26 rinsing unit is in operation, the operating elements of the AVS®470 (membrane and mini keyboard) are locked in order to avoid any improper operation. Upon the completion of the rinsing cycle, these operating elements will be unlocked again. Please note that this is the only logic linkage between the measuring and the rinsing operation.
In this context, please refer to the operating instructions of the AVS®24 or AVS®26, too, in order to ensure the proper connection of the viscometer. These operating instructions also contain a description of how to program the rinsing unit you are using.

 **Safety information:**

Make sure that the AVS® 470 Viscosity Measuring Unit is always the first device you switch off! Prior to replacing any functional unit, please be sure to the mains plug MUST be pulled out of the mains socket.

**Caution**: Liquid dripping off may be hazardous to the user!

## 2.4 Trouble shooting

Check whether the AVS® 470 Viscosity Measuring Unit is switched on:

**Air bubbles in the viscometer**
Is the filling quantity sufficient? Check, fill viscometer if required.
Is the viscometer of properly connected?

- in the case of pressing operation, please check whether the filling tube is connected; if necessary connect properly.
- for operation in suction mode, please check whether the capillary tube is connected; if necessary, connect properly
- please check whether the venting port is tightly connected; if necessary re-tighten its screwed connection.

**Over-pumping of measurement medium in the thermostat bath:**

Is the tubing set properly connected?

- for pressing operation
- for operation in suction mode

When using AVS® measuring stands:

- check position of the rack within the stand
- check the electrical connection from the measuring stand to the ViscoPump type II module
- The green LED on the measuring stand is illuminated

When using TC viscometers:

– Is the viscometer properly connected?

## 2.5 Initialisation and Software upgrade

### 2.5.1 Initialisation

At the time of delivery, all memory values of the AVS® 470 Viscosity Measuring Unit are set to starting values (so-called default values). If it should prove necessary to restore this delivery status at any time, this can be achieved in the form of a so-called initialisation. This process is triggered by simultaneously pressing the “Up ↑ “ and “Down ↓ “key for at least 2 seconds as shown in figure 5 after switching the device off and on again, initialisation is completed.

### 2.5.2 Software upgrade

The software of the AVS® 470 Viscosity Measuring Unit can be upgraded, but such an upgrade has to be done by specially trained service personnel. If such an upgrade should become necessary, please contact SI Analytics (address can be found at the end of the present operating instructions) to take the required action.

## 2.6 Description of the front-panel elements:

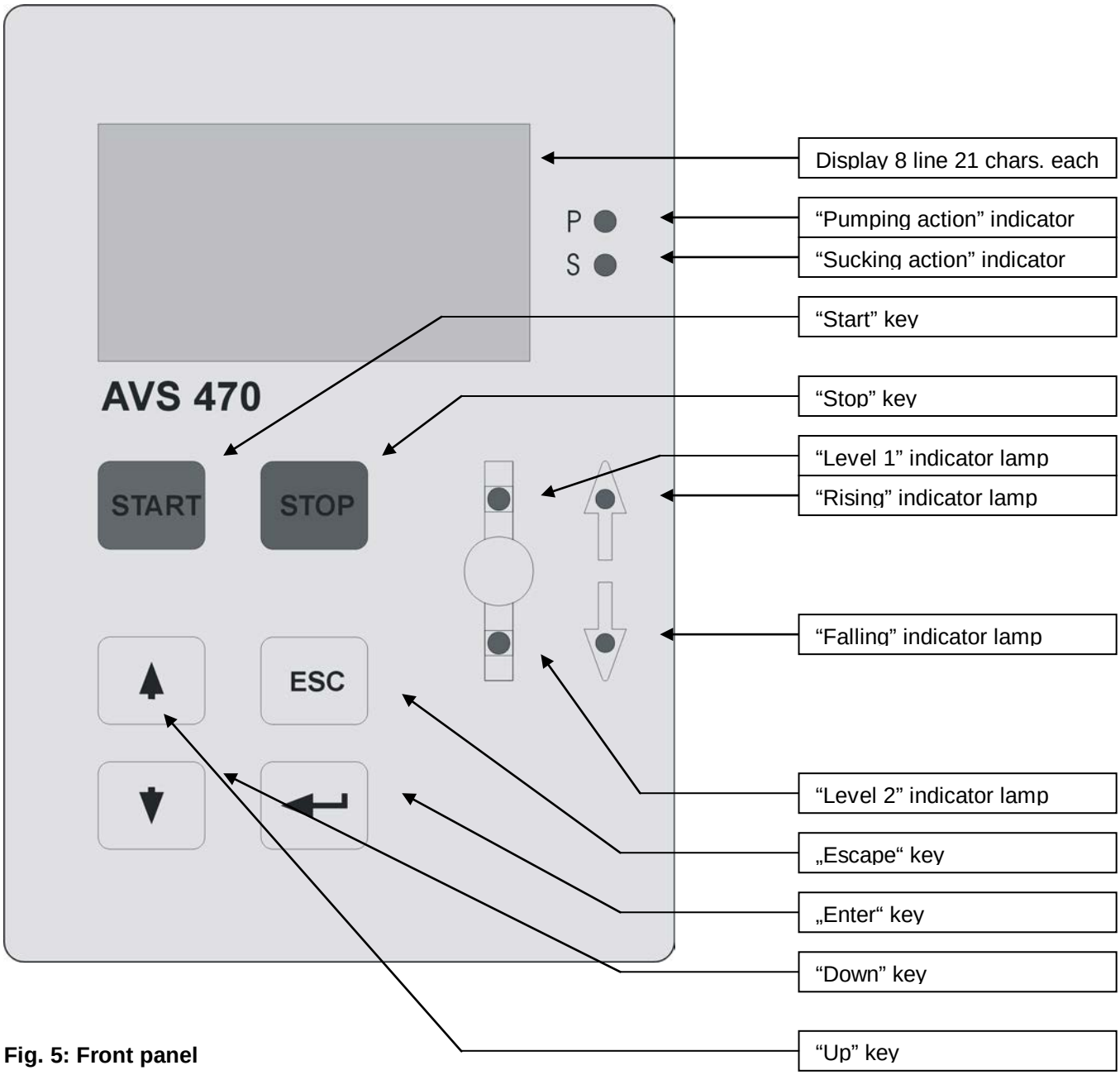



**Fig. 5: Front panel**

# 3 Performing measurements using the AVS® 470 Viscosity Measuring Unit

## 3.1 Measurements using a single unit

Setting the measurement parameters for a method

(Sample) description (optional) <▲, ▼, ↵>

User (optional) <▲, ▼, ↵>

Lot (optional) <▲, ▼, ↵>

Measurement type [Abs., Saybolt, rel., blank value] <▲, ▼, ↵>

Number of measurements [1 … 99] <▲, ▼, ↵>

Pre. temp. time [1…20 min] <▲, ▼, ↵>

Input of the temperature pre-adaptation time in minutes. In the course of the temperature pre-adaptation, the liquid is permanently pumped upwards and flows through the viscometer, just as in the course of a measurement; this process is intended for a speedy temperature adaptation. The input of the temperature pre-adaptation time may be as high as 20 minutes.

| | | |
|---|---|---|
| Bath temperature | [°C] | <▲, ▼, ↵> |
| Max. abberation | [%] | <▲, ▼, ↵> |
| Viscometer ID | [1 digit] | <▲, ▼, ↵> |
| $t_0$ time | [s] | <▲, ▼, ↵> |
| Constant | [$mm^2/s^2$] | <▲, ▼, ↵> |

(For the further way of proceeding, please refer to **chapter 5.6, Functional description**)

## 3.2 Completing a measurement

Depending on the specific circumstances, there is a number of conditions which lead to the completion or cancellation of the measurement program in the AVS® 470 Viscosity Measuring Unit:

- Automatically, as soon as the specified number(s) of measurements including the repeated measurement has been performed; this is the normal case.
- Abortion of the respective measurement series by selecting “Stop”. In this case all device measurement values will be lost; this feature should only be used in emergency cases.
- Abortion of the respective measurement series by a time-out error. In this case all device measurement values will be lost, and the measurement is to be restarted.
- Mains failure: In the case of a power failure all device measurement values will be lost. After the return of the mains current the condition will be as it was after parameterisation, prior to the measurement. The set and stored parameters will remain preserved in the EPROM.

# 4 Data transfer

## 4.1 RS-232-C Interface

The AVS® 470 Viscosity Measuring Unit is equipped with one RS-232-C interface. In combination with an optional data printer, for instance a **Z900**, this interface is used to for documentation purposes.

**Interface configuration:**

The interface parameters can not be changed. All transmission parameters are firmly set to the following default values:

Parity: none
Stop bits: 1
Data bits: 8

It is essential to set the printer to the same parameter settings. The optional Z900 printer from SI Analytics is ex-works set to these parameters.

The other possible settings include:

RS-Parameter:

| **Baud:** | **Bit:** | **Stopp:** | **Parity:** |
|---|---|---|---|
| 2400 | 7 | 2 | No |
| 4800 | 8 | 1 | No |
| 9600 | 7 | 1 | Odd |
| | 8 | 1 | Odd |
| | 7 | 1 | Even |
| | 8 | 1 | Even |

Meaninig., the baud rate applicable to the respective parameter sets can be set independently; please refer to fig. 27 and 28.

# 5 Working with the AVS® 470 Viscosity Measuring Unit

## 5.1 Introduction

The AVS® 470 Viscosity Measuring Unit including the ViscoPump II module are controlled by the operating software of the AVS® 470. The measurement values determined by the ViscoPump II module are received and evaluated by the software. the results may be output on a printer (Report) and shown on the display. The user can store the various measurement parameters of a method. Below please find a description of the functioning and operation of the software. The selection from the various options is done using the cursor, followed by a depression of the “Enter” key.

## 5.2 Hardware requirements

**For the operation of the AVS® 470 Viscosity Measuring Unit we recommend the following minimum equipment.**
1 keyboard (TZ 2835)
2 printer (RS-232-C) serial (e.g. Z900)
3 ViscoPump II module measurement plug-in unit (VZ 8511 or VZ 8512)

## 5.3 Operation

### 5.3.1 Operation using the PS2 keyboard

All the functions described in chapter 5.6 can be called using the keyboard.

| | |
|---|---|
| “Enter“ key | = To confirm input and continue with the programming cycle |
| “Esc“ key | = Escape, backward jump to the previous screen |
| “↓“ key | = To scroll backwards |
| “↑“ key | = To scroll forwards |
| “←“ key | = Move to the left |
| “→“ key | = Move to the right |
| “F1“ key | = Go to “start” |
| “F2“ key | = Go to “stop/reset” |
| “F3“ key | = selection on the main menu, refer to chapter 5.6 Fig.4 |
| “F4“ key | = Go to blank-value determination |
| “F5“ key | = Call measurement values |
| “F6“ key | = Result protocol; you may use the F6 function key to create a new printout of the result protocol as long as the method creating the protocol was not changed, and unless the AVS® 470 Viscosity Measuring Unit was switched off; if no printer is used, the protocol can be viewed on the display |
| “Pg Up“ key | = Increase LCD contrast |
| “Pg Dn“ key | = Decrease LCD contrast |

For any input to be made please use the numeric and character keys.

### 5.3.2 Operation using the front membrane keyboard

The front membrane keyboard may be used for starting and stopping the program, or for restricted programming operations, i.e. only such programming steps can be modified or selected which do not require any data to be input, but just a selection to be made; please refer to chapter 5.6.

“Enter“ key = To confirm input and continue with the programming cycle
“Esc“ key= Escape, backward jump to the preceding screen
“↓“ key = To scroll backwards
“↑“ key = To scroll forwards
“Stop“ key= Go to stop/reset
“Start“ key = Start the program

## 5.4 General information

### 5.4.1 Selection of menu items

After selecting the required menu item using the selection bar = cursor in combination with the ↓ and ↑ arrow keys, the item will be highlighted in black. Pressing the “Enter” key will confirm your selection.
Input of values: Any values to be input are to be entered in the corresponding empty or default-value fields. After selecting the corresponding fields using the selection bar = cursor in combination with the ↓ and ↑ arrow keys, the respective field will be highlighted in black. If the upper or lower limits are ignored in the selection, you cannot proceed by simply pressing the “Enter”. The default value will be displayed.
Please note: If a numeric field (other than a floating-point field) allows the input of e.g. 3 digits, but only 1 or 2 of the digits to be input are of significance, a trailing “0” has to be added.
Example: The value 100 is to be changed to 30; the input would be 0 - 3 - 0; on the display the value will be shown as 030.
Storing the values or selection: The values entered or changed, or the selection made, respectively, are taken over and memorized only after an explicit confirmation. Return to previous screen: If you wish to return to the preceding screen without saving any changes, please press the “Esc” key.

### 5.4.2 Selection of the operating mode:

(Chapter 5.6, fig. 23) A selection can be made between “sucking” and “pressing” action. After power-up, the selected operating mode will be signalled in the form of the letter “P” or “S” on an indicator light (red LED) on the front panel.

 The user is responsible for using the appropriate hose sets and connecting them properly!

### 5.4.3 ViscoPump parameters:

ViscoPump parameters, you may set the “Ramp”, “Pump power”, “Meas. delay” and “Suction above N1” parameters in addition to the operating mode Chapter 5.6, Fig. 23). Legend:

Ramp: This is the gradient angle applicable to the individual pump-pressure increases (dynamic pumping / suction); the default setting is 15 (fictitious measure).

Pump power: The max. achievable performance, the default value = 30%!

Meas. delay: A factor which may be added as a holding period to the period of time which was calculated from the flow time and which is to be observed between two subsequent measurements in order to shorten this time out of a system-inherent necessity, or to increase it, for instance, to allow the capillary to run empty.

Suction above N1: A factor which may be used to shorten or increase the period of time which was calculated from the flow time as required for sucking/pumping above the upper N1 level, if this seems to be appropriate out of a system-inherent or application-technological necessity.

The default values of these parameters are selected in such a manner that a large portion of all applications can be carried out without any problem. In special cases, for instance in the case of very short run times in micro viscometers, or in the case of very high toughness, or also for optimising the total throughput, these parameters may require an adaptation.

**Please note that such an adaptation has to be made only in small steps and with due care. Any improper modification may cause damage to the ViscoPump II module of the AVS® 470 and lead to the loss of warranty.**

## 5.5 Notes on programming

Below you find a description of how to program the AVS® 470 Viscosity Measuring Unit. In principle, the settings are to be made as in the case of other automatic viscosity measurement devices and software packages froSI Analytics. Users who are conversant with such devices will not encounter any problems with the AVS® 470 Viscosity Measuring Unit. Other users who are working for the first time with devices of this kind should at first try out the various settings to gather some experience on their influence on the measurements.
In the delivery state, all the settings are present in the form of so-called default or basic settings to which they will also be restored in the case of a deletion of the memory contents.
In the operating mode used to create a method or to set the parameters of the ViscoPump or the system parameters, you can use the “Esc” key to return to the preceding screen.

## 5.6 Functional description

After power up, the following screen will appear on the display:

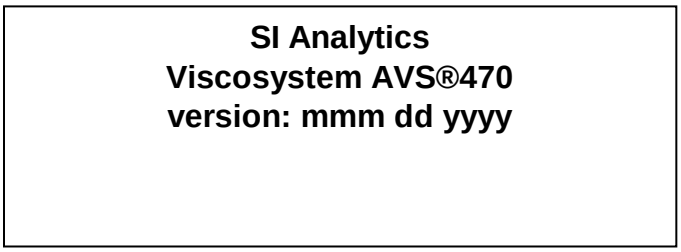



**Fig. 1** Power-up screen for 5-10 s

After the power-up screen has disappeared, either of the two screens below may appear:

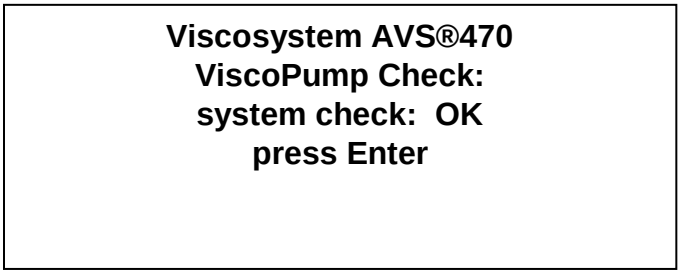



**Fig. 2** System ok, press “Enter” to proceed to **Fig. 4**

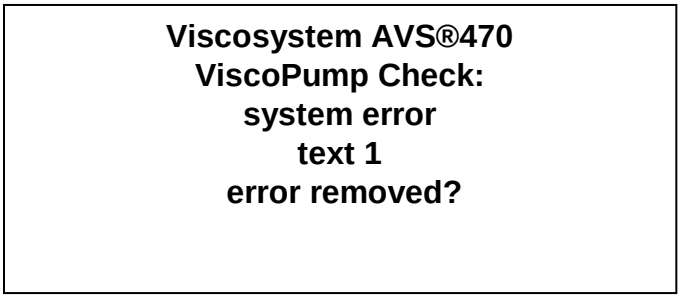



**Fig. 3** System is not ok, please follow the error removal instructions; as soon as everything is ok and the elimination of the problem was confirmed, you will be taken to **Fig. 2**. As long as the error persists, you will be hold at **Fig. 3**

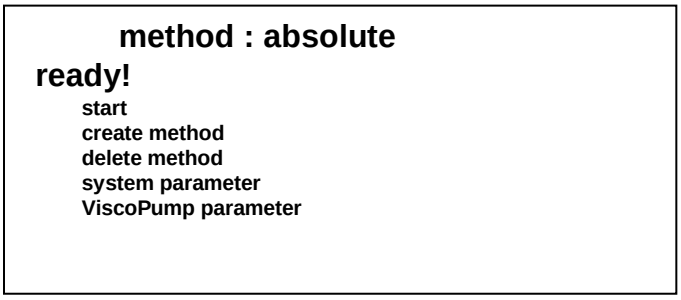



**Fig. 4. Main menu**

Display of the set method (e.g. absolute)
Start the set method Fig. 5
Create/change the set method Fig. 14
Delete the method Fig. 32
Change/set the system parameters Fig. 25
Change&/set the ViscoPump parameters Fig. 23

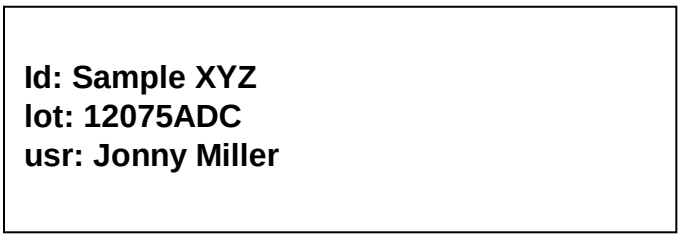



**Fig. 5 Input after start**
Id: The designation of a method; in the present case the field is empty (after a reset, or yet unused) or contains the last input
lot: The lot designation (as above)
usr.: User (as above)
No mandatory entry, press “Enter” to proceed

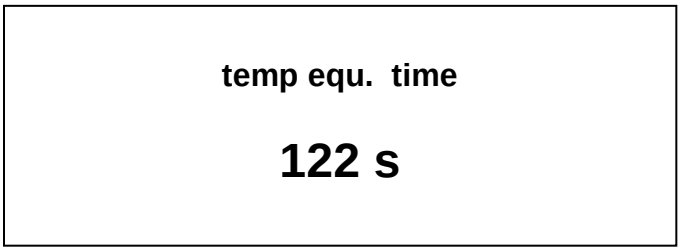



**Fig. 6 after Fig. 5**

If “pre. temp.” (fig. 17) was set, this screen will display the remaining time of the running temperature pre-adaptation in terms of seconds.

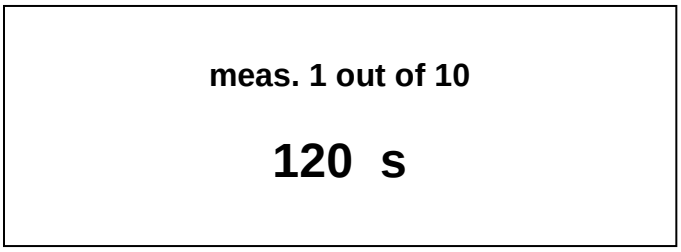



**Fig. 7 Measurement after temperature pre-adaptation**

After temperature pre-adaptation, the set number of measurements (Fig. 17) will be preformed and displayed here on a running basis in steps of 1 s.

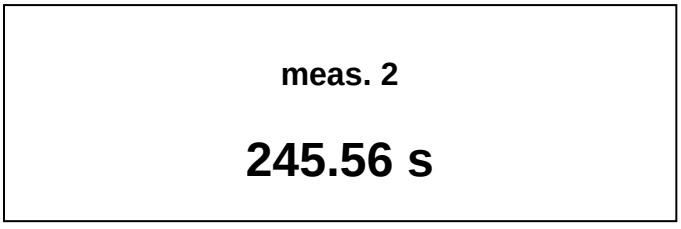



**Fig. 8 Measurement value at the end of a measurement**

Upon completion of a measurement, the respective result will remain on the display until the next measurement begins.

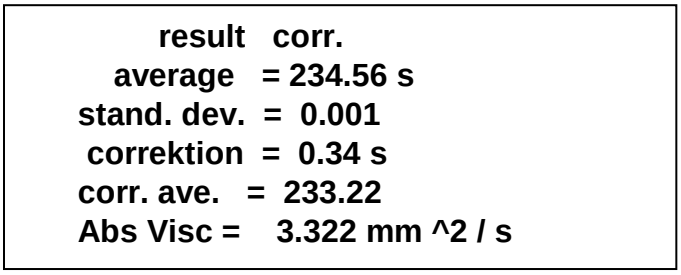
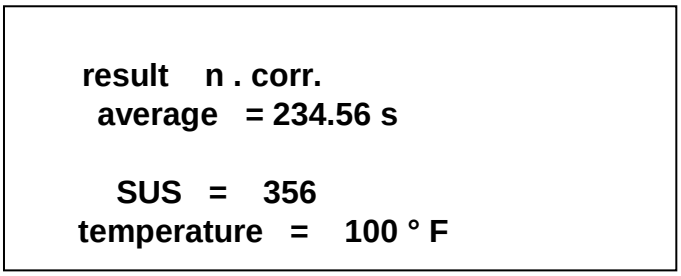



**Fig. 9 Display of the measurement result Example: Absolute measurement with correction**
The present example shows the result of an absolute measurement in which the Hagenbach-Couette correction was applied. The average shown corresponds to the **(exemplary!)** amount, reduced by the number of correction seconds which are also shown.




**Example: Absolute measurement with calculation of SUS** (Sayboldt Universal seconds) without Hagenbach-Couette correction (exemplary!)

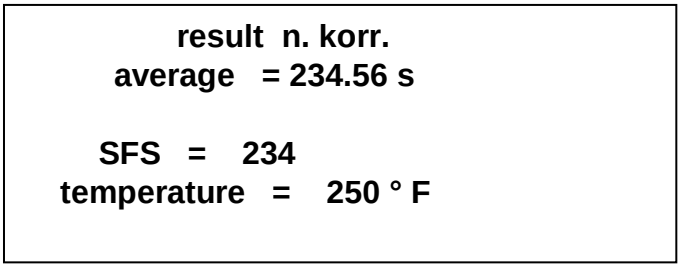



**Fig. 11 Display of the measurement result**
**Example: Absolute measurement with calculation of the SFS** (Sayboldt Furol seconds) without Hagenbach-Couette correction (exemplary!).

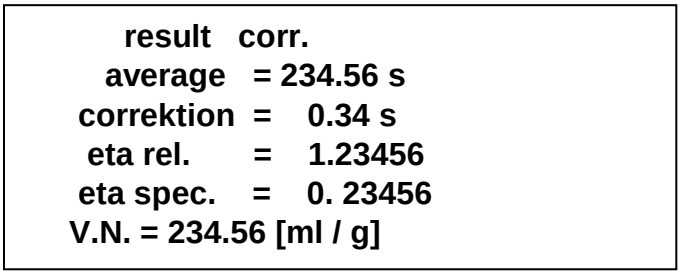



**Fig. 12 Display of the measurement result**
**Example:** Relative measurement with correction
This example shows the result of a relative measurement with the application of the Hagenbach-Couette correction. The average shown represents the amount, reduced by the correction seconds which are also shown **(exemplary!)**
The VN (viscosity number) is determined using the concentration which was input in Fig. 19. As soon as you confirm the result with Enter, you will be taken to the "(Retrieve) Measurements" mode.


**Fig. 13 Retrieve measurement values**
If the measurement mode was selected, you can retrieve the individual measurement values one by one at this point.
If this is not needed, you can return to the starting screen **(Fig. 4)**.

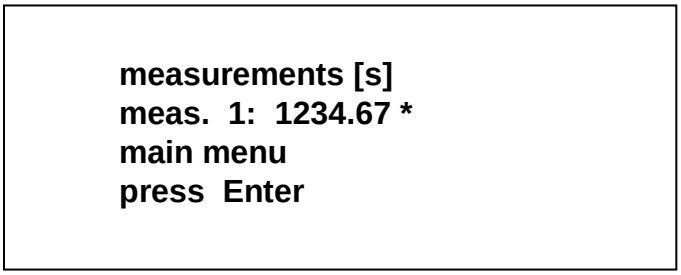



**Fig. 14 Retrieve and scroll through measurement result**
Use the ↑ and ↓ key to retrieve the individual measurement results.
The "*" sign means that this value was used in the calculation.
To finish, press the "Enter" key to return to **Fig. 4**.

In the „Creation mode", you can at any time return to the previous screen by pressing the "Esc" key.

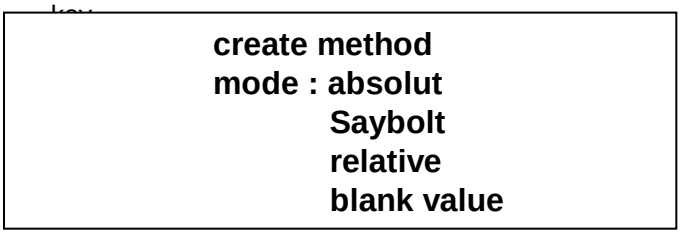



**Fig. 15 Creation mode following Fig. 14**
Selection from 4 modes: With the "Enter" key
If you select "absolute" and "relative", you will proceed to **Fig. 16.** Selecting "Saybolt" will take you to **Fig. 18**
Select "Blank value" to proceed to **Fig. 21**

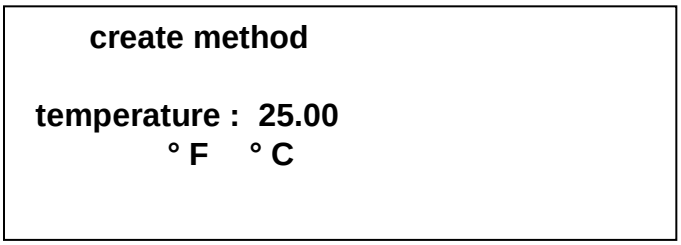



**Fig. 16 Creation mode following Fig. 15**
Input of the temperature value to document and select its temperature scale (°C or °F), if the “abs” or “rel” mode was selected - press the “Enter” key to proceed to **Fig. 17** or to **Fig. 19** in “relative” mode.

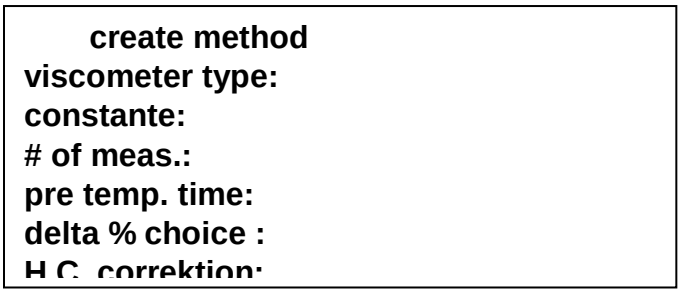



**Fig. 17 Creation mode following Fig. 16**
Selection of the viscometer type from the list in chapter 9
Input of the constants or guideline constants
Input of the number of measurements
Input of the temperature pre-adaptation time
Input of the maverick test, 0 = no, number = yes
Selection criterion in ± n.nn%
Selection of HC correction, 0 = no, 1 = yes.
Press “Enter” to proceed to selection in **Fig. 20**

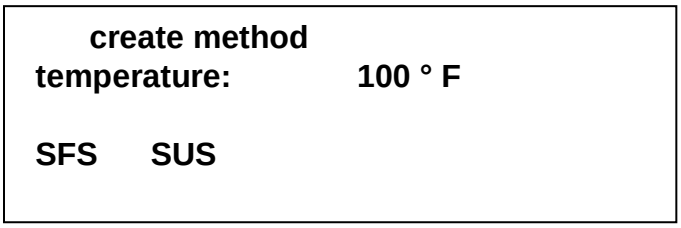



**Fig. 18 Creation mode following Fig. 16**
If Sayboldt calculation was selected in Fig. 15, this is the point to enter the working temperature in terms of **°F**; subsequently, you have to specify SUS or SFS for the calculation in the selection field below.Press “Enter” to proceed to **Fig. 17**

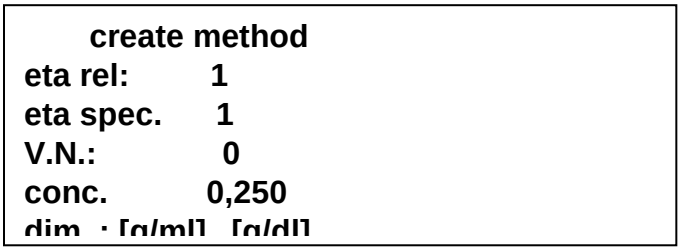



**Fig. 19 Creation mode following Fig. 17**
If “relative” was selected in **Fig. 15**:
Selection of the calculation types: 0 = no selection, 1 = selection. Please note: eta rel. includes eta rel. and VN eta rel. and eta spec.
Input of the concentration, and selection of its unit; only one value is possible.
Press “Enter” to proceed to **Fig. 17**

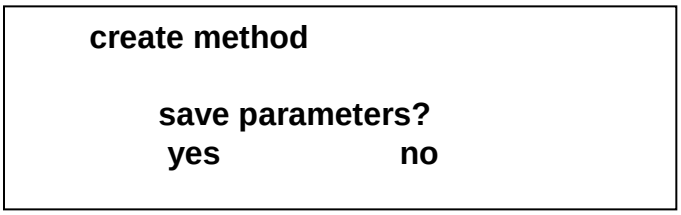



**Fig. 20 Creation mode, confirmation prompt following Fig. 17**
This prompt is issued for data integrity reasons to avoid the automatic take-over of any erroneous input or changes. Yes means: accept and store data
No means: discard changes
Press “Enter” to return to **Fig. 4** or, in **“Relative” mode,** to **Fig. 21** if “yes” was selected.

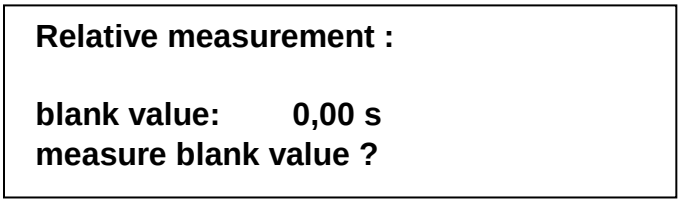



**Fig. 21 “Relative” creation mode**
If “Relative mode” or “Blank value” was selected in **Fig. 15**, you will be prompted here to know whether the blank value ($t_0$) is to be entered manually, or whether it is to be measured instead. The measurement will be made using the parameters which were input in **Fig. 17**. If manual input is specified you will proceed to **Fig. 14**, Measurement, pressing “Enter” will take you to **Fig. 22**.

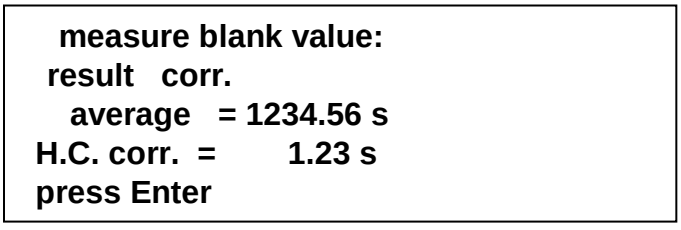



**Fig. 22 “Relative” creation mode, measurement result**
As soon as the measurement of a blank value is completed, the result will be displayed here; by selecting

the “press Enter” field you can accept the result as $t_0$; subsequently, you will be taken to **Fig. 4**.

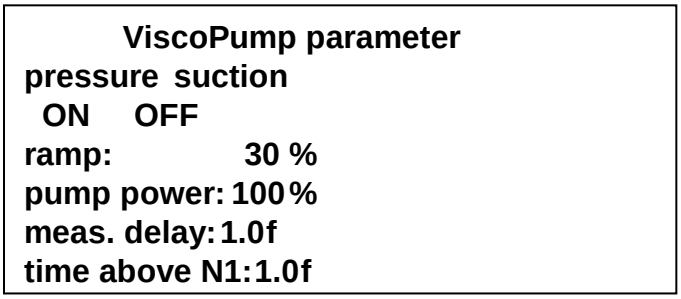



**Fig. 23 Input mode for the ViscoPump parameters from Fig. 4**
Pressure/Suction action: Adjustable working mode
Ramp: This refers to the steepness of the pressure increase in terms of scale sections (1-50, default value = 15)
Pump power: % of the programmed normal value
Measurement delay: Between the individual measurements x factor
Above N1 Suction: Time of suction above the upper light barrier x factor
Pressing “Enter” will take you to **Fig. 24**.

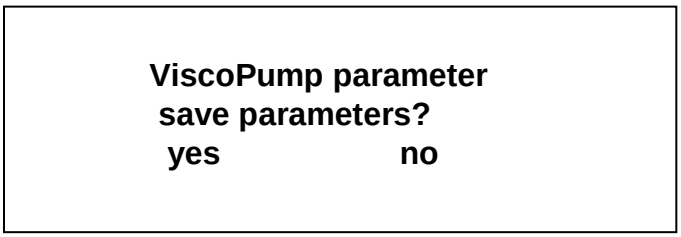



**Fig. 24 Input mode for the ViscoPump parameter prompt following Fig. 23**
This prompt is issued for data integrity reasons to avoid the automatic take-over of any erroneous input or changes.
Yes means: accept and store data
No means: discard changes
Press “Enter” to return to **Fig. 4**.

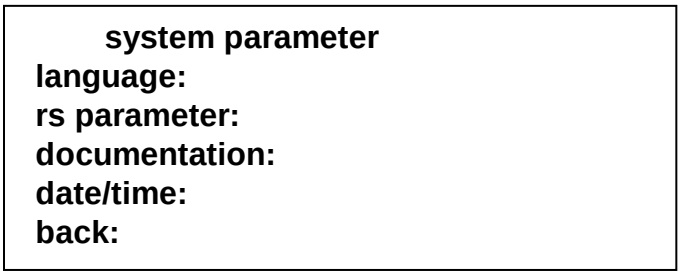



**Fig. 25 Input mode for the system parameters from Fig. 4**
Selection of the language: Proceed to **Fig. 26**
Selection of the RS parameters: Proceed to **Fig. 27**
Selection of the documentation: Proceed to **Fig. 29**
Set time and date: Proceed to **Fig. 30**
Possibility of returning to **Fig. 4**
Confirm, press the “Enter” key to jump to the function

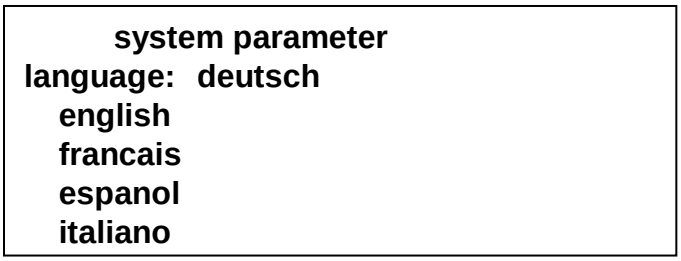



**Fig. 26 Input mode for the system parameters: Language**
Select from:
German, English, French, Spanish, and Italian
Press the “Enter” key to return to **Fig. 25**

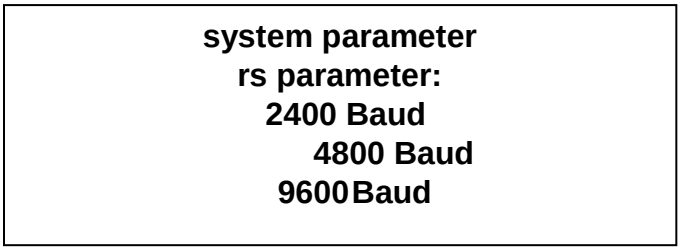



**Fig. 27 Input mode for the system parameters: RS baud rate**
Select the baud rate 2400, 4800, or 9600
Used to adapt to the RS printer
Press the “Enter” key to proceed to **Fig. 28**

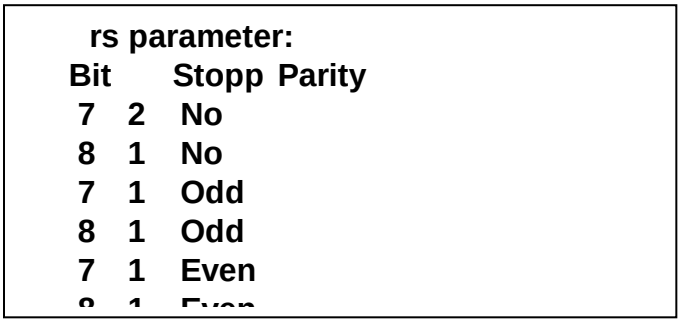



**Fig. 28 Input mode for the system parameters: more RS parameters**
At this point you can select the word length, the stop bit, and the parity

Used to adapt to the RS printer Press the “Enter” key to return to **Fig. 25**

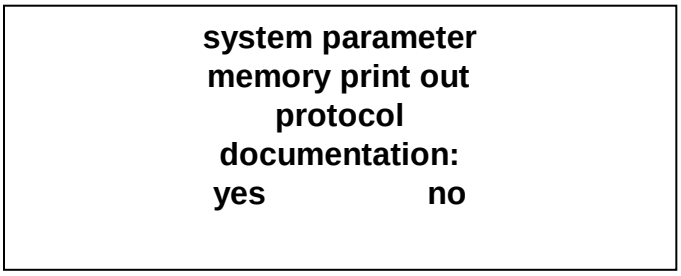



**Fig. 29 Input mode for the system parameters: more RS parameters**
Pressing the “Enter” key will trigger an immediate memory printout, followed by the return to **Fig. 25**
Result protocol: **please refer to description of function key F6 on page 26**
Documentation yes / no means that a printout is to be made after the end of a measurement series. This requires that a printer is connected; subsequently, press the “Enter” key to proceed to **Fig. 25**

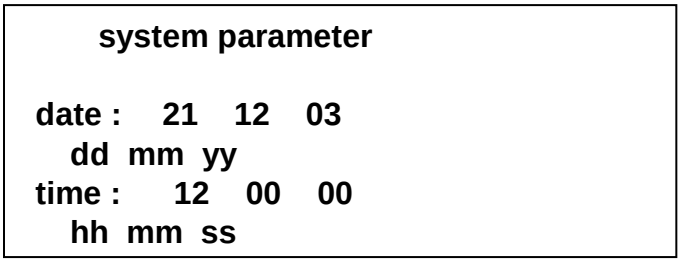



**Fig. 30 Input mode for the system parameters: date and time**
At this point you can set the internal clock. Confirm, then press the “Enter” key to proceed to **Fig. 31**

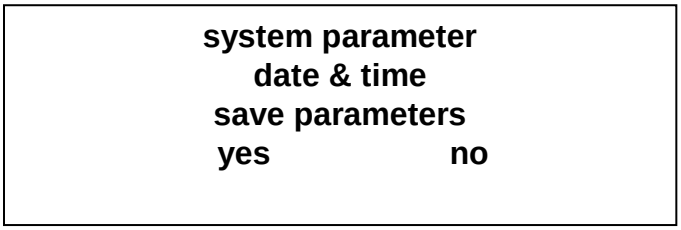



**Fig. 31 Input mode for the system parameters: confirmation**
This prompt is issued for data integrity reasons to avoid the automatic take-over of any erroneous input or changes.
Yes means: accept and store data
No means: discard changes
Press “Enter” to return to **Fig. 25**

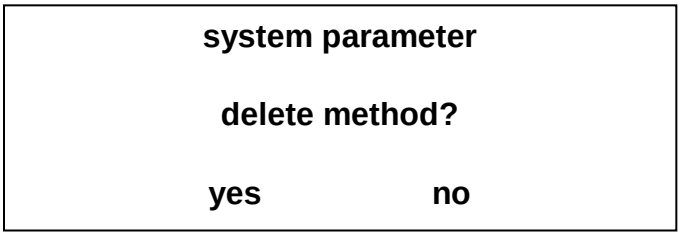



**Fig. 32 Input mode for the system parameters: delete confirmation**
If you confirm this question with “yes”, all system parameters will be reset to the starting valued (default values), followed by a move to Fig. 33; if you confirm with “no”, you will be taken to **Fig. 4**

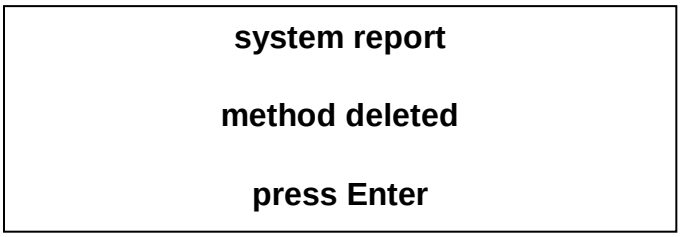



**Fig 33 System message: method deleted**
If confirmed with the “Enter” key, you will be taken back to **Fig. 4**

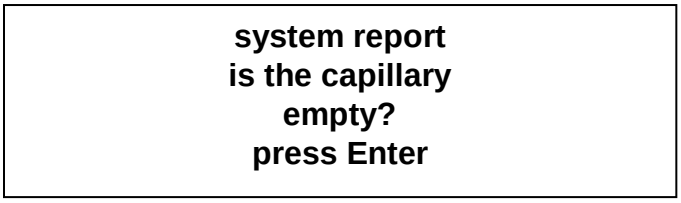



**Fig 34 System message: following a stop!**

You are asked whether the capillary have run empty in order to ensure that no malfunction will be caused by bubbles or splashes in the case of a restart.


**Fig. 35 Error message: measurement time-out**
The cause of the time-out has to be removed. In most cases the measurement has to be restarted, since this error message is almost always caused by a fatal error, such as viscometer empty, connected incorrectly or not at all etc.
Please refer to: **Chapter 2.4, Trouble Shooting**
Press the “Enter” key, and you will be taken back to **Fig. 4**


**Fig. 36 Error message: safety sensor**
In this case the safety bottle has to be discharged and cleaned, the cause of the overfilling has to be dicovered and has to be removed.
Press the “Enter” key, and you will be taken back to **Fig. 4**

# 6 Maintenance and care of the AVS® 470 Viscosity Measuring Unit and the viscometers

Maintaining the proper functioning requires certain inspection and maintenance work.

Maintenance and service work includes:
→ Visual check: Display front foil
→ Interface functions, ViscoPump II and rinsing burettes.
→Once per quarter, the electrical contacts have to be inspected for corrosion, if the viscosity measuring unit is used in premises with an occasional occurrence of corrosive matters in their atmosphere.

**Maintenance intervals Normal operation:**

As a rule, the max. intervals for carrying out all work is 6 months

Under particular strain: As a rule, the max. intervals for carrying out all maintenance work are 4 weeks.
In case of disturbances:
If any disturbance, malfunction, or other defect becomes obvious, the work has to be carried out immediately.

## 6.1 Maintenance work to be carried out

- Check the hoses, screwed connections for signs of visible damage, contamination, and leaks.
- Check the electrical plug contacts for corrosion and mechanical damage (on the AVS® 470 Viscosity Measuring Unit and on the cables).
- If necessary, the exterior of the casing of the viscosity measuring unit can be cleaned with a piece of cloth soaked with a household cleaning agent. The lower and rear sections have to be dry-treated. In no case must liquid penetrate into the interior of the lower section.
- Defective parts must be repaired or replaced with new ones. Defective glass parts must always be replaced.

## 6.2 Maintenance and care of the VZ 7215 absorbent bottle

The VZ 7215 absorption traps which prevent contaminations from penetrating into the pneumatic system of the ViscoPump have to be inspected at regular intervals. If soda lime is used as an absorption agent with acidic solvents, the colour condition of the indicator is to be checked on a daily basis. As soon as this condition has shifted to **BLUE** in the half of the absorber material, this is the very last moment to replace the material for safety reasons.

**Please note:** If such a colour shift cannot be observed over an extended period of time, this may be attributable to the fact that an acidic over-saturation of the material has caused a de-colouration; this may then appear as “normal”, but it will definitely result in the destruction of the pneumatic system after some time. **This situation is explicitly excluded from the warranty coverage!**
When using activated carbon as an absorption agent (e.g. with solvents or used mineral oils), a replacement should be made at intervals of 1 month; this depends on the load factor which depends on the volatility of the materials.

## 6.3 Periods without operation

If the capillary viscometers are not used for a long period, the fluids contained in the system, particularly aggressive solutions, must be removed. If the liquid remains in the system, it must be expected that changes occur, and the solutions used attack the glass to over time, in particular the capillaries.
**Cleaning:** Cleaning agents should be matched to the previous samples or impurities. In many cases, an aqueous cleaning agent (glass cleaners, detergents) or organic solvents (such as acetone or hydrocarbons) are sufficient. Strong oxidizing cleaning agents such as chromic acid may only be used by trained personnel and must be suitably disposed for safety and environmental reasons - the current guidelines for handling hazardous materials must be observed. In the last rinse cycle, the viscometer should be rinsed with a suitable solvent with a low boiling point (such as acetone), and dried by an air flow, which is preferably generated by underpressure (for example, water jet pump). The viscometer is dry and dust-free by this treatment and can thus be used for manual and automatic measurements.

## 6.4 Reproducibility of results

The measurement or analysis results depend on a variety of factors. Please check the plausibility of the measurement results or analysis results at regular intervals, and carry out the required reliability tests. In this regard, please adhere to the usual validation procedures and especially to the “Viscometers within quality assurance systems” chapter.

## 6.5 Viscometers within quality assurance systems

Recommendations for companies that have introduced a quality assurance system in accordance with the DIN EN ISO 9001 standards. In this quality assurance system, an inspection of the measuring equipment is planned. The intervals and required accuracy can be defined by each company according to its own requirements. The standard DIN/ISO 10 012, Part 1 serves as a guideline in this matter. We recommend regular inspection of the viscometers in defined intervals.

Inspection of the viscometer constants:

1. Calibration using comparative measurements with reference measuring standards
Comparative measurements must be performed with a viscometer (reference measuring standard) which was tested at the PTB (Federal German Physical-Technical Institute) and provided with a constant. Alternatively, calibrated viscometers by the accredited Wolfen ZMK (DKD) can be used as a measurement standard. During this comparative measurement, the viscometer to be inspected and the normal viscometer were placed simultaneously in the same thermostat bath. The test liquid tested, the viscosity of which must not be known exactly, is filled into both viscometers, tempered and the flow-through time then measured. The constants of the viscometers to be inspected are then calculated according to the following equation:

$$K = \frac{K_{PTB} \cdot t_{PTB}}{t}$$

K = Constant of the viscometer to be tested
$K_{PTB}$ = Constant of the viscometer measurement standard
t = Flow time of the viscometer to be tested (Hagenbach-Couette correction)
$t_{PTB}$ = Flow time of the viscometer measurement standard (Hagenbach-Couette correction)

Within the quality assurance system in accordance with DIN EN ISO 9001, traceability of the measuring equipment to national measuring standards is demanded. This traceability can be achieved by inspecting the comparative viscometers (reference measuring standards) at regular intervals at the PTB. The time intervals are defined according to the specifications made in the quality assurance system of the user.

2. Calibration of the capillary viscometer with normal oils of PTB or DKD

In this calibration, a certified standard oil of a known viscosity is used as a reference - measurement standard. The measurement is performed by means of a flow measurement of standard oil in the viscometer to be tested in a thermostatic bath whose temperature must correspond exactly with the test temperature of the standard oil. The greatest regard must be placed on the accuracy of the temperature in this case. In the event of a temperature deviation, an erroneous value of the calibration constant results for the viscometer. A temperature deviation of 0.01 K, for example, already causes a measurement error of up to 0.1%. A "calibration" of the deviating temperature into the viscometer - constant is not allowed.

3. Inspection bySI Analytics with quality certificates in accordance with DIN 55 350-18-4.2.2
The inspection atSI Analytics is carried out by means of comparative measurements using viscometers as reference measuring standards that were tested at the PTB (corresponds to Item 1).

Information on the stability of viscometer constants:

Each test (even with certificate), can only guarantee the measurement accuracy for a limited time. The constants of viscometers of borosilicate glass DURAN®, however are generally unchanged over the years when the viscometers are removed from changing influences. Particularly great changes are expected from the use of liquids, which attack glass, in particular hot sodium hydroxide (NaOH) or in glass blowing repairs (including at seemingly minor ones).
Liquids whose components adhere to the glass wall also cause errors. In such cases, regular cleaning is required whereby the corrosive action cleaning agent on the glass must be eliminated.
For this reason, we recommend that the user should write up a special processing instructions for all important measurements and include them in his quality assurance manual in accordance with DIN EN ISO 9001. In all cases the user is responsible for the correctness of his measuring and testing equipment and is not released from his responsibility for quality (cp. DIN 55 350, Part 18).

# 7 Storage and transportation

If the AVS® 470 Viscosity Measuring Unit has to be stored over some time, or to be dislocated, using the original packing will be the best protection of the device. However, in many cases this packing will not be available any more, so that one will have to compose an equivalent packaging system. Sealing the device in a foil is recommended.

If viscometers are to be stored temporarily, or transported, all liquids contained in the system, especially aggressive solutions, have to be drained.

# 8 Recycling and disposal

The present viscosity measuring unit and its packing material were mainly made from materials which can be disposed of and recycled in an environmentally friendly manner.
Should you have any questions regarding disposal, please contactSI Analytics.

**Disposal of the memory backup batteries**: The main printed board carries 2 lithium batteries. Batteries should not be made part of the domestic waste. They will be taken back at no charge by the manufacturer and forwarded to proper reuse or disposal.

# 9 Viscometer Reference list

The following viscometers can be used in the AVS® 470 Viscosity Measuring Unit for evaluation with Hagenbach-Couette correction:

| | |
|---|---|
| Ubbelohde-Viscometer according DIN | =Type **1** |
| Ubbelohde- Viscometer according ASTM | =Type **2** |
| Micro-Ubbelohde- Viscometer | =Type **3** |
| Cannon-Fenske Routine Viscometer | =Type **4** |
| Micro-Ostwald Viscometer | =Type **5** |

The type number is to be set on the menu (chapter 5.6, Fig. 17).

A further distinction will be made on the basis of the input constant or its table guideline values.

# 10 Appendix for Spare Parts

A catalog for spare parts is available separately as download from the web site of SI Analytics GmbH.

## Index :

**Typ / type / type / tipo** **AVS® 470**

**Bescheinigung des Herstellers**

Wir bestätigen, dass das oben genannte Gerät gemäß DIN EN ISO 9001, Absatz 8.2.4 „Überwachung und Messung des Produkts“ geprüft wurde und dass die festgelegten Qualitätsanforderungen an das Produkt erfüllt werden.

**Supplier’s Certificate**

We certify that the above equipment has been tested in accordance with DIN EN ISO 9001, Part 8.2.4”Monitoring and measurement of product” and that the specified quality requirements for the product have been met.

**Certificat du fournisseur**

Nous certifions que le produit a été vérifié selon DIN EN ISO 9001, partie 8.2.4 ”Surveillance et mesure du produit” et que les exigences spécifiées pour le produit sont respectées.

**Certificado del fabricante**

Certificamos que el aparato arriba mencionado ha sido controlado de acuerdo con la norma DIN EN ISO 9001, sección 8.2.4 „Seguimiento y medición del producto“ y que cumple con los requisitos de calidad fijados para el mismo.

SI Analytics

a xylem brand

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