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OPERATING MANUAL

AVS® 370

VISCOSITY MEASURING DEVICE

SI Analytics

a xylem brand

Wichtige Hinweise:

Die Gebrauchsanleitung ist Bestandteil des Produktes. Vor der ersten Inbetriebnahme bitte sorgfältig lesen, beachten und anschließend aufbewahren. Aus Sicherheitsgründen darf das Produkt ausschließlich für die beschriebenen Zwecke eingesetzt werden. Bitte beachten Sie auch die Gebrauchsanleitungen für eventuell anzuschließende Geräte.

Alle in dieser Gebrauchsanleitung enthaltenen Angaben sind zum Zeitpunkt der Drucklegung gültige Daten. Es können jedoch vom Hersteller sowohl aus technischen und kaufmännischen Gründen, als auch aus der Notwendigkeit heraus, gesetzliche Bestimmungen verschiedener Länder zu berücksichtigen, Ergänzungen am Produkt vorgenommen werden, ohne dass die beschriebenen Eigenschaften beeinflusst werden. Eine möglicherweise aktuellere Version dieser Gebrauchsanleitung finden Sie auf unserer Webseite. Die deutsche Fassung ist die Originalversion und in allen technischen Daten bindend!

Important notes:

The operating manual is part of the product. Before initial operation, please carefully read and observe the operating manual and keep it. For safety reasons the product may only be used for the purposes described in these present operating manual. Please also consider the operating manuals for the devices to be connected.

All specifications in this operating 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, the manufacturer may perform additions to the product without changing the described properties. A potentially more recent version of this manual is available on our internet website. The German version is the original version and binding in all specifications!

Instructions importantes:

Le mode d'emploi fait partie du produit. Lire attentivement le mode d'emploi avant la première mise en marche de produit, et de le conserver. Pour des raisons de sécurité, le produit ne pourra être utilisé que pour les usages décrits dans ce présent mode d'emploi. Nous vous prions de respecter également les modes d'emploi pour les appareils à connecter.

Toutes les indications comprises dans ce mode d’emploi sont données à titre indicatif au moment de l'impression. Pour des raisons techniques et/ou commerciales ainsi qu'en raison des dispositions légales existantes dans les différents pays, le fabricant se réserve le droit d'effectuer des suppléments concernant le produit pour séries de dilution qui n’influencent pas les caractéristiques décrits. Une version éventuellement plus récente de ce mode d'emploi est disponible sur notre site Internet. La version allemande est la version originale et obligatoire quelles que soient les spécifications!

Instrucciones importantes:

El manual de instrucciones forma parte del producto. Antes de la operación inicial de producto, lea atentamente y observe la manual de instrucciones y guárdelas. Por razones de seguridad, el producto sólo debe ser empleado para los objetivos descritos en este manual de instrucciones. Por favor, observe el manual de instrucciones para los dispositivos a conectar.

Todas las especificaciones en este manual de instrucciones son datos orientativos que son válidos en el momento de la impresión. No obstante, por motivos técnicos o comerciales, o por la necesidad de respetar las normas legales existentes en los diferentes países, el fabricante puede efectuar modificaciones del producto sin cambiar las características descritas. Una versión más reciente de este manual se encuentra disponible en nuestra página de Internet. ¡La versión en alemán es la versión original y se establece en todas las especificaciones!

TABLE OF CONTENT

1 Technical Specifications of the AVS® 370

1.1 Notes to the operating manual

The provided operating manual will allow you the proper and safe handling of the product. For maximum security, observe the safety and warning instructions in the operating manual!

⚠ Warning of a general danger:
Non-compliance results (can result) in injury or material damage.
ℹ Important information for device use.
🕮 Refers to another part of the operating manual.

The menu screens shown in this operating manual serve as an example and may differ from what you see!

1.2 Intended Use

The AVS® 370 is a measuring unit for determining absolute and relative viscosity of liquid media. This device must only be operated by skilled personnel.

1.3 Technical Specifications

1.3.1 AVS® 370

Translation of the legally binding German version (Release: 18. Oct 2021)

CE
FC

EMC compatibility according to the Council Directive: 2014/30/EU;
applied harmonized standards: EN 61326-1
Low-voltage directive according to the Council Directive 2014/35/EU;
Testing basis EN 61 010-1: for laboratory equipment
RoHS Council Directive 2011/65/EU
FCC Part 15B and ICES 003

Country of origin: Germany, Made in Germany

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 parameters: to be set using the WinVisco software

Method: Absolute or relative viscosity

Viscometers: Ubbelohde viscometers (DIN, ASTM, micro); micro Ostwald; Cannon-Fenske routine; TC Ubbelohde viscometers and dilute-solution viscometers

ViscoPump: Pump parameters (ramp, pressure, suck over N1)

Time for temperature: adaption: 0...20 min, to be selected in increments of 1 min

Number of measurements: 1…10 for each sample

Measurement ranges:

Viscosity: “pressing” mode 0.35 … 1800 mm^2/s (cSt) measuring temperature of approx. 20 ... 25 °C
“sucking” mode 0.35 … 5800 mm^2/s (cSt) measuring temperature of approx. 20 ... 25 °C

Pumping pressure: Fully automatically controlled “sucking” action to approx. -160 mbar
Fully automatically controlled “pressing” action to approx. +160 mbar

Measurement precision:
Precision (reproducibility and comparability) 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: bidirectional, serial interface interface according to EIA RS-232-C

Data format: word length 7 bits, 2 stop bits, 4800 baud, no parity

Connections Back panel of the device:

Data in- and output: 2 serial RS-232-C interfaces: 9-channel sub-miniature D sockets
1st serial interface: Connection of a personal computer (PC)
2nd serial interface: Connection of a TITRONIC®, or a 2nd AVS® 370

Spill-over guard VZ 8551 for waste bottle:
DIN round plug connector 4 channels with screw-type cap according to DIN 45321

Bath backlighting: Circula connectors with bayonet lock DIN 4 pin, 24 V, 350 mA

Pump connector: Cold-device socket in accordance with EN 60320 for connecting a 230 V or

115 V vacuum pump. The nominal voltage of the vacuum pump has to match the nominal operating voltage of the AVS® 370.
Max. power consumption required for the operation of the pump 2.5 A
Max. performance with 115 V: 285 VA
Max. performance with 230 V: 575 VA

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 III modules:

Pneumatic connectors:
Aerate pressure/suction to be connected to viscometer.
Overflow protection for suction hose VZ 8552

Capacitive sensor: DIN round-plug connector, 4-channel (ViscoPump III module)
Screwed cap according to DIN 45321

ViscoPump III module:
for viscometer: Round-plug connector with bayonet catch, DIN 5 channels
for AVS®/S (measurement stand), 5-channel socket or
for TC viscometer, 4-channel DIN socket

Power supply: Corresponds to Protection Class 1 according to DIN 57 411, Part 1 / VDE 0411, Part 1
Mains connection: 100 - 240 V, 50 ... 60 Hz
Mains fuse: Fine-wire fuse 5 x 20 mm, 250 V~, 4 A, time-lag design
Power consumption: 100 VA (without connection of a 115 V / 230 V vacuum pump)

Casing: Steel/aluminium casing with chemically resistant two-component coating, stackable

Dimensions: approx. 255 x 204 x 320 mm (W x H x D)

Weight: approx. 5.34 kg with 1 ViscoPump III module
approx. 7.67 kg with 4 ViscoPump III modules

Ambient conditions:

⚠ **Do not use the device in hazardous locations!**

Climate: Ambient temperature: + 10 ... + 40 °C for operation and storage
Humidity according to EN 61 010, Part 1:
Max. relative humidity 80 % for temperatures up to 31 °C,
linear decrease down to 50 % relative humidity at a temperature of 40 °C

Pollution degree: Pollution degree IP 20, indoor use only.

1.4 Warning and safety information

1.4.1 General

The device corresponds to protection class I.

It was manufactured and tested according to DIN EN 61 010, Part 1, "**Protective Measures for electronic measurement devices**" and control devices and has left the factory in an impeccable condition as concerns safety technology. In order to maintain this condition and to ensure safe operation, the user should observe the notes and warning information contained in the present operating instructions. Development and production is done within a system which meets the requirements laid down in the DIN EN ISO 9001 standard.

⚠ For reasons of safety, the device must only be used for the range of application described in the present operating manual. Nonobservance of the intended proper use of the device may result in personal injury or damage to property.

⚠ For reasons of safety, the devics and the power supply must be opened by authorised persons only; this means, for instance, that work on electrical equipment must only be performed by qualified specialists. **In case of nonobservance of these provisions the device and the power supply may constitute a danger: electrical accidents of persons or fire hazard!** Moreover, in the case of unauthorised intervention in the device or the power supply, as well as in the case of negligently or deliberately caused damage, the warranty will become void.

⚠ Prior to switching the device on it has to be ensured that the operating voltage matches the mains voltage. The operating voltage is indicated on the specification plate (backside of the device). Only insert the power plug into a receptacle with ground contact. Any interruption of the conductor inside or outside of the device or the loosening of a protective conductor connector is not permitted and can lead to hazardous risk situations of the device. Only use fuses of the indicated type and rated amperage as a replacement. The use of repaired fuses or shorting the fuse box is prohibited. **Nonobservance of this provision may result in damage to the t device and the power supply, or in personal injury or damage to property!**

⚠ **If it has to be assumed that safe operation is impossible, the device has to be put out of operation and secured against inadvertent putting to operation.** In this case please switch the device off, pull plug of the mains cable out of the power supply, and remove the device from the place of work.

Examples for the assumption that a safe operation is no longer possible,

- if the package is damaged,
- if the device shows visible damages,
- if the power supply shows visible damages,
- if the device does not function properly,
- if liquid has penetrated into the casing.
- if the unit has been altered technologically or if unauthorized personnel tried or succeeded to open the device as attempt to repair it.

In case that the user operates such a device, all thereof resulting risks are on the user!

⚠ The device must not be stored or operated in humid rooms.

⚠ **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. On the part of the user it has to be ensured that the persons entrusted with the use of the unit are experts in the handling of substances used in the environment or that they are supervised by specialized persons, respectively.

⚠ When handling the substances used, the chemical resistance of the materials of the device must be taken into account.

⚠ For all work with chemicals: **Always wear protective glasses!** Please observe the memorandums of the employer's liability insurance associations and the safety data sheets of the manufacturers.

⚠ Please also note the corresponding Operating instructions for the devices to be connected!

1.4.2 Chemical and biological safety

The device is not intended for use with potentially biohazardous substances.

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. On the part of the user it has to be ensured that the persons entrusted with the use of the unit are experts in the handling of substances used in the devices or that they are supervised by specialized persons, respectively.

When using biohazardous substances, the regulations for handling the substances used must be observed. In such cases, the use is the sole responsibility of the user.

For all work with chemicals: **Always wear protective glasses!** Please observe the memorandums of the employer's liability insurance associations and the safety data sheets of the manufacturers.

Dispose of all used solutions in accordance with national regulations and laws. Select the type of protective equipment according to the concentration and quantity of the hazardous substance at the respective workplace.

1.4.3 Flammable liquids

When handling flammable liquids, make sure that there is no naked flame in the vicinity of the equipment. Adequate ventilation must be provided. Only small quantities of flammable liquids should be kept in the workplace.

1.5 Functioning of the device

The AVS® 370 is used to perform flow-time measurements in capillary viscometers in combination with the WinVisco software. It is operated via a Personal Computer. The WinVisco software can be used to display the time readings. The results of a measurement series can be stored on the PC.

When using up to four different modular ViscoPump III units, the AVS® 370 can be upgraded in two ways to be used for meniscus sensing.

The available capillary viscometers enable viscosity measurements 0.35 of approx. 5,000 mm^2/s (cSt) to be carried out at a measuring temperature of approx. 20 ... 25 °C.

Connecting TC viscometers to the ViscoPump III VZ 85622 module will also enable the measurement of black and opaque liquids. As an alternative option it is possible to use viscometers in combination with the light-optical ViscoPump III VZ 8561 module viscometers for meniscus sensing with the measurement stand, e.g. the AVS ®/S.

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 (see 🕮 Fig.2 and Fig. 3).

The pumping pressure is controlled automatically by the AVS® 370 via the ViscoPump III 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 AVS® 370 is equipped with two RS-232-C interfaces for data transfer; these interfaces also allow several units to be chained.

The number of devices which can be connected to the computer depends on the software being used (presently it is limited to two AVS® 370, with 4 ViscoPump III modules each).

A maximum of 2 AVS® 370 viscosity measuring devices, each with up to 4 ViscoPump III module, can be connected to one PC.

The AVS® 370 can also be operated with ViscoPump II - modules, the older ViscoPump generation. A mixed configuration with ViscoPump II und III - modules is also possible. In the case of a mixed configuration, please note: **The ViscoPump II - modules may only be used in the first measuring positions, i.e. in the slots to the left of the ViscoPump III - modules** (see 🕮 Fig. 1). **If the ViscoPump modules are placed in the wrong order, transmission errors will occur during RS communication!**

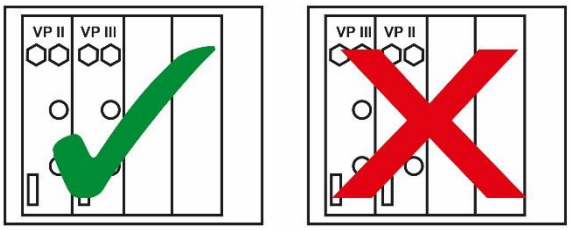


Fig. 1 Measuring positions ViscoPump II and III – Module in the AVS® 370

1.6 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.

In the case of the AVS® 370, as with all viscometry measuring devices from SI Analytics®, the liquid meniscus is captured on the measurement planes, either in an optoelectronic manner by means of light barriers, or else on a thermo-resistivity basis by thermistors.

1.7 Measurements principles

a) Optoelectronic sensing of the liquid meniscus

The near-infrared light which is generated in LEDs located in the upper section of the measurement stand AVS®/S 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.

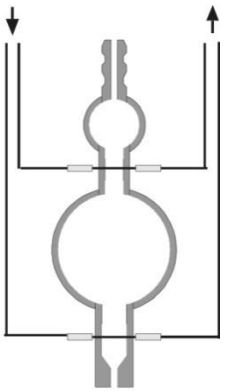


Fig.2 Viscometer for optoelectronic measurements

b) Viscometer with thermistor sensors (TC viscometer)

In the case of TC viscometers, glass-coated thermistors serving as sensors are inserted 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 inserted hermetically tightly into the glass coating of the viscometer.

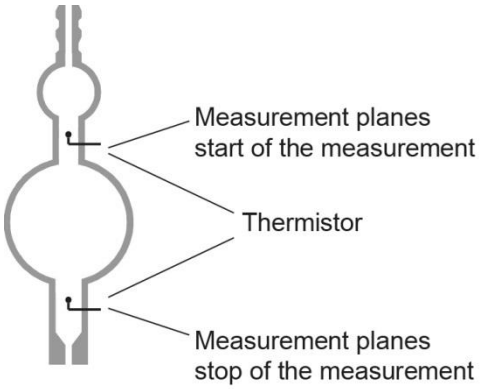


Fig. 3 Viscometer for optoelectronic measurements

2 Installation and Commissioning

2.1 Unpacking and setting up

The installation of the AVS® 370 and the connection of the desired additional devices is generally conducted by a trained service technician.

Please observer the operating voltage! It is indicated on the type plate (back side of the device).

The device may be placed and operated on a plane surface.

We recommend placing on the VZ 8571.

Up to two devices may be stacked.

2.2 Connecting the devices

2.2.1 Connecting cables

Description	Length	Connects:	to:
VZ 7116	4.0 m	AVS® 370	PC
TZ 3089	10.0 m	AVS® 370	PC
VZ 7115	0.9 m	AVS® 370	AVS® 370
TZ 3084	1.5 m	AVS® 370	AVS® 370
TZ 3095	1.5 m	AVS® 350/360	TITRONIC® universal
TZ 3084	1.5 m	AVS® 370	TITRONIC® 110Plus
TZ 3087	1.5 m	AVS® 370	TITRONIC® universal/ TITRONIC® 300
TZ 3094	1.5 m	TITRONIC® universal/ TITRONIC® 300	TITRONIC® universal/ TITRONIC® 300

2.2.2 Deployable hose combinations

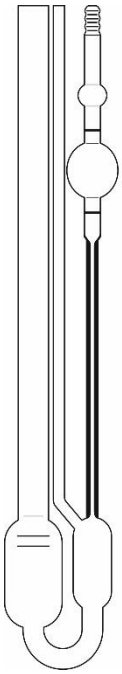
Hose combinations Type no.	Description	Application
VZ 5505	Silicone hose kit, oppressive, for Ubbelohde viscometers (3 legs), and Cannon-Fenske and Ostwald viscometers	Standard, but please observe: the sample can leak from the capillary tube during a malfunction
VZ 5505 + VZ 8526	Silicone hose kit, suctioning, for Ubbelohde viscometers (3 legs)	Standard, safer than oppressive operation, as the sample cannot leak from the capillary tube. Unsuitable for volatile samples.
VZ 8523	PTFE hose set, suction, for Ubbelohde viscometer (3 legs)	For aggressive samples that attack silicone, such as sulphuric acid. Hose lengths are designed to fit the AVS® 370 on the support console VZ 8571. All hose sets for suctioning operation can be combined with the suction set and the sample fill set.
VZ 8524	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. Depending on the sample, an active carbon filter VZ 7216 can be used instead of the soda lime filter VZ 7215. Hose lengths are designed to fit the AVS® 370 on the support console VZ 8571.
VZ 7218 + VZ 8535	PTFE hose kit, suctioning, for Ubbelohde viscometers (4 legs)	For Ubbelohde viscometers with additional 4th pipe for filling and cleaning Hose lengths are designed to fit the AVS® 370 on the support console VZ 8571.
VZ 8530	PTFE hose kit, suctioning, with soda lime filter VZ 7215 for Ubbelohde viscometers (4 legs)	For Ubbelohde viscometers with additional 4th pipe for filling and cleaning Hose lengths are designed to fit the AVS® 370 on the support console VZ 8571. For aggressive samples whose vapors are absorbed by soda lime filters to protect the ViscoPump.
VZ 5606	For TC viscometers (3 and 4 legs) with screw connections: Silicone hose fittings with connecting cable. For oppressive operation	For TC viscometers (3 and 4 legs) with 4th pipe for filling and cleaning Typical applications are measurements of oils.

The hose combinations are to be selected on the basis of the required application.

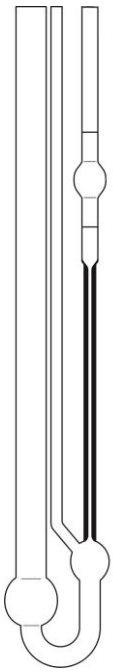
When using Micro Ubbelohde viscometers with TV sensors, the ignition temperature of the media to be measured has to be taken into account! It has to be higher than 250°C.

2.2.3 Suitable viscometer types, racks, and measurement stands

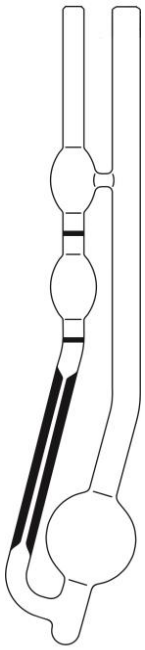
Viscosmeter (Type)	Rack (Type no.)	Measuring stand (Type)
Ubbelohde (DIN) 532… 530… 501… 541… 545…	053 92	AVS®/S AVS®/SK
Ubbelohde (ASTM) 525… 526… 527… 545…	053 92	AVS®/S AVS®/SK
Mikro Ubbelohde 536… 537… 538…	053 92	AVS®/SAVS®/SK
Ubbelohde dilute-solution viscometers 531…	---	AVS®/SK-V
Cannon-Fenske-routine 513… 520…	---	AVS®/SK-CF
Mikro-Ostwald 516… 517… 518…	053 97	AVS®/S AVS®/SK
Ubbelohde (TC) 562… 563… 564… 567… 568… 569…	053 93	---



DIN-Ubbelohde-viscometer

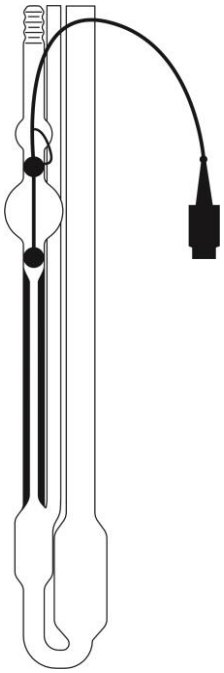


Micro-Ubbelohde-viscometer

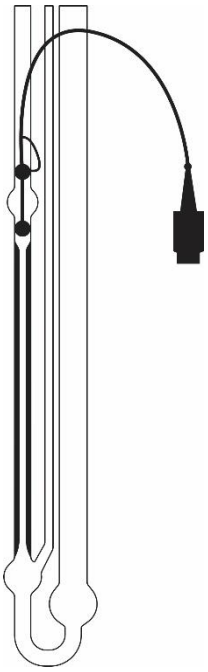


Cannon-Fenske-Routine-viscometer

Micro-Ostwald-viscometer



Ubbelohde-viscometer
with TC sensor



Micro-Ubbelohde-viscometer
with TC sensor

Fig. 4 Suitable viscometer types

2.3 Connecting the viscometers and other devices

The AVS® 370 Viscosity Measuring Unit allows the use of most various viscometer types from SI Analytics®: Ubbelohde viscometers according to DIN and ASTM, micro Ubbelohde viscometers according to DIN, Cannon-Fenske routine and micro Ostwald viscometers as well as TC 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 correction) are valid. Gauging by the user is not necessary, since the corrections correspond to the theoretical values as taken from the operating instructions for the viscometers. This statement is true for both Ubbelohde viscometers of normal size as well as for micro viscometers.

It is also possible to connect or control other devices (such as absorption traps, overflow guards etc.). Depending on the intended use of the AVS® 370, it may be highly recommendable to connect these devices, please refer to the items below.

2.3.1 TC-Viscometer with thermistor sensors

Fill the viscometer (approx. 18 - 20 ml), then place it in the thermostat bath. Connect the AVS® 370 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 III module VZ 8562 (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 = sucking, black = venting) when attaching the pneumatic screwed connections to the ViscoPump III module of the AVS® 370.

2.3.2 Viscometer with light-barrier sending

Use the hose/cable combination to make an electrical and pneumatic connection between the AVS® 370 and the measurement stand. The plugs are firmly connected to the sockets by rotating the union sleeve. Please observe the colour codes (red = 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. 5, 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. 5 Inserting or replacing a viscometer with light-barrier sensing

2.3.3 Connection of VZ 7215 absorption traps

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

For these cases, a hose fitting “suctioning” VZ 8524 must be used!
(includes the absorption traps VZ 7215 and appropriate connecting hoses).

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.

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 decolouration; 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 absorption agent (e.g. with solvents or used mineral oils), a replacement should be made at intervals between 1 and 2 weeks; this depends on the load factor which, in turn, is a function of 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 III 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 III module). The holder on the safety bottle accommodates the capacitive sensor.

When using the ViscoPump III module VZ 8561 (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 III module VZ 8562 (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 III.

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 on).

2.3.5 Connection of the overflow guard for the VZ 8551 waste bottle

We urgently recommend the connection of the VZ 8551 (weighing balance) overflow guard for the waste bottle (available as an option) for rinsing and dry operation. The connection of the weighing balance prevents the VZ 5379 waste bottle (2000 ml) from spilling over.

The sensitivity of the weighing balance has to be adapted to the medium being used!
To do so, please adjust the set screw in such a manner that the weighing balance triggers as soon as the desired filling volume has been reached. After emptying the waste bottle, you may continue with the measurements. When making the connection, please make sure that the VZ 8551 overflow guard is correctly assigned to the ViscoPump III modules.

2.3.6 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.

The transparent thermostats from SI Analytics® which were developed especially for capillary viscometry, meet the requirements imposed on precision and constancy. The CT 72/2, 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 °C corresponds to a possible error of 0.5 %.

In principle, two different transparent thermostats can be used on the AVS® 370:

for measurements at different temperatures, the CT 72/2, CT 72/4 transparent thermostats are available. These thermostats can be equipped with two or four viscometers including other equipment. For measurements up to 60 °C, the thermostat CT 72/P of acrylic can be used.

The bath body of the thermostat CT 72/P consists of acrylic (PMMA)! Acrylic can be damaged by a variety of organic solvents as well as by concentrated acids/bases. Therefore, a contact of the bath body with such substances should be avoided, as the acrylic may be damaged.

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

2.3.7 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/CK 310 flow cooler as a counter cooler at bath temperatures exceeding 40°C.

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

2.3.8 ViscoPump III module

The ViscoPump III modules control the entire measurement process, among other things the temperature pre-adaptation process of the samples in the viscometers, the process of pumping the liquid up into the storage containers of the viscometers, the measurement of the flow times etc. The serial interface of the AVS® 370 Viscosity Measuring Unit ensures a speedy and simple data transfer with the PC.

To replace the ViscoPump III module, please proceed as follows:

- Remove the pneumatic and electrical connections from the front panel of the ViscoPump III module to be replaced.
- Loosen the screws located at the corners of the front panel.
- Use the upper and lower insertion handles to leverage the ViscoPump III module out of its rearside plug connection.
- Pull the ViscoPump III module out of the AVS® 370.
- After inserting the new ViscoPump III module, please secure it again with the screws of the front panel. Re-establish the electrical and pneumatic connections.

2.3.9 System enhancements

A number of functional units of the AVS® 370, such as the viscometers and the ViscoPump III modules, can be replaced or added.

Make sure that the AVS® 370 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!**

2.3.10 Troubleshooting

Check whether the AVS® 370 is switsche on.

Trouble	Troubleshooting
Air bubbles in viscometer	• Is the filling quantity sufficient? - Check, fill viscometer if required. • Is the viscometer of properly connected? - in the case of pressing operation, please checked 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.
Excessive pumping of measuring medium into the thermostat bath or into the safety bottle	• Is the viscometer properly connected? - for pressing operation? - for operation in suction mode? When using AVS measuring tripods • check position of the rack within the stand • check the electrical connection from the viscometer to the ViscoPump type III module • Is the green LED on the measuring stand illuminated? When using TC viskometers • Is the viscometer properly connected?
The data transfer to the PC is not functioning properly.	• Are you using a suitable cable? - Please refer to 🕮 2.2.1 • Cable properly connected? - Check cable connection - are the screws on the PC side properly • Cable defective? - replace cable • ViscoPump II module? - The software version must be equal of greater than 3.06

3 Data transfer

3.1 RS-232-C Interfaces

The AVS® 370 has two RS-232-C interfaces. Interface 1 is used to communicate with the computer; interface 2 is used to connect to another viscosity meter AVS® 370 and burettes.

Connection between more than one AVS® 370
To establish the data transfer between more than one AVS® 370, please proceed as follows:

- Make a RS-232-C connection from the computer to interface 1 of the first device.
- Then use another cable to make a connection from interface 2 of the first device to interface 1 of the second device.

The device address of the second connected AVS® 370 must be different from the address of the first viscosity AVS® 370. Therefore, a jumper must be moved on the second device when connecting a second AVS® 370 device. Please contact the service (backside of these operating manual).

If burettes are used, these can be connected to interface 2 of the AVS 370 via an RS-232-C cable.

3.2 Interface configuration

The interface parameters cannot be changed! All transmission parameters are firmly set to the following values:

Baud rate	4800
Parity	None
Stop bits	2
Data bits	7

All other devices to be connected (especially burettes for rinsing) must have the same parameter settings.

3.3 Connection to a USB port on the PC

The AVS® 370 can also be connected to a USB port on the computer if suitable adapters are used USB serial. We recommend the adapter USB-RS232 TZ 3080.

This adapter is part of the delivery scope of the AVS® 370.

3.4 Device address

In order for the devices to be addressed by the software, you need unique addresses.
The communication protocol used allows the addressing of 16 devices.
The addresses used are 0 to 15.

3.4.1 Automatic address assignment with the AVS® 370

Within **an** AVS® 370 module, the ViscoPump inserts are automatically populated based on their positions at the addresses 1 (first slot) to 4 (fourth slot).

When using **an additional** AVS® 370 module, this address must be moved by moving a jumper, so that the addresses 5 to 8 are allocated in this module.

The addresses of the other devices must be different from the address of the ViscoPump. If, for example 3 ViscoPumps are used in the AVS® 370, addresses 1-3 are occupied. Only addresses 4-15 and address 0 can then be used for other connected devices.

Please check the instructions for use of the respective devices.

The WinVisco 3 software expects viscosity measurement devices in the address zone 1 to 8 (ViscoPump, AVS® 350, AVS® 360). Burettes are expected in the address range 9 to 15 and at address 0.

The current WinVisco 4 software allows the use of addresses also in the range 2-8, if they are not already occupied by ViscoPumps, which automatically occupy the addresses from 1 upwards according to their number. For example, in an AVS® 370 with 2 ViscoPumps, addresses 1 and 2 are occupied by these devices and are no longer available for connected burettes.

3.4.2 Address assignment for burettes when rinsing with solvents:

When rinsing with solvents by means of connected burettes, one or two burettes are connected to each measurement slot, depending on whether you are rinsing with one or two different solvents. The following addresses have to be set for the burettes:

	Address for burette solvent 1	Address for burette solvent 2
1. Measuring point	9	13
2. Measuring point	10	14
3. Measuring point	11	15
4. Measuring point	12	0

Fig. 6 Address allocations for burettes

With WinVisco 3, only the first 4 measuring points can be supported with burettes for flushing with solvent.

4 Software WinVisco

4.1 Introduction

With the WinVisco 4 software described herein, it is possible to control up to 8 ViscoPump III modules (this also works for the earlier generation ViscoPump II). The measurement values determined by the ViscoPump III modules are received and evaluated by the software. The results can be printed (report), output as a pdf file or saved in a text file (CSV format). In parallel operation of up to 8 measurement rigs, flexible and fast viscosity determination is possible.

The installation instructions are enclosed separately with the WinVisco 4 software. The user manual for the software is located as a pdf file on the data carrier of the software. The instructions for use can also be opened in the start window of the software.

4.2 Hardware and software requirements

The product is subject to various software and hardware requirements. The minimum requirements must absolutely be fulfilled for a smooth operation.

Contact your IT administrator prior to installation, if you are not clear about the specification of your PC system.

Minimum requirements

Operating system (OS)	from Microsoft Windows7 SP1 \ 8.x \ 10
Processor (CPU):	1 GHz
Memory (RAM):	1 GB (with 32-Bit), 2 GB (with 64-Bit)
Hard drive (HDD):	up to 2.5 GB of free disk space*
Graphics (GPU):	128 MB DirectX 9-capable graphics card with at least 1024x768 pixel resolution
Connections:	at least one RS-232 Type C interface (COM)

* WinVisco requires free storage space as a pure software product. The storage requirement increases if components necessary for the operation are missing on the target system. The setup recognizes missing software components, notifies this and offers the possibility to install it as well.

Recommended requirements

Operating system (OS)	Microsoft Windows 10
Processor (CPU):	Intel Core 2 @ 2 GHz AMD Athlon X2 @ 2GHz
Memory (RAM):	4 GB
Hard drive (HDD):	up to 2.5 GB of free disk space*
Graphics (GPU):	256 MB DirectX 10-capable graphics card with at least 1280x1024 pixel resolution
Connections:	at least one RS-232 Type C interface (COM)

Further requirements

Microsoft Access Database Engine 2010	(can be installed automatically through the setup)
Microsoft .NET Framework 4.6.2	(can be installed automatically through the setup)

Basically, the computer must be sufficient in its processing capacity/resources (pulse frequency, memory, hard drive memory, etc.) for the intended operating system.

5 Maintenance and care of the device and the viscometers

Maintaining the proper functioning requires certain inspection and maintenance work.

Maintenance and service work includes:
- Visual check
- Interface function, ViscoPump III, 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	intervals for carrying out all work is 6 months
Under particular strain	the max. intervals for carrying out all maintenance work are 4 weeks
In case of disturbances	the work has to be carried out immediately

5.1 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 device 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.

5.2 Maintenance and care of the absorber traps VZ 7215

The VZ 7215 absorption traps which prevent contaminations from penetrating into the pneumatic system of the ViscoPump have to be inspected at regular intervals.

⚠ **The measurements will not work if there is an incorrect connection!** There is a risk of the sample leaking from the viscosimeter or being suctioned into the ViscoPump.

⚠ **If sodium lime is used** acidic solvents **as an absorption agent**, 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.
- 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 monthly. This depends on the load factor which, in turn, is a function of the volatility of the materials.

5.3 Periods without operation

If the capillary viscometers are not used over a long period of time, the liquids contained in the system, in particular aggressive solutions, have to be drained. If the liquid is left in the system, one has to reckon that the solutions used will alter in the course of time and attack the glass, in particular the capillaries.

⚠ **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.

5.4 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.

5.5 Viscometers within quality assurance systems

Recommendations for companies that have introduced a quality management system (OM system) according to DIN EN ISO 9001: 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:

a) 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. During this comparative measurement, the viscometer to be inspected and the PTB - tested 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:

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

K	constant of the tested viscometer
K_{PTB}	constant of the standard reference viscometer
t	low time (HC) of the tested viscometer (corrected by Hagenbach-Couette)
t_{PTB}	flow time (HC) of the standard reference viscometer (corrected by Hagenbach-Couette)

Within the quality management 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 quality management system of the user.

b) Calibration of the capillary viscometer with normal oils of the PTB

During this calibration, a normal oil from the PTB with known viscosity is used as a reference measuring standard. The measurement is performed by means of flow-through measurement of the PTB normal oil in the viscometer to be inspected in a temperature bath, the temperature of which must correspond precisely to the test temperature of the PTB. In this case, it is extremely important to make sure that the temperature is absolutely correct. In case of temperature variation, this will always result in a constant for the viscometer that deviates from the constant applied. A temperature variation of 0.01 K, for instance, will result in a measuring error of up to 0.01 %. The calibration of the deviating temperature into the viscometer constant is not permitted.

c) Inspection by Xylem Analytics Germany with a quality certificate in accordance with DIN 55 350-18, 4.2.2

The inspection at the manufacturer is carried out by means of comparative measurements using viscometers as reference measuring standards that were tested at the PTB (corresponds to Item 1).

General Information on the stability of viscometer constants

Each inspection (even with a certificate) can guarantee the technical measuring direction only for a limited period of time. The constants of viscometers made of the borosilicate glass DURAN®, however, can remain unchanged for long periods of time if the viscometers are kept away from altered influences. Especially extreme changes can be expected, for instance, during the use of liquids that attack glass, in particular hot caustic soda hydrated (NaOH) orduring glass-blowing repairs (even for apparently insignificant repairs).

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 instruction for all important measurements and include them in his quality management 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).

6 Guarantee

We provide guarantee for the device 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 device results in loss of the guarantee rights. The guarantee does not cover wear parts. The breach of glass parts is also excluded. To ascertain the guarantee liability, please return the instrument and proof of purchase together with the date of purchase freight paid or prepaid.

7 Storage and transportation

If the AVS® 370 has to be stored over some time, or to be dislocated, the use of the original packing will be the best protection of the devices. However, in many cases this packing will not be available anymore, so that one will have to compose an equivalent packaging system. Sealing the lower section in a foil is hereby recommended.

The devices should be stored in a room with a temperature between +10 and +40°C, and the (relative) humidity of the air should not exceed 70 %.

If the interchangeable have to be stored over some time, or to be dislocated, the fluids inside the system, especially aggressive solution have to be removed.

8 Recycling and Disposal

Please observe the applicable local or national regulations concerning the disposal of “waste electrical and electronic equipment”.

The AVS® 370 and his packaging are manufactured as far as possible from materials which can be disposed of environmental-friendly and recycled in a technically appropriate manner. If you have any question regarding disposal, please contact the service (see backside of this manual).

9 EC – Declaration of Conformity

The corresponding declaration of conformity of the device can be found on our homepage. It will also be made available to you on request.

Typ / type / type / tipo **AVS® 370**

Bescheinigung des Herstellers

Wir bestätigen, dass oben genanntes 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.

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