

1.7 AVS® Pro III

Automatic viscosity measurement has been improved ...

The AVS® Pro III automatic sampler is a fully automated instrument for determining the viscosity of Newtonian fluids using capillary viscometers. The system is mainly used for polymer analytics, e.g. according to ISO 307, ISO 1628 or ASTM D4603. But it also complies to the requirements of absolute measurements according to DIN 53 000, ASTM D445/D446 and ISO 3104/3105. In spite of the high sample throughput, the AVS® Pro III provides maximum accuracy and reproducibility. Furthermore, working with the automatic sampler is easy and allows unattended 24-hour operation.

In comparison to AVS® 370, at AVS® Pro III also the filling of the viscometer is automated. Therefore the complete measuring sequence - filling, measuring, discharging and rinsing - is fully automated, to enable unattended operation. The filling is done by a dosing module (piston/cylinder) in a 4-axis robotic system:

The samples are sucked by a sample needle from a sample bottle and transferred to the viscometer. Due to medium hose lines of only minimum length, any carryover can be kept low easily.

Particularly for high sample throughput, the AVS® Pro III helps to substantially reduce the burden on qualified users. The fully automatic mode offers an increased level of safety when handling aggressive media, e.g. sulphuric acid.

Applications

For the concept of AVS® Pro III, particularly the requirements of polymer quality control have been incorporated, e.g. for measurement of intrinsic viscosity, viscosity number, K value, or similar measures. But also the measurement of petrochemical products is possible.

Different configurations

The AVS® Pro III typically is equipped with 2 to 4 measuring positions, to achieve higher sample throughput when measuring in parallel.

The following viscometer types can be used: Ubbelohde (DIN, ASTM), Mikro-Ubbelohde (DIN), Cannon-Fenske routine and Micro-Ostwald of SI Analytics®.

The standard waste system contains a waste bottle for each measuring position. The advantage: This system is very reliable in operation, as it does not need valves being in contact to the medium. But as a special configuration, also a waste system with only one waste bottle is available.

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... with the AVS® Pro III Automatic Sampler

Safety and reliability

The AVS® Pro III has an outstanding reliability: The dosing system (available as standard and Micro version) is operating without valve and therefore is suitable for nearly all samples. Due to further development of hardware components and software, the system has been continuously improved, resulting in a minimization of error sources. E.g., in the robotic system, proximity switches are in use. And the system abstains from medium-conveying valves, if not required for special customer applications. Even more

important than reliability is the safety for the user. For this, the liquid in the waste system is transferred only by suction instead of high pressure: Therefore, the liquid is only aspirated to the waste bottle, not pressed. In case of leakage, only air can enter into the system, but never liquid leave the system.

Regarding safety devices, there are capacitive sensors to control the suction line between viscometer and control unit, as well as liquid level detection of the waste bottles. In case of a signal of these safety devices, the corresponding measuring position is switched off.



- Fully automatic and highly precise measuring station. Time measurement with a precision of +/- 0.01 s (but less precise than 0.1%)
- Ideal for highly aggressive media
- Although in combination of optical and thermal sampling of the meniscus channel or different capillary sizes and types, up to four viscometers selectable
- Durch die optionale Filtration mit dem ProClean system eliminate manual filtration of the sample
- Individually configurable, e.g. for rinsing with sample or solvent, or use of different viscometer types.

Advantages
AVS® Pro III

Rinsing: Either with sample or with solvent

The rinsing of dosing module and viscometer is carried out according to the application and customer's preferences. Both alternatives have benefits and drawbacks.

Most AVS® III systems are configured for rinsing with next sample. For this, in total 3 fillings of viscometer are required: Using the first 2 charges, the dosing module and the viscometer are rinsed, and only the 3rd filling is used for measurement.

As Ubbelohde viscometers of standard size require a liquid volume of about 17 ml, the total sample volume needed is about 60 ml.

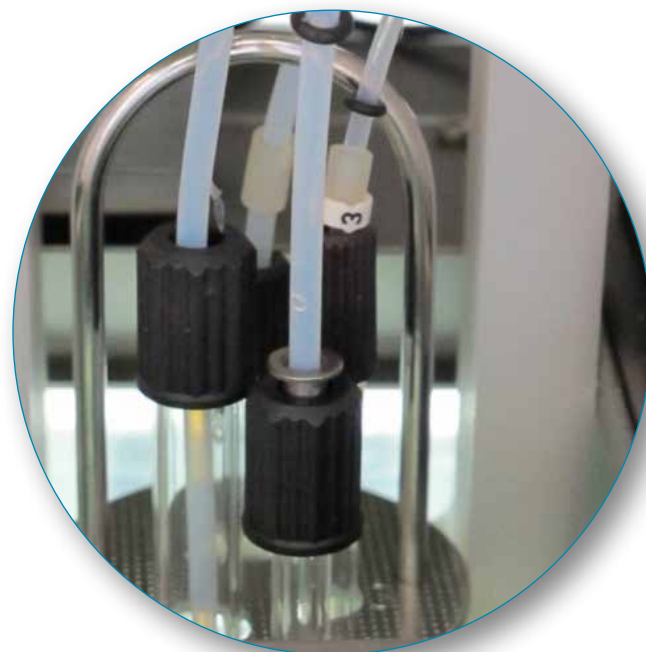
Therefore typically sample bottles of 100 ml volume are used. We recommend this configuration for applications in polymer analytics, when supply and disposal of the sample solvent is cheap and rinsing with external solvent exhibits drawbacks. An important application is the measurement of polyamide in sulfuric acid (96%) according to ISO 307.

When using expensive and hazardous solvents, e.g. for measurement of polyesters according to ISO 1628-5 or ASTM D4603, often the user wants to use only a small amount of sample. In this case it is possible to use micro viscometers with filling volume of max. 4 ml - in this case a sample volume of 20 ml is sufficient for rinsing and measurement. In case of micro viscometers, the AVS® Pro III is equipped with a special dosing module for small sample volumes.

Alternatively, instead changing to viscometers with smaller sample volume, there is the option of rinsing with external solvent - then only one filling of viscometer is required. In this way, also for standard Ubbelohde viscometers a total sample volume of 25 ml is sufficient. Using solvent rinsing, dosing module and viscometer are rinsed 2 times with solvent. Preferably, this solvent is volatile, to enable a drying step directly afterwards. Otherwise, subsequent a second solvent with low boiling point has to be used, but this does not need to be a solvent for original sample. During drying the remaining residues of

solvent are evaporated by applying vacuum respective in a stream of air, therefore afterwards the next sample can be filled in.

When rinsing with sample, not only some reagent for sample preparation is saved: due to smaller sample bottles, sample racks with 56 instead of 16 positions can be used.



4-tube viscometer, for rinsing with solvent

As a special option it is also possible, to insert an additional rinsing sequence at the end of a measuring series.

Sample rack

There are several sample racks available, depending on the size of the sample bottles. For 100 ml bottles a sample rack with 16 positions is used. For 40 ml bottles and 20 ml vials, there is a sample rack with 56 positions available. The samples are positioned in the sample rack, which is easy to load due to an electric sample lift. The AVS® Pro III allows free selection of sample sequence and moreover individual allocation of samples to certain viscometers.



Two different sample racks are supplied:
a) rack with 56 positions for 20 ml and 40 ml (new) sample bottles.



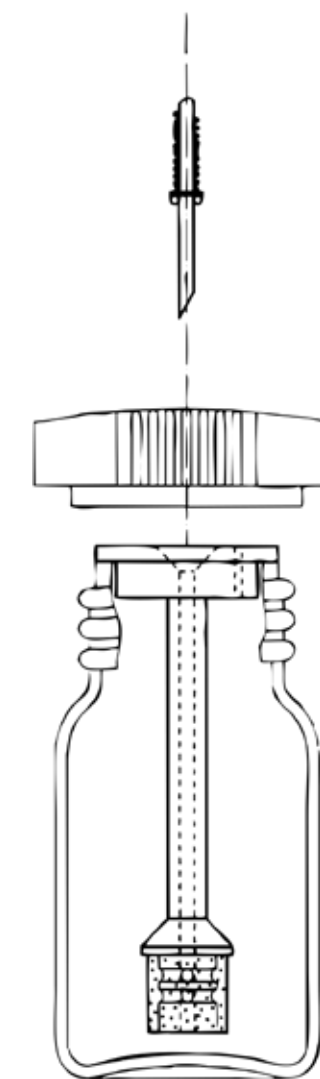
b) Rack with 16 positions for 100ml sample bottles and viscometer with standard sample volume and rinsing with sample



The electric sample lift ensures positioning of the samples in the rack at a convenient and easily monitored working height.

Filtration

As long as particle-free liquids are measured, there is no filtration necessary. In case of only occasional particles, inline filters can be integrated into the filling hoses, to avoid any issues by impurities entering the viscometer. But in case of measuring e.g. glass fiber inforced polymer samples, inline filter can't be used - they would be blocked within short time of use. For such samples there is the ProClean filtration system available, which is already filtering the sample in the sample bottle.



Filtration system ProClean

Working with the AVS® Pro III is ...

The AVS® Pro III is controlled by a PC. The intuitive user interface guides the user clearly through the program. All data inputs are made using the computer keyboard and mouse.

A faulty operating status is indicated by acoustic or optical signals such as arrows, icons and other status messages or request messages. During the entire work sequence, the respective status of the AVS® Pro III is documented on the computer screen. Furthermore, status indicators can be selected for each individual measuring position, which provide additional information on operation.

For the respective type of measurement, pre-parameterized sets of parameters depending on the viscometers, temperature and other measurement criteria are already provided. In addition, all parameters can be individually adjusted to special requirements at a special menu level. All of the standard calculation methods are available:

- mean value
- standard deviation
- outlier test (A %)
- Hagenbach correction
- absolute viscosity, dynamic viscosity (density value required)
- viscosity index (measurement at two temperatures required)
- SUS and SFS
- relative viscosity
- specific viscosity
- reduced viscosity (viscosity number)
- inherent viscosity
- intrinsic viscosity and
- K-value after Fikentscher

The proved and tested AVS® Pro III software also makes it possible to prepare additional individually selected calculations:

During the entire process, all of the parameters (depending on the menu level) and the respective status of the individual measuring positions, the temperature regulation system and the sample transfer system are either visible or can be selected.

The operator interface of the AVS® Pro III is available in German and English. Commercially available

printers for which Windows drivers are available are suitable for documentation purposes.

The AVS® Pro III is built in accordance with international equipment safety standards: and CE certified (equipment safety, low voltage safety, emitted interference and interference immunity).

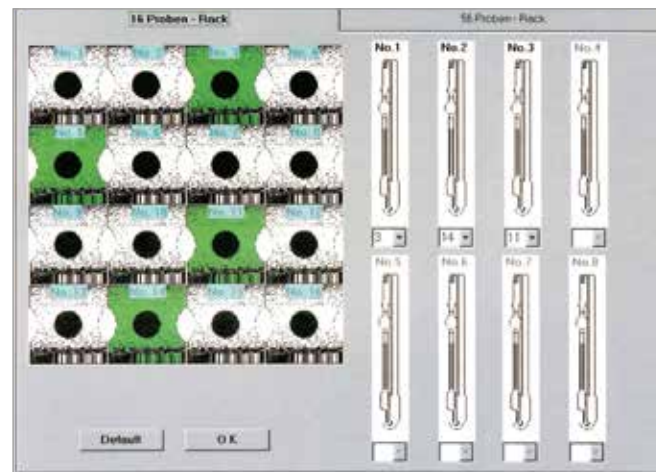
If requested, the AVS® Pro III automatic sampler can be supplied with a manufacturer's inspection certificate based on direct comparison with normal viscometers of the first order in accordance with DIN 53 000-3.

Software

Some features of the software are described in the following.

Individual sample allocation

The AVS® Pro III allows individual allocation between the characteristics of the sample and the viscometers that are currently in operation.



The allocation between the sample and the viscometer is shown on the status display.

In practice, samples of different viscosities can be filled into viscometers of different size and measured at the same time. This even applies to a combination of optical and thermal scanning. Therefore, preliminary sorting of the samples with regard to viscosity and the size of capillary required for the testing process is not necessary.

... easy, reliable and safe

Method

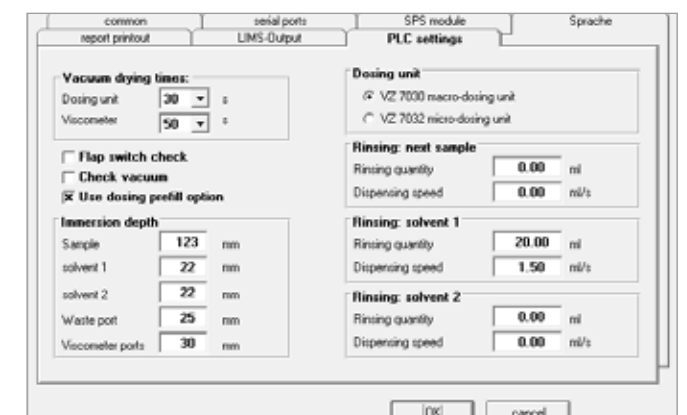
This mode is used to specify what monitoring parameters are to be activated, e.g. if the temperature control of the thermostats is supposed to be handled via the PC.

Options

In several windows, configuration details are parameterized: e.g. size of dosing module, immersion depth of the sample needle, volumes of rinsing solvent, activation of safety devices and temperature control of bath thermostat, but also change of language English/German etc.



Selection of method



Options



Technical data AVS® Pro III

Sampling system	Sample bottles	100 ml screw-type and bottles with standard ground joint (16 pcs per rack)
		20 ml round bottom glass pieces (56 pcs. per rack)
		40 ml EPA-Screw-thread bottle (16 or 56 pcs. per rack)
	Sample rack	for 100 ml screw-type and bottles with standard ground joint
		for 20 ml round bottom glass pieces
		for 40 ml EPA-Screw-thread bottle (16 or 56 pcs. per rack)
Measured value recording	Method	meniscus scanning by means of opto-electronic system or thermal conductivity (TC)
Measuring parameter	throughput time in seconds [s]	
	temperature in degrees Celsius [°C]	
Calculated parameters	mean value, standard deviation, outlier test (A %), Hagenbach correction, absolute viscosity, dynamic viscosity (knowledge of density required), viscosity index (measurement at two temperatures required) SUS and SFS, relative viscosity, specific viscosity, reduced viscosity (viscosity number), inherent viscosity, K-value, intrinsic viscosity	
Selection parameters	by means of PC keyboard, mean value, standard deviation, outlier test (A %), Hagenbach correction, absolute viscosity, dynamic viscosity (knowledge of density required), viscosity index (measurement at two temperatures required) SUS and SFS, relative viscosity, specific viscosity, reduced viscosity (viscosity number), inherent viscosity, K-value, rack position, date/ time, temperature regulation period, number of measurements, number of rinsing operations, start, stop/reset	
	Number of measurements	1 to 99
	Temperature regulation period	0 to 99 min., selectable in increments of 1 min.
	Number of Viscometer tests	0 to 10 with next sample (observe sample quantity) or with external rinsing solvent
	Data memory	by means of PC
Viscosity measurement range	0.35 to 1,200 mm²/s (at room temperature of samples)	
	Time	up to 9999.99 s, resolution = 0.01 s
	Vacuum pressure	automatically controlled
	Viscometers available for use	Ubbelohde viscometer in accordance with DIN standards
		Ubbelohde viscometer in accordance with ASTM standards
		Micro-Ubbelohde viscometer in accordance with DIN standards
		Micro-Ostwald viscometer, Cannon-Fenske-Routine visco
		Cannon-Fenske-Routine viscometer
		TC Ubbelohde viscometer
	TC Micro-Ubbelohde viscometer	

Measuring accuracy	± 0.01 s ± 1 digit, but not more precise than 0.01 %	
	The measuring uncertainty for measurements of absolute kinematic viscosity is also dependent on the uncertainty of the numeric value for the viscometer constant and on the measuring conditions, especially the measuring temperature.	
Evaluations / results	Correction	Hagenbach correction (HC) for Ubbelohde, Cannon-Fenske-Routine, Micro-Ubbelohde and Micro-Ostwald viscometers
	Statistical evaluation	standard deviation, outlier search
Ambient conditions	Ambient temperature	10 to + 40 °C
	Air humidity	max. 85 % relative humidity
Equipment safety	CE-symbol	in accordance with Guideline 89/336/EEC of the Council (EMC compatibility)
		in accordance with Standard EN 50 081, Part 1
		interference immunity in accordance with Standard EN 50 082, Part 2
		in accordance with Guideline 73/23/EEC of the Council (low-voltage guideline)
Housing	plastic/stainless steel / aluminium casing with chemically resistant two-component coating of the plastic pieces	
	Dimensions	w = 1.300 mm, h = 1.000 mm, d = 620 mm (~51" x 43" x 24")
	Weight	dependent on the number of measuring positions ~70 kg
Connections	Pneumatic connections	screw-type connections for viscometer
	Electric connections	circular connectors with bayonet lock for measuring stand and TC viscometer
	Viscometers	up to 4 viscometers connected by individual control units
	Temperature	via serial interface RS232-C of suspended thermostat type: 1 pc. CT 72/4 or up to 2 pcs. CT 72/2, 1 pc. CT 72/2
	Interfaces	control system using PC with 2 x RS232-C interfaces bzw. USB/RS232-Adapter
	Safety	overfilling safety device of waste bottle and suction hose
	Mains connection	European built-in plug DIN 49 457 6 with fuse
Data transmission	Interface internal	bidirectional serial interface in accordance with EIA RS232-C (daisy chain concept)
	Interface external	via PC, bidirectional serial interface in accordance with EIA RS232-C
Power supply	Mains voltage	230 V (AC) or 115 V (AC), 50 to 60 Hz (AC)

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