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HAAKE Viscometer



Falling Ball Viscometer, Viscotester®  
and Accessories

Analyze • Detect • Measure • Control™

**Thermo**  
ELECTRON CORPORATION

## Basic principles of rheology, selecting a viscometer

### Viscometry

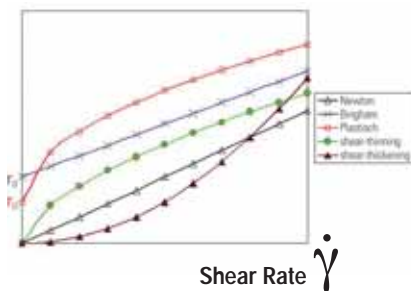
Measuring instruments for the determination of the flow behavior of fluids are called viscometers. Viscosity is a material property which is dependent on different parameters such as mechanical stress and strain, time as well as temperature and other ambient conditions.

### Flow behavior

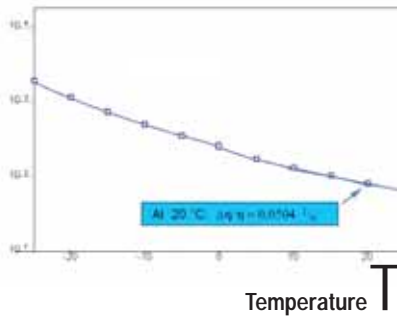
In rheology we differentiate between so-called Newtonian and non-Newtonian materials. Newtonian materials are characterized by a viscosity which may depend on temperature but is independent of the shear rate (and shear stress). In contrast, the viscosity of non-Newtonian materials depends on the shear rate. For most non-Newtonian materials the viscosity decreases with increasing shear rate. This behavior is called shear-thinning, or pseudoplastic. A material which viscosity increases at increasing shear rates is called shear-thickening or dilatant.

Materials that do not flow until the applied shear stress surpasses a certain value are said to have a yield-stress.

### $\tau$ Shear Stress



### $\eta$ Viscosity



### Rotational viscometers

Using a rotational viscometer, the viscosity is calculated from the measured torque and rotational speed as well as the dimensions of the measuring geometry. If the measuring geometry fulfils certain requirements (e.g. small gap), which is the case for coaxial cylinder, plate/plate and cone/plate measuring geometries (DIN 53018, DIN 53019...), the absolute value of the viscosity can be calculated.

If the dimensions of the measuring geometry are not well defined, only a relative value for the viscosity can be determined. In this case, the measured viscosity value not only depends on the ambient conditions, but also on the test method, i.e. the measuring geometry.

### Falling ball viscometers

The falling ball viscometer is a conventional and highly accurate instrument for the determination of the absolute value of the viscosity of a Newtonian material. The viscosity can be calculated from the falling time of the ball, the density of the ball as well as the diameter of the tube and the ball.

### Overview of HAAKE Viscometers and Rheometers

#### Falling Ball Viscometers

HAAKE Falling Ball Viscometer Type C  
HAAKE MicroVisco 2

#### Rotational Viscometers

HAAKE Viscotester® 1 plus & 2 plus\*  
HAAKE Viscotester® 6 plus & 7 plus  
HAAKE Viscotester® 550\*  
HAAKE RotoVisco 1\*

#### Rotational Rheometers

HAAKE RheoStress 1\*  
HAAKE RheoStress 600\*

#### Optical Rheometers

HAAKE RheoScope 1\*

#### Extensional Rheometers

HAAKE CaBER 1\*

\*Description in separate brochures.



### Viscometer selection

This table should help you to choose a viscometer. It includes an overview of the HAAKE viscometers and their typical features.

### Viscometer selection

HAAKE	Viscotester 1 plus & 2 plus	Viscotester 6 plus & 7 plus	Falling Ball Viscometer type C	MicroVisco2
Description	Page 3	Pages 4/5	Page 6	Page 7
Measurement	relative	relative	absolute*	absolute*
Standards		ISO 2555	DIN 53015, ISO 12058	DIN 53015, ISO 12058
Viscosity	VT1plus: low VT2plus: medium	L-Version: low to medium R-Version: medium to high	low to high	low
Specials	battery-powered hand-held instrument, digital display	2 years warranty	measurements on gases	small sample volume

\*For Newtonian substances.

## HAAKE Viscotester 1 plus & 2 plus

### Application

These small, battery-operated rotational viscometers are suitable for quick and reliable tests and comparative measurements for quality control applications. The hand-held instruments can also be operated on a stand.

### User friendliness

The operation of the HAAKE Viscotester 1 plus & 2 plus is especially easy due to the one-button operation. The Viscotester is switched on and off by pushing the button once. Pushing the button again selects the rotor type and starts the measurement.

### Digital display

Contrary to the traditional Viscotester models where the viscosity value is read from an analog dial, the HAAKE Viscotesters 1 plus and 2 plus show the viscosity value on a digital display. Therefore, errors caused by misreading the dial belong to the past. Possible handling errors as well as service information are also shown on the display.

### Main features

- Quick, exact and reliable
- One button operation
- LCD display
- No mains supply required

### Typical application fields

- Quick viscosity tests, e.g. for process optimization or machine adjustment
- Batch control in production

### Typical samples

- Printing inks, paints, inks
- Shampoos, creams, lotions
- Oils, greases, pastes
- Sauces, thickeners

### Measuring principle

A rotor rotating at a constant speed is immersed in the fluid to be tested; the fluid's resistance to the rotation measures the viscosity of the fluid. The small battery-operated rotational viscometer can be operated independent of a mains supply, so that quick and reliable viscosity measurements can be performed virtually everywhere.

### Compatibility

Measuring cups and rotors of the previous models HAAKE VT01 and VT02 can also be used with the plus units.

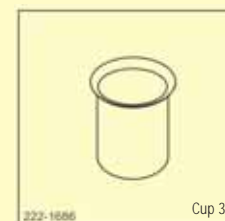
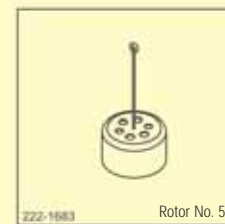
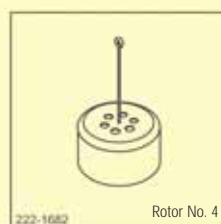
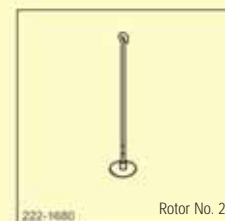
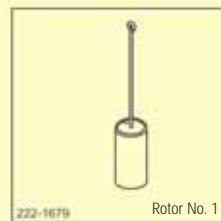
### Technical data

- Viscosity range:  
1 plus: 1.5 - 330 mPas  
2 plus: 0.3 - 4000 dPas
- Temperature: up to 150°C
- Rotor speed: 62.5 rpm
- Reproducibility:  $\pm 1\%$  FSD
- Measuring accuracy:  
standard:  $\pm 5\%$  FSD  
optional:  $\pm 1\%$  FSD
- Standard display:  
VT 1 plus  $\eta$  in mPas  
VT 2 plus  $\eta$  in dPas  
Optional:  
VT 1 plus  $\eta$  in dPas  
VT 2 plus  $\eta$  in mPas



### Order information

Order-No.	Description
399-0100	HAAKE Viscotester 1 plus: Basic instrument with batteries instrument holder 2 Measuring cups (A and B) 3 Rotors (No. 3, 4, 5) Delivered in a carrying case
399-0200	HAAKE Viscotester 2 plus: Basic instrument with batteries instrument holder 1 Measuring cup (3) 3 Rotors (No. 1, 2, 3) Delivered in a carrying case
222-1693	Calibration to a measuring accuracy of $\pm 1\%$ FSD
222-1688	Battery charger incl. 4 AA batteries



## HAAKE Viscotester 6 plus &amp; 7 plus

**Application**

The HAAKE Viscotester 6 plus & 7 plus units can be used for tests and comparative measurements for quality control according to recognized standards.

**Measuring principle**

The HAAKE Viscotester is a classical rotational viscometer that measures the resistance of a test substance against a preset speed. The resulting torque or resistance measures the viscosity of the fluid.

The higher the torque, the higher the viscosity. Due to the standardized geometry, the shear rates generated can only be determined precisely for Newtonian substances.

**Compatibility**

The basic ISO 2555 standard describes the design and the characteristic measuring technique of a viscosity measuring instrument (torque, speed, rotor geometry). If a rotational viscometer meets these requirements – as the HAAKE Viscotester 6 plus & 7 plus do – the results comply with the Brookfield method and are 100 %-compatible as long as comparable viscometer versions are used.

**Standards**

The HAAKE Viscotester 6 plus & 7 plus meets the following standards:

BS: 6075, 5350

ISO: 2555, 1652

ASTM: 115, 789, 1076, 1084, 1286, 1417, 1439, 1638, 1824, 2196, 2336, 2364, 2393, 2556, 2669, 2849, 2983, 2994, 3232, 3236, 3716

**Common features of HAAKE Viscotester 6 plus & 7 plus**

- Ready to go package – unpack, switch on and start measuring viscosity
- Digital display of viscosity, % torque, speed, spindle, upper viscosity limit
- Integrated automatic diagnostic functionality
- Visual and acoustic signals at critical measuring conditions
- Digital calibration of the torque with nationally traceable standards
- Digital speed control with built-in accuracy via step motor
- 2 years warranty for the most stable measuring instrument in its class

**Additional features of the HAAKE Viscotester 7 plus**

- Bi-directional RS232 interface
- HAAKE RheoWin software (optional) for measurement and data evaluation
- Temperature sensor Pt100 to monitor the sample temperature

**Version "L" or "R"?**

**L** is mainly used for low-viscous substances such as diluted solutions, oils, dispersions and emulsions. Milk-like fluids (2-5 mPas) would be an example at the low end of viscosity and motor oil would represent the high end. The measuring range is from 3 - 6 000 000 mPas.

**R** for medium-viscous substances is the "standard" viscometer for 80 % of all viscosity measurements. It is especially suited for the medium viscosity range extending from sewing machine oil up to PVC plastisols or whipped cream. The measuring range is from 20 - 40 000 000 mPas.

**Technical data**

■ **Ambient conditions:**

The instruments can be used at ambient temperatures from +10 °C to +40 °C and a relative humidity of up to 80 %. The power supply should be between 110 - 240V/50-60Hz.

■ **Display:**

- η dynamic viscosity in mPas (cP)
- upper viscosity limit in mPas (cP)
- % τ torque in % of the max. value
- n speed in rpm
- # number of the selected spindle
- T temperature in °C (F)
- (only HAAKE Viscotester 7 plus)

■ **Rotational speeds:**

0.1 / 0.2 / 0.3 / 0.5 / 0.6 / 1 / 1.5 / 2 / 2.5 / 3 / 4 / 5 / 6 / 10 / 12 / 20 / 30 / 50 / 60 / 100 / 200  
Accuracy: <math>\pm 0.5\%</math> of the absolute value

■ **Torque:**

The versions L and R differ in the torque range roughly by a factor of 6. The value displayed is measured with a maximum uncertainty of  $\pm 1\%$  in relation to the full scale (100 %).

■ **Viscosity range:**

Accuracy:  $\pm 1\%$  of full scale  
Reproducibility:  $\pm 0.2\%$ .

Version L:  
3 - 6.000.000 mPas in 84 ranges  
(21 speeds with 4 spindles)

Version R:  
20 - 40.000.000 mPas in 126 ranges  
(21 speeds with 6 spindles)



**Order information**

The HAAKE Viscotester 6 plus & 7 plus is supplied as a complete measuring unit consisting of the basic instrument with stand, set of spindles with a storage rack in a stable carry case with multilingual documentation.

Order-No.	Description
387-0100	HAAKE Viscotester 6L plus: Basic instrument with stand, spindles L1 to L4, rack, spindle guard in a case
388-0100	HAAKE Viscotester 6R plus: Basic instrument with stand, spindles R2 to R7, rack, spindle guard in a case
389-0100	HAAKE Viscotester 7L plus: Basic instrument with stand, spindles L1 to L4, rack, spindle guard, Pt100 sensor in a case
390-0100	HAAKE Viscotester 7R plus: Basic instrument with stand, spindles R1 to R4, rack, spindle guard, Pt100 sensor in a case

**Optional accessories:**

Order-No.	Description
	Measuring and evaluation software HAAKE RheoWin; incl. cable
098-5037	HAAKE Viscotester 7L plus
098-5038	HAAKE Viscotester 7R plus
	Helipath stand to penetrate motor driven new test fluid; incl. spindles
222-1380	Helipath stand (230V/50Hz)
222-1386	Helipath stand (115V/60Hz)
222-1379	(UL)-Adapter for low-viscous samples, which extends the measuring range down to lower viscosities; incl. spindle
222-1378	(AKV)-Adapter for small sample volumes Necessary accessory:
222-1397	Set of spindles for L-Version of the Viscotester resp.
222-1387	Set of spindles for R-Version of the Viscotester
222-1395	Spindle R1 for the HAAKE Viscotester R-Version
222-1398	Set of spindles for the HAAKE Viscotester L-Version (L1-L4)
222-1396	Set of spindles for the HAAKE Viscotester R-Version (R2-R7)



**Helipath**

- for comparative measurements on high viscous samples such as creams, pastes, gels etc.
- up and down movement of the measuring head allowing the needle spindle to cut into fresh material tracing a helicoidal path through the sample



**Adapter**

- stainless steel sample chamber, removable
- Flow jacket that allows temperature control of the sample between -10°C and 100°C

**UL-adapter for low viscosities**

- allows reproducible and accurate measurements of the viscosity from 1.0\*mPas for L-models and 6.4 mPas for R-models  
(\* Taylor vortices may result in additional errors.)

**AKV-adapter for small samples**

- sample volume from 8 to 13 ml, depending on the spindle used

## HAAKE Falling Ball Viscometer type C

### Application

The HAAKE Falling Ball Viscometer type C provides a very accurate way of measuring the viscosity of transparent Newtonian liquids and gases. It meets the requirements of the German DIN 53015 as well as ISO 12058 standard and it is accepted as an official reference instrument. Its measuring accuracy when supported with the precise temperature control of a circulator is among the highest available in any type of viscometer.

- Chemical industry (polymer solutions, solvents, inks)
- Pharmaceutical industry (raw materials, glycerine)
- Food industry (gelatin, sugar solutions)
- Mineral oil industry (oils, liquid hydrocarbons)

### Measuring principle

The rolling and sliding movements of a ball through the sample liquid are timed in an inclined cylindrical measuring tube. The sample viscosity is correlated to the time needed by a ball to traverse a definite distance. By turning the measuring tube upside down again the return of the ball may also be used for an additional measurement.

The test results are given as dynamic viscosity in the internationally standardized, absolute units of milli Pascal seconds (mPas).

### Technical data

- Viscosity range: 0.5 - 10<sup>5</sup> mPas (cP)
- Temperature range: -20°C to +120°C
- Reproducibility: < 0.5 %
- Comparability: < 1 %
- Material: Falling tube, balls 1, 2 and G, boron silicical glass; balls 3, 4, 5 and 6, Nickel iron alloy

Viscosity $\eta$ 20°C (mPas)		Ball
10 <sup>5</sup>	Tar	6
10 <sup>4</sup>	Honey	5 6
10 <sup>3</sup>	Glycerine	5 4
10 <sup>2</sup>	Lubricating oil	3 4
10 <sup>1</sup>	Olive oil	3 2
	Spindle oil	3 2
10 <sup>0</sup>	Water	1 2
10 <sup>-1</sup>	Ether	1 6
10 <sup>-2</sup>	Neon	6

### Order information

Order-No.	Description
356-0001	Falling Ball Viscometer type C including 6 balls, instrument case, thermometer -1°C up to 26°C (0.1°C divisions), cleaning tools, calibration sheet, instruction manual
800-0176	Stopwatch, LCD-Display up to 9 h, 59 minutes, 59.99 seconds
800-0009	Ball G for gas measurements
333-0639	Pt100 temperature sensor for falling ball - DC50 circulator



## Application

The HAAKE MicroVisco 2 unit is a fully automatic, miniaturized version of the traditional falling ball viscometer according to Höppler with integrated Pelties temperature control. It is specially designed for measurements of optical transparent Newtonian fluids which are of low to medium viscosity and only available in a small sample volume.

## Applications

### ■ Precise viscosity measurements

Solvent, inks, plasma, serum, beverages, sugar solutions, gelatine solutions, beer, oils, polymer solution

### ■ Small sample volume

Tears, eluate of HPLC

### ■ Automatic reactions kinetic

To monitor the polymerisation in the laboratory; characterization of enzymatic reactions

### ■ Temperature dependency

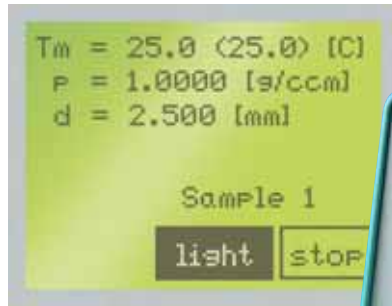
The microprocessor-controlled temperature system allows for monitoring of the viscosity-temperature behavior of a fluid

## Measurement

The sample to be measured is pulled into the syringe without bubbles and placed into the temperature controlled holder of the HAAKE MicroVisco 2 unit. The sample reached the test temperature after approx. 5 min, and the measuring ball is pulled in the upper start position by means of a magnet. The ball then rolls down the wall of the syringe, which is inclined (15°C) to avoid bouncing. The fall of the ball is delayed by the resistance of test fluids. The falling ball time is proportional to its viscosity. The test result is the falling time for a defined distance which is measured electronically and converted into viscosity units by the stored calibration factors.

## Technical data

- Viscosity: 0.2 - 1000 mPas
- Repeatability: ± 0.3 %
- Comparability: ± 0.5 %
- Uncertainty: 0.2 - 0.7 % (depends on ball used)
- Temperature: 0 - 100°C
- Volume: 400 µl
- Meas. time: 3 - 5 minutes
- Display in: mPas, cP, cSt, ms
- Dialog languages: english, german
- Mains voltage: 100/230 V/50-60 Hz



Order information	
Order-No.	Description
284-1001	HAAKE MicroVisco 2 measuring instrument with built-in processor, Peltier temperature control, 2 measuring syringes, 4 set of balls, 10 balls each, instruction manual
222-1517	400 µl syringe for HAAKE MicroVisco 2 set with 5 steel and 5 gold plated balls each
222-1518	D = 2.381 mm
222-1519	D = 2.5 mm
222-1520	D = 3.0 mm
222-1521	D = 3.175 mm

## Standard Liquids

According to ISO 9000, measuring devices which are used in the production and quality processes have to be inspected...

- periodically at regular intervals
- with nationally traceable standards

The inspection intervals, criteria and admitted tolerances are defined in the quality handbook of the company using the instrument.

Thermo supplies liquids with different qualities.

Order information			
Order-No.	Type	Description	η (20°C)*
082-5303	100BW	Standard liquid 100 ml	100 mPas*
082-5304	2000AW	Standard liquid 100 ml	2000 mPas*
082-5305	10000BW	Standard liquid 100 ml	10000 mPas*
082-5042	E7	Test fluid 100 ml	5 mPas
082-5043	E200	Test fluid 100 ml	120 mPas
082-5044	E2000	Test fluid 100 ml	1900 mPas
082-5046	E6000	Test fluid 100 ml	6000 mPas
082-5336	E15000	Test fluid 100 ml	15000 mPas
082-5335	E40000	Test fluid 100 ml	40000 mPas

\* Viscosity values for further temperatures: 23, 25, 30, 40 and 100°C.

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