Instruction Manual

HAAKE Falling Ball Viscometer Type C

Analyze • Detect • Measure • Control™

Thermo
ELECTRON CORPORATION

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1. Quality Assurance

Dear customer,
Thermo Electron (Karlsruhe) implements a **Q**uality **M**anagement **S**ystem certified according to DIN/EN/ISO 9001:2000. This guarantees the presence of organizational structures which are necessary to ensure that our products are developed, manufactured and managed according to our customers expectations. Internal and external audits are carried out on a regular basis to ensure that our **QMS** is fully functional. We also check our products during the manufacturing process to certify that they are produced according to the specifications as well as to monitor correct functioning and to confirm that they are safe. This is why we initiate this monitoring process of important characteristics already during manufacturing and record the results for future reference.

The “Final Test” label on the product is a sign that this unit has fulfilled all requirements at the time of final manufacturing.

Please inform us if, despite our precautionary measures, you should find any product defects. You can thus help us to avoid such faults in future.

2. Your Contacts at Thermo Electron (Karlsruhe) GmbH

Please get in contact with us or the authorized agent who supplied you with the unit if you have any further questions.

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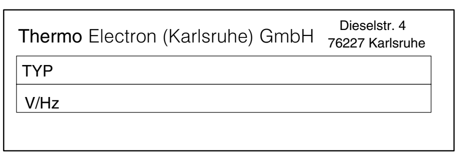


The following specifications should be given when product enquiries are made:

Unit name printed on the front of the unit and specified on the name plate.

3. Key to Symbols

! Warns the user of possible damage to the unit.

☞ Denotes an important remark.

1 Indicates the next operating step to be carried out and…

⇒ …what happens as a result thereof.

4. Safety Precautions

These notes are intended to draw your attention to risks which only **YOU** can recognize and avoid or overcome. They are intended to enhance your own safety consciousness.

We have set the highest quality standards for ourselves and this unit during development and production. Every unit meets relevant safety regulations. **The correct unit usage and proper handling is however solely your responsibility.** The following notes must be observed:

! **This instruction manual must be carefully studied! It contains important information on the connection to the local mains supply, correct unit usage and safe handling.**

! **Check for transportation damage during unpacking. Get in contact with supplier and/or carrier for settlement of damage claims. Do not try to start up a damaged unit before the damage has been repaired or you have ascertained the effect of the damage.**

! **Ensure that this manual is always at hand for every unit operator.**

! **Only use this unit solely for the intended application.**

! **Repairs, alterations or modifications must only be carried out by specialist personnel. Considerable damage can be caused by improper repairs. The Thermo Electron (Karlsruhe)-service department is at your disposal for repair work.**

! **Do not operate the unit with wet or oily hands.**

! **Do not expose the unit to spray water.**

! **Do not clean the unit with solvents (fire risk!) – a wet cloth soaked in household detergent is normally sufficient.**

! **Only use the heat transfer liquids recommended by Thermo Electron (Karlsruhe). Please refer to the respective EC – Safety Data Sheet.**

You alone are responsible for the handling of these substances!

Our advice:

- If in doubt, consult a safety specialist.
- Read the product manufacturer's or supplier's "*EC – SAFETY DATA SHEET*"
- Read relevant regulations concerning dangerous materials
- Observe relevant guidelines for laboratories in your country

5. Unpacking

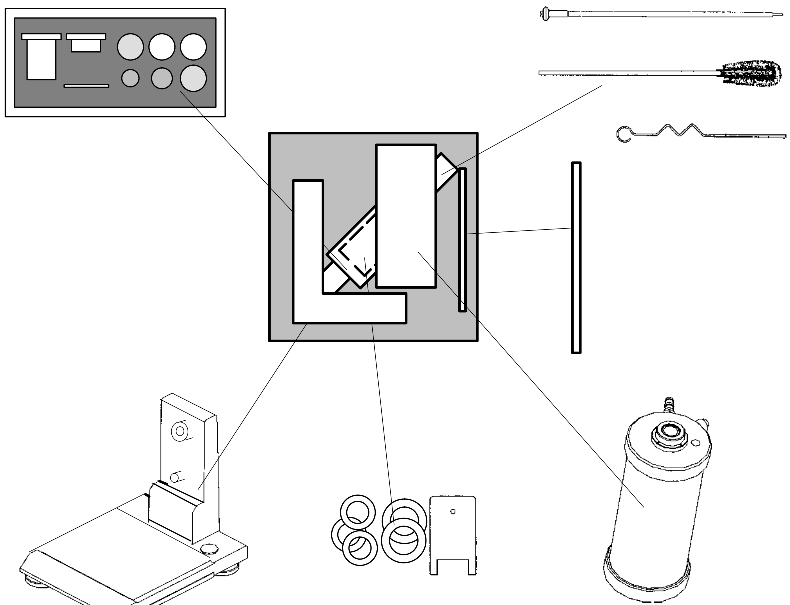
5.1 Transportation damage?

- Notify carrier (forwarding merchant, railroad, post office etc.),
- Compile a damage report.

5.2 Before return delivery:

- Inform dealer or manufacturer (Small problems can often be dealt with on the spot).

5.3 Contents of Delivery



The following standard accessory is delivered together with the falling ball viscometer:

Order-No.	Description	
002-7580	Falling ball viscometer, ready for testing	
800-0182	Set of balls 1–6 (see chapter 10.3)	
800-0012	Hollow stopper	
800-0013	Stopper	
800-0119	Ball tweezers	
800-0125	Cleaning piston	
800-0131	Cleaning brush	
800-0014	Cover plate	
800-0027	Stopper gasket	∅ = 15.6 mm
800-0061	Thermometer gasket	∅ = 10 mm
003-2110	Socket wrench (see chapter 10.2)	
002-7585	Instruction manual	

5.4 Material for use

No other material except for cleaning material (800-0125 cleaning piston, 800-0131 cleaning brush) is necessary at normal use.

5.5 Spare parts

See chapter 13.

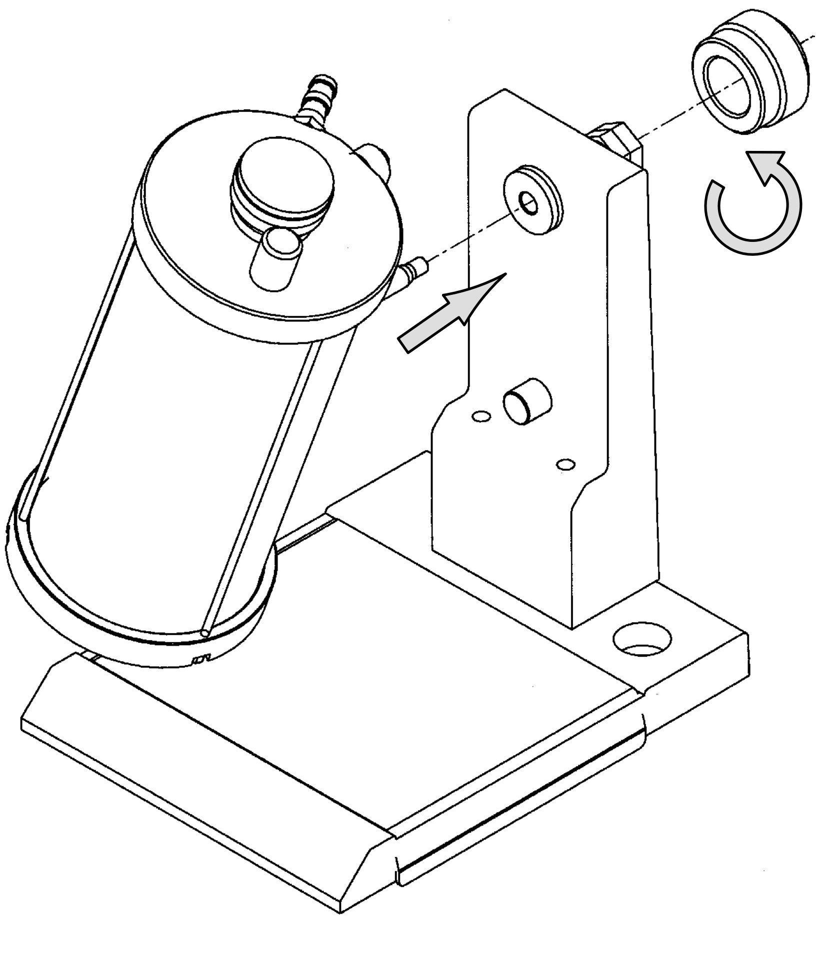
5.6 Waste disposal

The transportation packing is made out of paper and can be recycled.

6. Setting Up

6.1 Assembly

Insert the measuring tube into the stand and fasten it with the knurled nut.



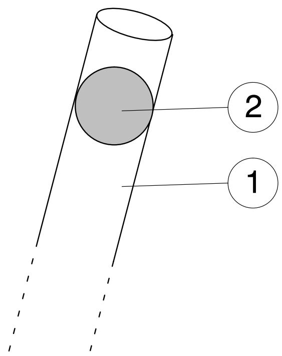
7. Unit Description

7.1 Principle of the measurement

The HAAKE Falling Ball Viscometer measures the viscosity of transparent newtonian liquids. This viscosity is correlated to the time a ball requires to fall a defined distance. The rolling and sliding movement of the ball through the sample filled into a slightly inclined cylindrical measuring tube is described by means of the fall time. The test results are given as the dynamic viscosity using the internationally standardized absolute unit of ”milli Pascal seconds” (mPa·s).

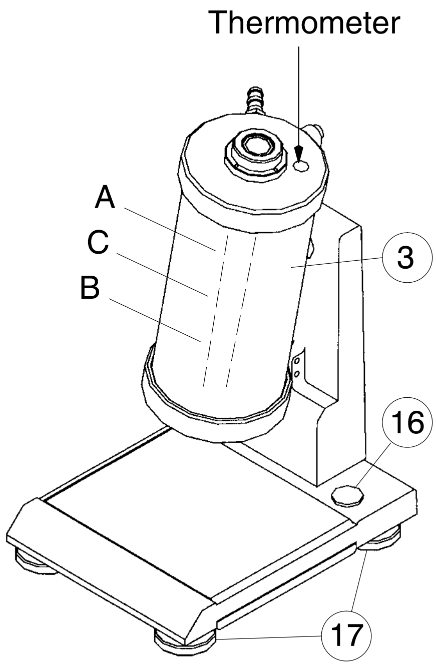
Note: 1 mPa·s = 1 cP (centi Poise)

The Falling Ball Viscometer corresponds to the requirements of many international standards, i.e. ISO 12058 and the german standard DIN 53 015.



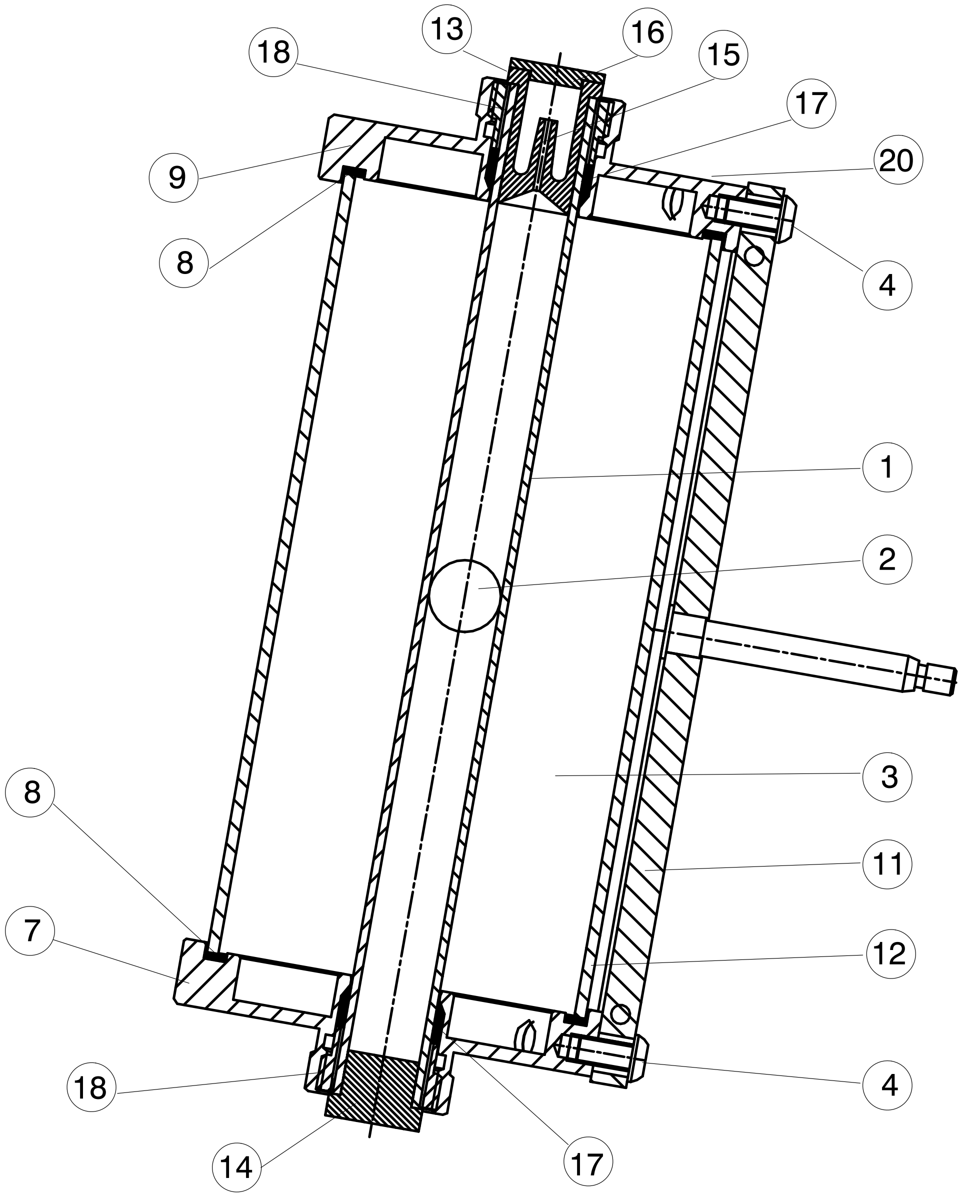
7.2 Description of the instrument

The heart of the instrument is the measuring tube made of glass **1** and a ball **2**. This tube carries two ring marks A and B, which are spaced 100 mm apart and which limit the measuring distance (ring mark C is equidistant between A and B). The measuring tube is jacketed by means of an outer glass tube, which encloses a room **3** to be filled with a temperature controlled liquid. The measuring tube is fastened to the stand in such a way that its axis is inclined with respect to the vertical by 10° during the measurement.



The measuring tube together with the jacket may be pivoted in order to turn the tube upside down again to let the ball return to the initial position before a measurement. The measuring tube is closed on both sides by two stoppers, one of which **13** contains a capillary and a small reservoir. This stopper prevents undesirable changes of pressure in the liquid sample and has a passage for air bubbles when the temperature is being changed. The viscometer incloses all samples completely to prevent volatization and film forming. The stand may be levelled by means of its water level **16** and the levelling screws **17**. The easily interchangeable thermometer allows a precise temperature control.

8. Functional Elements



1	Falling tube	**12**	Jacket tube
2	Ball	**13**	Hollow stopper
3	Tempering room	**14**	Stopper
4	Screw	**15**	Capillary
7	Set screw	**16**	Closing plate
8	Gasket	**17**	Gasket for falling tube
9	Cover	**18**	Threaded bush
11	Brace	**20**	Connecting rod

9. Measuring

9.1 Preparation for a test

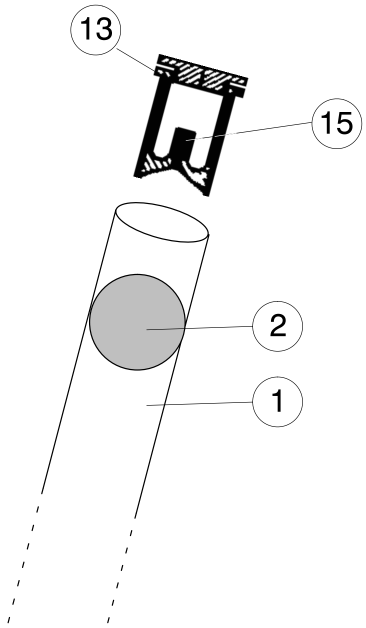
9.1.1 Temperature control

The HAAKE Falling Ball Viscometer may be temperature controlled in a temperature range from –20 up to +120°C using liquid circulators, i.e. one of the HAAKE "DC" or "F" series.

The sample should rest at least some 15 minutes in the measuring tube at the test temperature before the measurement is started.

The temperature in the jacket around the measuring tube must be maintained within a temperature tolerance of ± 0.03°C for test temperatures between 10 up to 80°C.
For test temperatures beyond these limits the tolerances may be increased to +0.05°C.

The tempering room **3** must be free of air bubbles.



9.1.2 Loading the sample

All parts of the viscometer being in direct contact with the sample must be kept clean and dry.

A sample volume of approximately 45 cm^3 is poured into the measuring tube **1** up to 20 mm below the rim of the tube. Then the ball **2** is placed into the tube and the hollow stopper **13** is introduced. The liquid should reach a level just beyond the capillary **15**. The sample in the tube must be free of air bubbles.

Before the final test data are taken the ball should run through the tube up and down at least once to improve the homogeniety of the samples and its temperature uniformity.

9.1.3 Selection of the balls

The standard ball set contains 6 balls, which pass through the measuring tube of an inner diameter of approximately 15.94 ±0.01 mm.

Order-No.	Ball No.	Made of	Density ρ g/cm³	Diameter of the ball mm	Constant K (approx.) mPa·s·cm³/g·s	Recomm. measuring range mPa·s
800–0002	1	boron silica glass	2.2	15.81 ± 0.01	0.007	0.6 – 10
800–0003	2	boron silica glass	2.2	15.6 ± 0.05	0.09	7 – 130
800–0004	3	nickel iron alloy	8.1	15.6 ± 0.05	0.09	30 – 700
800–0005	4	nickel iron alloy	8.1	15.2 ± 0.1	0.7	200 – 4800
800–0006	5	W.-No. 4034	7.7–8.1	14.0 ± 0.5	4.5	800 – 10000
800–0007	6	W.-No. 4034	7.7–8.1	11.0 ± 1	33	6000 – 75000

Additionally the following balls are deliverable:

Order-No.	Ball	Made of	Density ρ g/cm³	Diameter of the ball mm	Constant K (approx.) mPa·s·cm³/g·s	Recomm. measuring range mPa·s
800–0009	G	boron silica glass	2.2	15.91 ± 0.01	–	gases
800–0010	G3	boron silica glass	2.2	15.30	0.4	20 to 200
800–0011	G4	boron silica glass	2.2	14.40	3.5	150 to 1500

The measuring ranges for viscosity indicated are related to DIN 53015 / ISO 12058.

Sometimes it may be necessary to use two different balls in order to cover a wider measuring range, i.e. when the function of viscosity versus temperature is measured over a wide temperature intervall; in this case, you insert two different balls at the same time into the measuring tube with the smaller ball inserted first. The reduced starting distance will not influence the test result significantly, but increases the uncertainty.

9.2 Measurement of the falling times

The jacket tube snaps into a defined 10°-position at the bottom of the instrument.

By turning over the jacket tube, the ball is set to the measuring position.

The falling time of the ball moving from the ring mark A to ring mark B is determined by using a stop watch. The time period starts when the lower periphery of the ball touches the ring mark A, which must appear as a straight line. The falling time ends when the lower periphery of the ball touches the ring mark B, which again must appear as a straight line. If one uses the distance AC or CB to reduce very long falling times for high viscous liquids the double of the measuring time period must be taken into account.

Turning the jacket tube 180° again the ball returns to its start position. It is good practice to take the mean value out of several falling time values (3 to 5).

The falling times for the ball returning may vary from the normal value (up to 1 %). If the returning of the ball should also be used for exact measurements a new constant K must be determined.

Constant for the returning of the ball:

$$K_{return} = \frac{\text{normal falling time} \cdot \text{normal constant K}}{\text{falling time when returning}}$$

When testing dark liquids it is usually very difficult to see the lower part of the ball. In this case we advise to take the ball equator when it passes through the ring marks.

9.3 Evaluation of the test results

The dynamic viscosity η (in mPa·s) is calculated using the following equation:

$$\eta = K (\rho_1 - \rho_2) \cdot t$$

where:

K = ball constant in $mPa \cdot s \cdot cm^3/g \cdot s$ (see chapter 11)

ρ_1 = density of the ball in g/cm^3 (see chapter 11)

ρ_2 = density of the liquid to be measured at the measuring temperature in g/cm^3

t = falling time of the ball in seconds.

Test results:

The dynamic viscosity η is given in units of mPa·s (cP) and must be completed by stating the sample temperature.

The dynamic viscosity η may be converted to the kinematic viscosity ν by using the following equation:

$$\nu = \frac{\eta}{\rho}$$

ν = kinematic viscosity [mm^2/s] [1 mm^2/s = 1 cSt]

η = dynamic viscosity [mPa·s]

ρ = density of the liquid sample [g/cm^3]

To evaluate the reliability of the results the following criteria may be used:

9.3.1 Reproducibility (one person, one instrument)

If one person determines two test results under identical test conditions, these results are supposed to be acceptable if they do not vary more than the figures stated in the table below from the average value.

9.3.2 Comparability (several persons, several different instruments)

If two sets of test results are reached in two different laboratories under comparable conditions, these results are supposed to be acceptable if they do not vary more than the figures stated in the table below from the average value.

Ball-No.	Reproducibility %	Comparability % DIN 53015	Comparability % ISO 12058
1	1.0	2	2
2, 3, 4	0.5	1	2
5	0.7	1.5	1
6	1.5	3	3

☞ Please note: Even when using balls with different diameters for newtonian liquids identical viscosity values will be obtained.
When non-newtonian liquids are tested varying viscosity values will result when balls of differing ball diameters are being used. Test data of non-newtonian liquids only allow comparing similar samples, but test results must not be given using mPa · s units!

Non-newtonian liquids may be fully characterized rheologically by means of absolute rotational viscometers, i.e. the HAAKE VISCOTESTER® or ROTOVISCO®.

9.3.3 Example

(sugar solution of 40 %)

Density of ball 2:	2.2 (g/cm^3)
Density of the solution:	1.18 (g/cm^3)
Ball constant K :	0.09 (mPa·s·cm^3/g·s)
Falling time:	61 s
Measuring temperature:	20.0°C

The absolute viscosity is ...

$\eta_{20°C} = 0{,}09 \cdot (2{,}2 - 1{,}18) \cdot 61 = 5{,}60$ (mPa · s)

In most cases the densities of the test liquids are known. The evaluation may be simplified by introducing a factor which includes the densities. In our example of the sugar solution the exact factor is ...

$(\rho_1 - \rho_2) \cdot K = 0{,}1098$ (mPa · s / s)

9.4 Viscosity determination of gases

The viscosity determination of gases has to be done with ball G which is made out of glass.

1. The measuring tube must be closed with rubber stoppers fitted with glass stopcocks.

Measuring tube, glass ball and gas must be clean and dry.

2. The tube is flushed several times with the gas to be tested to push out any remains of air. Then the tube filled with the gas sample is closed with the stopcocks and raised to the test temperature.

The calculation of the gas viscosity is based on the comparison with the viscosity of air at 20 ° C (η = 1815·10^{-5} mPa·s):

$$\eta_{gas} = \frac{F_G}{F_A} \cdot 1815 \cdot 10^{-5} \text{ (mPa} \cdot \text{s)}$$

where:

η_{gas}: viscosity of the gas at the temperature T

F_G : falling time of the ball in the gas at the temperature T

F_A : falling time of the ball in air at a temperature of +20°C

Viscosity of the air at a temperature of +20°C:

1815 · 10^{-5} (mPa · s)

10. Cleaning the Measuring Tube

1 Usually the tube is cleaned by rinsing it with a suitable solvent.

2 High viscous liquids (glue and heavy oils, etc.) have to be removed with the cleaning piston which is supplied with the instrument. Push this piston slowly through the tube.

⇒ After this, there will be only a thin film of the liquid left on the walls of the tube which then can be removed with a solvent.

☞ Especially when measuring with balls 1 and G it is very important, that the tube and the ball are clean.

11. Calibration of the Falling Ball Viscometer

The falling ball viscometer is checked according to the HAAKE regulations before delivery. The geometry relates strictly on the DIN 53015/ISO 12058 and therefore the listed ball constants can be used.
The calibration of the instrument can be done using nationally recyclable calibration fluids. This procedure is also recommended for new balls or after repairs and for falling ball viscometers integrated into a measuring procedure according to ISO 9000.

Testing ...

periodically: to be defined by the user or to be read in the QC-hand book.

with nationally recyclable standards: Calibration fluids acknowledged in the corresponding user country, e.g. Europe: DKD/PTB calibration fluids, in Japan: JIS fluids or in the USA: Cannon calibration fluids.

The calibration excludes the influence of allowed tolerances when measuring balls and falling tubes.

The following Thermo Electron (Karlsruhe) products can be used for testing the instrument:

Order-No.	Type	η (mPas) at 20°C	for balls
082–5042	E7	5	1
082–5043	E200	120	2, 3
082–5044	E2000	1900	4
082–5046	E6000	6000	5, 6
082–5336	E15000	15000	6

For calibration of the falling ball viscometer the following calibration fluids (recyclable in Europe) are recommended:

Order-No.	Type	η (mPas) at 20°C	for balls
082–5303	100 BW	100	2, 3
082–5304	2000 AW	2000	5
082–5305	10000 B	10000	5, 6

The calibration fluids should be stored in dark rooms and be used within 3 months after their date of expiry.

The disposal depends of the composition of the substance which is listed in the “*EC – SAFETY DATA SHEET*”.

It is absolutely essential that for calibration the instructions for filling the tube and cleaning are closely adhered to.
It is very important to observe the test temperature of the calibration liquids as indicated on the bottles.

☞ **To avoid contamination the test fluid should never be poured back into the original bottle.**

An officially calibrated thermometer is required which allows reading the temperature with an accuracy of ± 0.02°C.

11.1 Example: Calibration of ball 1

K = ball constant to be found

η_E = 4.63 [mPa·s] viscosity of the standard liquid

ρ_1 = 2.217 [g/cm³] density of the ball

ρ_2 = 0.81 [g/cm³] density of the standard liquid

t = 417.7 [s] average of the falling time

For the calculation of the ball constant K the following formula applies:

$$K = \frac{\eta_E}{(\rho_1 - \rho_2) \cdot t} = \frac{4.63}{(2.217 - 0.81) \cdot 417.7} = 0.00788$$

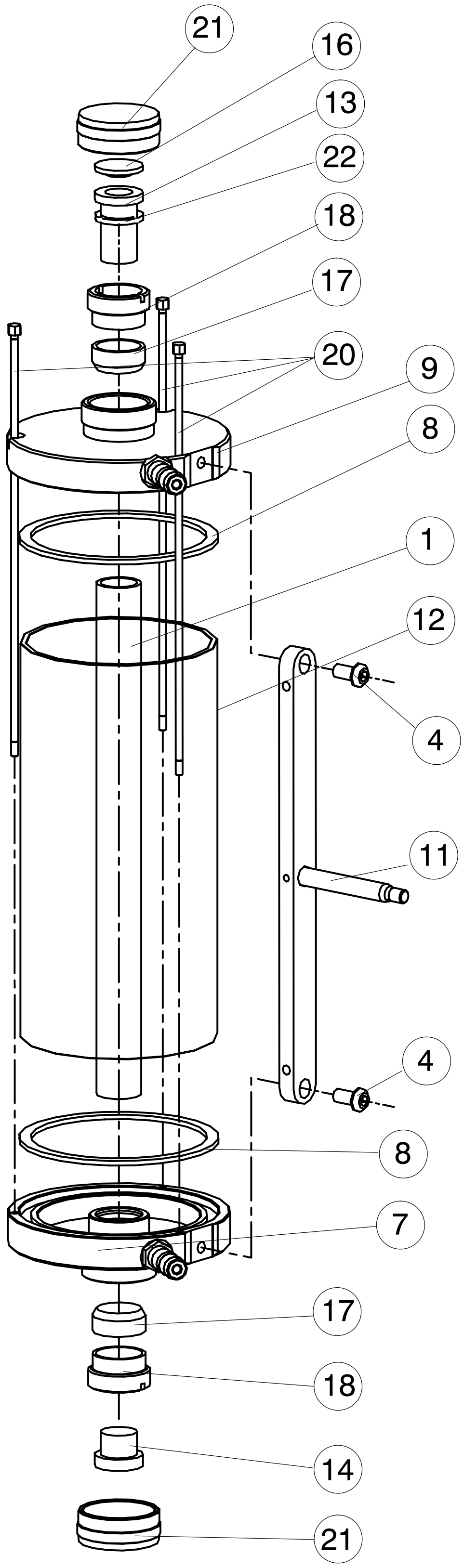
The determination of the constants of the other balls should be done in the same way.

11.2 Determination of the ball factors for special tests

The ball factors can be determined by the user for the single balls of the set and for different densities of the liquids.

The formula ”$(\rho_1 - \rho_2) \cdot K$” can be described as the factor for measurements with a constant density.

Consequently, when determining the viscosity, multiply the factor by the measured falling time in order to obtain the viscosity in (mPa · s).



12. Maintenance by the User

12.1 Exchange of the measuring tube and the jacket tube

1 Unscrew the screws **4** and remove brace **11**.

2 Loosen threaded bush **18** with socket spanner no. 003-2110.

3 Unscrew connecting rods **20**.

4 Now remove both cover lids **7** and **9**.

5 Exchange jacket tube **12**.

6 In order to exchange the measuring tube remove bush **19** and gasket **17**.

Assembly

7 Screw jacket tube **12**, flat gasket **8**, cover **7** and **9** together with the connecting rods **20**.

! Don't tighten the connecting rods initially.

8 Insert measuring tube **1** with gasket **17** into the covers **7** and **9**.

9 Mount brace **11**, don't tighten the screws **4** initially.

10 Please tighten the connecting rods **20** evenly and carefully.

! Recommended tightening moment 0,8-1,0 Nm. Please control, whether the jacket tube is moveable axially.

11 Fix the screws **4**.
Please control, whether the jacket tube is moveable axially.

12 Fix threaded bush **18** with the socket spanner 003-2110 slightly.

12.2 Order numbers

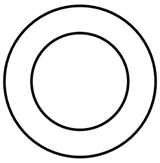
002-7575 Stand (cast iron)
002-2917 Levelling screws of the stand
002-6968 Falling tube (**1**)
800-0190 Balls (**2**)
002-8746 Screws M 6x12 (**4**)
003-2108 Cover (**7**)
003-2109 Cover (**9**)
002-9261 Brace, mounted (**11**)
800-0030 Jacket tube(**12**)
800-0012 Hollow plug (**13**) (**15**)
800-0013 Plug (**14**)
800-0014 Closing plate (**16**)
003-2079 Threaded bush (**18**)
003-2106 Connecting rod (**20**)
800-0052 Closing Gap (**21**)
799-3001 Set of gasket (**8**),(**17**),(**22**)

13. Spare Parts

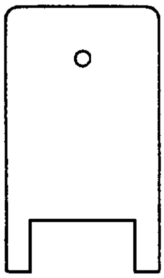
13.1 Recommended spare parts for a period of 3 years

800-0119	Ball tweezers
800-0131	Cleaning brush (3 x)
800-0125	Cleaning piston (3 x)
800-0182	Set of balls 1 – 6
002-6968	Falling tube
800-0030	Jacket tube
800-0015	Hollow plug, Perbunan
800-0090	Hollow plug, Brass
800-0017	Closing plate, Perbunan
800-0014	Closing plate, Brass
800-0016	Plug, Perbunan
800-0093	Plug, Brass
800-0052	Closing Gap
800-0190	Spirit level
800-1507	Checking thermometer –1 to 26° C, scaling 0.1° C
800-0176	Stop watch
799-3001	Set of gasket

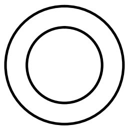
13.2 Single parts



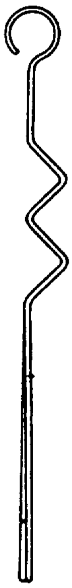
800–0027
gasket ∅ 15.6
(teflon)



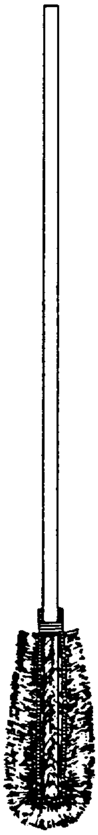
003-2110
socket spanner



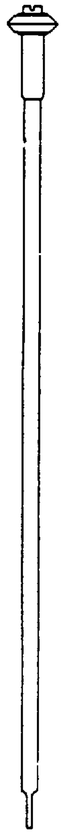
800–0061
gasket ∅ 10.0
(perbunan)



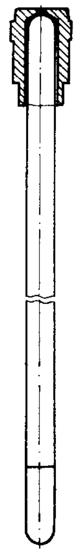
800–0119
ball tweezers



800–0131
cleaning brush



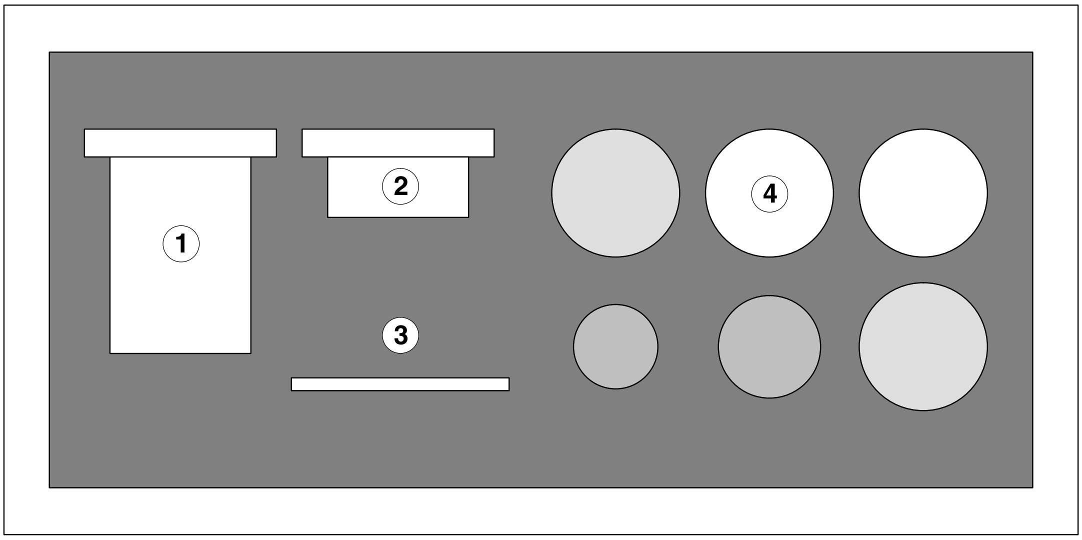
800–0125
cleaning piston



Control thermometers:

800-1506	–35	to	1°C,	scaling	0.2°C
800-1507	–1	to	26°C,	scaling	0.1°C
800-1508	24	to	51°C,	scaling	0.1°C
800-1509	49	to	76°C,	scaling	0.1°C
800-1510	74	to	101°C,	scaling	0.1°C
800-1511	99	to	126°C,	scaling	0.1°C
800-1518	19	to	21°C,	scaling	0.02°C
806-1154	21	to	24°C,	scaling	0.02°C

13.3 Contents of the ball box



(1)	800-0012	Hollow plug (brass)
(2)	800-0014	Cover plate
(3)	800-0118	Ball gauge to differ between the balls G, 1 and 2

(4) Balls:

800-0002	Ball 1; ∅ 15.81;	glass
800-0003	Ball 2; ∅ 15.6;	glass
800-0004	Ball 3; ∅ 15.6;	iron
800-0005	Ball 4; ∅ 15.2;	iron
800-0006	Ball 5; ∅ 14.0;	steel
800-0007	Ball 6; ∅ 11.0;	steel

14. List of calculation factors

Example:

Prüfbescheinigung / Test certificate **HAAKE**

Produkt

Kugelfallviskosimeter C / Falling ball viscometer C

Nr./No. Viscosimeter Viscometer	Nr./No. Kugelsatz Set of balls	Kugel-Nr. Ball-No.	m Masse Mass [g]	d Durchmesser Diameter [mm]	ρ_1 Dichte Density [g/cm³]	K Konstante Calculation factor
195002243001	19417634007	1	4,57866	15,801	2,217	0,00933
		2	4,45366	15,647	2,220	0,06354
		3	16,22790	15,610	8,148	0,08626
		4	15,11570	15,246	8,146	0,55715
		5	11,69180	14,280	7,668	4,55193
		6	5,53098	11,101	7,722	33,82589

Die Berechnung der absoluten Viskosität in [mPas] ist gemäß Bedienungsanweisung für HAAKE Kugelfallviskosimeter nach Höppler und der unten angegebenen Formel vorzunehmen:

The absolute viscosity in [mPas] is calculated as stated in the instruction manual HAAKE Falling - ball - Viscometer according to Hoeppler in accordance with the following equation:

$$\eta = t * (\rho_1 - \rho_2) * K \quad [mPa*s]$$

HAAKE - Prüfbedingungen / HAAKE - test conditions

Temperatur / temperature			Temperaturmeßgerät U = 0,025mK	
Temperaturkonstanz / temperature constancy			+- 0,03 K	
Fallzeitmessung / falling time measurement			Stoppuhr Auflösung < = 0,1 sec	
		Normalöle / Standard fluids		
HAAKE-Typ	geprüft nach	Normalöl Bezeichnung	ID-Nr. Prüfstelle DKD-K-06901	Probennummer
E7	HPA 608-0012	10AW	4-0040/95-01	3
E200	HPA 608-0012	100AW	4-0041/95-01	5
E6000	HPA 608-0012	5000AW	4-0043/95-01	5

Die eingesetzten Prüfmittel unterliegen der Prüfmittelüberwachung nach DIN/ISO 9000ff bzw. VDI/VDE/DGQ 2618.

The control of measuring and test equipment is established according to DIN/ISO 9000ff and VDI/VDE/DGQ 2618.

		Qualitätswesen / Quality control Gebr. HAAKE GmbH * Dieselstraße 4 * 76227 Karlsruhe	
Unterschrift/Signature	Datum	Abteilung / Department	

Formular Reg.-Nr.: 892008g

Präzisions- und Kontrollthermometer

Durch Erschütterungen, Überhitzung oder zu starke Abkühlung während des Transportes können bei Thermometern fehlerhafte Temperaturanzeigen auftreten. Bitte achten Sie deshalb vor dem Gebrauch auf folgende Punkte:

a) Geteilte Quecksilbersäule:
Liegt die Trennstelle sehr tief, erwärmen Sie bitte das Thermometer, bis die Trennstelle ungefähr bis zur Mitte der oberen Kapillarerweiterung gestiegen ist. Die Kapillarerweiterung darf nicht bis oben mit Quecksilber gefüllt werden, da sie sonst gesprengt wird. Klopfen Sie dann das Thermometer (Quecksilbergefäß unten) senkrecht auf eine weiche Unterlage. Dabei fügt sich das Quecksilber wieder zusammen. Liegt die Trennstelle zu tief, sammeln Sie das Quecksilber durch starke Abkühlung unten im Quecksilbergefäß und vereinigen es dann durch vorsichtiges Klopfen.

b) Quecksilberteilchen in der oberen Kapillarerweiterung:
Sammeln Sie bitte die Teilchen durch vorsichtiges Klopfen im unteren Bereich der Erweiterung und vereinigen Sie die Säule durch Erwärmen des Quecksilbergefäßes.

c) Kleine Luftblase im Quecksilbergefäß:
Häufig sitzt die Luftblase an der Übergangsstelle Quecksilbergefäß–Kapillare und ist zu erkennen an der Lageveränderung bei leichtem Klopfen. Zur Beseitigung ziehen Sie das Quecksilber durch Abkühlen nach unten. Durch leichtes Klopfen steigt die Luftblase nach oben in die trichterförmige Verengung. Durch anschließende Erwärmung wandert die Blase in Form einer Trennstelle nach oben.
Diese Trennstelle beseitigen Sie bitte wie unter a) beschrieben.

Fehler a) und c) haben eine zu hohe, Fehler b) hat eine zu tiefe Temperaturanzeige zur Folge.

Precision Monitoring Thermometers

Incorrect thermometer temperature readings can occur after transportation as a result of vibration, overheating or too rapid cooling down. Please therefore check the thermometers for the following signs before usage:

a) Mercury filling split:
If the mercury filling is split at a low thermometer position, heat the thermometer until the separation point is approximately in the middle of the upper capillary tube. Please ensure that the upper capillary tube is not filled completely to the top with mercury as this can burst the thermometer. Now tap the thermometer in a vertical position (with the mercury bulb at the bottom) against a soft surface. The mercury filling should now join up again. If the separation point is too low, collect all the mercury in the bulb by rapid cooling down and then cause it to unify by careful tapping.

b) Mercury droplets in the upper capillary tube:
Collect the droplets in the lower area of the capillary tube by careful tapping against a soft surface and reunify the filling by heating the mercury bulb.

c) Small air bubble in the mercury bulb:
The air bubble is often situated between the mercury bulb and the upper capillary tube and can be recognized when its position changes after careful tapping. Draw the mercury downwards by cooling down and cause the air bubble to rise through the funnel-shaped passage by careful tapping. Subsequent heating causes the bubble to rise further and form a separation point in the mercury filling. This separation point can be removed by following the instructions in section a).

Faults a) and c) result in an excessive temperature display and fault b) causes an insufficient reading.

Thermomètres de contrôle et de précision

Les vibrations, une température ou un refroidissement excessif durant le transport peuvent être l'origine d'une indication de température erronée. Le cas échéant, conformez-vous aux instructions ci-après:

a) Colonne de mercure divisée:
Si la division se situe dans le bas de la colonne, réchauffez le thermomètre jusqu'à ce que la division atteigne approximativement le milieu de la zone d'expansion du tube capillaire. Veillez cependant à ce que cette partie ne se remplisse pas intégralement de mercure au risque sinon de faire éclater le tube. Tapotez ensuite le thermomètre (réservoir de mercure orienté vers le bas) sur un support souple. La colonne de mercure se reconstitue. Si la division est trop basse, faites retourner le mercure dans le réservoir par un fort refroidissement et reconstituez la colonne en tapotant légèrement.

b) Particules de mercure dans la zone d'expansion du tube capillaire:
Regroupez les particules au fond de la zone d'expansion en tapotant légèrement et reconstituez la colonne en chauffant le réservoir de mercure.

c) Petite bulle d'air dans le réservoir de mercure:
La bulle d'air se trouve généralement dans la zone de transition entre le réservoir de mercure et le tube capillaire. Elle se repère facilement en la faisant bouger par un léger tapotement du thermomètre. Pour la faire disparaître, rétractez la colonne de mercure par refroidissement. Un léger tapotement fait remonter la bulle dans l'étranglement conique. Réchauffez alors le thermomètre pour faire remonter la bulle dans la colonne. Supprimer la division constituée par la bulle comme indiqué sous a).

Les défauts a) et c) se traduisent par une indication supérieure, le défaut b) par une indication inférieure à la température réelle.

Subject to alterations

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