TQC ROTATIONAL VISCOMETER
DV1400, DV1401

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Contents

1 General information

1.1 Introduction

Thanks to design and lightness, Viscometers of the DV1400 series can be used both as portable viscometer or lab viscometer. Instrument is delivered completely assembled and ready to be used: open the case, take instrument out, place it in a leveled surface and attach selected spindle.

Viscometers of the DV1400 series are battery operated and work at a fixed speed (20, 30, 50 or 60 rpm). The low consumption of the unit makes it possible to work continuously for more than 24 hours without need to recharge or change the batteries. Speed selection must be set when ordering the viscometer according to the measurement range required by end user. Viscosity readings are delivered only in one unit: milli-Pascal-seconds (mPas). To achieve the whole measurement range, the viscometer is delivered with a set of different R spindles (R2 – R7, and optionally R1).

The most outstanding feature of the portable viscometers of the DV 1400 Series is their simplicity. This characteristic makes them an ideal tool to carry out measurements in the own premises during the manufacturing process, in laboratories or in research centres whenever quick and reliable viscosity readings are needed.

1.2 Intended use

The DV1400 series has been developed specifically to fulfil viscosity readings in all kinds of fluids. Only skilled or specially trained personnel must operate the viscometer.

Everyone who works with the viscometer DV1400 must strictly follow the security precautions and observe the safety rules of the laboratory.

It is not allowed to operate the viscometer for any other purpose as the one described in this chapter. No right to claim warranty will be granted if any of the above norms are disregarded.

1.3 Security symbols

Installation and operation of the DV1400 viscometer are user-friendly and very easy if instructions of this manual are strictly followed.

Be aware that any use of this equipment out of the scope described by the manufacturer may compromise the security of the operator.

Besides this and in order to stress the points that may represent any risk both for the operator and the viscometer itself, this manual uses following symbols and messages:

DANGER

Wherever this symbol, along with the message DANGER, appears in this manual, it indicates a potential personal injury hazard or damage on the viscometer. For your security, strictly observe instructions provided.

CAUTION

Wherever this symbol, along with the message CAUTION, appears in this manual, it indicates that damages on the viscometer may occur if instructions are not observed.

For the proper operation of the equipment, instructions must be strictly observed.

INFORMATION

This symbol refers to specific details of the viscometer which must be specially considered because of their relevance.

Apart from the instructions contained in this manual, everyone who operates the portable viscometer of the DV 1400 series is obliged to know and observe the security and hygienic measures of the laboratory where this device is operated.

Everyone who should operate and set up the viscometer must have completely read and understood these instructions before starting the operations.

1.4 Safety notes

Operator security may be at risk if instructions of this manual are not observed.

Please observe the following general precautions during operation of this instrument. Failure to comply with these precautions violates safety standards and the intended use of the instrument. TQC is not liable for misuse of the instrument and failure to comply with basic safety requirements.

Battery operated

The viscometer works with batteries. It is strictly forbidden to remove the instrument hood during operation. Component changes and settings must only be fulfilled by specialized personnel. Use only original spare parts when changing any component. Battery replacement must be carried out after switching off the unit and removing the spindle from the shaft.

Danger in explosive environment

The instrument must not be operated in the presence of flammable gases. It is also forbidden to expose the instrument in environments where dangerous gas concentrations may occur.

Hazard of malfunction

To avoid damages on the instrument, it must be only operated in a controlled electromagnetic environment. According to this, transmitters such as mobile phones must not be operated near to it.
In case of malfunctions and/or service work, please turn off the instrument and contact TQC.

1.5 Certification, warranty and documentation

Certification TQC certifies that this instrument has been tested and checked carefully. Its technical data has been verified before shipment to be in accordance with the published specifications. The instrument complies with applicable international safety regulations.

Warranty This product is warranted against defects in material and workmanship for a period of 2 (two) years. Parts which prove to be defective during the warranty period will be repaired or replaced free of charge. No other warranty is expressed or implied. Unauthorized modification or repair by third party persons will void the warranty. The warranty will expire in case of improper or wrong use of the instrument and in case the warning and precautionary messages are not observed. TQC is not liable for any occurring damage.

Once the warranty period has expired, we recommend signing a service contract in order to guarantee the perfect functionality of the instrument.

Documentation This user manual will be delivered together with each instrument.

Errors and omissions excepted. Subject to amendment and improvement without further notice.

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2 Technical data

Portable viscometer VP 1000 M Series	
Power requirements	**Alkaline batteries 4x AA/LR6 (6V)**
	Rechargeable batteries 4 x AA/R6 (6V)
Batteries capacity	**Alkaline: 1.900 mAh**
	Rechargeable: 2.500 mAh
Batteries autonomy	**24-30 hours under continuous operation**
Displayed data	▪ **fixed rpm (20 rpm, 30 rpm, 50 rpm or 60 rpm)** ▪ **selected spindle (R2 – R7). Optional: R1** ▪ **dynamic viscosity (mPas)** ▪ **full scale range** ▪ **full scale percentage** ▪ **battery level indicator**
Compatibility	**100% compatible with Brookfield method**
Spindles	**standard spindle set (R2-R7)** **optional: R1**
Speeds	. **Model DV1401: 60 rpm** . **Model DV1402: 20 rpm**
Viscosity ranges **(with standard spindles)**	▪ **Model DV1401: 66 – 66.600 mPas** ▪ **Model DV1402: 200 – 200.000 mPas**
Accuracy	**± 2% of full scale**
Repeatability	**± 1%**
Measurements	**17 x 11 x 41 cm**
Weight	**1.800 g**

Operating conditions:	**from +10°C until +40°C** **(at a max. rel. humidity of 80% without condensation)** **altitude up to 2000 m M.S.L.** **for indoor use only.**
Pollution degree:	**2**
Protection category:	**IP 20**

3 Setting up the viscometer

3.1 Reception and unpacking of the instrument

Follow these steps after receiving the instrument:

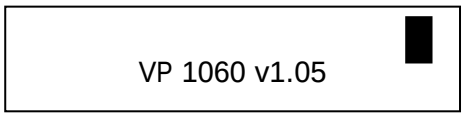
- Please check carefully the packaging box of the viscometer before removing it in order to find out transportation damages.
- Should the packaging box be broken or have suffered any other damage, please contact the shipping agency before opening it.
- Once you have taken the instrument out of the box, check if damages can be observed. Should this be the case, please inform the forwarder that has delivered you the equipment.
- Remove all packing straps, protectors and accessories used during transport. Recyclable materials are to be disposed in the containers provided therefore.

3.2 Scope of delivered parts

- Portable rotational viscometer of the DV 1400 series
- Standard spindle set (R2 – R7)
- Measuring vessel
- 4 alkaline additional batteries AA/LR6 (6V)

3.3 Setting up viscometer

Portable viscometers of the DV 1400 Series are battery operated. The basic delivery scope comprises 4 alkaline batteries 4xAA/LR6 (6V) installed in the unit and 4 additional batteries for replacement. The unit can work both with alkaline batteries from type AA/LR6 and with rechargeable ones from type AA/R6. In continuous operation, batteries have a lifespan of 24 to 30 hours. Battery level is indicated on the display by means of a symbol.



Batteries are positioned on the back side of the viscometer (fig. 3). To replace them, proceed as follows.

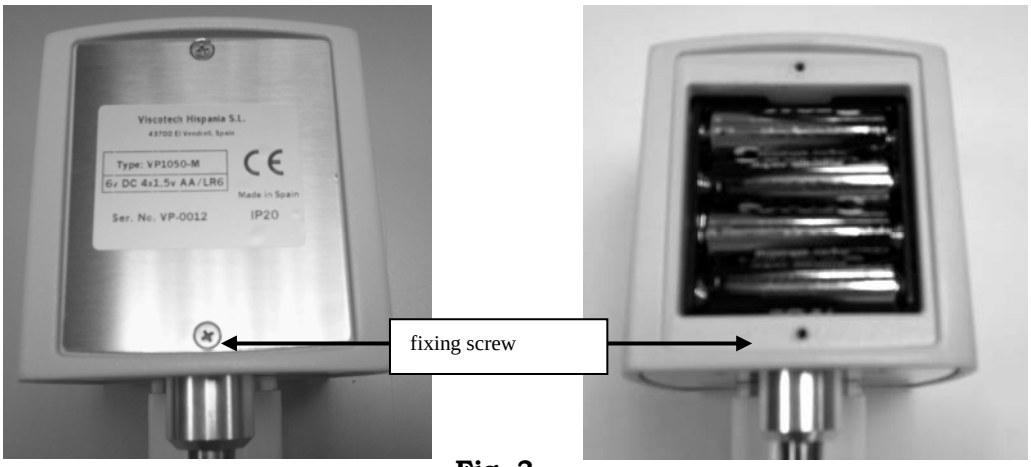
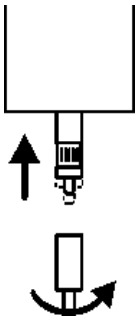


Fig. 3

- Remove the two screws as indicated in the illustration.
- Remove the cover plate of the battery housing and replace the batteries. Please pay attention to the correct polarity when doing this operation.
- To replace the cover in its original position, place correctly the cover and tighten the screws again. On the cover plate there is a label with the most relevant data of the viscometer.

3.4 Setting up the spindle

Apart from R7, all spindles included in the standard set are disc spindles. Because of this shape, spindles must be smoothly immersed into the fluid to avoid bubble formation below the surface.



- To assemble the spindle, hold firmly the pivot shaft with one hand and screw up the spindle onto it using the other hand.
- To screw up the spindle, turn it in the direction shown in the illustration on the left.
- Once it has been inserted, submerge the spindle into a fluid until it reaches the notch that indicates the top immersion level allowed. In doing so, please take care not to hit neither the spindle nor the pivot shaft with the vessel to avoid distortion of spindle perpendicularity.

Be very careful when you perform this operation in order to prevent the spindle from bending or the pivot shaft from suffering damages.

Both the spindle and the screw must be in perfect conditions and extremely clean.

R7 spindle must be immersed up to the middle mark included in the shaft recess.

Spindles are made of stainless steel. Each spindle carries the reference name on its head.

3.5 Measuring vessel

To avoid that rotation stress might drag measuring vessel containing sample to be analyzed, viscometer features a very simple anchorage system: three holes in the viscometer base where the fixing pins of the measuring vessel are inserted.

! **As the viscometer stand is not equipped with regulating feet, the surface where the instrument is placed must be perfectly levelled.**

! **The filling mark (370 ml) in measuring vessel must be respected to be able to work with the complete set of standard spindles (R2-R7).**

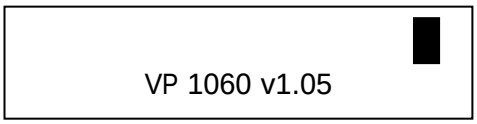
4 Operation

4.1 Initial turn-on and configuration

The configuration of the DV 1400 viscometer is very simple, because the only parameter that can be modified refers to the spindle. The information on the display can be modified using the ENTER button and the two arrows ▲ (up) and ▼ (down).

Initial turn-on and configuration

Turn on the viscometer by pressing for an extended time (between 6 and 10 seconds) the ENTER button. After that, an introductory display with a symbol of the battery state appears. This screen shows program version and rpm used (in this concrete case 60 rpm)

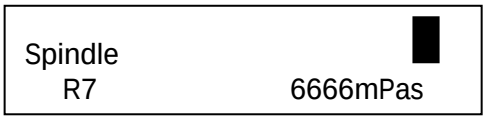


Shortly afterwards, you can view the main display with the configuration that was last used with the viscometer.

The display includes the following information: speed (rpm), measurement unit (mPas), spindle type (R1 – R7) and full scale percentage. As mentioned in chapter 1, the viscometer works always at one speed (rpm) –20, 30, 50 or 60 rpm–, which can be selected when ordering the unit, and one unique measurement unit: milli Pascal seconds (mPas). The only parameter that can be modified is the spindle. Should you carry out measurements with a different spindle as the one that appears on the display, follow these steps to modify the information:

- Press shortly any one of the arrows (▲ or ▼).

In doing so, the display will show following information:



- The spindle reference last used flashes on the display. At the right side, you can see the full scale range corresponding to the combination of selected spindle and instrument speed.

The full scale range refers to the maximum viscosity reading that the viscometer can achieve with selected combination of speed and spindle. This value helps the user to select the correct spindle according to the viscosity of the sample that must be analyzed.

- Use the arrows (▲ or ▼) to set the correct spindle type between R1 and R7.
- When the correct type appears on the display, press ENTER to validate. After that, the main display appears again with the new modification introduced.

!

If by any reason you omit to press ENTER during 15 seconds when modifying the spindle, the viscometer returns automatically to the main display and will accept the last spindle selected.

It is therefore very important to check that the spindle that has been set up in the viscometer matches with the one that is being showed on the display.

4.2 Measurement

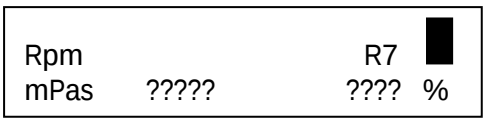
Measurement start

To start the spindle rotation and trigger the measurement,

- press simply ENTER.

The spindle beginns to rotate and the display shows following data: speed (20, or 60 rpm) , spindle reference and question marks meaning that viscometer waits for viscosity reading,

Waiting for viscosity reading



Viscosity readings (in mPas) and full scale percentage will be displayed afterwards.

Overrange

If following display appears during the measurement process, you have exceeded the maximum reading's limit (overrange). In this case, change the spindle and insert a different one having a lower reference.

It is advisable to operate with viscometer in the best measuring range, this is between > 10% and < 90% of full scale range. Nevertheless, viscometer shows viscosity readings between 5% and 100% of FS.

Below 5% display shows “0” viscosity reading

Finish of measurement

To finish the measurement process,

- press ENTER again

to stop the drive. The measurement result along with the full scale percentage will remain on the display.

To start another measurement, proceed as described before.

Turn off the viscometer

- Press the ENTER key for an extended time to turn off the viscometer.
- By doing this, following information appears on the display.

Power Off Shutting Down

Don't forget to switch off the instrument (by pressing for a few seconds the ENTER button) when you have finished the measurements. Otherwise, the viscometer will remain active and batteries will run out.

In the event that battery level was not enough to perform accurate measurements, viscometer will inform user and will turn off automatically.

Low Battery Shutting Down

5 About viscometer’s calibration

The instrument delivered has been calibrated with standard calibration Newtonian oils by the manufacturer before shipping. We recommend carrying out calibration checks on a regular basis according to operation frequency. For the correct calibration of the viscometer, please contact your TQC.

5.1 Viscometer's verification

We recomend to check the proper functionallity of the viscometer on a regular basis using our Newtonian viscosity standards, available on demand.

The calibration oils are calibrated at two (2) different temperatures (20 and 25°C) and allow a more accurate correlation between temperature and viscosity. According to the model, the standards suggested are as follows:

Viscometer model	viscosity standard (mPas)
VP 1020	approx. 5.000
VP 1030	approx. 5.000
VP 1050	approx 2.500
VP 1060	approx. 2.500

When carrying out the verification of the viscometr, we suggest to work with spindle R4. Once the viscometer began to rotate and after allowing a mimimum of 5 readings, the value on the display should correspond with the one indicated in the certificate of the standard oil, considering also the allowances (viscometer's accuracy + standard accuracy) involved.

Due to the great influence that temperature has on viscosity measurements, we strongly recommend to perform the viscometer's verification test with the oil at the temperature specified in the oil certification.

5.2 How to perform the “auto zeroing” function

If after turning on the viscometer and initiating the rotation of the spindle without immersing it in a fluid, the reading on the display does not indicate 'zero', you should proceed as follows:

- Turn on the viscometer by pressing for a few seconds the ENTER button. You will enter the introductory display where a symbol indicates the battery level.
- Press now the down arrow ▼ and ENTER consecutively in order to access to the Auto zero option
- After this, following information appears on the display

Options AutoZERO

- Press ENTER to enter the following screen

Remove Spindle Press <ENTER>

Don't forget that the "Auto zeroing" option must be carried out without spindle.

- Press ENTER to start the “Auto zero” process which will allow you to modify the "zero" value. During this process, following message appears on the display

AutoZERO wait....

- When the process has successfully finished, the display will automatically go back to the introductory screen and to the measuring mode.

6 Accessories (optional)

Battery charger R6 AA/Ni-Cd/Ni-Mh
Rechargeable batteries
Special spindle R1
Spindle rack
Newtonian certified calibration oils (600 ml)

7 About viscosity

7.1 Description

TQC viscometers of the DV 1400 series are rotational, portable viscometers that determine the viscosity of a wide range of fluids. The measurements are performed according to the Brookfield method; the results obtained with the DV 1400 series can therefore be perfectly compared to those gained with other equipment working also with the Brookfield method.

The principle applied by this viscometer is equivalent to that of the rotational viscometers: a (disc or cylindrical) spindle, immersed in the sample to analyze, measures the torque required to rotate in the fluid. The torque value specified by the viscometer is based on the rotational speed and on the spindle geometry; this method allows to obtain a direct viscosity value in mPas

Depending on the viscosity, the resistance exerted by a fluid opposing the motion of a spindle varies proportionally to the speed or size of the spindle. The viscometer has been calibrated to deliver readings in mPas, according to speed and spindle type used. The combination of the different spindle types allows obtaining optimal readings within the scale of each model of the portable viscometer series (VP 1020 M, VP1030 M, VP1050 M and VP1060 M).

7.2 Related concepts

Viscosity

Viscosity is a distinctive property of the fluids. It is the measure of internal friction of a fluid when a layer of this fluid is forced to move in relation to another layer. Viscosity is a value highly dependant on temperature.

The standard units for dynamic viscosity measurements are mPa.s (S.I) or cP (C.G.S).

1mPas=1cP (centi-Poise)

1 dPas= 100 mPas

1dPas=1P (poise)

Laminar flow

It is the ideal movement between layers without transfer of mass from one to the other. It is the base to calculate dynamic viscosity.

Turbulent flow

There is a certain speed from which a transfer of mass between layers occurs. Result is an apparently greater shear stress and an erroneously high viscosity reading. Turbulent flow is characterized by a sudden and notorious increase in viscosity above a certain speed.

Newtonian fluids

Viscosity in Newtonian fluids at a given temperature, remain constant regardless of viscometer model, spindle and speed being used. The most common Newtonian fluids are water and thin motor oils.

Non-Newtonian fluids

This kind of fluids do not show a lineal relation between shear stress and shear rate. Different working conditions have as a result different viscosity values.

Apparent viscosity is defined as the result of a fluid analysis. This result can be reproduced in another viscometer only if analysis is carried out maintaining identical working conditions and following a defined working process. Variables below influence results:

- Viscometer model
- Dimensions of sample container
- Filling level
- Sample temperature
- Spindle
- Rotating speed
- Spindle protector, yes or not.
- Duration of test (time dependant fluids)

Generally speaking each modification in the working method and working process will indefectibly lead to variations in final analysis results. There are different behaviors within the non-Newtonian fluids:

Pseudoplastic Samples whose viscosity decreases when increasing shear rate. It is also called “shearthinning” flow behavior. Most common pseudoplastic fluids are coatings, milk, ink and jam.

Plastic Under static conditions they might have a similar behavior to a solid. For a correct evaluation of the fluid it is necessary to reach the “yield value” to make fluid flow so that product later shows any of the possible material characterizations: Newtonian, pseudoplastic or dilatant.

Examples: toothpaste, chocolate, grease.

Dilatant Viscosity of dilatant fluids increases when shear rate increases. It is also called “shearthickening” flow behaviour.

Examples: solutions of sugar and water and mixtures of sand and water.

Time dependent fluids Viscosity of dilatant fluids increases when shear rate increases. It is also called “shearthickening” flow behaviour.

Thixotropic Those fluids in which viscosity and shear stress decrease, maintaining a constant shear rate, with time.

Ketchup, honey, anti-drop paints, mayonnaise .

Rheopeptic Those fluids in which viscosity and shear stress increase, maintaining a constant shear rate, with time.

Lubricants and some paints types are rheopeptic fluids.

Reference substances and viscosities

Substance	**Approx viscosity. (mPas)**
Motor oil SAE 10	65
Olive oil	84
Coatings (airbrushed)	100
Yogourt	150
Sugar solution 70%	400
Lubricating oil	50 – 1.000
Concentrated juice	1.500
Inks	550 – 2.200
Honey	10.000
Nanocellulose (common additive)	8.000 – 10.000
Toothpaste	100.000

8 Viscosity table

spindle	R1 optional	R2	R3	R4	R5	R6	R7
Model	viscosity in mPas						
VP1020	500	2.000	5.000	10.000	20.000	50.000	200.000
VP1030	333	1.300	3.300	6.600	13.300	33.300	133.000
VP1050	200	800	2.000	4.000	8.000	20.000	80.000
VP1060	166	660	1.600	3.300	6.600	16.600	66.600

Viscosity ranges (with standar spindles)
(between 10% - 100% of full scale):

Model VP1020 M: 200 – 200.000 mPas
Model VP1030 M: 130 – 133.300 mPas
Model VP1050 M: 80 – 80.000 mPas
Model VP1060 M: 66 – 66.600 mPas

9 Problems and solutions

Problem	Solution
The viscometer does not work	• Check the battery level
The instrument does no read 'zero' without fluids	• Carry out the “Autozeroing” function
Viscosity speed is unstable and inaccurate	• Check the rheological features of the sample that must be analyzed
	• Perform a calibration check using calibration standards.
	• Check if the spindle disk rotates steadily
	• Check if the sample temperature is stable

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