

PCE Americas Inc.  
711 Commerce Way  
Suite 8  
Jupiter  
FL-33458  
USA

From outside US: +1  
Tel: (561) 320-9162  
Fax: (561) 320-9176  
info@pce-americas.com

PCE Instruments UK Ltd.  
Units 12/13  
Southpoint Business Park  
Ensign way  
Hampshire / Southampton  
United Kingdom, SO31 4RF

From outside UK: +44  
Tel: (0) 2380 98703 0  
Fax: (0) 2380 98703 9  
info@pce-instruments.com

[www.pce-instruments.com/english](http://www.pce-instruments.com/english)  
[www.pce-instruments.com](http://www.pce-instruments.com)

## Manual

### Rotational viscometer PCE-RVI 2



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## 1 Introduction

Thank you for purchasing a rotational viscometer from PCE Instruments.

The device is used to measure the viscosity of a liquid, by calculating the mechanical resistance of a fluid against a rotating spindle. The results are displayed as a value between 3 and 13.000.000mPa s with an accuracy of  $\pm 1\%$  based on the geometry of the spindle being used.

## 2 Safety notes

Please read the operating manual thoroughly before using the device. The device must only be operated by qualified personnel and any service or repairs must be carried out by PCE Instruments.

No liability is accepted for personal injury or damage to the equipment if the operating procedure, as specified in the manual, is not adhered to.

- When carrying out measuring tasks, always ensure the instruction manual is kept accessible for reference purposes.
- Servicing must only be carried out by a PCE instrument authorised service agent. Unofficial updates or servicing could result in personal injury or damage to the device.
- Only original approved manufacturer's parts may be used for service or repair purposes.
- The device must only be used within the specified temperature range.
- The casing of the device should never be opened, except by approved PCE Instruments personnel.
- The device should not be placed on a surface with the user interface, i.e. keyboard face down.
- No unauthorised technical changes should be carried out on the device.
- The device can be cleaned using a damp cloth (pH neutral).

This user's handbook is published from PCE Instruments, no liability is taken.

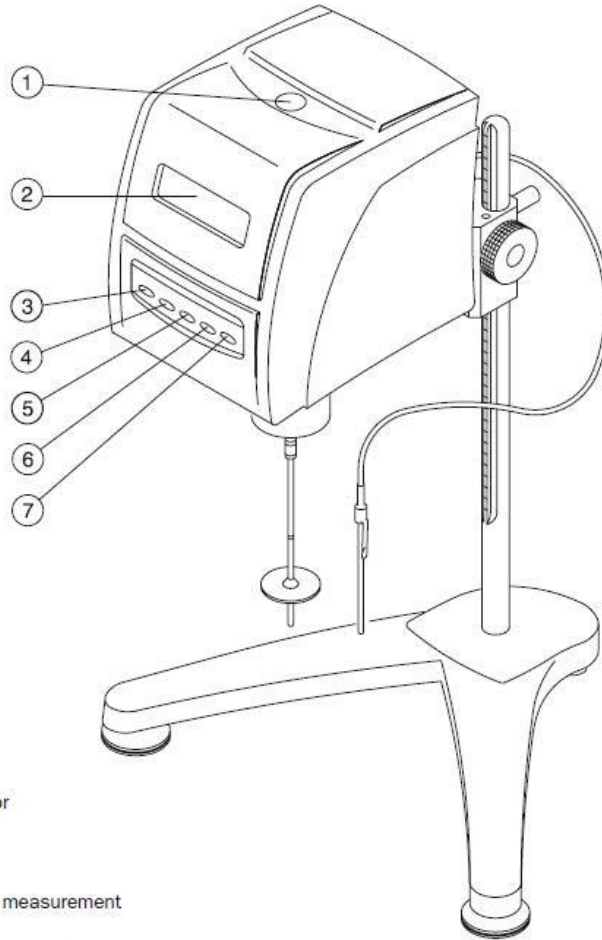
Please read our General Guarantee Terms, they can be found in our General Terms of Business.






If you have any queries, please contact PCE Instruments.

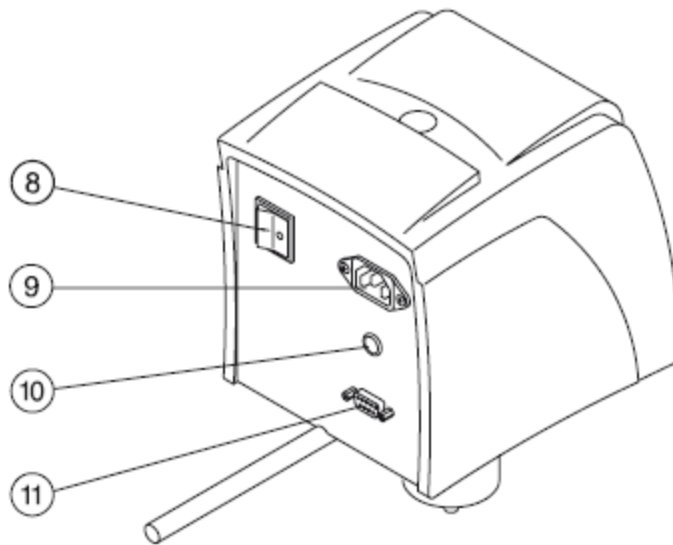
## 3 Specifications

Speed range	Modell V1 – L/R	0.3; 0.5; 0.6; 1; 1.5; 2; 2,5; 3; 4; 5; 6; 10; 12; 20; 30; 50; 60; 100; 200 rpm
Measurement range with default spindles	Model V1 – L	3 ... 2000000 mPa s in 76 ranges; 19 revs with 4 spindles
	Model V1 – R	20 ... 13000000 mPa s in 114 ranges; 19 revs with 6 spindles
	Accuracy	±1 % of the shown value
	Repeatability	±0.2 %
Thermometer	Range	-15 °C ... +180 °C (5° F ... 356 °F)
	Resolution	0.1 °C (0.1722 °F)
	Accuracy	±0.1 °C
Power supply	100 ... 240 V / 50...60 Hz	
Current consumption	0.2 A	
Max. altitude	2000 m above sea level	
Operation temperature	10 ... 40 °C	
Rel. humidity	<80 %	
Dimensions	330 x 300 x 430 mm	
Weight	10 kg	

## 4 System description



1. Levelling indicator
2. LCD Display
3.  Starts a measurement
4.  Stops a measurement
5.  Confirms parameter selection
6.  «Up» parameter selection key
7.  «Down» parameter selection key



- 8. Mains switch
- 9. Power supply socket
- 10. Pt -100 connector
- 11. RS 232 connector

## 5 Receipt of the device

Please check the packaging for any obvious signs of damage before opening.

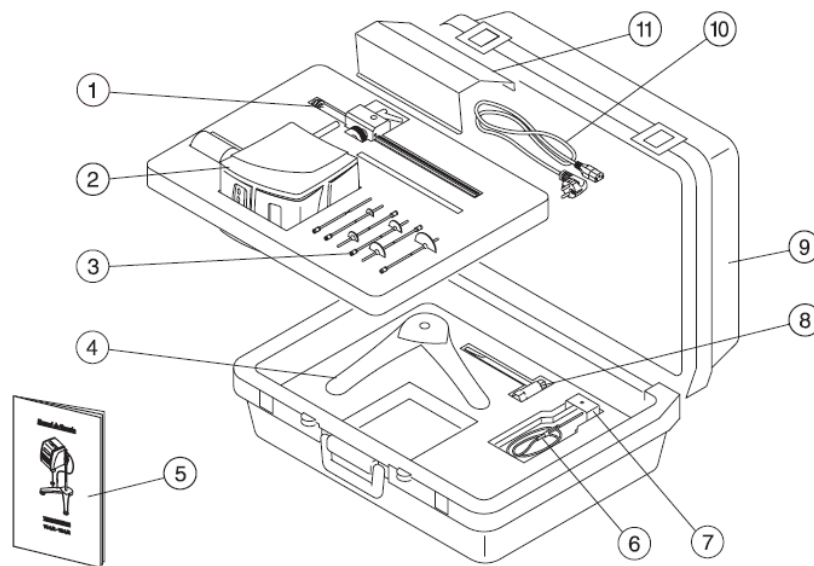
If the external packaging is found to be damaged, please notify the delivery company before opening.

After unpacking the viscometer, check the device for any obvious signs of damage. Should there be any visible signs of damage, please notify PCE Instruments.

### 5.1 Delivery content

- |   |  |
|---|--|
| 1. 1 x rack                                 | 7. 1 x guard for measuring spindle           |
| 2. 1 x rotational viscometer PCE-RVI 2      | 8. 1 x assembly tool                         |
| 3. 1 x set of spindles L1 to L4 or R2 to R7 | 9. 1 x carrying case                         |
| 4. 1 x laboratory stand                     | 10. 1 x power cable                          |
| 5. 1 x instruction manual                   | 11. 1 x storage stand for measuring spindles |
| 6. 1 x temperature sensor                   |  |

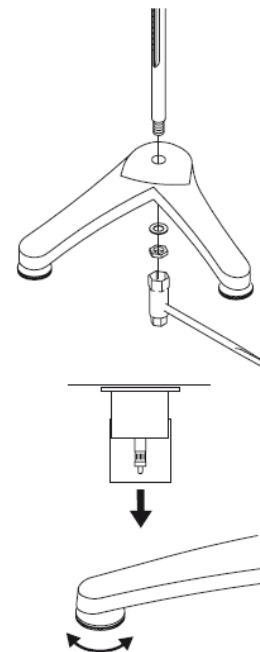
Keep the packaging, in case the instrument needs to be returned. Parts that are damaged by inappropriate packaging or inappropriate delivery are not covered by the manufacturer's warranty.



### 5.2 Installation

For an appropriate installation proceed as follows

- Remove the nut off the rack
- Place the rack on the stand in the correct position. The thread must be pointed in the direction of the stand's nut.
- Using the provided assembly tool and nut, screw the rack and the stand together.
- Attach the back pole to the clamp of the rack.
- Move the lever down to fix the device.
- Place the device on a solid and even surface.
- Slide the plastic cover of the back pole downwards to remove.
- The protection is only allowed to be moved to the side when the plastic protection has been successfully moved down.
- Balance the device with the rotary bases on the front of the stand. The levelling indicator on the top will show you when the device is levelled adequately.
- Connect the device to the power supply system.



### 5.3 Connecting to the mains

Ensure that your power supply is correctly earthed and your device is set to the correct voltage.

## 6 References to viscosity

### 6.1 Units

This viscometer is a classic rotational viscometer for quick determination of the viscosity according to 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

The operating principle of this viscometer is the same as with all rotational viscometers. A spindle (disc or cylinder) is immersed into the fluid being analysed, the torque required to set the spindle into motion is then measured. A spring is attached between the spindle and the drive-shaft of the motor. This rotates at a set speed. The deviation angle between the spindle and the spring is measured electronically and turned into a torque value. The torque value is dependent on both the spindle geometry and the rotational speed of the spindle. From this result, the viscosity of the liquid can be directly derived and displayed in mPa s/cP (dPa s/P).

Depending on the viscosity, the resistance against the movement of a substance changes in proportion to the rotational speed or size of the spindle. The viscometer has been calibrated to give viscosity readings in mPa s or cP (dPa s/P), depending on the rotational speed and the type of spindle used. Using a combination of various spindle types with different rotational speeds enables readings to be taken across a wide measurement range.

### 6.2 Important information

#### Viscosity:

Viscosity is the characteristic property of a liquid. It is a measure of the internal friction within a liquid when individual layers within the liquid are brought into motion against each other. Viscosity values are highly influenced by temperature. The standard units for dynamic viscosity measurement are: mPa s (S.I.) or cP (C.G.S.)

1 mPa s = 1 cP (centi-Poise)

1 dPa s = 1 P (Poise)

#### Shear stress:

Shear stress is the force per area unit required to move two fluid layers against each other (internal friction). Standard measuring units for the shear stress are: N/m<sup>2</sup> (S.I.) or dynes/cm<sup>2</sup> (C.G.S.).

#### Shear rate:

The shear rate is the velocity at which the various fluid layers move against each other. The standard measuring unit for the shear rate is the "reciprocal second", expressed as s<sup>-1</sup> or 1/s.

#### Laminar flow:

Occurs when a fluid flows in parallel layers with no disruption between the layers. Laminar flow is fundamental to the determination of dynamic viscosity.

#### Turbulent flow:

When a certain flow rate is exceeded, disruption between the layers of liquid can occur. This results in an apparent increase in shear stress and falsely high viscosity readings. The change from laminar to turbulent flow can be recognised by a sudden marked increase in viscosity values above a particular speed. Generally, liquids can be classified by the relation between their shear stress and shear rate.

#### Newtonian fluids:

In Newtonian fluids the shear stress and the shear rate are directly proportional to each other. At a given temperature, the viscosity of a Newtonian fluid remains constant regardless of the viscometer, spindle or rotational speed. Examples of fluids with these properties are water or thin engine oil.

**Non-Newtonian fluids:**

In these liquids there is no linear relationship between the shear stress and the shear rate. Therefore, differing viscosity values will be obtained under different environmental and operating conditions. The apparent viscosity of the liquid must be established by a fluid analysis. This result cannot be reproduced by using a different viscometer, unless the environmental and operating conditions are identical, and the analysis is carried out following a defined working process. The variables below influence the results:

- Viscometer model
- Dimension of the sample container
- Filling level
- Sample temperature
- Spindle
- Rotational speed
- Whether or not a spindle protector is being used
- Duration of the test (time dependant fluids)

Invariably, any change in the working methods will lead to a change in results. Non-Newtonian liquids can have a variety of properties:

**Pseudoplastic:**

A fluid the viscosity of which decreases with an increase in the shear rate is called pseudoplastic. This flow behaviour is also called “shearthinning”. Some examples of pseudoplastic fluids are: coatings, milk, ink or jam.

**Plastic:**

Under static conditions, these fluids appear to be solid. In order to carry out an analysis of these fluids, it is necessary for them to be subjected to a yield stress, so that they show characteristics similar to pseudoplastic or dilatant fluids. Examples: toothpaste, chocolate or grease.

**Dilatant:**

A fluid the viscosity of which increases with an increase in the shear rate (shear-thickening flow behaviour). Example: Solution of sugar and water or mixture of sand and water.

**Time-dependent fluids:**

A fluid the viscosity of which changes not only due to the shear rate, but also as a result of the time lapse since the shear process was started is called a time-dependent fluid.

**Thixotropic fluids:**

In thixotropic fluids, the viscosity decreases when the shear stress increases over time, e. g. when the fluid is stirred at a constant shear rate. The viscosity will increase when the shear stress ends. Examples: ketchup, honey, non-drip paint, mayonnaise.

**Rheopectic fluids:**

Fluids the viscosity of which increases with increasing shear stress at a constant shear rate are called rheopectic fluids. Examples: lubricants, special types of paint.

**6.3 Spindles**

The spindles are made with high precision to ensure maximum repeatability of test results, as long as the measuring instrument is used under the correct operating conditions.

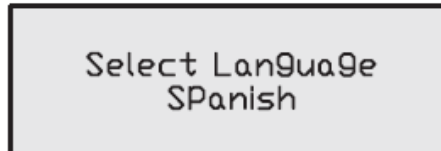


## 7 Configuration settings

Turn on the viscometer by pressing the main switch. The following notifications are displayed on the screen for 2 seconds.

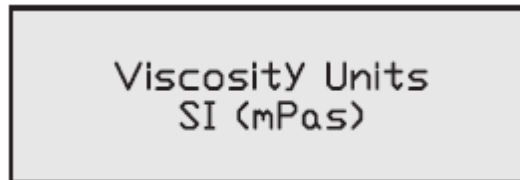


Press "Start" and "Enter" one after the other during these 2 seconds. The following appears on the display:



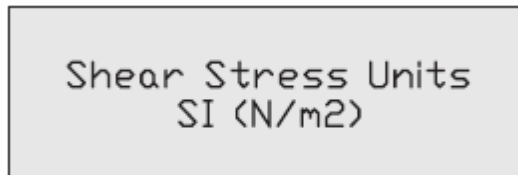
With the "Up" or "Down" keys, select the preferred language (German, Japanese, Spanish, Polish, French, English, Italian or Portuguese). Press "Enter" to confirm your language of choice.

The following notification then appears:



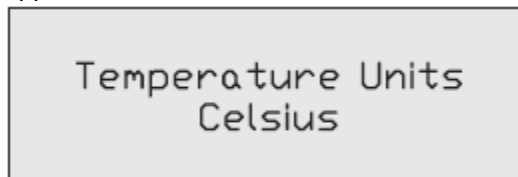
With the "Up" or "Down" keys, either select the unit for the viscosity SI (mPa s) or CGS (cP). Press "Enter" to confirm your entry.

The following notification then appears:



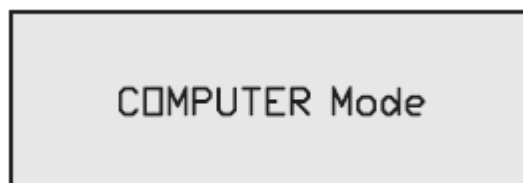
With the "Up" or "Down" keys, either select the unit for the shear stress (S.S.), SI (N/m<sup>2</sup>) or CGS (Dyne/cm<sup>2</sup>). Press "Enter" to confirm your entry.

The following notification then appears:



With the "Up" or "Down" keys, either select the unit for the temperature, Celsius or Fahrenheit. Press "Enter" to confirm your entry.

The following notification then appears:



With the **“Up”** or **“Down”** keys, either select the PRINTER or the COMPUTER mode. Press **“Enter”** to confirm your entry and to switch to the option mode.

The viscometer can be connected to a small thermal printer in PRINTER MODE (paper rolls ~57mm), to only print viscosity values when the **“Start”** key is pressed.

Every time the **“Start”** key is pressed, a ticket as shown will be printed.

The viscometer sends a permanent print job in COMPUTER mode. The viscometer and the computer have to be connected. The data format in PRINTER mode is not suitable for small printers.

The following notification then appears:

```

Set Clock
Viernes                (day)
27-12-02              (dd-mm-yy)
13:38:21              (hh:mm:ss)
  
```

The week day flashes. Press the **“Up”** or **“Down”** keys to change the day and press **“Enter”** to confirm. The first digit of the date will then begin to flash. Press the **“Up”** or **“Down”** keys to change the value and press **“Enter”** to confirm. Continue in this manner to set the date and time. After 2 seconds the notification changes to the data screen.

```

ROTATIONAL VISCOMETER
-----
Mode1:V2-L
Ser.No.
-----
Hour:08:15:30
Date:10-01-06
-----
RESULTS
-----
mPas: 00000930
%: 46.9
sp: L3
rpm: 60
T: 25.9C
-----
Signature
-----
  
```

## 8 Operation

Turn on the viscometer by pressing the main switch. The following notifications will appear on screen for the next 2 seconds (presentation screen):

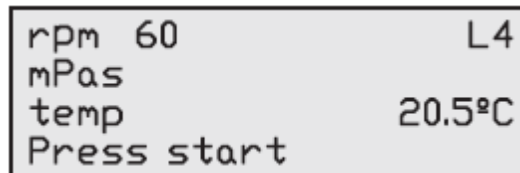


After 2 seconds, the display switches to the data screen and shows the latest saved parameters (spindle and rate).



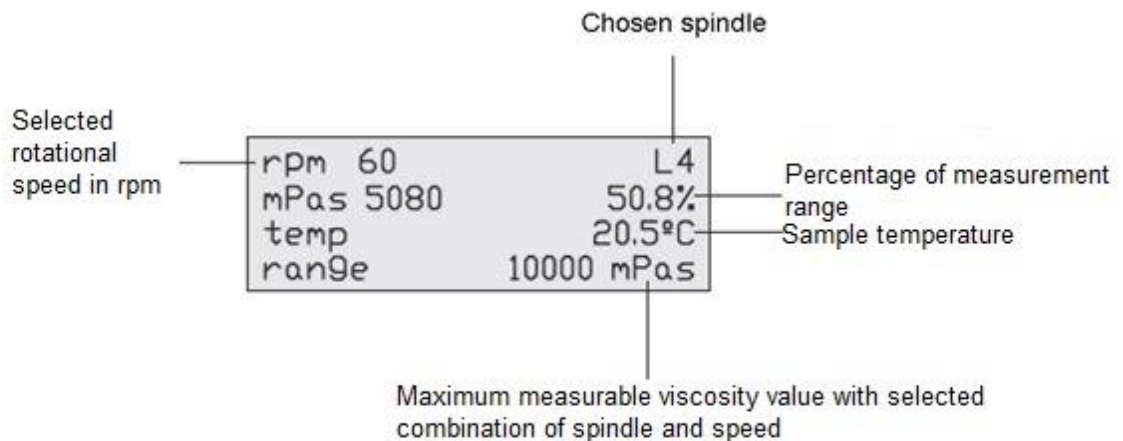
The name of the spindle flashes in the display. Press “Up” or “Down” to change the value and submit the input by pressing the “Enter” button. Now the rotation rate (rpm) starts to flash. Press the “Up” or “Down” keys to change the values and confirm the entry by pressing the “Enter” button. The parameter “range” informs you about the maximum measurable viscosity value of the chosen spindle and rpm.

The notification “Press Start” flashes in the fourth line. When you press “Start”, the spindle begins to rotate and the measurement starts. The operation screen appears:



The “Start” button can be pressed immediately. In this case, the device takes the last saved parameters of the chosen spindle and rotation rate value and starts the measuring procedure.

### 8.1 Operation screen



For the usage of the display, the following keys can be used:

UP	OR	DOWN	:	Adjusting the speed
STOP	:			Stops motor and measurement
START	:			Starts motor and measurement
ENTER	:			Stops the current process

## 8.2 Application of the spindle

If the plate spindle is chosen, be careful whilst immersing the spindle into the sample liquid to avoid bubbles under the plate. To apply the spindle, slightly move the shaft upwards with one hand and screw down the spindle with the other hand.



During this process, be careful to avoid bending the spindle and damaging the shaft.



The spindle and the core thread of its counterpart have to be dirt-free.

The spindle can now be immersed into the test liquid, up to the marker point (groove on the spindle). The spindle must not be allowed to come into contact with the sides of the container as otherwise the spindle and shaft could be knocked out of vertical alignment or even damaged.



The spindle L4 and R7 have to be immersed up to the boundary point. The spindles are made out of AISI 316 stainless steel. Every spindle is identifiable by its engraving.

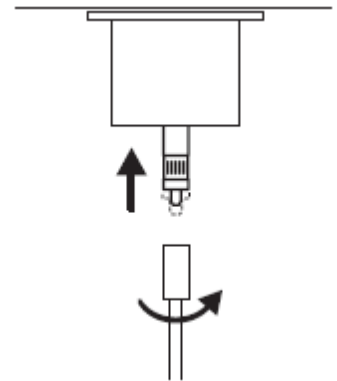
## 8.3 Start measurement

Press “**Start**” to begin the measuring procedure.

Constant flow conditions will be reached after a short period; the correct viscosity values can be read after a few seconds (depending on the chosen rotational speed and the sample viscosity).

The notification “**ERROR**” signals that the maximum measurable viscosity values have been exceeded. In this case, the velocity should be decreased or a bigger spindle should be used.

When you press the “**Stop**” key, the device’s motor stops; the viscosity value last measured is shown. To protect the instrument’s sensitive parts, the speed decreases to 0 rotations. By pressing the “**Start**” key again, the present speed will be reached. To change the speed or the spindle number, press the “**Enter**” key. In case the measured viscosity value exceeds the optimal range (<10 % and >90 % of the maximum value), an alert tone will sound.



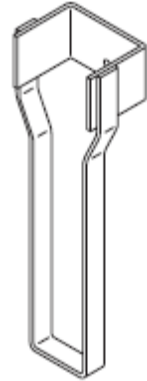
## 9 Selection tables



The tables contain orientation values for the viscosity. The recommended minimum reading is ~15 % of the full scale.

### 9.1 Viscometer PCE-RVI 2 V1L

The model PCE-RVI 2 V1L has 19 speeds (0.3; 0.5; 0.6; 1; 1.5; 2; 2.5; 3; 4; 5; 6; 10; 12; 20; 30; 50; 60; 100; 200 rpm). The model is delivered with the default spindle set (L1-L4). The spindle L1 is used for measurements with low viscosity. When using this spindle, use it along with the spindle protection to achieve correct measurements. The usage of the “adapter for low-viscosity material” and the cylinder spindle for low-viscosity substances is recommended to get accurate measurements. The spindle set TL5-TL7 is used with the “adapter for small probe volumes”. These accessories are not part of the standard delivery.



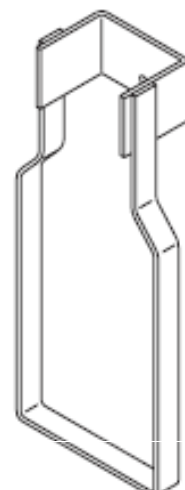
Spindle protection

PCE-RVI 2 V1L: Default spindles L1-L4

Spindle	L1	L2	L3	L4
rpm	Viscosity in mPa s			
0.3	$2 \times 10^4$	$1 \times 10^5$	$4 \times 10^5$	$2 \times 10^6$
0.5	$1.2 \times 10^4$	$6 \times 10^4$	$2.4 \times 10^5$	$1.2 \times 10^6$
0.6	$1 \times 10^4$	$5 \times 10^4$	$2 \times 10^5$	$1 \times 10^6$
1	$6 \times 10^3$	$3 \times 10^4$	$1.2 \times 10^5$	$6 \times 10^5$
1.5	$4 \times 10^3$	$2 \times 10^4$	$8 \times 10^4$	$4 \times 10^5$
2	$3 \times 10^3$	$1.5 \times 10^4$	$6 \times 10^4$	$3 \times 10^5$
2.5	$2.4 \times 10^3$	$1.2 \times 10^4$	$4.8 \times 10^4$	$2.4 \times 10^5$
3	$2 \times 10^3$	$1 \times 10^4$	$4 \times 10^4$	$2 \times 10^5$
4	$1.5 \times 10^3$	$7.5 \times 10^3$	$3 \times 10^4$	$1.5 \times 10^5$
5	$1.2 \times 10^3$	$6 \times 10^3$	$2.4 \times 10^4$	$1.2 \times 10^5$
6	$1 \times 10^3$	$5 \times 10^3$	$2 \times 10^4$	$1 \times 10^5$
10	$6 \times 10^2$	$3 \times 10^3$	$1.2 \times 10^4$	$6 \times 10^4$
12	$5 \times 10^2$	$2.5 \times 10^3$	$1 \times 10^4$	$5 \times 10^4$
20	$3 \times 10^2$	$1.5 \times 10^3$	$6 \times 10^3$	$3 \times 10^4$
30	$2 \times 10^2$	$1 \times 10^3$	$4 \times 10^3$	$2 \times 10^4$
50	$1.2 \times 10^2$	$6 \times 10^2$	$2.4 \times 10^3$	$1.2 \times 10^4$
60	$1 \times 10^2$	$5 \times 10^2$	$2 \times 10^3$	$1 \times 10^4$
100	60	$3 \times 10^2$	$1.2 \times 10^3$	$6 \times 10^3$
200	30	$1.5 \times 10^2$	$6 \times 10^2$	$3 \times 10^3$
Increment	1 mPa s	1 mPa s	10 mPa s	10 mPa s

### 9.2 Viscometer PCE-RVI 2 V1R

The model PCE-RVI 2 V1R has 19 speeds (0.3; 0.5; 0.6; 1; 1.5; 2; 2.5; 3; 4; 5; 6; 10; 12; 20; 30; 50; 60; 100; 200 rpm). The model is delivered with the default spindle set (R2-R7). The spindle R1 is used for measurements with low viscosity. With this spindle, you have to use the spindle protection to achieve correct measurements. Since the R models are normally used for medium-viscosity measurements, the R1 spindle is not used very often and is therefore not part of the standard tools but can be ordered separately. The spindle set TR8 – TR11 is used with the “adapter for small sample volumes”. This set is not included in the standard delivery.



Spindle protection

**PCE-RVI 2 V1R: Default spindles R2-R7 + optional R1**

Spindle	R1 (optional)	R2	R3	R4	R5	R6	R7
<b>rpm</b>	<b>Viscosity in mPa s</b>						
0.3	$33.3 \times 10^3$	$133.3 \times 10^3$	$333.3 \times 10^3$	$666.6 \times 10^3$	$1.3 \times 10^6$	$3.33 \times 10^6$	$13.3 \times 10^6$
0.5	$2 \times 10^4$	$8 \times 10^4$	$2 \times 10^5$	$4 \times 10^5$	$8 \times 10^5$	$2 \times 10^6$	$8 \times 10^6$
0.6	$16.6 \times 10^3$	$66.6 \times 10^3$	$166.6 \times 10^3$	$333.3 \times 10^3$	$666.6 \times 10^3$	$1.6 \times 10^6$	$6.6 \times 10^6$
1	$1 \times 10^4$	$4 \times 10^4$	$1 \times 10^5$	$2 \times 10^5$	$4 \times 10^5$	$1 \times 10^6$	$4 \times 10^6$
1.5	$6.6 \times 10^3$	$26.6 \times 10^3$	$66.6 \times 10^3$	$133.3 \times 10^3$	$266.6 \times 10^3$	$666.6 \times 10^3$	$2.6 \times 10^6$
2	$5 \times 10^3$	$2 \times 10^4$	$5 \times 10^4$	$1 \times 10^5$	$2 \times 10^5$	$5 \times 10^5$	$2 \times 10^6$
2.5	$4 \times 10^3$	$16 \times 10^3$	$4 \times 10^4$	$8 \times 10^4$	$16 \times 10^4$	$4 \times 10^5$	$1.6 \times 10^6$
3	$3.3 \times 10^3$	$13.3 \times 10^3$	$33.3 \times 10^3$	$66.6 \times 10^3$	$133.3 \times 10^3$	$333.3 \times 10^3$	$1.3 \times 10^6$
4	$2.5 \times 10^3$	$1 \times 10^4$	$2.5 \times 10^4$	$5 \times 10^4$	$1 \times 10^5$	$2.5 \times 10^5$	$1 \times 10^6$
5	$2 \times 10^3$	$8 \times 10^3$	$2 \times 10^4$	$4 \times 10^4$	$8 \times 10^4$	$2 \times 10^5$	$8 \times 10^5$
6	$1.6 \times 10^3$	$6.6 \times 10^3$	$16.6 \times 10^3$	$33.3 \times 10^3$	$66.6 \times 10^3$	$166.6 \times 10^3$	$66.6 \times 10^3$
10	$1 \times 10^3$	$4 \times 10^3$	$1 \times 10^4$	$2 \times 10^4$	$4 \times 10^4$	$1 \times 10^5$	$4 \times 10^5$
12	$8.33 \times 10^2$	$3.3 \times 10^3$	$8.3 \times 10^3$	$16.6 \times 10^3$	$33.3 \times 10^3$	$83.3 \times 10^3$	$333.3 \times 10^3$
20	$5 \times 10^2$	$2 \times 10^3$	$5 \times 10^3$	$1 \times 10^4$	$2 \times 10^4$	$5 \times 10^4$	$2 \times 10^5$
30	$3.33 \times 10^2$	$1.3 \times 10^3$	$3.3 \times 10^3$	$6.6 \times 10^3$	$13.3 \times 10^3$	$33.3 \times 10^3$	$133.3 \times 10^3$
50	$2 \times 10^2$	$8 \times 10^2$	$2 \times 10^3$	$4 \times 10^3$	$8 \times 10^3$	$2 \times 10^4$	$8 \times 10^4$
60	$1.66 \times 10^2$	$6.6 \times 10^2$	$1.6 \times 10^3$	$3.3 \times 10^3$	$6.6 \times 10^3$	$16.6 \times 10^3$	$66.6 \times 10^3$
100	$1 \times 10^2$	$4 \times 10^2$	$1 \times 10^3$	$2 \times 10^3$	$4 \times 10^3$	$1 \times 10^4$	$4 \times 10^4$
200	50	$2 \times 10^2$	$5 \times 10^2$	$1 \times 10^3$	$2 \times 10^3$	$5 \times 10^3$	$2 \times 10^4$
Increment	1 mPa s	1 mPa s	10 mPa s	10 mPa s	10 mPa s	100 mPa s	100 mPa s

## 10 Accessories

### 10.1 Adapter for small sample volumes

#### Measurement range

Model V1L: 1.5\* - 200000 mPa s/cP

Model V1R: 25\* - 3300000 mPa s/cP

\*High rotational speeds required for very low-viscosity measurements can have a negative influence on viscosity readings.

\*Viscosity measurements have to be carried out under laminar flow conditions as turbulent flow conditions can cause erroneously high viscosity values.

#### Description

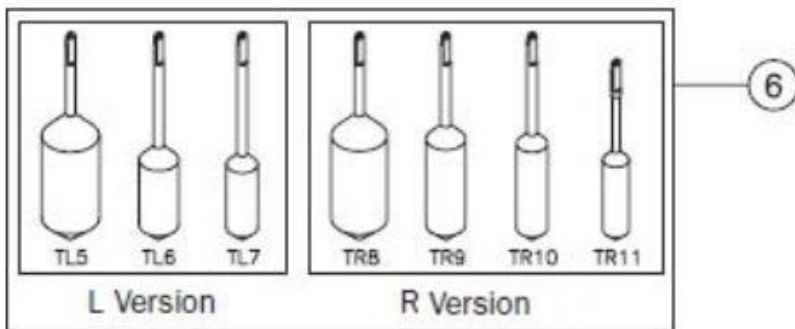
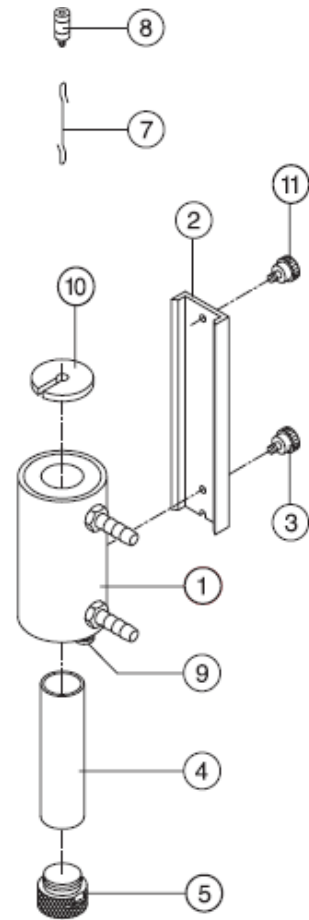
The adapter for small fluid volumes is available as an accessory for precision spindles which rotate inside a sample container. The container fits into a water jacket which enables water circulation and thus precise temperature control (between -10 °C and 100 °C). The adapter for the special spindle set must be ordered separately. It is normally used for testing very small fluid volumes (8-13ml)

This accessory part is available to order in two versions:

- Standard adapter
- Adapter with temperature sensor in the lower cap to allow direct sample temperature monitoring

**Assembly**

- Using the provided screw (3), fix the water jacket (1) onto the rear support (2).
- Close the sample container (4) with the lower cap (5). Ensure that the lower cap is properly fixed.
- Fill the sample container (4). Ensure that there are not any bubbles in the container. Tilt the container and fill it with a large syringe. The needed sample volume is relatively small (8-13 ml).
- Check the sample volume. The spindle should be covered completely.
- Hang the desired spindle (6) onto the spindle hook (7). Attach the hook to the screw (8).
- Insert the spindle with hook and screw into the sample container.
- Insert the sample container (4) into the water jacket (1) from below.
- Fix the sample container (4) in the water jacket (1). The groove of the lower cap has to be aligned with the fastening screw (9) of the water jacket. Turn the sample container to do so.
- Attach the upper cap (10). Make sure that the spindle does not fall into the sample container.
- Using the provided screw (11), fix the rear support (2) onto the viscometer.



**Selection tables for special spindles  
PCE-RVI 2 V1L (TL5-TL7)**

Spindle	TL5	TL6	TL7
rpm	Viscosity in mPa s		
0.3	$1 \times 10^4$	$1 \times 10^5$	$2 \times 10^5$
0.5	$6 \times 10^3$	$6 \times 10^4$	$1.2 \times 10^5$
0.6	$5 \times 10^3$	$5 \times 10^4$	$1 \times 10^5$
1	$3 \times 10^3$	$3 \times 10^4$	$6 \times 10^4$
1.5	$2 \times 10^3$	$2 \times 10^4$	$4 \times 10^4$
2	$1.5 \times 10^3$	$1.5 \times 10^4$	$3 \times 10^4$
2.5	$1.2 \times 10^3$	$1.2 \times 10^4$	$2.4 \times 10^4$
3	$1 \times 10^3$	$1 \times 10^4$	$2 \times 10^4$
4	$7.5 \times 10^2$	$7.5 \times 10^3$	$1.5 \times 10^4$
5	$6 \times 10^2$	$6 \times 10^3$	$1.2 \times 10^4$
6	$5 \times 10^2$	$5 \times 10^3$	$1 \times 10^4$
10	$3 \times 10^2$	$3 \times 10^3$	$6 \times 10^3$
12	$2.5 \times 10^2$	$2.5 \times 10^3$	$5 \times 10^3$
20	$1.5 \times 10^2$	$1.5 \times 10^3$	$3 \times 10^3$
30	$1 \times 10^2$	$1 \times 10^3$	$2 \times 10^3$
50	60	$6 \times 10^2$	$1.2 \times 10^3$
60	50	$5 \times 10^2$	$1 \times 10^3$
100	30	$3 \times 10^2$	$6 \times 10^2$
200	15	$1.5 \times 10^2$	$3 \times 10^2$
Increment	0.1 mPa s	1 mPa s	10 mPa s

**Characteristics of special spindles**

Spindle	Shear rate (S. R.) (Seg.-1)	Sample volume (cc)
TL5	1.32 x rpm	8.0
TL6	0.34 x rpm	10.0
TL7	0.28 x rpm	9.5

The stated shear rates (S.R.) have been calculated based on the assumption that the fluids have Newtonian characteristics.

**PCE-RVI 2 V1R (TR8-TR11)**

Spindle	TR8	TR9	TR10	TR11
rpm	Viscosity in mPa s			
0.3	$166.6 \times 10^3$	$833.3 \times 10^3$	$1.6 \times 10^6$	$3.3 \times 10^6$
0.5	$1 \times 10^5$	$5 \times 10^5$	$1 \times 10^6$	$2 \times 10^6$
0.6	$83.3 \times 10^3$	$416.6 \times 10^3$	$833.3 \times 10^3$	$1.6 \times 10^6$
1	$5 \times 10^4$	$25 \times 10^4$	$5 \times 10^5$	$1 \times 10^6$
1.5	$33.3 \times 10^3$	$166.6 \times 10^3$	$333.3 \times 10^3$	$666.6 \times 10^3$
2	$25 \times 10^3$	$125 \times 10^3$	$25 \times 10^4$	$5 \times 10^5$
2.5	$2 \times 10^4$	$1 \times 10^5$	$2 \times 10^5$	$4 \times 10^5$
3	$16.6 \times 10^3$	$83.3 \times 10^3$	$166.6 \times 10^3$	$333.3 \times 10^3$
4	$12.5 \times 10^3$	$62.5 \times 10^3$	$125 \times 10^3$	$25 \times 10^4$
5	$1 \times 10^4$	$5 \times 10^4$	$1 \times 10^5$	$2 \times 10^5$
6	$8.3 \times 10^3$	$41.6 \times 10^3$	$83.3 \times 10^3$	$166.6 \times 10^3$
10	$5 \times 10^3$	$25 \times 10^3$	$5 \times 10^4$	$1 \times 10^5$
12	$4.16 \times 10^3$	$20.83 \times 10^3$	$41.6 \times 10^3$	$83.3 \times 10^3$
20	$2.5 \times 10^3$	$12.5 \times 10^3$	$25 \times 10^3$	$5 \times 10^4$
30	$1.6 \times 10^3$	$8.3 \times 10^3$	$16.6 \times 10^3$	$33.3 \times 10^3$
50	$1 \times 10^3$	$5 \times 10^3$	$1 \times 10^4$	$2 \times 10^4$
60	$83.3 \times 10^2$	$4.16 \times 10^3$	$8.3 \times 10^3$	$16.6 \times 10^3$
100	$5 \times 10^2$	$2.5 \times 10^3$	$5 \times 10^3$	$1 \times 10^4$
200	$2.5 \times 10^2$	$1.25 \times 10^3$	$2.5 \times 10^3$	$5 \times 10^3$
Increment	10 mPa s	100 mPa s	100 mPa s	100 mPa s



**Characteristics of special spindles**

Spindle	Shear rate (S. R.) (Seg.-1)	Sample volume (cc)
TR8	0.93 x rpm	8.0
TR9	0.34 x rpm	10.5
TR10	0.28 x rpm	11.5
TR11	0.25 x rpm	13.0

The stated shear rates (S.R.) have been calculated based on the assumption that the fluids have Newtonian characteristics.

**10.2 Adapter for low-viscosity materials**

**Measurement range**

Model V1L: 0.3\* ... 2000 mPa s/cP

Model V1R: 3.2\* ... 21333 mPa s/cP

\*High rotational speeds required for very low-viscosity measurements can have a negative influence on viscosity readings.

\*Viscosity measurements have to be carried out under laminar flow conditions as turbulent flow conditions can cause erroneously high viscosity values.

**Description**

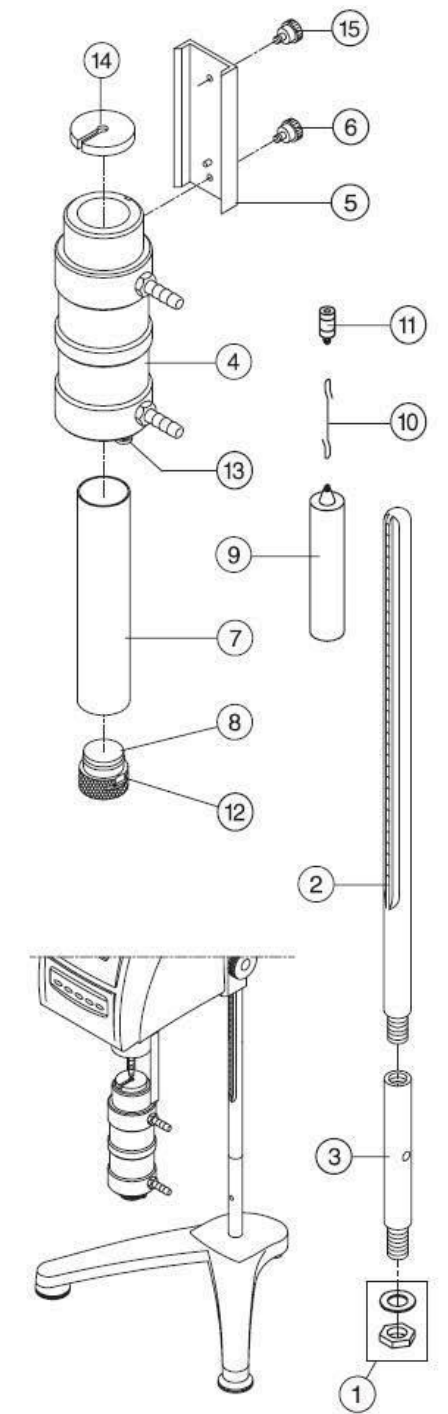
An adapter for low viscosity materials is available as an accessory for precision spindles which rotate within a sample container. To maintain an accurate temperature control, the sample container is located within a water mantle. The adapter including the LCP spindle must be ordered separately. This spindle enables low viscosity fluids to be analysed, giving accurate reproducible readings, including shear rates.

This accessory can be ordered in three variations:

- Standard adapter
- Adapter with a temperature sensor in the lower cap to enable direct temperature monitoring.
- High temperature adapter. The test fluid's temperature is controlled by immersing the container into a temperature-controlled bath. The upper and lower caps of the sample container are made of Teflon (PTFE), supporting temperatures of up to 200 °C.

**Assembly**

- Remove the nut and the washer (1) from the rack (2).
- Using the nut and the washer (1), fix the extension rod (3) between the stand and the rack (2). The extension rod is needed due to the length of the LCP adapters. Without the extension rod, it would be difficult to attach the adapter to the viscometer.
- Using the screw (6), attach the water jacket (4) onto the rear support (5).
- Close the sample container (7) with the lower cap (8). Ensure that it is sufficiently tight.
- Fill the sample container (7). Be careful that there are not any bubbles in the container. Use a large syringe to fill the container. The sample amount needed is very small (18 ml).
- Check the filling level. The spindle should be completely covered to be the correct sample amount.
- Hang the LCP spindle (9) onto the spindle hook (10). Attach the hook to the screw (11).
- Insert the spindle with the hook (10) and screw (11) into the sample container.
- Insert the sample container (7) into the water jacket (4) from below.
- Fix the sample container (7) in the water jacket (4). The groove of the lower cap (12) has to be aligned with the fastening screw (13) of the water jacket. Turn the sample container to do so.
- Attach the upper cap (14). Make sure the spindle does not fall into the sample container. Let the spindle lean on the upper cap.
- Using the provided screw (15), attach the rear support (5) to the viscometer.



**Selection table for PCE-RVI 2 V1L / V1R**

Spindle	V1L	V1R
	LCP	LCP
rpm	Viscosity in mPa s	
0.3	2000.00	21333.00
0.5	1200.00	12800.00
0.6	1000.00	10666.00
1	600.00	6400.00
1.5	400.00	4266.00
2	300.00	3200.00
2.5	240.00	2560.00
3	200.00	2133.00
4	150.00	1600.00
5	120.00	1280.00
6	100.00	1066.00
10	60.00	640.00
12	50.00	533.00
20	30.00	320.00
30	20.00	213.00
50	12.00	128.00
60	10.00	106.00
100	6.00	64.00
200	3.00	32.00
Increment	0.01 mPa s	0.16 mPa s

**Characteristics of special spindles:**

Spindle	Shear rate (S. R.) (Seg.-1)	Sample volume (cc)
LCP	1.224 x rpm	18

The stated shear rates (S.R.) have been calculated based on the assumption that the fluids have Newtonian characteristics.

**10.3 Adapter for spiral movements**

**Measurement range**

Model V1L: 156\* ... 9400000 mPa s/cP

Model V1R: 1660\* ... 100000000 mPa s/cP

\*High rotational speed for the measurement of low-viscosity values can have a negative influence on the readings.

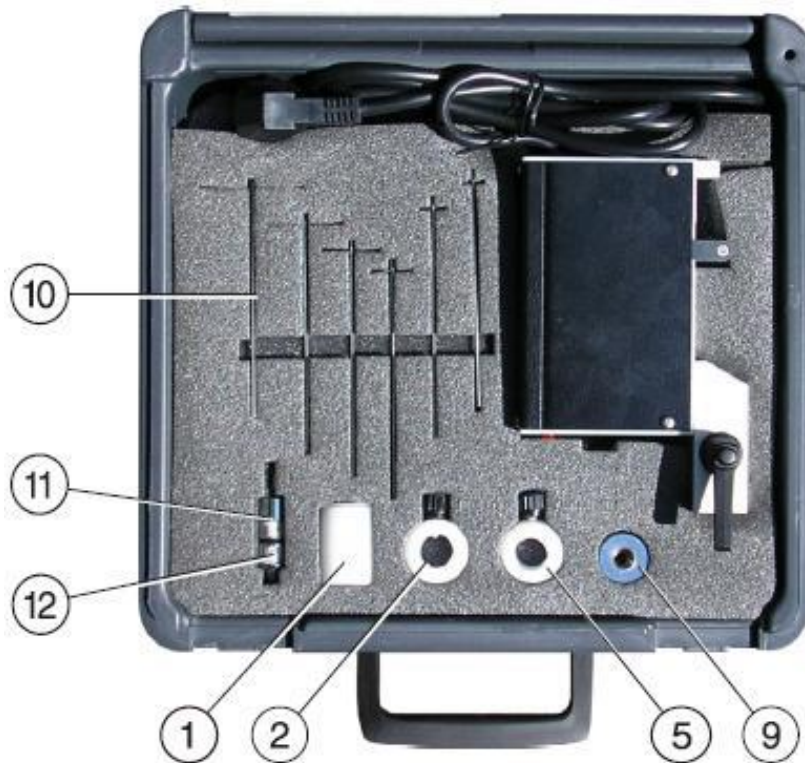
\*Viscosity measurements have to be carried out under laminar conditions. Turbulent flow conditions can cause erroneously high viscosity values.

**Description**

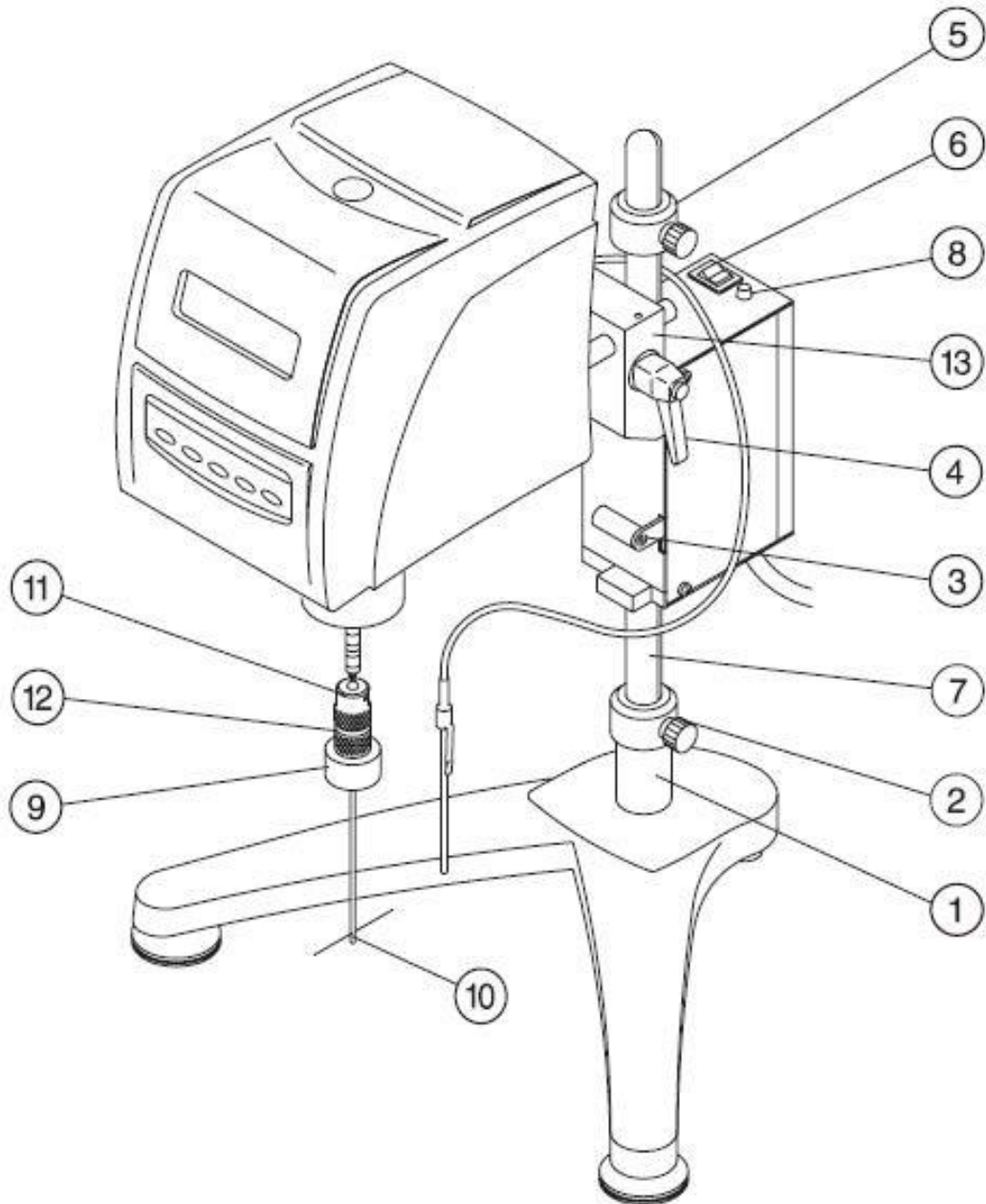
This adapter for analysing spiral movements enables comparative viscosity measurements in substances that cannot be tested using the standard methods and spindles. It is particularly useful for testing creams, gels, gelatine and other materials which do not flow easily.

The adapter for spiral movements consists of a motorised unit which causes the measuring head to move vertically between two stopper rings. When one of the two stoppers is touched, the unit changes its direction of movement automatically. This results in a spiral, corkscrew motion within the test substance, without forming any cavities or channels within the material being tested.

The adapter is supplied with 6 T-type special spindles (PA, PB, PC, PD, PE, PF).

**Assembly**

- Remove the nut and the washer from the rack (7).
- Using the provided nut and washer, attach the rack (7) to the stand. The cogged side of the rack has to be pointed towards the back of the stand.
- Insert the rack into the security socket (1).
- Use the lower stopper ring (2) to fix the rack to the security socket. Tighten it with the screw but be careful that you do not screw too tight.
- Attach the adapter for spiral movements to the rack and fix it with the sliding knob (3).
- Using the screw, fix the upper stopper ring (5) onto the rack. Be careful not to screw too tight.
- Level the device.



- |   |                    |
|---|--------------------|
| 1. Security socket                        | 8. Power indicator |
| 2. Lower stopper ring with screw          | 9. Counterweight   |
| 3. Sliding knob for the adapter           | 10. T spindle      |
| 4. Fixing lever for the measuring element | 11. Coupling screw |
| 5. Upper stopper ring with screw          | 12. Counter nut    |
| 6. ON/OFF switch                          | 13. Clamp          |
| 7. Rack                                   |                    |

- Connect the adapter to the viscometer using the clamp (13) and tighten it with the fixing lever (4).
- Attach the counterweight (9) to the counter nut (12) and coupling screw (11).
- Slightly loosen the connection between the counter nut and the coupling screw but do not separate the parts.
- Insert the T-spindle (10) into the counterweight (9) and tighten it. There should always be a small gap between the counter nut and the coupling screw.
- Turn the coupling screw (11) clockwise to attach it to the viscometer. The coupling screw and the internal thread have to be dirt-free.
- Place the sample container under the viscometer and dip the spindle into the sample by means of the sliding knob (3).
- Attach the stopper rings in consideration of the following:  
Upper stopper ring: Spindle must stay dipped in the probe.  
Lower stopper ring: Spindle must not come in contact with the container base. Otherwise, the spindle could be damaged and determine incorrect viscosity values.
- Connect the viscometer and the adapter to the power supply. Turn on the viscometer and choose a spindle and a rotational speed.
- Turn on (6) the adapter. Check if the power indicator lights up (8).

Selection table for PCE-RVI 2 V1L

Spindle rpm	PA	PB	PC	PD	PE	PF
Viscosity in mPa s						
0.3	$62.4 \times 10^3$	$124.8 \times 10^3$	$312 \times 10^3$	$624 \times 10^3$	$1.56 \times 10^6$	$3.12 \times 10^6$
0.5	$37.44 \times 10^3$	$74.88 \times 10^3$	$187.2 \times 10^3$	$374.4 \times 10^3$	$936 \times 10^3$	$1.872 \times 10^6$
0.6	$31.2 \times 10^3$	$62.4 \times 10^3$	$156 \times 10^3$	$312 \times 10^3$	$780 \times 10^3$	$1 \times 10^6$
1	$18.72 \times 10^3$	$37.44 \times 10^3$	$93.6 \times 10^3$	$187.2 \times 10^3$	$468 \times 10^3$	$936 \times 10^3$
1.5	$12.48 \times 10^3$	$24.96 \times 10^3$	$62.4 \times 10^3$	$124.8 \times 10^3$	$312 \times 10^3$	$624 \times 10^3$
2	$9.36 \times 10^3$	$18.72 \times 10^3$	$46.8 \times 10^3$	$93.6 \times 10^3$	$234 \times 10^3$	$468 \times 10^3$
2.5	$7.488 \times 10^3$	$14.976 \times 10^3$	$37.44 \times 10^3$	$74.88 \times 10^3$	$187.2 \times 10^3$	$374.4 \times 10^3$
3	$6.24 \times 10^3$	$12.48 \times 10^3$	$31.2 \times 10^3$	$62.4 \times 10^3$	$156 \times 10^3$	$312 \times 10^3$
4	$4.68 \times 10^3$	$9.36 \times 10^3$	$23.4 \times 10^3$	$46.8 \times 10^3$	$117 \times 10^3$	$234 \times 10^3$
5	$3.744 \times 10^3$	$7.488 \times 10^3$	$18.72 \times 10^3$	$37.44 \times 10^3$	$93.6 \times 10^3$	$187.2 \times 10^3$
6	$3.12 \times 10^3$	$6.24 \times 10^3$	$15.6 \times 10^3$	$31.2 \times 10^3$	$78 \times 10^3$	$156 \times 10^3$
10	$1.872 \times 10^3$	$3.744 \times 10^3$	$9.36 \times 10^3$	$18.72 \times 10^3$	$46.8 \times 10^3$	$93.6 \times 10^3$
12	$1.56 \times 10^3$	$3.12 \times 10^3$	$7.8 \times 10^3$	$15.6 \times 10^3$	$39 \times 10^3$	$78 \times 10^3$
Increment	1 mPa s	1 mPa s	2 mPa s	4 mPa s	8 mPa s	16 mPa s

**Selection table for PCE-RVI 2 V1R**

Spindle	PA	PB	PC	PD	PE	PF
rpm	Viscosity in mPa s					
0.3	$666.6 \times 10_3$	$1.3 \times 10^6$	$3.3 \times 10^6$	$6.6 \times 10^6$	$16.6 \times 10^6$	$33.3 \times 10^6$
0.5	$4 \times 10_5$	$8 \times 10^5$	$2 \times 10^6$	$4 \times 10^6$	$10 \times 10^6$	$20 \times 10^6$
0.6	$333.3 \times 10_3$	$666.6 \times 10^3$	$1.6 \times 10^6$	$3.3 \times 10^6$	$8.3 \times 10^6$	$16.6 \times 10^6$
1	$2 \times 10_5$	$4 \times 10^5$	$1 \times 10^6$	$2 \times 10^6$	$5 \times 10^6$	$10 \times 10^6$
1.5	$133.3 \times 10_3$	$266.6 \times 10^3$	$666.6 \times 10^3$	$1.3 \times 10^6$	$3.3 \times 10^6$	$6.6 \times 10^6$
2	$1 \times 10_5$	$2 \times 10^5$	$5 \times 10^5$	$1 \times 10^6$	$2.5 \times 10^6$	$5 \times 10^6$
2.5	$8 \times 10_4$	$16 \times 10^4$	$4 \times 10^5$	$8 \times 10^5$	$2 \times 10^6$	$4 \times 10^6$
3	$66.6 \times 10_3$	$133.3 \times 10^3$	$333.3 \times 10^3$	$666.6 \times 10^3$	$1.6 \times 10^6$	$3.3 \times 10^6$
4	$5 \times 10_4$	$1 \times 10^5$	$25 \times 10^4$	$5 \times 10^5$	$1.25 \times 10^6$	$2.5 \times 10^6$
5	$4 \times 10_4$	$8 \times 10^4$	$2 \times 10^5$	$4 \times 10^5$	$1 \times 10^6$	$2 \times 10^6$
6	$33.3 \times 10_3$	$66.6 \times 10^3$	$166.6 \times 10^3$	$333.3 \times 10^3$	$833.3 \times 10^3$	$1.6 \times 10^6$
10	$2 \times 10_4$	$4 \times 10^4$	$1 \times 10^5$	$2 \times 10^5$	$5 \times 10^5$	$1 \times 10^6$
12	$16.6 \times 10_3$	$33.3 \times 10^3$	$83.3 \times 10^3$	$166.6 \times 10^3$	$416.6 \times 10^3$	$833.2 \times 10^3$
Increment	5 mPa s	10 mPa s	25 mPa s	50 mPa s	125 mPa s	250 mPa s

### 11 Calibration

Contact PCE Instruments.

### 12 Troubleshooting

The device does not work.	<ul style="list-style-type: none"> <li>• Check power connection.</li> <li>• Check switch position.</li> </ul>
The spindle does not rotate centrally.	<ul style="list-style-type: none"> <li>• Check the correct alignment of the spindle in the shaft.</li> <li>• Check connection between spindle and shaft for contamination.</li> </ul>
The instrument does not display "0" in vacuum.	<ul style="list-style-type: none"> <li>• Check correct levelling of the device.</li> </ul>
The viscosity reading fluctuates or is inaccurate.	<ul style="list-style-type: none"> <li>• Check correct levelling of the device.</li> <li>• Check correct selection of the spindle and speed.</li> <li>• Ensure constant sample temperature.</li> <li>• The problem could be due to the special characteristics of the sample.</li> </ul>

### 13 Warranty

Guarantee on processing and material errors. Damaged parts will be replaced. There are not any other special warranties. Unauthorized updates and repairs by third parties lead to an expiry of the guarantee. The guarantee also expires if the instrument is used incorrectly or is not used as described in this manual. Even though we try to produce a complete and correct manual, we are not able to provide a guarantee for misprint.

## 14 Disposal

For the disposal of batteries, the 2006/66/EC directive of the European Parliament applies. Due to the contained pollutants, batteries must not be disposed of as household waste. They must be given to collection points designed for that purpose.

In order to comply with the EU directive 2012/19/EU we take our devices back. We either re-use them or give them to a recycling company which disposes of the devices in line with law.

If you have any questions, please contact PCE Instruments.



## 15 Contact

If you have any questions about our range of products or measuring instruments please contact PCE Instruments.

### 15.1 PCE Instruments UK

**By post:**

PCE Instruments UK Ltd.  
Units 12/13 Southpoint Business Park  
Ensign Way, Southampton  
Hampshire

United Kingdom, SO31 4RF

**By phone:**

02380 987 035

### 15.2 PCE Americas

**By post:**

PCE Americas Inc.  
711 Commerce Way  
Suite 8  
Jupiter  
33458 FL  
USA

**By phone:**

561 320 9162