

elcometer®



Rotational
Viscosity

www.elcometer.com

Viscosity

Viscosity is perceived as 'thickness' or resistance to pouring, but there is more to viscosity than this. All fluids have an internal friction between molecules, which determines how well fluid flows. Due to this internal friction, energy is required to move the liquid and viscosity is the measure of the resistance to flow.

Definitions:

- Viscosity:** A measure of the resistance of a liquid to flow.
- Kinematic Viscosity:** The absolute viscosity of a fluid divided by the density of the fluid. Also known as the coefficient of kinematic viscosity.
- Centipoise:** A unit of measurement of which water is the standard at 1cP.
- Newtonian fluids:** such as water and some oils, are fluids that continue to flow at a given temperature, regardless of the forces acting on it. No matter how fast it is stirred or mixed, Newtonian fluids will always behave in the same manner. Newtonian fluids are generally measured with flow and dip viscosity cups. The viscosity of a Newtonian liquid is dependent only on temperature, not on shear rate and time.
- Non-Newtonian fluids:** such as paints and ketchup, are fluids which change viscosity when a force is applied. The viscosity of Non-Newtonian fluids is dependent on temperature, shear rate and time. There are several different categories and sub-categories of non-Newtonian fluids, they can be described as the following:
- Thixotropic* - substances which are gel-like at rest but liquid when agitated, eg: non-drip paints, tomato ketchup and most varieties of honey.
- Rheopectic* - substances where viscosity increases with duration of stress, eg: some lubricants.
- Pseudoplastics* - also known as shear thinning - the viscosity decreases with increased shear rate, eg: blood, gelatin and clay.
- Dilatant* - also known as shear thickening - the viscosity increases with increased shear rate, eg: suspensions of rice, corn starch or concentrated sugar solution.

Depending on how viscosity changes with time, the flow behaviour is characterised as:

- Thixotropic:** Time thinning, i.e. viscosity decreases with time. Thixotropic liquids are quite common in the chemical and food industries.
- Rheopectic:** Time thickening, i.e. viscosity increases with time. Rheopectic liquids are very rare. Some liquids show time thinning behaviour due to breakdown of the structure. This phenomenon is sometimes known as *Rheomaiaxis*.

Depending on how viscosity changes with shear rate, the flow behaviour is characterised as:

- Pseudoplastics:** Also known as shear thinning, the viscosity decreases with increased shear rate.
- Dilatant:** Also known as shear thickening, the viscosity increases with increased shear rate.
- Plastic:** Exhibits a so-called yield value, i.e. a certain shear stress must be applied before a flow occurs.

Measuring Viscosity

Elcometer manufactures and supplies a wide range of viscosity gauges from flow cups and dip cups to rotational viscometers.

Flow Cups

The process of flow through an orifice can often be used as a relative measurement and classification of viscosity. This measured kinematic viscosity is generally expressed in seconds of flow time which can be converted into Centistokes using a viscosity disc calculator.

Dip Cups

Using the same principle as flow cups, dip cups - Frikmar, Zahn, Shell etc. - can be used to provide a quick viscosity measurement either on-site or on the shop-floor.

For more information on our range of Viscosity Flow Cups and Dip Cups visit www.elcometer.com

Rotational Viscometers

Rotational viscometers gather data on a material's viscosity behaviour under different conditions.

Rotational viscometers consist of two parts - a head unit with a motor and a spindle that is driven by the motor. The viscosity is determined by measuring the resistance of the spindle rotating in the sample. Rotational viscometers are ideal for determining the viscosity of liquids which do not depend solely on temperature and pressure.



Standards Explained: In this leaflet both National and International Standards have been identified. Those in orange are current and those in grey have been superseded but are still recognised in some industries. For more information please visit the Standards page on the Elcometer website.

C : Calibration certificate supplied as standard

Elcometer 2250 Krebs Viscometer

Featuring a unique automatic test mode, the Elcometer 2250 Krebs Viscometer measures the viscosity of paints, varnishes, adhesives, pastes and liquid inks at the touch of a button.

Designed for use in accordance with National and International Standards - the Elcometer 2250 is ideal for both process control and quality assurance.

Fully automated Krebs test - simply set up and press 'Start'

Choice of measurement units: Krebs Units (KU), Grams (g), or Centipoise (cP)

Designed for use with either a 600ml beaker, 1 pint or ½ pint cans

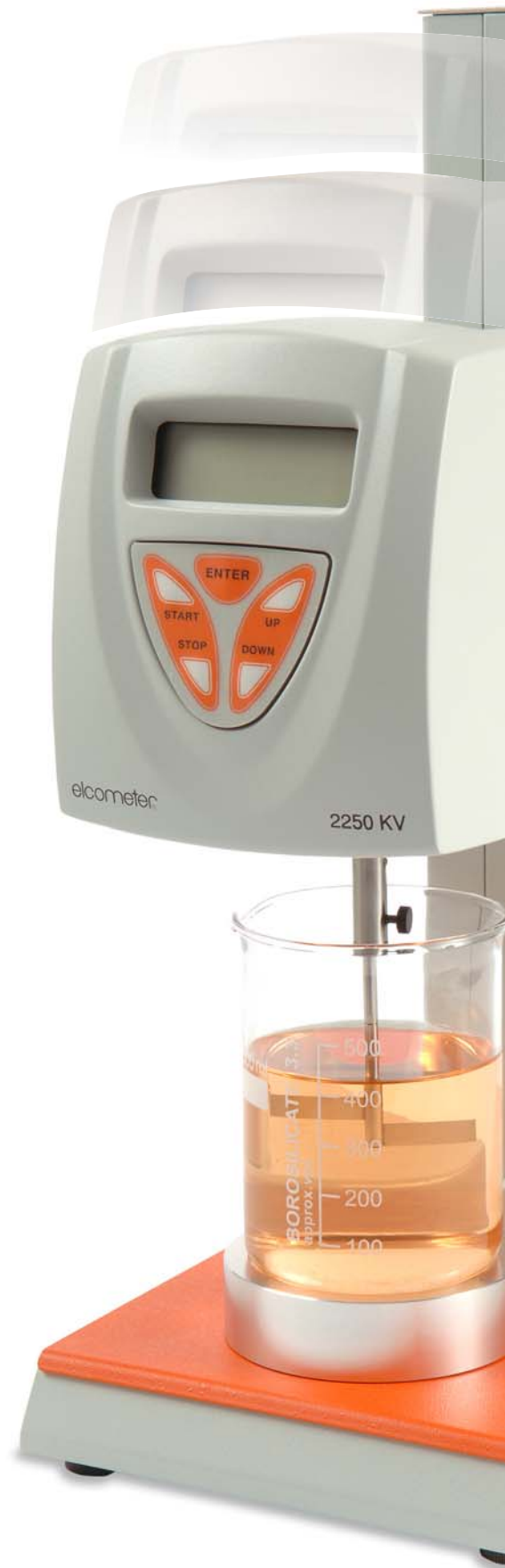
Standard Krebs spindle with fixed spindle speed of 200rpm

Can be used with non-standard containers and sample volumes

User adjustable "Sample Waiting Time" and "Measuring Time"

Date and time stamp for each reading

Optional thermal printer for a permanent record of results





The Elcometer 2250 offers users both a fully automatic or manual Krebs viscosity test. The unit has a fixed spindle speed of 200rpm and displays the viscosity value on screen in Krebs Units (KU), Grams (g) or Centipoise (cP).

The Elcometer 2250 has two operating modes; 'Automatic' and 'Manual'.

Automatic Mode: Fully automatic test - ensuring reliability and consistency of results - ideal for repeatable and reproducible testing.

Once the sample beaker is positioned on the support, and the 'Start' button is pressed, the drive head automatically moves down until the spindle reaches the correct position within the sample.

After a pause to let the sample settle, the Elcometer 2250 begins the test and displays the viscosity value.

Once the test has been completed, the head automatically returns to the start position allowing the sample to be removed.

Manual Mode: The Elcometer 2250 can also be used manually - ideal for measuring using non-standard sample sizes.

Can be used in accordance with:
(See Standards Explained on page 2)

AS/NZS 1580.214.1	ASTM D 562
ASTM D 856	ASTM D 1084-C
ASTM D 1131	

Technical Specification

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Part Number	Description
K2250M001	Elcometer 2250 Krebs Viscometer
Range	Krebs Units (KU) Grams (g) Centipoise (cP) 40 KU to 141 KU 32g to 1099g 27 cP to 5274 cP
Resolution	0.1 KU 1g 5 cP
Measurement Accuracy	±1% of full scale
Repeatability	±0.5%
Speed (Accuracy)	200rpm (±1rpm)
Operating Temperature	10°C to 40°C (50°F to 104°F)
Maximum Altitude	2000m (6500ft) above sea level
Ingress Protection	Level 2
Dimensions	500 x 325 x 190mm (19.7 x 12.8 x 7.5")
Weight	8.5kg (18.7lb)
Packing List	Elcometer 2250 Krebs Viscometer, krebs spindle, large sample container support for 600ml glass beaker or 1 pint (USA) can, small sample container support for ½ pint (USA) can, sample container support locating plug, glass beaker 600ml (20.3fl.oz.), hexagonal wrench, 3 x mains lead (UK, EUR and US), calibration certificate and operating instructions

Accessories

Part Number	Description
KT00225021791	Standard Krebs Spindle
KT00225022906	Special Paste Spindle
KT00225021793	Can Support Locating Plug
KT00225021794	Sample Container Support for 600ml (20.3fl.oz.) Glass Beaker or 1 Pint (USA) Can
KT00225021795	Sample Container Support for ½ Pint (USA) Can
KT00225021796	600ml (20.3fl.oz.) Glass Beaker
KTUK999920179	Thermal Printer, UK 240V
KT00999920178	Thermal Printer, EUR 220V
KTUS999920180	Thermal Printer, US 110V

Krebs Viscosity Standard Calibration Oils

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Part Number	Description	Krebs Units (KU)	Centipoise (cP)
KT002250N001	Krebs Calibration Oil: S200	64	400
KT002250N002	Krebs Calibration Oil: N350	79	750
KT002250N003	Krebs Calibration Oil: N400	84	940
KT002250N004	Krebs Calibration Oil: S600	95	1400
KT002250N005	Krebs Calibration Oil: N1000	115	2600

Supplied in 500ml (1 pint) bottles complete with calibration certificate and accurate to ±1% of the stated viscosity values

Elcometer 2300 RV1 and RV2 Digital Rotational Viscometers

Available in four versions with a choice of low to medium or medium to high viscosity ranges, either manually or PC controlled, the Elcometer 2300 range of rotational viscometers can be used to measure the viscosity of liquids in accordance with ISO 2555 and several ASTM standards.

Low to medium or medium to high viscosity versions - manually or PC controlled via ViscosityMaster™

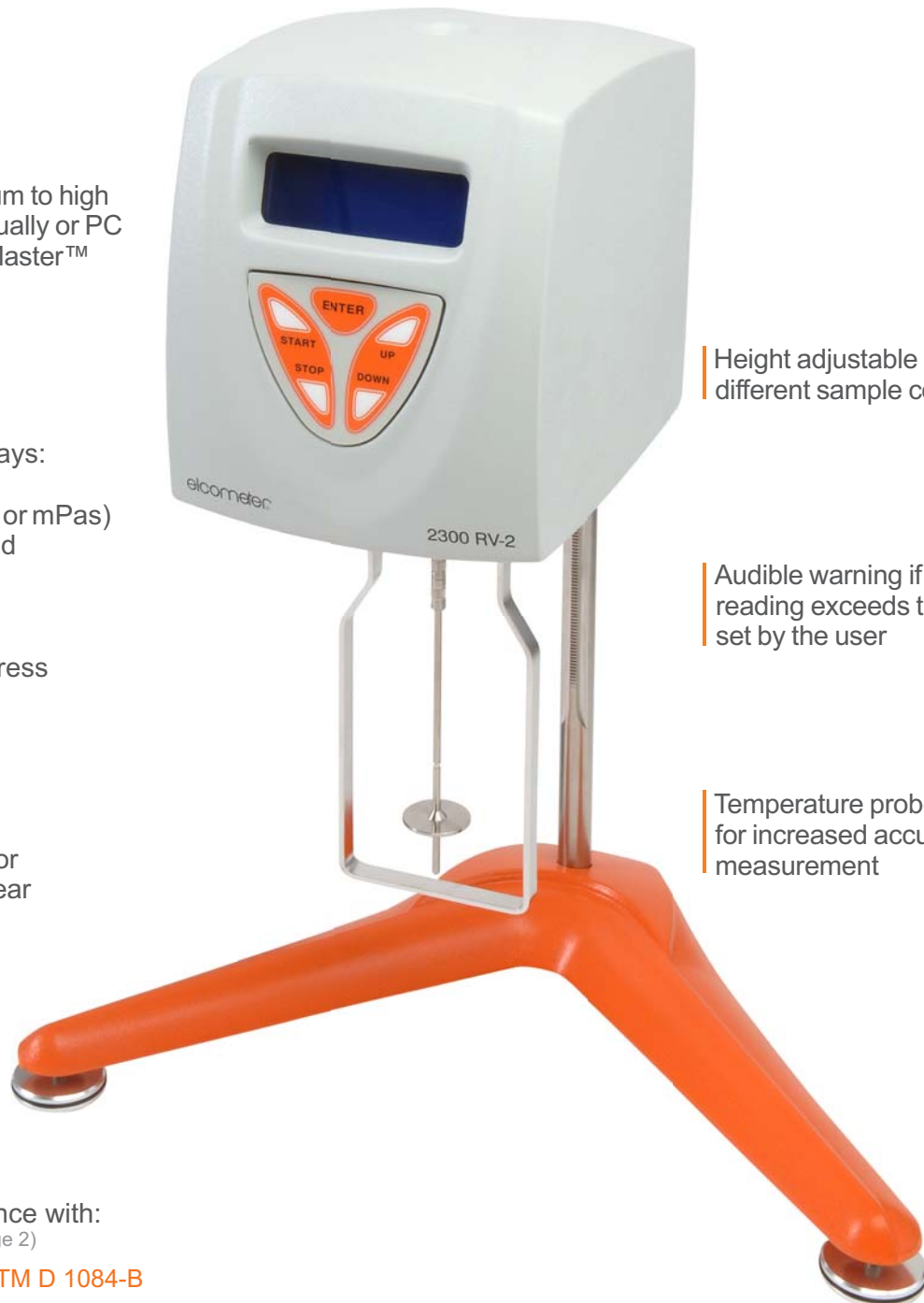
Clear, backlit LCD displays:

- Viscosity reading (cP or mPas)
- Spindle rotation speed
- % torque
- Sample temperature
- Auto range
- Shear rate & shear stress

Wide range of spindles for various viscosity and shear rate measurements

Can be used in accordance with:
(See Standards Explained on page 2)

- | | |
|-------------------|---------------|
| AS/NZS 1580.214.5 | ASTM D 1084-B |
| ASTM D 2196 | BS 3900-A7-2 |
| ISO 2555 | ISO 2884-2 |



Height adjustable head to fit different sample containers

Audible warning if viscosity reading exceeds the limits set by the user

Temperature probe supplied for increased accuracy of measurement

Technical Specification

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Model	Elcometer 2300	RV1-L	RV2-L	RV1-R	RV2-R
Part Number		K2300M101	K2300M201	K2300M102	K2300M202
Backlit LCD		■	■	■	■
Readings in cP and mPas		■	■	■	■
Sample Temperature Measurement		■	■	■	■
Manually Controlled		■	■	■	■
PC Controlled			■		■
Low to Medium Viscosity		■	■		
Medium to High Viscosity				■	■
Measuring Range (mPas)		3 - 2,000,000	3 - 2,000,000	20 - 13,000,000	20 - 13,000,000
Spindles Supplied		L1 to L4	L1 to L4	R2 to R7	R2 to R7
Measurement Accuracy		±1% of full scale			
Repeatability		±0.2%			
Maximum Altitude above Sea Level		2000m (6562ft)			
Speeds (rpm)		0.3, 0.5, 0.6, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 10, 12, 20, 30, 50, 60, 100, 200			
Accuracy (Speed)		<0.5% of the absolute value			
Sample Temperature Measurement Range [†]		-15°C to +180°C (5°F to 356°F)			
Sample Temperature Measurement Resolution [†]		0.1°C (0.18°F)			
Sample Temperature Measurement Accuracy [†]		±0.1°C (±0.18°F)			
Ingress Protection		Level 2			
Dimensions (of carry case)		495 x 420 x 200mm (19.5 x 16.5 x 8")			
Weight (including carry case)		9kg (20lb)			
Packing List		Elcometer 2300 Digital Rotational Viscometer, spindle set, 3 x mains lead (UK, EUR and US), hexagonal wrench, RS232 connection cable, ViscosityMaster™ Software [‡] , calibration certificate and operating instructions			

[†] Temperature measurement using PT100 Thermometer

[‡] RV1 Models: For data transfer from Viscometer to PC only; RV2 Models: For bi-lateral data transfer between viscometer and PC

Elcometer 2300 Oils



Rotational Viscosity Standard Calibration Oils

Silicone standard oils are used to check viscosity measurements. The values are given for 6 different temperatures between 20°C and 27°C (68°F and 80°F).

These oils are specifically manufactured for use with Elcometer 2300 Rotational viscometers and values quoted are nominal at 25°C (77°F).

Elcometer 2300 Accessories



Spindles

Each Elcometer 2300 is supplied with a set of stainless steel spindles as standard, suitable for both Newtonian & non-Newtonian fluids.

Elcometer 2300 RV-L supplied with spindles L1-L4 for low to medium viscosity testing.

Elcometer 2300 RV-R supplied with spindles R2-R7 for medium to high viscosity testing.

A large R1 spindle (highlighted) can be supplied upon request.



Small Sample Adaptor

The small sample adaptor consists of a cylindrical sample chamber which can be used in conjunction with spindles TL & TR to accurately obtain viscosity measurements, shear rate and shear stress of sample volumes between 8 - 13ml (0.27 - 0.44fl.oz). The TL spindles are for low to medium viscosity samples and TR spindles are for use with medium to high viscosity samples.



Low Viscosity Adaptor

The low viscosity adaptor consists of a cylindrical sample chamber and is supplied complete with spindle. Used to accurately obtain viscosity measurements, shear rate and shear stress of low viscosity materials from 1cP (mPa), the stainless steel chamber can hold a sample volume from 16 - 18ml (0.54 - 0.61fl.oz) and keep it at a constant specified temperature of between 0°C and 100°C (32°F and 212°F).



High Temperature Adaptor

Ideal for use with materials such as hot resins, bitumens and oils, the high temperature adaptor allows precise measurement of viscosity at high temperatures. It can accurately obtain viscosity measurements, shear rate and shear stress from 1cP (mPa) up to temperatures of 200°C (392°F). The stainless steel chamber can hold a sample volume from 16 - 18ml (0.54 - 0.61fl.oz). Each adaptor is supplied complete with a spindle.



Helical Movement Adaptor

Some materials, such as creams, pastes and gels, do not flow easily, so standard spindles and testing methods cannot be used as they create a 'hole' in the material, generating invalid results.

The helical movement adaptor moves smoothly up and down, automatically staying within pre-programmed limits, allowing the needle style spindle to cut into the material without making a 'hole' and making the measurement of viscosity possible. The kit is supplied with the motor and 6 T-shaped spindles: PA, PB, PC, PD, PE, PF.



Spindles



Small Sample Adaptor



Low Viscosity Adaptor



High Temperature Adaptor



Helical Movement Adaptor

Accessories

Part Number	Description
KT00230019698	Spindle Set: Type L1 to L4 for Low to Medium Viscosity Testing
KT00230019699	Spindle Set: Type R2 to R7 for Medium to High Viscosity Testing
KT00230019700	R1 Spindle
KT00230019702	Adaptor Kit for Small Volume Samples [†]
KT00230019784	Adaptor Kit for Small Volume Samples & Integrated Temperature Sensor [†]
KT00230019703	Small Volume Spindle Set: Type TL5 to TL7 for Low to Medium Viscosity Testing
KT00230019704	Small Volume Spindle Set: Type TR8 to TR11 for Medium to High Viscosity Testing
KT00230019710	Low Viscosity Adaptor Kit with Spindle
KT00230019711	High Temperature Adaptor Kit with Spindle
KT00230019705	Helical Movement Adaptor Kit with Spindle Set, UK 240V
KT00230019706	Helical Movement Adaptor Kit with Spindle Set, EUR 220V
KT00230019707	Helical Movement Adaptor Kit with Spindle Set, US 110V
KTUK999920179	Thermal Printer, UK 240V
KT00999920178	Thermal Printer, EUR 220V
KTUS999920180	Thermal Printer, US 110V

[†]Small volume spindle set required

Rotational Viscosity Standard Calibration Oils

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Part Number	Description	Centipoise (cP)
60ml (2fl.oz.)	500ml (1 pint)	
KT009999N001	KT009999N101 RV Standard Calibration Oil	300
KT009999N002	KT009999N102 RV Standard Calibration Oil	700
KT009999N003	KT009999N103 RV Standard Calibration Oil	1000
KT009999N004	KT009999N104 RV Standard Calibration Oil	25000
KT009999N005	KT009999N105 RV Standard Calibration Oil	40000

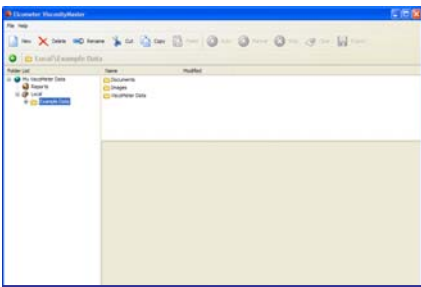
Supplied complete with calibration certificate.

Elcometer ViscosityMaster™ Software

ViscosityMaster™ is the powerful, yet easy to use software supplied with all Elcometer 2300 Rotational Viscometers. Specifically designed to maximise the versatility and usability of the viscometer, data can be stored along with associated photographs, test notes and all related test information.

There are two operating modes: Manual and Automatic.

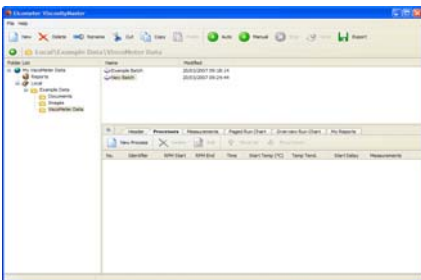
- Manual Mode - measurements are recorded as they are taken by the instrument, but the viscometer is not controlled by the software.
- Automatic Mode (PC controlled)[#] - measurements are recorded and the viscometer can be controlled by the software via a PC. When running a batch in automatic mode, the viscometer will start and stop under the control of ViscosityMaster™ and measurements and charts are shown in real time



ViscosityMaster™ makes it easy to collate and use the data recorded. Whether the data is required for analysis or to create professional reports for distribution to customers or colleagues, ViscosityMaster™ can deliver.

With inbuilt report templates and easy access to all data, images and other associated files, ViscosityMaster™ makes managing data quick and easy.

The end result is a software package which can be fully tailored to meet specific requirements, producing detailed reports in landscape or portrait format quickly, easily and effectively.



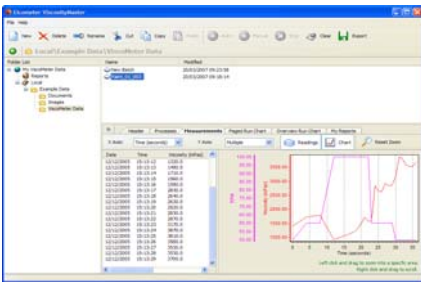
ViscosityMaster™ software has been designed to be familiar and intuitive to any PC user.

It is simple to batch all associated files and folders, create new batches or reports and programme the viscometer.

An example batch is pre-loaded into the software helping the user to discover all the features available.

The Process Wizard will ask the user to define process variables such as Identifier, Start RPM, End RPM, Time etc. On input of the information required, select 'Finish' and the new process will appear in the 'Processes' tab window.

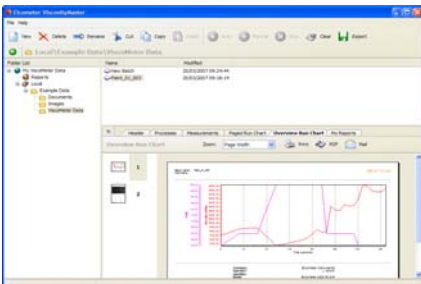
Once the particular test procedure has been defined, it is simple to create as many processes as are required.



Viewing measurement data and producing standard reports is achievable in just a few clicks.

The user can zoom in on an area of the chart, view multiple batches simultaneously, view thumbnails of your report or see the report page by page.

Customising the display window makes ViscosityMaster™ even quicker to use. Viewing tabs can be added or deleted to suit the particular test methods and reporting procedures.



Custom reports are produced with report wizards and page designers. Aside from the measurements and charts, the user can include photographs, images, Word documents etc. When complete, this can be saved and exported as a PDF or a JPEG image and e-mailed as an attachment anywhere that is required.

[#] Available on models RV1-R and RV2-R

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