



LAMY
RHEOLOGY
INSTRUMENTS

USING MANUAL

LV and RV SPRING

VERSION N° SPLVRV-UK06/2025



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1 INTRODUCTION

The instrument is a device able to measure the viscosity, which is capacity of a product to resist to the flow.

The fluid is forced to a shear rate (rotational speed) and the shear stress (motor torque) is measured. The values of shear rate and shear stress then make it possible to calculate the viscosity using the Newton equation and the constants associated with the mobile used.

$$\text{Equation of Newton is: } \eta = \frac{\tau}{\dot{\gamma}}$$

With η for viscosity in Pa.s, τ for shear stress in Pa and $\dot{\gamma}$ for shear rate in s⁻¹.

Shear stress and shear rate are calculated by using constants of each measuring system as:

$$\tau = M \times K_{\text{Tau}} \text{ with } M \text{ for motor torque in mNm and } K_{\text{Tau}} \text{ in Pa/mNm.}$$

$$\dot{\gamma} = n \times K_D \text{ with } n \text{ for rotational speed in rpm and } K_D \text{ in s}^{-1}/\text{rpm.}$$

The instrument calculates the viscosity by dividing the shear stress by the shear rate for each measuring point. The K_{Tau} and K_D constants used depend on the measuring system selected for the measurement.

Viscosity depends on the temperature, then it must be essential that all viscosity values are associated to a reading of the sample temperature, in order to compare viscosity for different samples.

There are some products for which the viscosity, to a constant temperature, stay unchanged, even if we change the shear rate. Those samples are named **Newtonian fluids**, i.e. : Oils, Water, Glycerol, etc...However, many substances have a variation of viscosity in function of speed of shearing, and the Flow Behaviour of those samples could be determined with measuring instruments able to set many speeds of rotation.

The instrument consists of a stepper motor to ensure high precision in the rotational speed of the spindle, a spring (LV or RV), and a transducer. The transducer measures the spring compression corresponding to the viscosity of the fluid to be measured. The instrument features a highly readable touchscreen display that displays the PT100 probe temperature, speed, measurement system reference, measured compression, and dynamic viscosity in mPa.s (or Pa.s).

Lamy Rheology offers two types of springs:

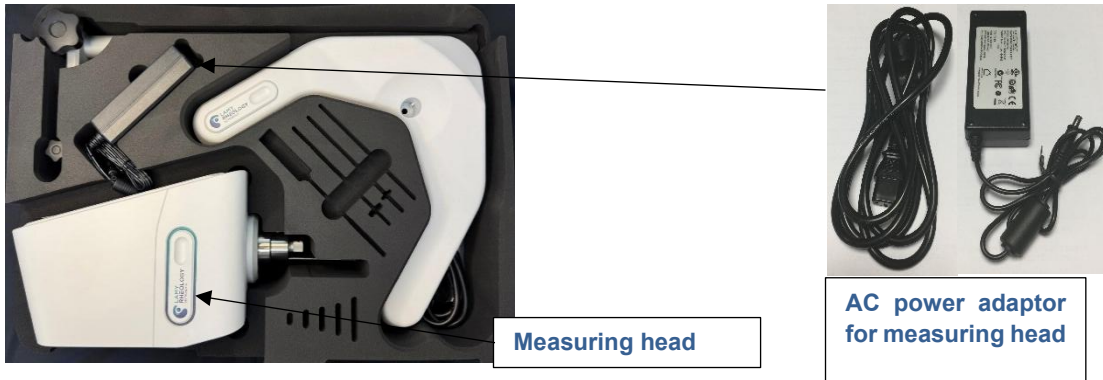
- SPRING LV with a maximum spring torque of 0.0673 mNm.
- SPRING RV with a maximum spring torque of 0.7187 mNm.

The instrument can be used with various measurement systems, including the following:

- **MS RV/LV SPRING:** Measuring spindles according to ASTM / ISO 2555 (316L stainless steel). These systems are ideally suited for simple viscosity measurement at controlled rotational speed in all areas of activity. The standard recommends use of 600ml beaker for measurement.
- **MS SV SPRING:** Measuring systems for low volumes (316L stainless steel). These systems, unlike the MS-RV/LV systems, make it possible to measure products in small quantities by applying a shear rate up to temperatures of 300 ° C (according to models, see table). With RT1, these systems are compatible with ASTM D3236 or D4402.
- **MS ULA SPRING:** Measuring system (316L stainless steel) for low viscosities usable with instruments SPRING version. This system makes it possible to measure low viscosity products in control by applying a shear rate from 1 mPa.s with LV SPRING..
- **T-BARS:** Special spindle (316L stainless steel) used with HELIPRO stand. These spindles allow while move up/down of lift to avoid cavity formation. They are highly recommended with non-flowing materials.

1.1 Components

Instrument is delivered inside a foam protection to avoid any problem during transport. This foam is inside a carrying case and can contain measuring system.



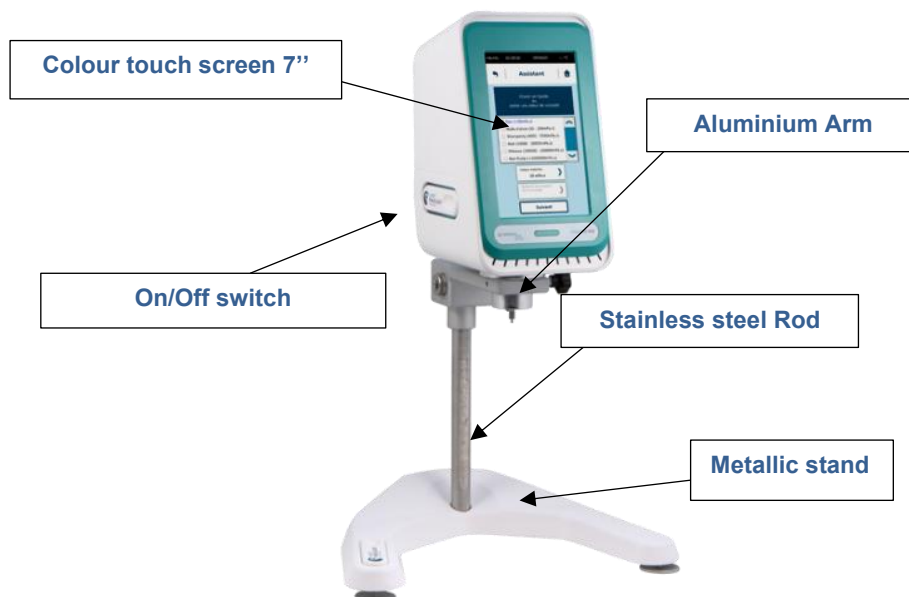
In detail, you will find different part in your box as shown below.

Instrument with rack stand.



1.2 General view of your device

Once your device will be mounted and installed, it looks like this;



- **TOUCH Screen**

The new SPRING series is equipped with a 7" colour touch screen. It gives you greater working comfort and a clearer view of your data and analysis results.

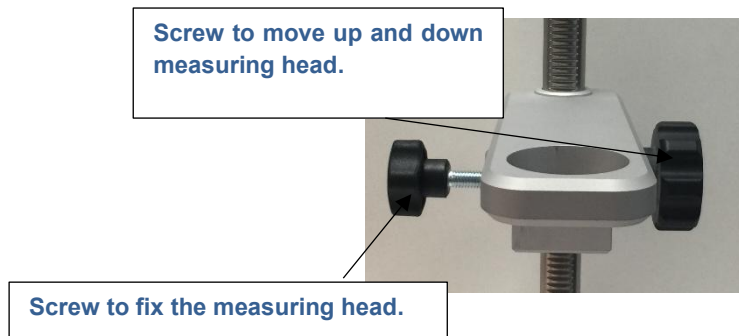
- **On / Off Switch**

Always with the aim of improving your experience, LAMY RHEOLOGY has decided to equip all of its SPRING range with a ON/OFF switch. It has been placed in the rear panel of the device for greater intuitiveness.



- **Aluminium arm**

The aluminium arm of the rack support is fitted with a button for raising or lowering the measuring head. The measuring head is attached to arm using a screw fitted with a tightening knob.



- **Stainless steel rod**

The rod of supports is made of stainless steel for a solid hold on the measuring head. They have a very long lifespan.

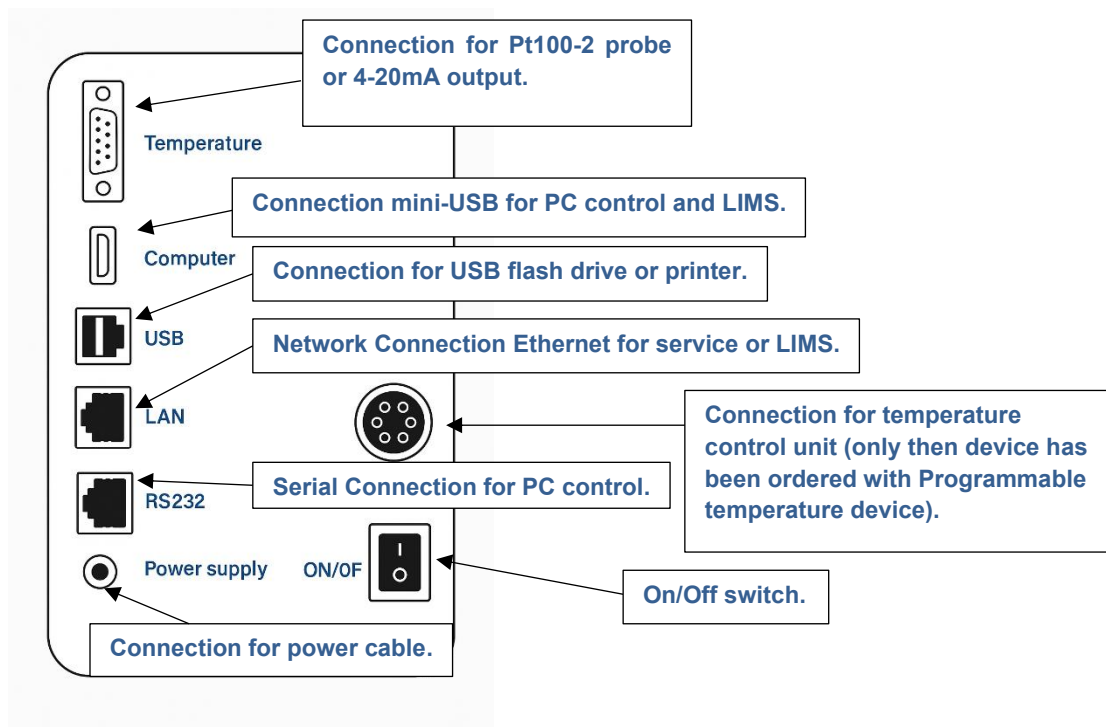
- **Metallic support**

The stand is entirely made of ZAMAC. It gives our instruments an unmatched stability. It is equipped with two adjustable feet for leveling.



1.3 Connections

According to your order, rear panel of device get these available connections.



1.4 Specifications

Type of instrument: Rotating Spring viscometer with 7" Touch screen.

Rotation speeds: Unlimited number of speeds between 0.1 and 250 rpm.

Torque range:

- SPRING LV with a maximum spring torque of 0.0673 mNm.
- SPRING RV with a maximum spring torque of 0.7187 mNm.

Accuracy: +/- 1 % of the full scale.

Repeatability: +/- 0,2 %.

Display: Viscosity – Speed – Torque – Time - (Temperature in option) - Choice of viscosity units: cP/Poises or mPa.s / Pa.s.

Language: French/English/Russian/Spanish/Turkish/German/Italian/Korean/Portuguese/Ukrainian.

Compatible measuring system: MS-LV/RV SPRING, MS-SV SPRING, MS ULA SPRING, T-BARS.

Compatible temperature control: EVA LR-BV, RT-1 (Thermocell), EVA MS DIN.

Supply voltage: 90-240 VAC 50/60 Hz

Connection: USB, RS232 and LAN

Options: See brochure

Dimensions and weight: Head: L180 x W130 x H230 mm, Hardened steel stand: L280 x W200 x H30 mm, Stainless steel rod: Length 500 mm, Weight: 6.7 kg.

1.5 Installation

Your instrument should be installed in a clean, vibration-free environment. A device levelling is required when starting the instrument (see section 2.6.8). Choose a stable and flat table.

This installation notice concern only instrument without any temperature device. If you have it, please refer to specific notice of temperature unit for installation.

After unpacking all accessories from the box (or case if it is supplied), you must first screw the rod to the base with the help of the screw and the key provided.



The motor shaft of the instrument is protected for transport with a small white sleeve. When you need to move the instrument, make sure it is always installed.



You can then put the instrument on the arm. Align the measuring head correctly and secure it with the screw provided. Then unscrew the small white cap.



Installing the GuardLeg LV or RV is the same, depending on your instrument. Equip yourself with it and the small screw. Locate the threaded hole at the back of the circular part around the instrument's axis. Slide the GuardLeg onto this circular part and then screw the screw into the thread.



Connect your instrument by plugging power cable on to rear panel of device. Also, cable for software connection and for temperature control unit (EVA or RT-1/THERMOCELL) when they are provided.

Your instrument will be used with different measuring system. To know how to mount and use it, please see section 3.

2 GETTING STARTED

Once power cable has been plugged on rear panel of device (see section 1.3), you can click on button to switch on your device (see section 1.3).

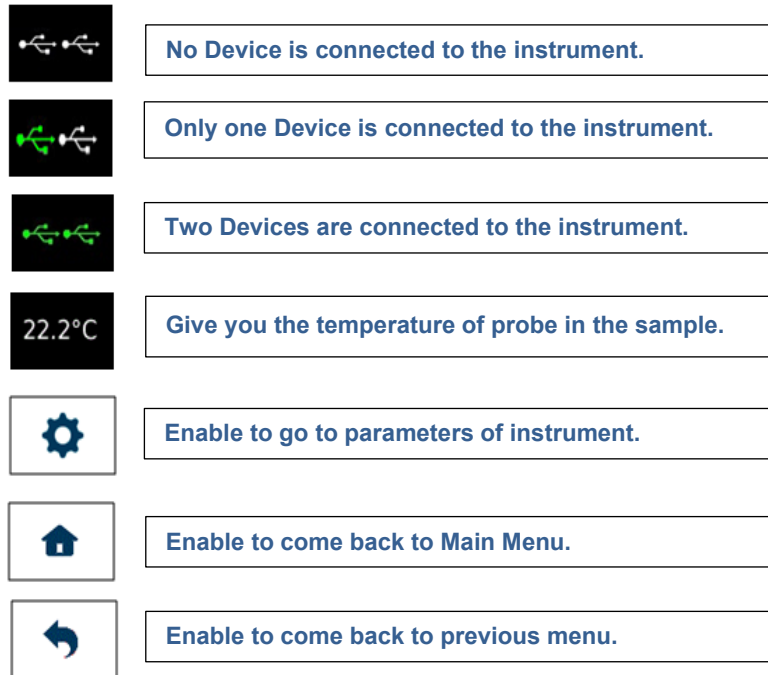
Each time you turn on your instrument, it checks its level (see section 2.6.8). This is essential for the proper functioning of the spring motor. This levelling can be performed at any time in the "Settings" menu, "Miscellaneous" section.

When the levelling is complete, the instrument will request a zero adjustment (see section 2.5).

Once these two steps are complete, you can select the "Home 🏠" button to access the main menu (see section 2.2).

2.1 State icons

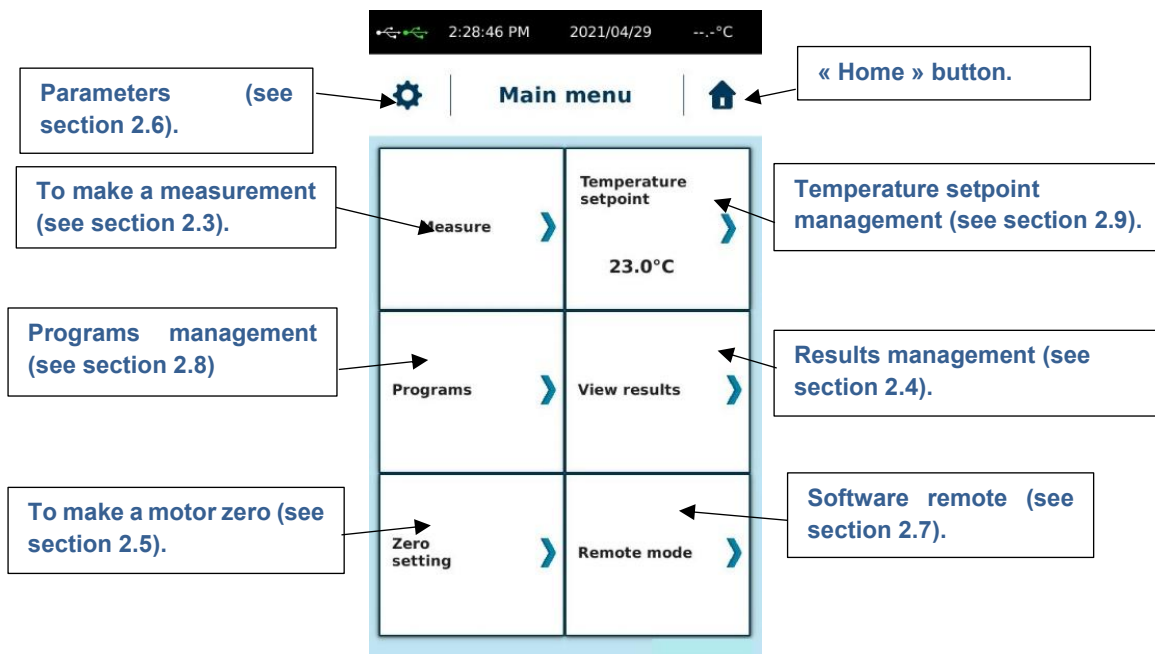
Once your device is switched on, you will see some icons on Touch Screen.



Some instruments are equipped with an external temperature sensor. When it has been ordered, the temperature display is shown at the top right of the screen. If this is not the case, see section 2.6.8 to enable reading. The USB port icon indicates that a USB flash drive has been connected. This is used to update the firmware or to transfer the results.

2.2 Main Menu

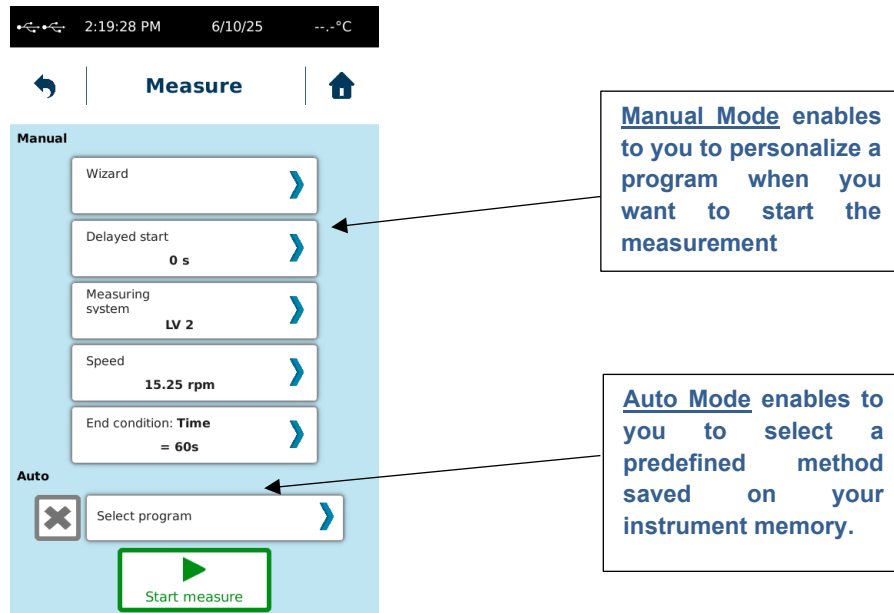
Main menu enables you to browse between different tabs of your instrument. Acces is always available by clicking



The "Temperature setpoint" button is present when the instrument has been ordered and delivered with a programmable temperature control such as EVA or THERMOCELL / RT-1. If you purchase such a unit at a later date, we invite you to contact LAMY RHEOLOGY or your local agent to activate this function.

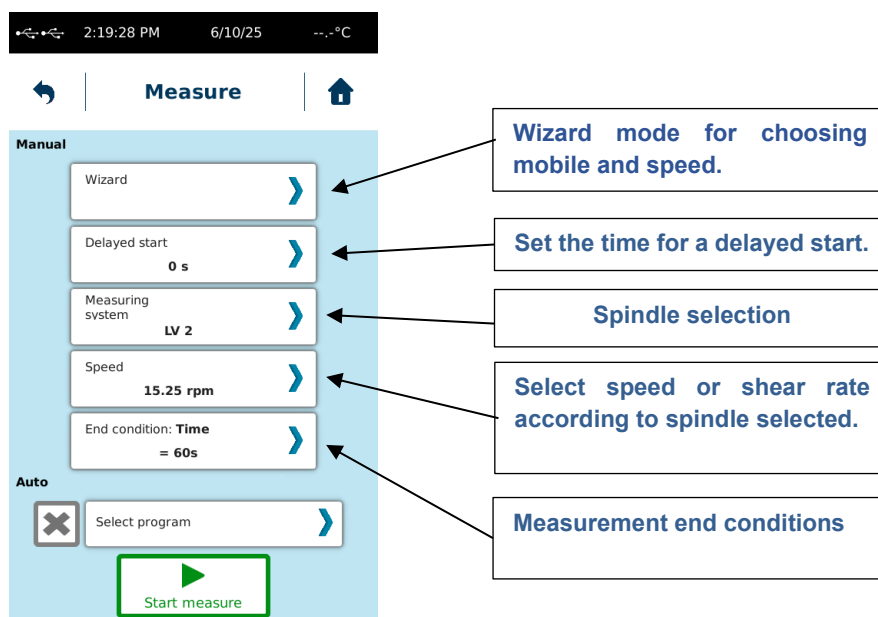
2.3 Measure menu

Measure tab is central part of your instrument. Before to use it, you should install your measuring system and your sample (please see section 3).



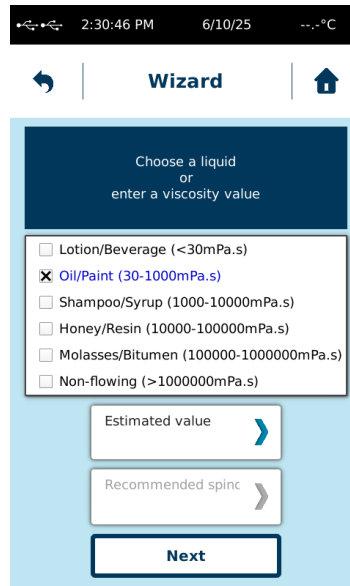
2.3.1 Manual measure mode

Manual Mode enables to choose your measurement parameters by using wizard mode or by selecting "Measuring System", "Speed or shear rate", "Time of measurement" and "Delayed start".

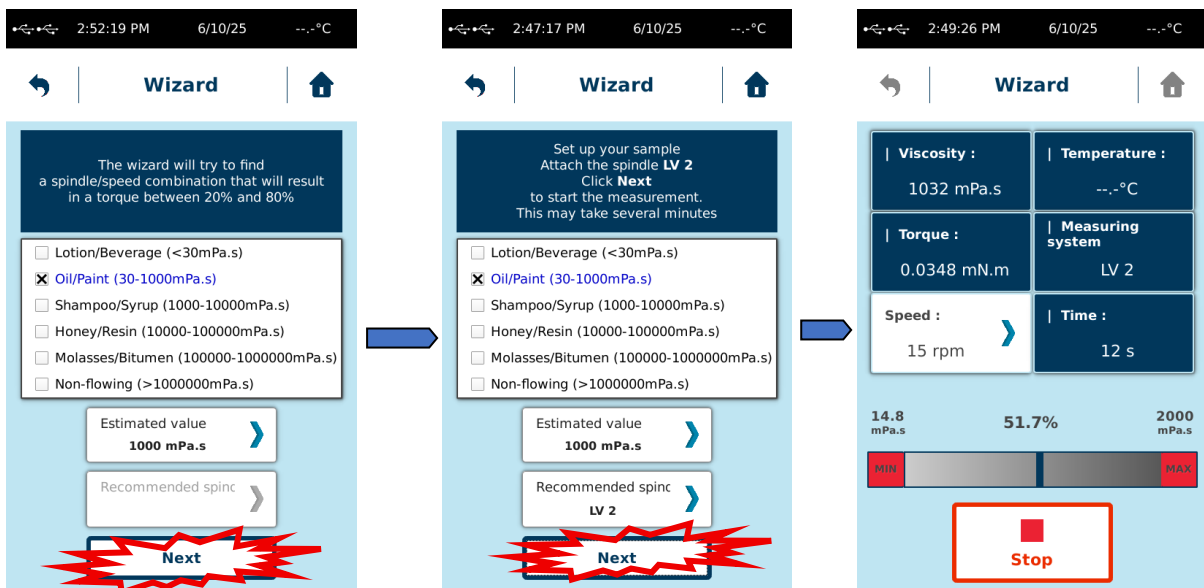


2.3.1.1 Wizard mode for measurement

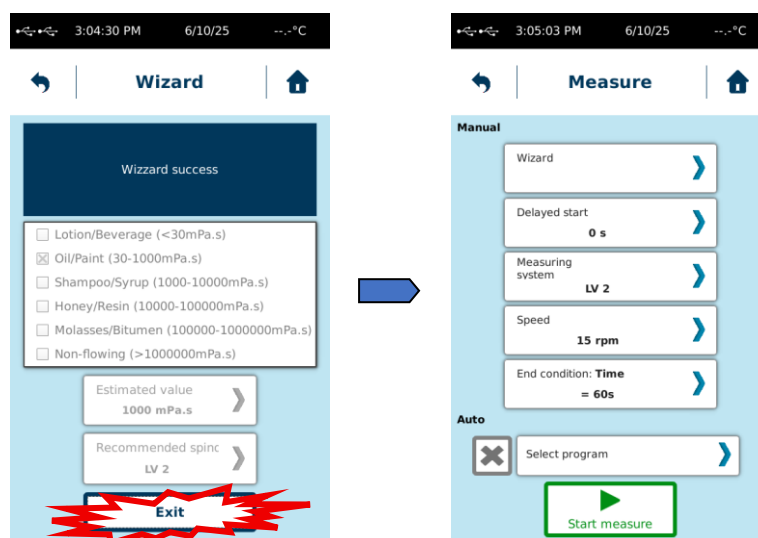
Lamy Rheology now offers a mode to assist you in taking your measurements by searching for the spindle and speed suited to your product. As shown below, you have the option of choosing a product type with a consistency close to yours, or entering an expected viscosity value. The search mode selection cannot be combined (choice of type and viscosity value). As long as no viscosity value is entered, the choice of product type will be decisive. In the other case, the instrument will base its search on the viscosity value. Depending on the type of spring on your instrument (LV or RV), the choice of spindles will not be the same. An instrument with an LV spring will recommend LV spindles. With an RV spring, only RV spindles will be recommended.



After selecting the desired mode (product type or viscosity value), you must select "Next". The instrument displays its next step, indicating that it will search for the best possible combination. When you click "Next" again, the instrument recommends a spindle and asks you to place the spindle in the sample (see section 3.2 for sample placement). Once the placement is complete, you can click "Next" to start the measurement. The instrument displays the current test as shown below.



When the wizard is finished, the display switches to the measurement menu with the settings filled in for your next measurement.



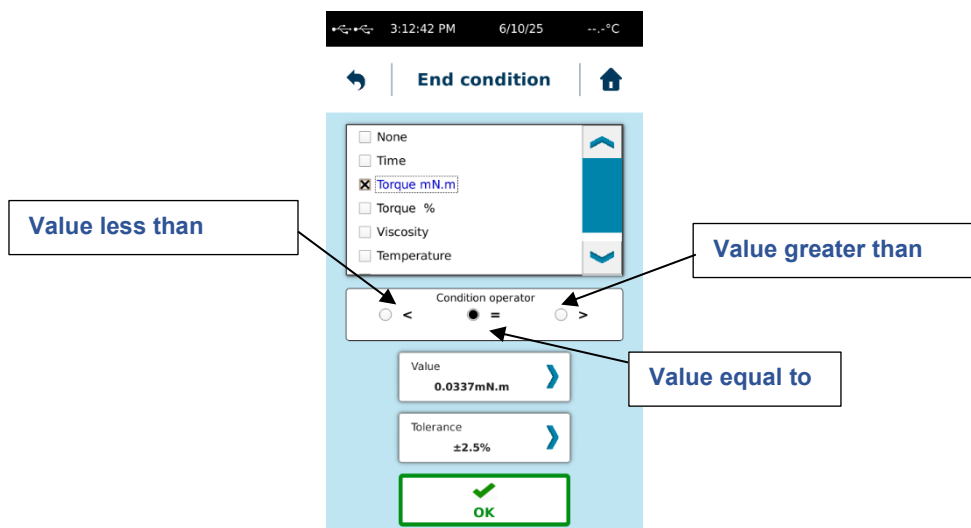
2.3.1.2 Measure in manual mode

With or without using the wizard mode, you can modify the parameters of your measurement. The delayed start adds a waiting time, which starts counting down when you click on "Start measurement". You must then select the mobile you wish to use or follow the wizard's instructions. If your mobile is not in the list, you must create it (see paragraph 2.6.6). Also indicate your rotation speed (or the one chosen by the wizard) or your shear gradient.

The choice between "Speed in rpm" or "Shear rate in s-1" depends on your measuring system. For RV, LV, or mobile T bars (T-Letter + Number) systems, you only have the option to set the speed in rpm. For MS-SV4xxS measuring systems, the instrument automatically switches to using the shear rate. You can force the "rpm" mode by setting the instrument parameters (see section 2.6.8). If you need to know the corresponding rotational speed, you must use the KD constant of your measuring system (information available in section 2.6.6). With speed in rpm, shear rate in s-1 and KD in (rpm)/s-1.

$$\text{SPEED} = \text{SHEAR RATE} / \text{K}_D$$

As shown below, you have the choice of the measurement end condition: Either when the time is reached ("Time" options), when a torque is reached ("Torque" options in mNm or in % of spring compression), when a viscosity value is reached ("Viscosity" options) or when a temperature is reached ("Temperature" option). If you choose "None", you will have to stop the measurement manually and no value saving will be available at the end.



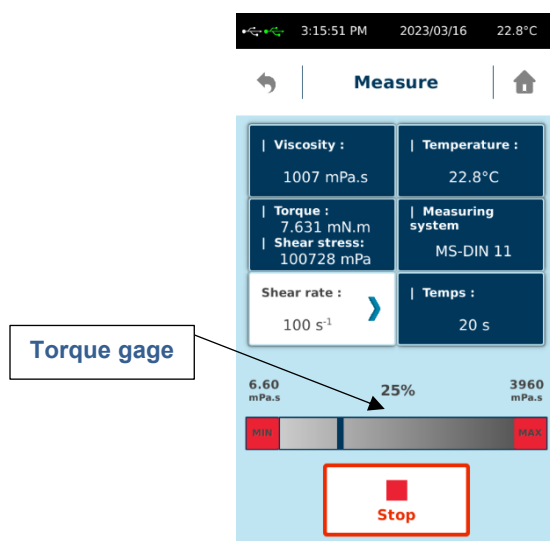
If one of the "Torque", "Viscosity" or "Temperature" options is selected, the "Condition Operator" box becomes accessible. You can choose to set a value "greater than", "less than" or "equal to". When the latter option is selected, the "Tolerance" box becomes accessible. You will then be able to enter a tolerance as a percentage of the target value. In the example above, the measurement will stop when the torque value reaches 0.0337mNm +/- 2.5%.

When your parameters are entered, make sure that the zero adjustment of the motor has been performed before starting your measurement. Depending on the model of instrument you have, the procedure may be different (see section 2.5).

Make sure that the measuring system you are using has been correctly installed (see section 3).

When all these checks have been carried out, you can click on "Start measure" to start your measurement.

If a delayed start has been requested, the instrument displays a countdown then switches to the next view.

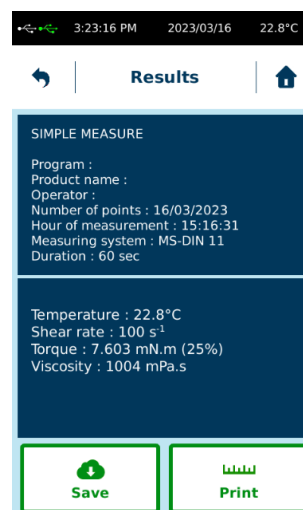


During your measurement in manual mode, you will see a torque gauge. The displayed viscosity limits are calculated based on the selected speed or shear rate and the measuring spindle used. The percentage value indicates the spring compression value.

The accuracy and repeatability values given in the specifications (see section 1.4) are valid for spring compression values between 10% and 99%. You should check that the measured torque percentage is not too close to the upper or lower limit, as you may receive a "Torque too low" or "Torque too high" message, and the measurement will automatically stop. If this is the case, increase the speed/shear rate or use a larger measuring system if you are close to the lower limit. Decrease the speed/shear rate or choose a smaller measuring system if the torque reading is close to the upper limit.

You will find several information available on the screen such as torque (mN.m), Shear stress (Pa, can be set on section 2.6.8), temperature (° C), time (s) or viscosity (mPa.s). If the units do not suit you, you can change them in parameters (see section 2.6.5).

Then your measurement is finished, you will get this window below. You will find all data you need and get possibility to save them into internal memory or print it if printer is connected. If you choose "Save", instrument will ask you to give a name of your measurement. You will have after possibility to read it later (see section 2.4).



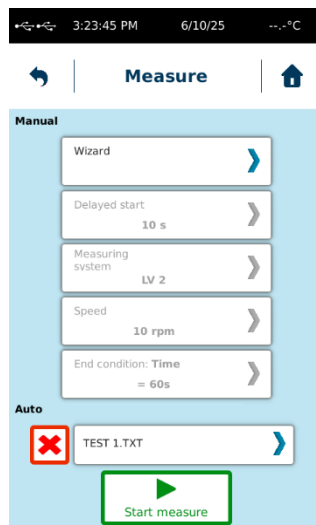
2.3.2 Automatic measure mode


Auto mode allows you to select pre-recorded programs (see section 0). Press “Select program” to see the list of saved method.



The extension shown next to the program name indicates the type of method according to: “*.TXT” for 1-point method, “*.PSS” for step method and “*.”

Select the program to use. The instrument displays the measurement view with some information from the selected method.



If you made a mistake in choosing the method, you can use the symbol  to allow you a new selection.

When your parameters are entered, make sure that the zero adjustment of the motor has been performed before starting your measurement. Depending on the model of instrument you have, the procedure may be different (see section 2.5).

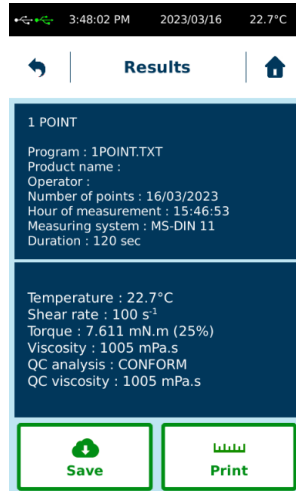
Make sure that the measuring system you are using has been correctly installed (see section 3).

When all these checks have been carried out, you can click on "Start measure" to start your measurement.

2.3.2.1 1 point method measure mode

The results displayed during the measurement is no different from the manual mode with simple measurement (see paragraph 2.3.1).

At the end of measure, instrument show you this new window with important information according to settings of your method.



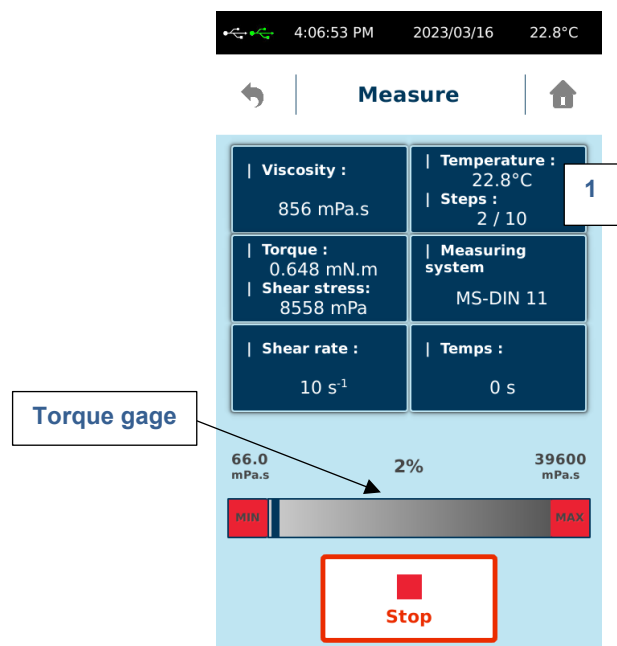
Additionally, to explication on section 2.3.1, you see type of method with name of program on first part of display. On second part of display, you show information about QC analysis if your program had it (see section 2.8.1.1). “QC viscosity” is the measured value used for “QC analysis”.

You will find all data you need and get possibility to save them into internal memory or print it if printer is connected. If you choose “Save”, instrument will ask you to give a name of your measurement. You will have after possibility to read it later (see section 2.4).

2.3.2.2 Step method measure mode

After starting the measurement using a step method, the instrument asks you for a file name to save in its memory.

If a delayed start has been requested, the instrument displays a countdown then switches to the next view.



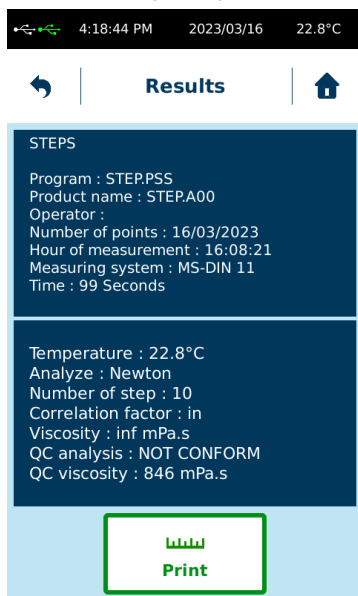
During your measurement, the instrument displays several information. The case marked "1" changes during the measurement. If you have set a setpoint temperature with a start when the setpoint is reached (see section 2.8.1.2), the instrument displays the current temperature and the elapsed waiting time. When the setpoint condition is reached, case "1" switches to the display of the step in progress.

The instrument displays a torque gauge with displayed viscosity limits calculated according to measuring spindle used and the speed or shear rate of each step in progress. The percentage value indicates the percentage of compression of the spring. This torque percentage display can be set on the device (see section **Erreur ! Source d u renvoi introuvable.**).

You must check that the measured torque is not near the upper or lower limit, because you may get the message "Torque too low" or "Torque too high" and the measurement will stop automatically. If so, increase the speed or shear rate of your method's steps or use a larger measuring system if you are near the lower limit. Please decrease the speed or shear rate or choose a smaller measurement system if the torque reading is near the upper limit.

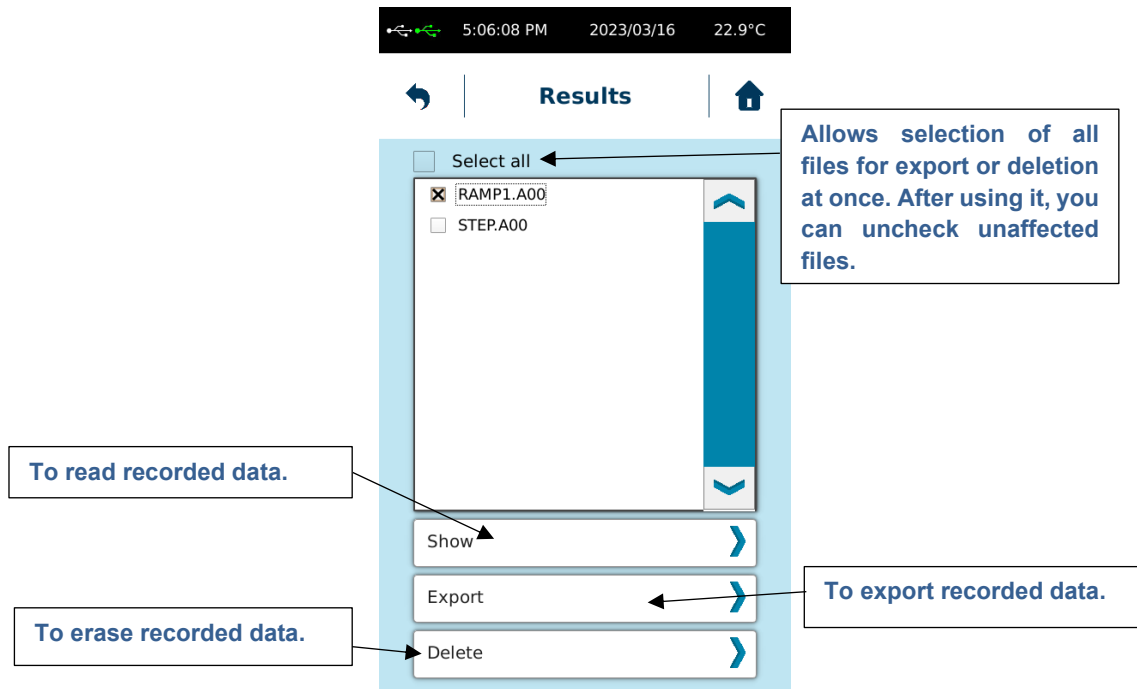
You will find several information available on the screen such as torque (mN.m), stress (Pa) (see section 2.6.8 to display this variable), temperature (°C), time (s) or viscosity (mPa.s). If the units do not suit you, you can change them in the settings (see section 2.6.5).

When your measurement is finished, you will get the window below. You will find all the data you need and will be able to print it if a printer is connected. The instrument displays the results of the rheological analysis and the "QC limits" analysis if your method includes these options (see paragraph 2.8.1.2). Note that the "QC Limits" analysis is performed on the viscosity measured during the last measured step (displayed on the screen after "QC Viscosity"). The data having been automatically saved in memory and you will then be able to read them later (see section 2.4).



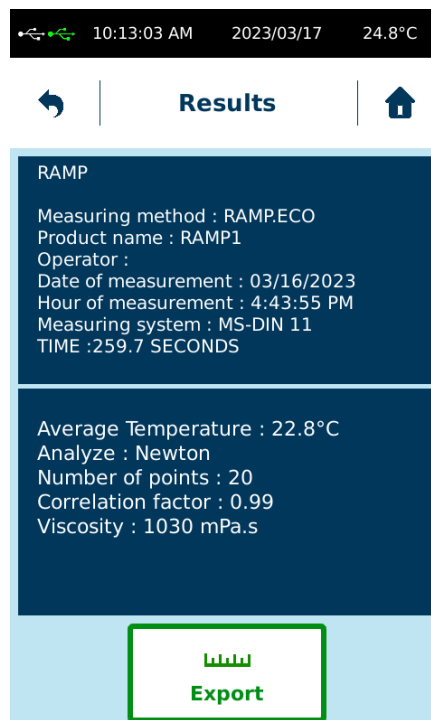
2.4 View results menu

This menu allows you to read, export or delete data from internal memory. Press on « View results » tab in Main menu.



2.4.1 Show results

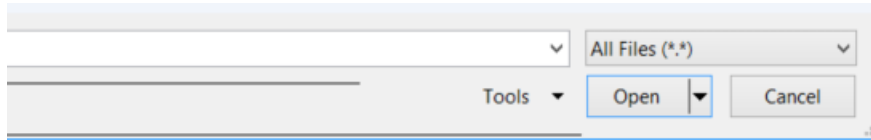
By clicking on this tab, you will be able to view the information concerning the selected measure. The data display format is the same as the one you get at the end of the measurement (see paragraph 2.3.2). You also have the possibility of printing or exporting depending on whether a printer or a USB key is connected to the instrument.



2.4.2 Export results

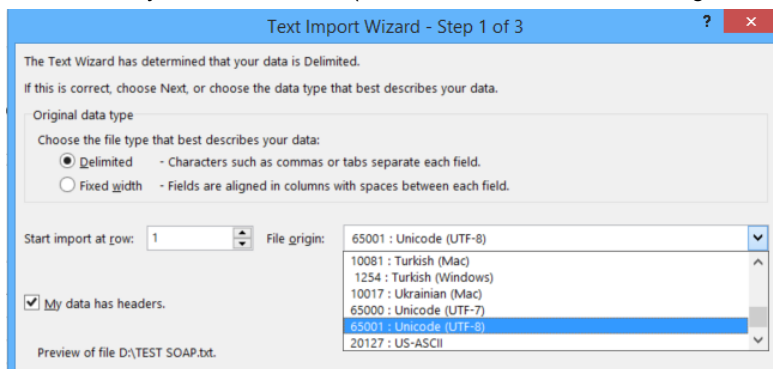
By clicking on "Export" you can transfer the measurements recorded to a USB key if it is connected to the back (see section 1.3). The "Select all" function allows you to export all the measurements at once.

The format of the data generated and saved by the instrument is ASCII (*.txt). Once your data has been copied to the USB drive, you can open the files using the EXCEL spreadsheet. To do this, simply copy the data from the USB key to your computer. Then open Excel, choose "File", "Open", taking care to select "All files *.*".

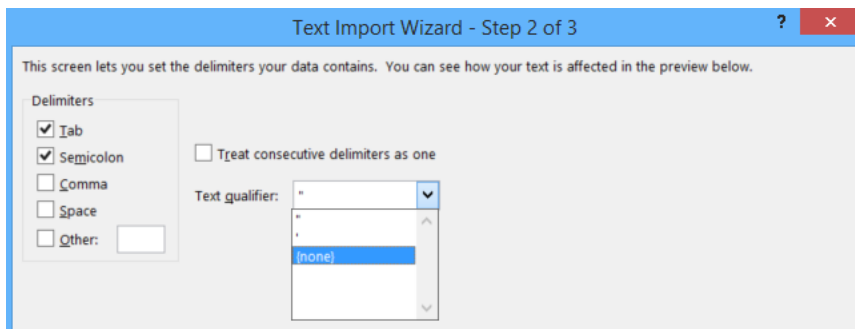


Find your file and click "Open". Excel will offer you to convert your data by displaying three successive windows.

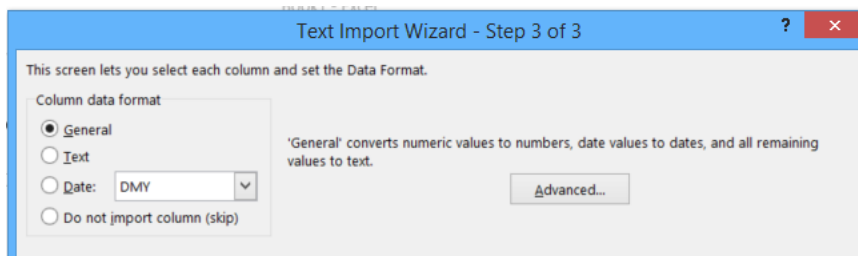
Select "Unicode UTF8" and "My data has Header" (last selection available according Office version) and click "Next".



On second step, it will be necessary to choose the option "Tab" and "Semicolon" for separation of the columns. For "Text qualifier", you should set "none".



On last step, please choose "General" and click "Finish".

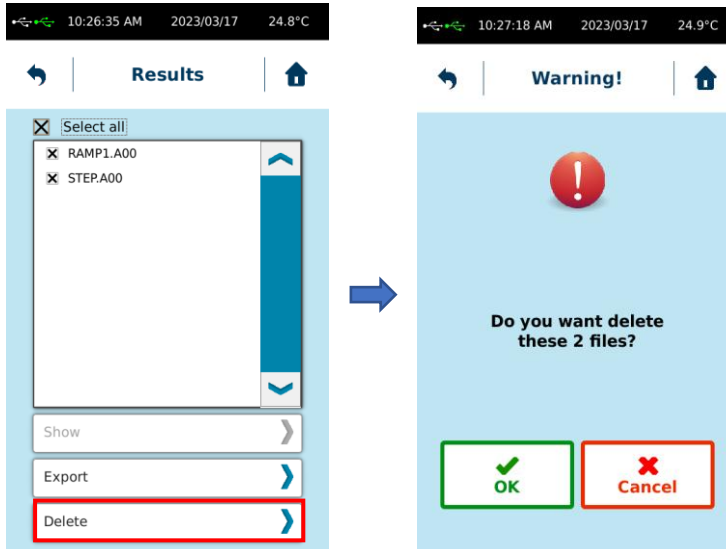


You can then see your measurement results with the possibility to save a new file in Excel format.

2.4.3 Delete results

By clicking on this tab, you can delete all the measurements recorded on your instrument. The "Select all" function allows you to delete all the measurements at once.

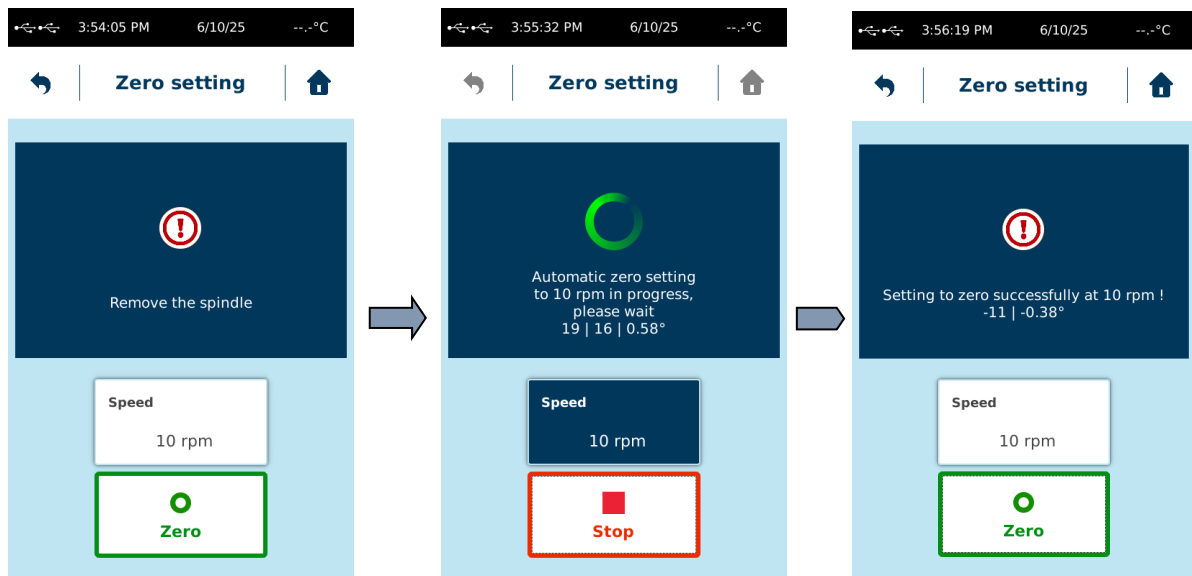
When you click "Delete", the recorded data will be completely deleted from the internal memory after further confirmation from you.



2.5 Zero setting


Zero adjustment allows you to calibrate your instrument and calibrate the spring's tension. This adjustment is required after powering up your instrument and completing the levelling phase. This function is accessible at any time from the main menu (see section 2.2).

The zero-adjustment speed can be changed. By default, it is set to 10 rpm, but you can choose a speed close to the one you use for your measurements. The adjustment is always performed without a spindle and in air.

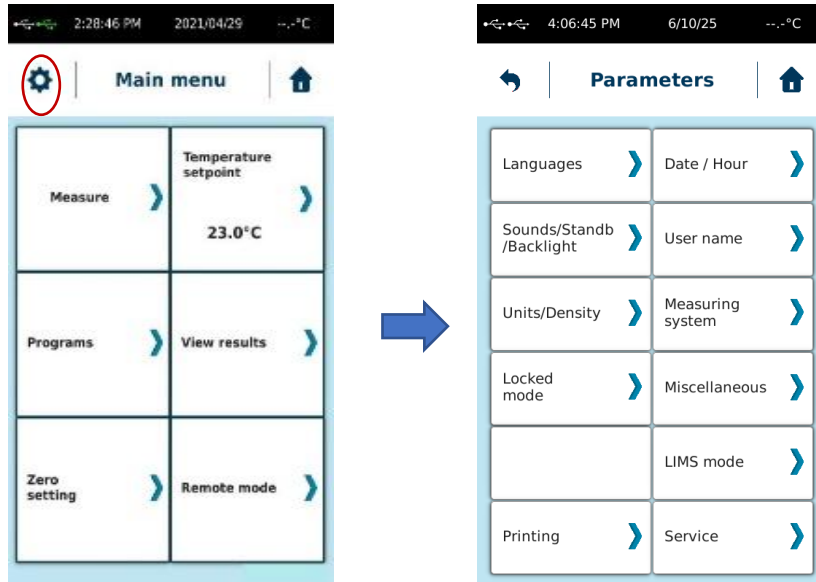


When the zero adjustment is complete, you can use the "Home" button to switch to the main menu (see section 2.2).

2.6 Parameters menu

This parameters menu allows you to change settings of your device. It is reachable by clicking on icon “

This icon is only available then you are in “Main menu”.



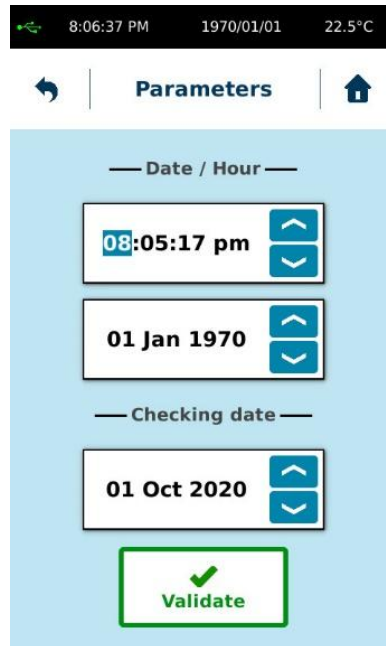
2.6.1 Languages

Enable you to select language of your instruments. You have choice between French, English, Russian, Turkish, Deutsche, Italian, Korean, Ukrainian, Portuguese and Spanish. Then you have selected your desired language, you have to click on “Ok” and device will reboot automatically to show new language. In this menu you will be able to see Firmware version of your device.



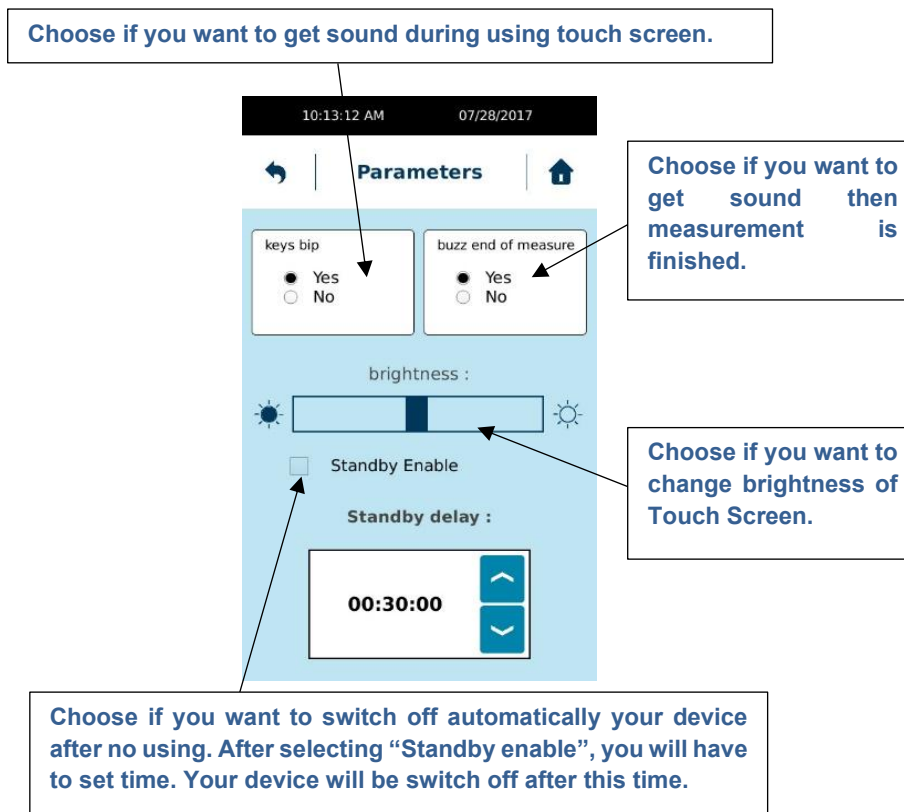
2.6.2 Date / Hour

Enable you to adjust hour and date of your instrument. On this location, you can also set date for next checking of device. Soon this date will be reached, device will show you message as device need to be checked.



2.6.3 Sounds/Standby/Lighting

Allow you to modify sounds, lighting and activate or not the Standby mode of your instrument.



2.6.4 User Name

Operator mode will allow you to create different operators for your instrument. The use of the operators makes it possible to identify the person making the measurement (to save name on saved file and see later who made this measurement) or lock some function on device for simple user.

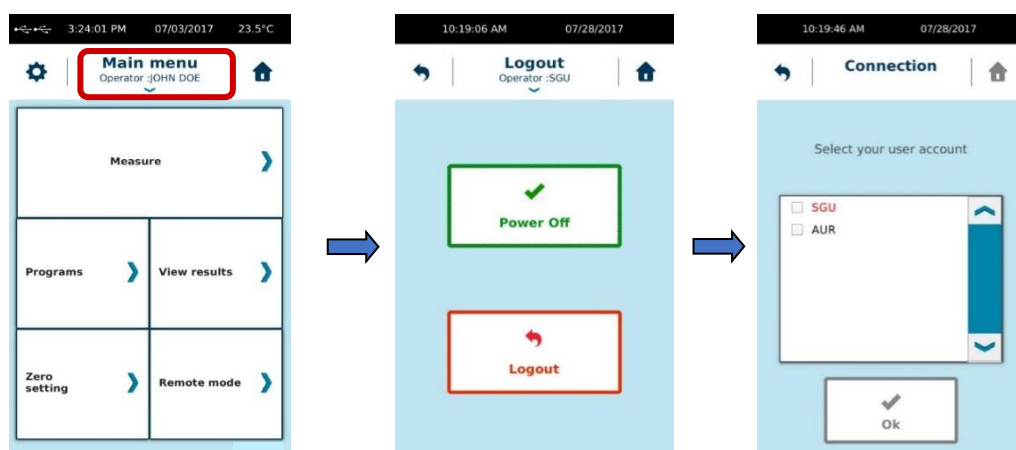
Operator management must always begin with the creation of the first account, which will become the administrator and thus create or delete another operator account. Click on "Create new user with PIN code". After specifying the name and password, the administrator will be named in red in the list.



You can now create another operator. The account of an operator may or may not be associated with a password (here called PIN code).

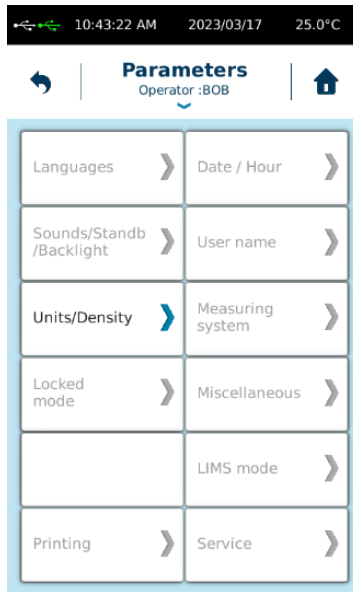
To delete an account, the administrator account must be used. Select the account you want to delete from the list and click on "Delete user name".

To use the operator accounts you must activate the mode by click "Enable User mode". Device will ask you to select user name you want to use. By returning to the Main Menu, you will see the name of the operator in use. By clicking on the arrow below the name of the operator, you can switch off the instrument or change operator. Click on "Logout" and device will ask you operator account you want to use



If the instrument is switched OFF and ON while operator mode is activated, device will ask you to select the operator you want use.

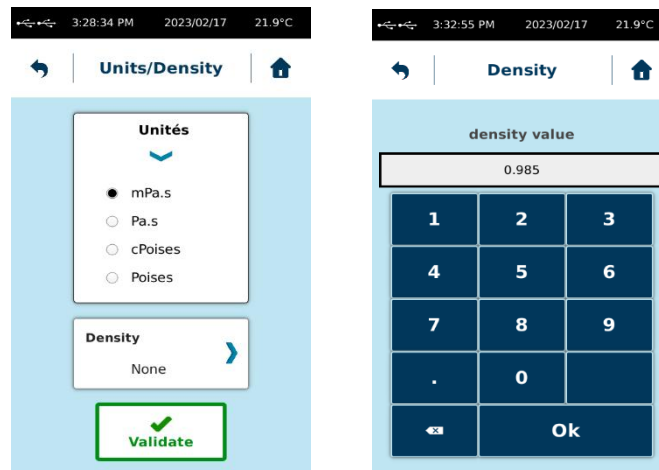
When User mode is enabled, some functions will be not editable for simple user as picture below shows it.



2.6.5 Units/Density

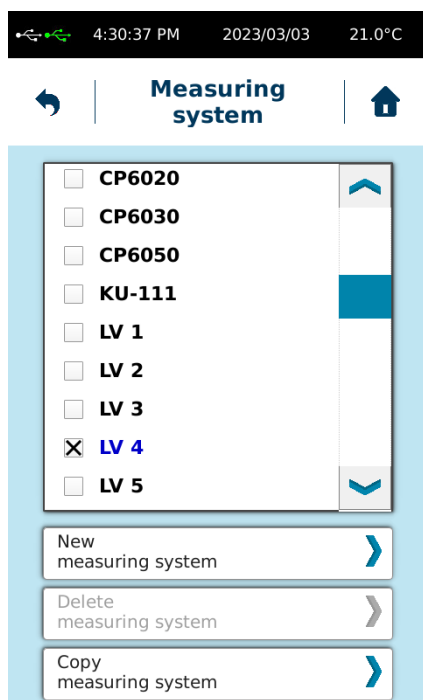
Enable you to change unit of viscosity values and to enter density value of your product to measure in order to calculate its kinematic viscosity.

If you set a density value, you will get all the time kinematic viscosity in cStoke. Please remove density information if you want to get back Pa.s or Poise for unit of viscosity.



2.6.6 Measuring System

Allows you to add, copy or delete a Measurement System.



All measurement systems stored by default in memory are not removable. Only those you have created yourself can be removed. To delete a measuring system, select it from the list and choose "Delete Measuring System". If this function remains greyed out when you have selected a system, it is part of the default mobile stored in the instrument's memory.

To add a new measuring system, you can use "New measuring system" or "Copy measuring system" functions. Device will ask you name and constants for this measuring system. In case of copy, device will propose you to keep constant from previous measuring system but you can modify them.

You are not allowed to change the constant of an existing measuring system. If you want to use a new constant for an existing measuring system, you have to copy and modify it. Note that the KD constant is used to convert rotational speed to shear rate and K τ to convert torque to shear stress. Shear rate and shear stress are used to calculate the viscosity value. If you use a different constant value, you will get a different viscosity result.

Here is the list of constants used for measuring systems compatible with the instrument.

MS RV/LV

SYSTEM	K τ / 1 mNm in Pa	Kd / 1 RPM in S-1	Ri / Ra
RV 1	13,91	1	1
RV 2	55,65	1	1
RV 3	139,1	1	1
RV 4	278,2	1	1
RV 5	556,5	1	1
RV 6	1391	1	1
RV 7	5565	1	1
LV 1 wg*	90	1	1
LV 1 wog**	107	1	1
LV 2	500	1	1
LV 3	1900	1	1
LV 4	8600	1	1
LV 5	17826	1	1

*) Avec Guardleg **), sans guardleg

MS SV and MS ULA

SYSTEM	Ktau / 1 mNm in Pa	Kd / 1 RPM in S-1	Ri / Ra
SV414	877	0.4	0.69
SV415	371	0.48	0.75
SV416	572	0.29	0.53
SV418	59.7	1.32	0.92
SV421	65.9	0.93	0.88
SV425	1918	0.22	0.25
SV427	126.8	0.34	0.62
SV428	205.2	0.28	0.49
SV429	367	0.25	0.40
SV431	166.5	0.338	0.62
SV434	271	0.28	0.49
SVC	68	0.43	0.71
SVTR8	66.15	0.92	0.88
SVTR9	127	0.34	0.62
SVTR10	204	0.28	0.49
SVTR11	374	0.25	0.40
MS-ULA	7.34	1.224	0.95

T-Bars

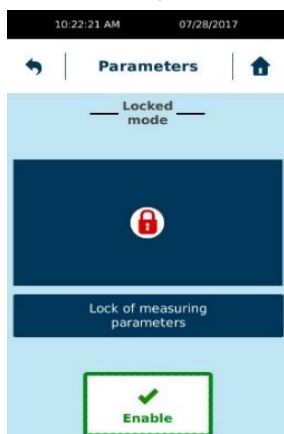
SYSTEM	Ktau / 1 mNm in Pa	Kd / 1 RPM in S-1	Ri / Ra
T-A 92	278	1	1
T-B 93	557	1	1
T-C 94	1392	1	1
T-D 95	2783	1	1
T-E 96	6957	1	1
T-F 97	13914	1	1

2.6.7 Locked Mode

This option allows you to block measuring parameters. It should be set by an administrator or responsible of the device.

This function is not comparable to the "User name" menu (please see section 2.6.4). It should be use if you want to protect measurement settings on your device. All settings will be not lock by this function. You will see below which settings are concerned.

This function will block also parameters for measure. In this way, if you want to use all the time same parameters for measurement, you should enable this locked mode to be sure that nobody will change settings for measurement.



When you click "Enable", the instrument will ask you to save a 4-digit code that will be required to disable this protected mode. Each activation is independent and can be done with a different code. The protected mode is indicated by the presence of a padlock-like icon. **BUT TO DISABLE THIS LOCKED MODE, YOU SHOULD USE 4-digit CODE USED TO ENABLE IT.**

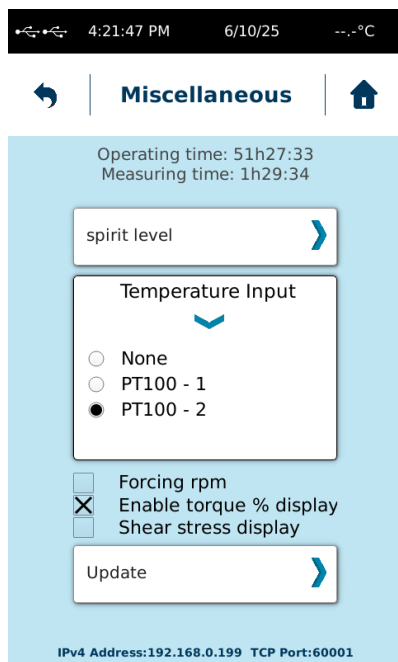
Once protected mode is activated, you will see this icon on instrument's screen (see picture below). Protected mode protect programs, measuring parameters and some menu as shown on pictures below.



To disable "Locked mode", you must return to service and "Locked mode" and click on "Disable" by entering the 4-digit code.

2.6.8 Miscellaneous (levelling device)

This menu allows you to select the temperature sensor used by the instrument. The instrument allows the use of an external probe (Pt100-2) which must be connected to the back of the instrument (see section 1.3). This setting is not available by default on instrument if this device is delivered without external temperature probe. If you buy it later and want to activate this function, please contact your local agent or LAMY RHEOLOGY.



"Update" function is used when updating the machine software is necessary. Do not go in this menu without being invited by the company LAMY RHEOLOGY. The update is done via a USB key connected to the "USB" port. You can then click on "Update" to update your instrument. At the end, your device will turn off and you will have to turn it on again.

"Operating time" and "Measuring time" settings indicate time while device has been switched ON and time while it was used for measurement.

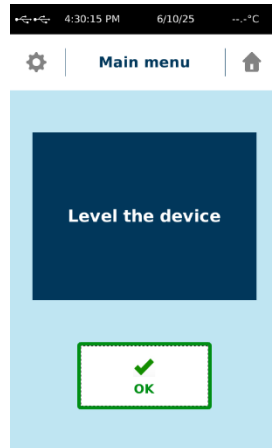
"Forcing rpm" allow you to force device setting only speed in rpm instead shear rate (s-1) when you are using measuring system compliant with DIN 53019 norm (as MS DIN, MS ULV, MS SV).

"Enable torque % display" allow device to show torque in % above torque gage while measurement.

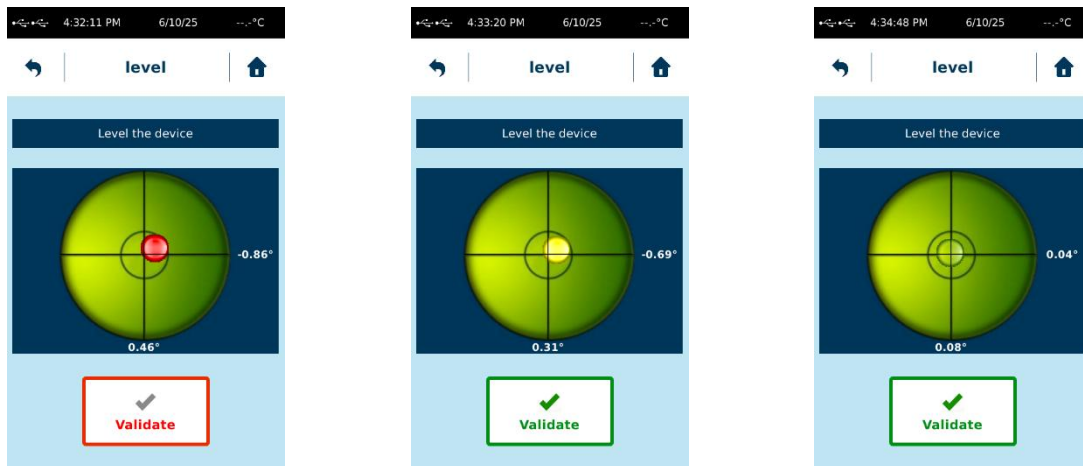
"Shear stress display" function will provide you shear stress value while measuring.

On bottom part of this view, you see information about network identification of this instrument. It helps you to identify instrument when you want to use LIMS function (see section 2.6.9). These parameters can be changed in menu Service (check with your local contact or Lamy Rheology to provide you access).

Each time you turn on your instrument, it checks the level. This is essential for the spring motor to function properly. When you turn it on, the screen below will appear.



By clicking on “Ok”, you get the following screen depending on the level status of your device (this step is not present when you come from parameters menu).



The color of the bubble indicates the quality of the levelling. For levelling, you must use the two adjustable feet on the stand base as shown in the photo below. When it is green, the level is correct and you can validate.



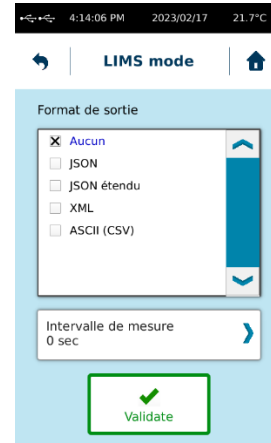
2.6.9 LIMS mode

This menu allows you to select the data format for the LIMS function. To activate this function, a data format must be selected and a “measurement interval” must be entered. Then the instrument will send data at regular intervals to a client (Server). The destination of the data will be configured via the LIMS software used. The connection used will be Ethernet (LAN) on the rear panel of the instrument. The IP address of the instrument for the LAN connection

is visible in the “Miscellaneous” menu (see section 2.6.8). The IP address of the instrument can be changed in the service menu. To do this, please contact LAMY RHEOLOGY or your local contact to provide you with an access password.

The “Measurement interval” function allows you to set the time interval used by the device to send data.

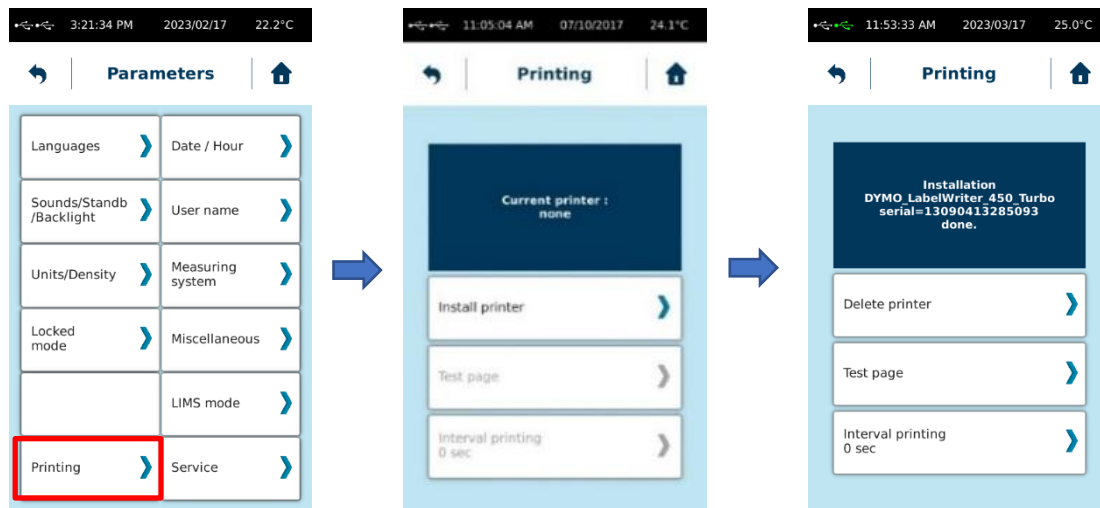
When a data format is selected, it is no longer possible to use the other connections (USB/RS232) for using the RheoTex software.



2.6.10 Printing

This menu allows you to connect a printer, print a test page, and choose the print interval time you want during measurement.

The instrument can be connected to all printers with a PCL5 print protocol. This includes many A4 printers. The connection is made to the "USB host" port on the back of the instrument.



Once the printer is connected, simply click on "Install Printer".

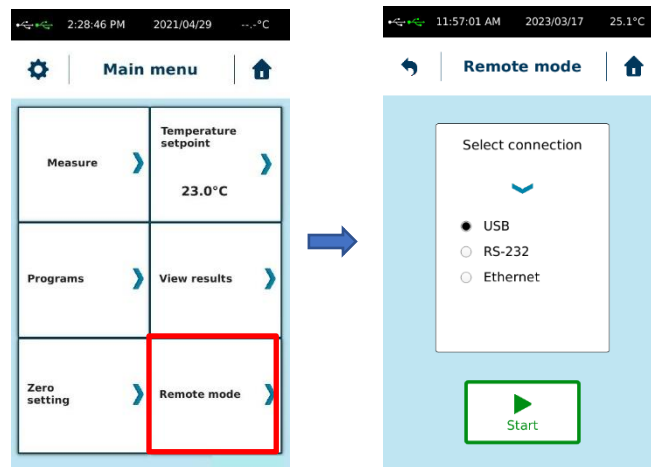
You can also print page for test or set time interval for automatic printing. Then you print data at the end of measure or a saved file, you will have only information shown on device screen as final result. If you want to have more data printed, you have to select “Interval printing” time to get data printed between start and end of your measurement.

2.6.11 Service

Reserved to LAMY RHEOLOGY or local partner engineers.

2.7 Remote mode menu

Remote mode allows you to control your instrument with RheoTex software. If all the connection choices are greyed out and the Ethernet port selected by default, LIMS mode has been activated (see paragraph 2.6.9).



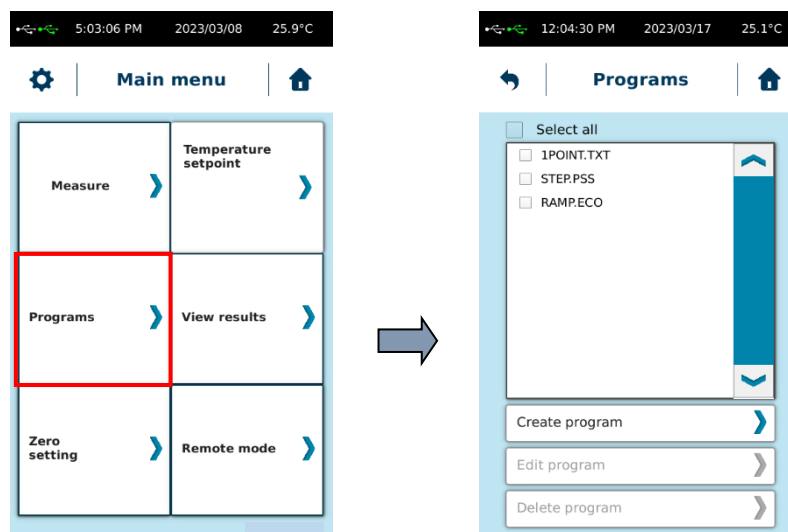
Once the device is connected to the PC, you must select the type of port (USB - RS232 for) and click on "Start" to launch the communication. As long as communication is not established, a "Waiting Connection ..." message appears on the screen. Then launch the software and check that the screen switches to the display below. If this is not the case, check the connections and make sure that the COM port number set in the default settings of the RheoTex software is correct and identical to that recognized by WINDOWS in "Control Panel", then "System and "Device Management" (see the operating instructions for the RheoTex software).

2.8 Programs menu

In the programs tab you will be able to configure, modify or delete your measurement methods. The saved programs can be found in the "Auto" tab of the "Measure" menu (see section 2.3.2).

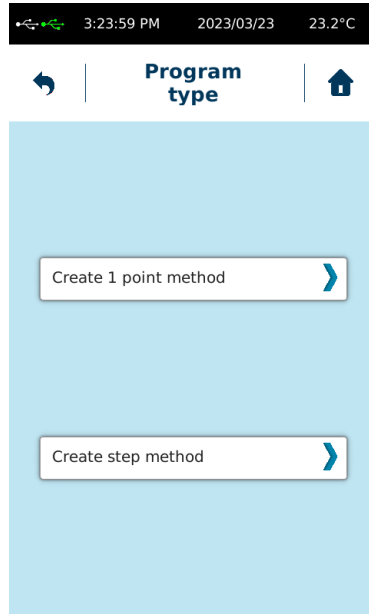
When you select the "Programs" function, you get a new window where you can see your recorded methods and functions as "Create program", "Edit Program" or "Delete a program". The "Select all" function can only be used for the deletion of methods.

The extension after the program name indicated the type of method according to: " *.TXT" for 1 point method, "*.PSS" for step method and " *".



2.8.1 Create new program

By selecting "Create program", the instrument displays the following view.

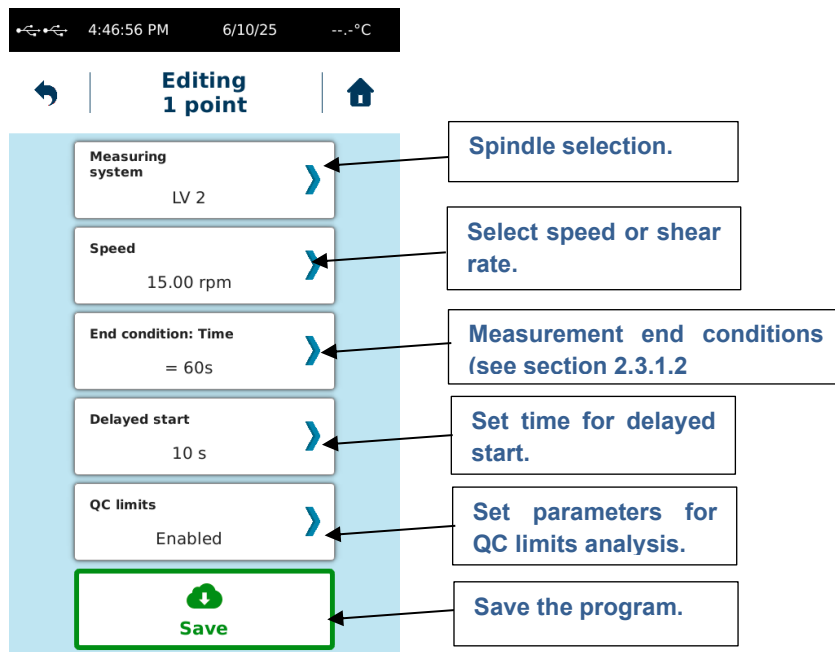


The "1 point method" makes it possible to measure your product viscosity at constant rotation speed or constant shear rate during a defined time. The instrument will display measured viscosity at the end of this measurement time.

The "Step method" allows you to fix measurement intervals at different rotation speed or shear rate in order to obtain viscosity values under different shear conditions. It also makes it possible to obtain a flow curve by fixing interval by interval the shear rate and time.

2.8.1.1 1 point method

When you choose 1 point method, the instrument displays the following view.



When creating a new method, the next buttons is activated after your validations progresses.

According to the selected mobile, the instrument will offer you to fix the shear rate (s^{-1}) instead speed (rpm) as that is the case for MS SV measuring systems. To force rotation speed in rpm, please read section 2.6.8 of this user manual.

The "Delayed start" function allows you to set a waiting time before the measurement. This time will be deducted as soon as you launch the measurement (see section 2.3). "End conditions" are explained in section 2.3.1.2.

The "QC limits" function makes it possible to verify that the measured viscosity value is between two limits that you have previously set. When choosing this function, the instrument displays the following view.

The screenshot shows the 'QC limits' configuration screen. At the top, there is a status bar with the time 5:45:18 PM, date 2023/03/08, and temperature 25.9°C. Below the status bar, there are navigation icons: a back arrow, the title 'QC limits', and a home icon. The main content area is a light blue box containing several fields:

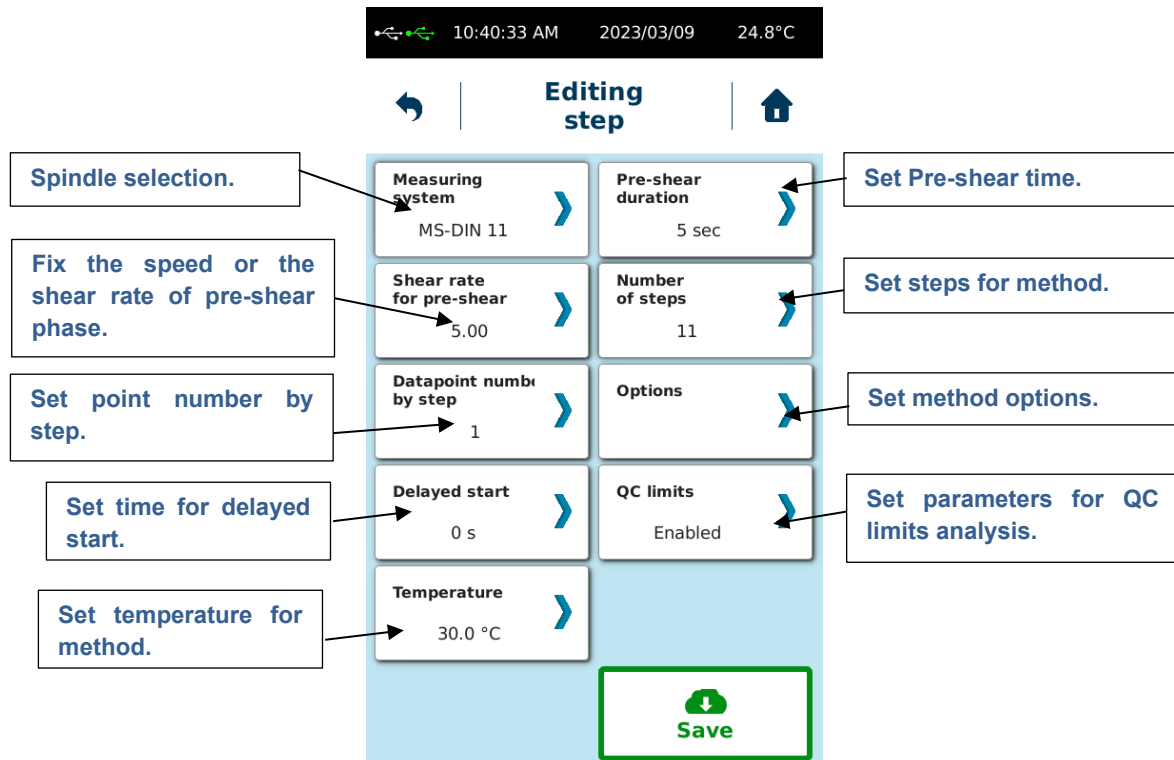
- An 'Enable' checkbox with an 'X' icon, which is checked. A callout box points to it with the text: "Enable the 'QC limits' function in the method."
- A 'Viscosity' field with a right-pointing arrow, containing the value '1000 mPa.s'. A callout box points to it with the text: "Set target value for viscosity check."
- A 'Tolerance' field with a right-pointing arrow, containing the value '+/- 5.0%'. A callout box points to it with the text: "Set the percentage tolerance to calculate the lower and upper limit from the target value."
- A 'Compliant message:' field containing the text 'GOOD'. A callout box points to it with the text: "Indicate the message to be displayed by the instrument at the measurement end according to the viscosity value is within the tolerance or not."
- A 'Not compliant message:' field containing the text 'NOT GOOD'.
- A green 'Validate' button with a checkmark icon at the bottom.

Do not forget to activate the "QC limits" function before validating to exit this window, otherwise the information will not be saved. At the measurement end according to the viscosity value is within the tolerance or not, the instrument will display the message that you have indicated in the "Compliant message" or "Not compliant message" fields.

Once you have finished setting up your method, you can save it by choosing "Save".

2.8.1.2 Step method

When you select step method, you will get the following view.



When creating a new method, the next buttons is activated after your validations progresses.

According to the selected mobile, the instrument will offer you to fix the shear rate (s^{-1}) instead speed (rpm) as that is the case for MS DIN or MS SV measuring systems. To force rotation speed in rpm, please read section 2.6.8 of this user manual.

The "Delayed start" function allows you to set a waiting time before the measurement. This time will be deducted as soon as you launch the measurement (see section 2.3).

The "Temperature" button is only present if the function has been activated in the instrument. This is the case when the instrument has been delivered with a programmable temperature regulation. By default, this function is not accessible. If you acquire a temperature control device later, we invite you to contact LAMY RHEOLOGY to activate this function.

The "QC limits" function is identical as defined in paragraph 2.8.1.1.

When you select the “Number of steps” button, the instrument displays a new view.

The screenshot shows the 'Step editor' screen with a list of 10 steps. Step 1 is selected. Below the list are buttons for 'Add new step', 'Delete step', 'Edit duration', and 'Edit value'. Callout boxes provide the following descriptions:

- Allows you to select the step for copy, edit or delete.** (Points to the selection checkboxes in the list)
- To delete selected step.** (Points to the 'Delete step' button)
- Allows you to change the speed or shear rate of selected step.** (Points to the 'Edit value' field)
- Allows you to copy selected step and then add it after it.** (Points to the 'Add new step' button)
- Allows you to modify the selected step duration.** (Points to the 'Edit duration' field)

Once changes have been done, you can use the button to return to the previous screen. The instrument will display the new number of steps.

The “Options” function allows you to integrate a rheological analysis or a temperature setting condition as described in the following view.

The screenshot shows the 'Options' screen with various settings. Callout boxes provide the following descriptions:

- Select this function if you want the instrument to chain the same succession of steps but in the opposite direction.** (Points to the 'Decreasing ramp' checkbox)
- Allows a rheological analysis to be carried out on the measurement results.** (Points to the rheological model selection list)
- Allows you to indicate on which step you wish to perform a rheological analysis. These buttons are disabled if "Use All Points" is selected.** (Points to the 'First step' and 'Last step' input fields)
- Allows you to wait for the temperature defined in the method to be reached before starting the measurement.** (Points to the 'Start at temperature' checkbox)
- Allows you to use all measuring points for your rheological analysis.** (Points to the 'Use all points' checkbox)
- Allows you to use the points generated by the steps used in the opposite direction. This option is only available if you have checked “Decreasing ramp” down”.** (Points to the 'Use falling curve' checkbox)

The "Start at temperature" option is only interesting if temperature control is activated on your instrument.

The "Decreasing ramp" option is interesting if you want to use the step method to generate a flow curve. This descending part will be carried out following the first succession of steps. The term "Decreasing" means that the

instrument will decrease the speed or the shear rate. It is therefore important that, during the first succession of stages, the speed or the shear rate are increasing.

2.8.2 Edit program

This function allows you to modify an existing method. Select a method by checking the corresponding box. The "Edit program" function becomes active and allows you to navigate through the parameters in the same way as described in paragraph 2.8.1. After modifying the method, you have the option of saving it under another name or overwriting the existing method name.

2.8.3 Delete program

This function allows you to delete a method from the instrument memory. Select the method concerned by checking the corresponding box. You can delete them all at the same time by selecting the "Select all" function.

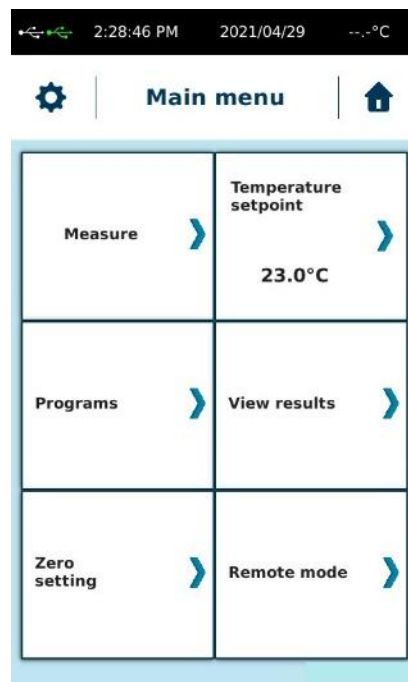
2.9 Temperature setpoint menu

This function is available in the main menu.

As described in paragraph 2.3, this function is only available if your device is delivered with a temperature control that can be controlled such as the EVA, RT-1 PLUS (THERMOCELL) units. By default, this function is inactive. If you subsequently acquire such a heating unit, you should contact LAMY RHEOLOGY or your local agent.

This mode does not allow temperature ramps to be carried out via the instrument. For this type of method, the use of RheoTex software is required.

Contrary to the use of the setpoint in a measurement method (see section 0), the use of this function is useful for controlling the temperature setting unit without performing a measurement. So, you can precondition your sample to the right temperature before starting the measurement.



3 MEASURING WITH YOUR DEVICE

This section will show how use the different measuring system with your device.

Instrument need to be installed before next section of this manual (see section 1.5).

When taking viscosity measurements with your instrument, there are two considerations that apply to measuring low-viscosity products:

- Viscosity measurements must be accepted within the equivalent torque range of 10% to 100% for any spindle/rotational speed combination.
- Viscosity measurements should be taken under laminar flow conditions, not turbulent flow conditions.

The first consideration concerns instrument accuracy. All Spring viscometers have an accuracy of +/- 1% of the range used for all standard RV and LV spindles (accuracy values may be higher than 1% when using other spindles such as T-BARS). We do not recommend taking readings below 10% of the range because the potential viscosity error of +/- 1% is calculated based on the maximum spring torque value. The lower the torque reading, the more the 1% error impacts the measurement. The calculation method is explained in section 4. The MIN-MAX viscosity values depending on your instrument, speed, and moving part are given in the appendices (see section 5).

The second consideration concerns fluid flow mechanics. All rheological measurements must be performed under laminar flow conditions. Laminar flow is a flow in which all particle movement occurs in layers driven by shear forces. When the inertial forces on the fluid become too strong (as can be the case with high speeds), the fluid flow becomes turbulent, creating vortices in which particle movement becomes random and the flow cannot be analyzed using standard mathematical models. This turbulence creates a falsely high viscometer reading, with the degree of nonlinear increase in the reading being directly related to the degree of turbulence in the fluid. For the following geometries, we have found that an approximate transition point to turbulent flow occurs:

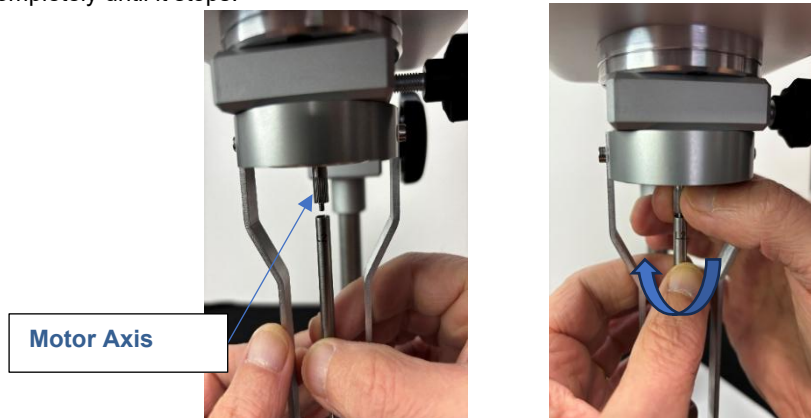
1. LV Spindle #1: 15 cP at 60 rpm
2. LV Spindle #2: 100 cP at 200 rpm
3. RV Spindle #1: 100 cP at 50 rpm
4. RV Spindle #2: 500 cP at 60 rpm
5. MS-ULA Spindle: 0.85 cP at 60 rpm
6. MS-SV418S: 1.25 cP at 240 rpm

Turbulent conditions will exist in these situations whenever the RPM/cP ratio exceeds the values indicated above.

3.1 Installation of measuring system

Read the installation of your measuring system in the following sections before inserting it on your instrument. Indeed, some measuring systems require the installation of accessory before the insertion of the spindle.

As the instrument has only one type of screw coupling, the method of installing the spindle on the instrument shaft is always the same. Only MS-SVSpring spindles require an adapter (see section **Erreur ! Source du renvoi introuvable.**). Hold the measuring system in front of the motor shaft, insert the spindle by screwing it clockwise. Screw it in completely until it stops.



If you have the optional temperature probe, it comes with a clip that clips onto the beakers. Then connect the probe to the back of the instrument (see section 1.3).



3.2 MS RV/LV (GuardLeg)

Measuring spindles according to ASTM / ISO 2555 (316L stainless steel).

These systems are ideal for simple viscosity measurement at controlled rotational speeds in all areas of activity. The standard recommends using a 600ml beaker for measurement. We recommend using Guardleg LV or RV when using this type of mobile device. Their use allows for better measurement repeatability by ensuring optimal positioning in the container for measurement.

Here below are all available mobiles:

Name	Part number	Viscosity range (mPa.s)	
MS-LV Spring-1	LV0001	from 15to60K	
MS-LV Spring-2	LV0002	from 50to300K	
MS-LV Spring-3	LV0003	from 200to1.2M	
MS-LV Spring-4	LV0004	from 1Kto6M	

RV Spring Mobiles (RV2, RV3, RV4, RV5 and RV6 discs screw onto the RV 1-6 axis).

Name	Part number	Viscosity range (mPa.s)	
Axe RV 1-6 pour RV SPRING	RV111000		
Disque RV-1	111001	from 100 to100K	
Disque RV-2	111002	from 160 to400K	
Disque RV-3	111003	from 400 to1M	
Disque RV-4	111004	from 800 to2M	
Disque RV-5	111005	from 1.6K to4M	
Disque RV-6	111006	from 4K to10M	
Axe RV-7 pour RV SPRING	RV111007	from 16K to 40M	

These spindles are composed of two groups. The mobiles L are intended for low viscosity fluids and R mobiles for medium to high viscosities (see tables section 5):

When measuring, it is strongly recommended to heat the 600ml beaker. You can use either a thermostatic bath or the EVA LR PLUS temperature control system.

Place the instrument on its support (see section 1.5). Fill the beaker with 500 ml of product to be tested, taking care not to introduce air bubbles. Place it in a bath (if you have one) for a sufficient time to reach the desired temperature. If the product contains volatile or hygroscopic material, cover the beaker for the duration of the operation.

Place the measuring head in the highest position (use screw on aluminium arm as wrote in section 1.2).

Install RV or LV Guardleg as pictures show below (see section 1.5).



Ensure that your instrument has been zeroed (see section 2.5) and is level (see section 2.6.8).

Screw the measuring system onto the motor shaft, taking care to lock the motor shaft with your other hand (see chapter 3.1).

With the rack and pinion mount, simply turn the knob to lower the measuring head. Be careful of bubbles under the disc!



Adjust the position of the spindle in the sample so that the spindle shaft is immersed up to the predefined mark. The liquid level must always be at the mark on the spindle shaft. Make sure that the spindle tip is 10 mm or more from the bottom of the beaker.



Then check that no air bubbles are trapped under the spindle (if your sample allows this observation due to its transparency). If a bubble is present, we advise you to unscrew the spindle without changing the height of the instrument. Tilt it to expel the bubble then screw the spindle back onto the axis, taking care to hold it with your other hand.

Wait until the temperature of the sample is within the prescribed limits (if you have temperature probe with your device).

Start the measurement at the desired speed and after choose the right measuring system (see section 2.3).

The torque measurement is indicated on the device's display using a gauge (see section 2.3). Ensure that the measured torque is always sufficiently far from the lower and upper limits (at least 10% compression). If this is not the case, you can either change the measuring spindle or change the measuring speed.

When your measurement is complete, raise the measuring head to the highest position and then remove the spindle for cleaning. Clean the temperature probe (if present) and the guard leg.

4 VERIFICATION OF YOUR DEVICE

Your instrument is calibrated at the factory with an MS-RV2 mobile or MS-LV2 measuring system (see calibration certificate) and a certified oil with a viscosity close to 1000 mPa.s. The verification method differs depending on the measurement system selected. You may decide to perform the verification with your own measurement systems, but it is highly recommended to use one of the two measurement systems mentioned above. In case other systems are used, please contact LAMY RHEOLOGY for the most appropriate verification method.

When checking your instrument, it is important to calculate the maximum permissible error for the measurement. This error combines the precision of the instrument (1% of full scale for all mobiles) and the uncertainty in the viscosity value of the verification oil (generally 1% of the nominal value).

The full scale is calculated according to:

$$\text{Full scale viscosity (Pa.s)} = (\text{KTAU} * \text{M}) / (\text{KD} * \text{RPM}).$$

using the maximum torque of the instrument M (see section 1.4) for each rotation speed RPM and integrates constants KTAU and KD from the measurement geometries (see section 2.6.6).

Example: Mobile LV2 with a LV SPRING model at 50 rpm. We have: M = 0.0673mNm (maximum torque of the instrument); KTAU = 500; KD = 1.

The full viscosity scale is therefore: $(500 * 0.0673) / (1 * 50) = 0.673 \text{ Pa.s}$.

1% of this value corresponds to: 6.73 mPa.s.

For a check on a 1 Pa.s standard oil, the uncertainty on this value is 1% or 10 mPa.s.

The maximum allowed error is therefore: 6.73 mPa.s (for the instrument) + 10 mPa.s (for the oil) so 16.73 mPa.s. A measurement of this oil between 983 mPa.s and 1017 mPa.s is therefore acceptable.

Viscosity measurement on a 500 mPa.s standard silicon oil with an ASTM 2555 RV2 measuring system for RV Spring.

- Fill the 600ml beaker with the standard oil.
- Insert the 600ml beaker in a controlled temperature unit like EVA LR system or thermostatic bath.
- Make a zero of your viscometer (see section 2.5.) and check levelling of device (see section 2.6.8).
- Insert the measuring system with the bayonet coupling in the motor shaft (see section 3.1 and 3.2).
- Immerge the spindle in the oil at the good level (mark on the spindle, see section 3.2).
- Wait for 15 minutes until the standard oil rises to the good temperature.
- Select on the instrument the measuring system RV2, select 50 rpm for the speed, select 60 seconds for the measuring time, and start the measurement (see section 2.3).

Viscosity measurement on a 500 mPa.s standard silicon oil with an ASTM 2555 LV2 measuring system for LV Spring.

- Fill the measuring tube DIN 1 with the standard oil.
- Insert the 600ml beaker in a controlled temperature unit like EVA LR system or thermostatic bath.
- Make a zero of your viscometer (see section 2.5.) and check levelling of device (see section 2.6.8).
- Insert the measuring system with the bayonet coupling in the motor shaft (see section 3.1 and 3.2).
- Immerge the spindle in the oil at the good level (mark on the spindle, see section 3.2).
- Wait for 15 minutes until the standard oil rises to the good temperature.
- Select on the instrument the measuring system LV2, select 30 rpm for the speed, select 60 seconds for the measuring time, and start the measurement (see section 2.3).

For both methods, the result at the end of the measurement must be within the tolerance due to the maximum tolerated error as explained previously. If the measurement is out of range, your instrument may require recalibration.

Check if the error does not come from a wrong filling, a wrong zero adjustment, a wrong spindle rotation, or a wrong temperature value.

5 ANNEXES

5.1 Viscosity range for RV Spring viscometer

Maximum Viscosity (mPa.s) value in function of speed for RV-1 to RV-7 spindles

Done for 100% spring compression

Max. Torque : 0,7187 mNm

Speed RPM	Spindle number						
	RV-1	RV-2	RV-3	RV-4	RV-5	RV-6	RV-7
200	50	200	500	1000	2000	5000	20000
150	67	267	667	1333	2667	6667	26667
100	100	400	1000	2000	4000	10000	40000
60	167	667	1667	3333	6667	16667	66667
50	200	800	2000	4000	8000	20000	80000
40	250	1000	2500	5000	10000	25000	100000
30	333	1333	3333	6667	13333	33333	133333
20	500	2000	5000	10000	20000	50000	200000
12	833	3333	8333	16667	33333	83333	333333
10	1000	4000	10000	20000	40000	100000	400000
6	1667	6667	16667	33333	66667	166667	666667
5	2000	8000	20000	40000	80000	200000	800000
4	2500	10000	25000	50000	100000	250000	1000000
3	3333	13333	33333	66667	133333	333333	1333333
2,5	4000	16000	40000	80000	160000	400000	1600000
2	5000	20000	50000	100000	200000	500000	2000000
1,5	6667	26667	66667	133333	266667	666667	2666667
1	10000	40000	100000	200000	400000	1000000	4000000
0,6	16667	66667	166667	333333	666667	1666667	6666667
0,5	20000	80000	200000	400000	800000	2000000	8000000
0,3	33333	133333	333333	666667	1333333	3333333	13333333
0,1	100000	400000	1000000	2000000	4000000	10000000	40000000

Minimum Viscosity (mPa.s) value in function of speed for RV-1 to RV-7 spindles

Done for 10% spring compression

Max. Torque : 0,7187 mNm

Speed RPM	Spindle number						
	RV-1	RV-2	RV-3	RV-4	RV-5	RV-6	RV-7
200	5	20	50	100	200	500	2000
150	7	27	67	133	267	667	2667
100	10	40	100	200	400	1000	4000
60	17	67	167	333	667	1667	6667
50	20	80	200	400	800	2000	8000
40	25	100	250	500	1000	2500	10000
30	33	133	333	667	1333	3333	13333
20	50	200	500	1000	2000	5000	20000
12	83	333	833	1667	3333	8333	33333
10	100	400	1000	2000	4000	10000	40000
6	167	667	1667	3333	6667	16667	66667
5	200	800	2000	4000	8000	20000	80000
4	250	1000	2500	5000	10000	25000	100000
3	333	1333	3333	6667	13333	33333	133333
2,5	400	1600	4000	8000	16000	40000	160000
2	500	2000	5000	10000	20000	50000	200000
1,5	667	2667	6667	13333	26667	66667	266667
1	1000	4000	10000	20000	40000	100000	400000
0,6	1667	6667	16667	33333	66667	166667	666667
0,5	2000	8000	20000	40000	80000	200000	800000
0,3	3333	13333	33333	66667	133333	333333	1333333
0,1	10000	40000	100000	200000	400000	1000000	4000000

Maximum Viscosity (mPa.s) value in function of speed for LV1 to LV4 spindles

Done for 100% spring compression

Max. Torque : 0,7187 mNm

Speed RPM	Spindle number			
	LV-1	LV-2	LV-3	LV-4
200	320	1600	6400	32000
100	640	3200	12800	64000
60	1067	5333	21333	106667
50	1280	6400	25600	128000
40	1600	8000	32000	160000
30	2133	10667	42667	213333
20	3200	16000	64000	320000
12	5333	26667	106667	533333
10	6400	32000	128000	640000
6	10667	53333	213333	1066667
5	12800	64000	256000	1280000
4	16000	80000	320000	1600000
3	21333	106667	426667	2133333
2,5	25600	128000	512000	2560000
2	32000	160000	640000	3200000
1,5	42667	213333	853333	4266667
1	64000	320000	1280000	6400000
0,6	106667	533333	2133333	10666667
0,5	128000	640000	2560000	12800000
0,3	213333	1066667	4266667	21333333
0,1	640000	3200000	12800000	64000000

Minimum Viscosity (mPa.s) value in function of speed for LV1 to LV4 spindles

Done for 10% spring compression

Max. Torque : 0,7187 mNm

Speed RPM	Spindle number			
	LV-1	LV-2	LV-3	LV-4
200	32	160	640	3200
100	64	320	1280	6400
60	107	533	2133	10667
50	128	640	2560	12800
40	160	800	3200	16000
30	213	1067	4267	21333
20	320	1600	6400	32000
12	533	2667	10667	53333
10	640	3200	12800	64000
6	1067	5333	21333	106667
5	1280	6400	25600	128000
4	1600	8000	32000	160000
3	2133	10667	42667	213333
2,5	2560	12800	51200	256000
2	3200	16000	64000	320000
1,5	4267	21333	85333	426667
1	6400	32000	128000	640000
0,6	10667	53333	213333	1066667
0,5	12800	64000	256000	1280000
0,3	21333	106667	426667	2133333
0,1	64000	320000	1280000	6400000

5.2 Viscosity range for LV Spring viscometer

Maximum Viscosity (mPa.s) value in function of speed for RV-1 to RV-7 spindles

Done for 100% spring compression

Max. Torque : 0,0673 mNm

Speed RPM	Spindle number						
	RV-1	RV-2	RV-3	RV-4	RV-5	RV-6	RV-7
200		19	47	94	188	469	1875
100		38	94	188	375	938	3750
60		63	156	313	625	1563	6250
50		75	188	375	750	1875	7500
40		94	234	469	938	2344	9375
30		125	313	625	1250	3125	12500
20		188	469	938	1875	4688	18750
12		313	781	1563	3125	7813	31250
10		375	938	1875	3750	9375	37500
6		625	1563	3125	6250	15625	62500
5		750	1875	3750	7500	18750	75000
4		938	2344	4688	9375	23438	93750
3		1250	3125	6250	12500	31250	125000
2,5		1500	3750	7500	15000	37500	150000
2		1875	4688	9375	18750	46875	187500
1,5		2500	6250	12500	25000	62500	250000
1		3750	9375	18750	37500	93750	375000
0,6		6250	15625	31250	62500	156250	625000
0,5		7500	18750	37500	75000	187500	750000
0,3		12500	31250	62500	125000	312500	1250000
0,1		37500	93750	187500	375000	937500	3750000

Minimum Viscosity (mPa.s) value in function of speed for RV-1 to RV-7 spindles

Done for 10% spring compression

Max. Torque : 0,0673 mNm

Speed RPM	Spindle number						
	RV-1	RV-2	RV-3	RV-4	RV-5	RV-6	RV-7
200		2	5	9	19	47	188
100		4	9	19	38	94	375
60		6	16	31	63	156	625
50		8	19	38	75	188	750
40		9	23	47	94	234	938
30		13	31	63	125	313	1250
20		19	47	94	188	469	1875
12		31	78	156	313	781	3125
10		38	94	188	375	938	3750
6		63	156	313	625	1563	6250
5		75	188	375	750	1875	7500
4		94	234	469	938	2344	9375
3		125	313	625	1250	3125	12500
2,5		150	375	750	1500	3750	15000
2		188	469	938	1875	4688	18750
1,5		250	625	1250	2500	6250	25000
1		375	938	1875	3750	9375	37500
0,6		625	1563	3125	6250	15625	62500
0,5		750	1875	3750	7500	18750	75000
0,3		1250	3125	6250	12500	31250	125000
0,1		3750	9375	18750	37500	93750	375000

Maximum Viscosity (mPa.s) value in function of speed for LV1 to LV4 spindles

Done for 100% spring compression

Max. Torque : 0,0673 mNm

Speed RPM	Spindle number			
	LV-1	LV-2	LV-3	LV-4
200	30	150	600	3000
100	60	300	1200	6000
60	100	500	2000	10000
50	120	600	2400	12000
40	150	750	3000	15000
30	200	1000	4000	20000
20	300	1500	6000	30000
12	500	2500	10000	50000
10	600	3000	12000	60000
6	1000	5000	20000	100000
5	1200	6000	24000	120000
4	1500	7500	30000	150000
3	2000	10000	40000	200000
2,5	2400	12000	48000	240000
2	3000	15000	60000	300000
1,5	4000	20000	80000	400000
1	6000	30000	120000	600000
0,6	10000	50000	200000	1000000
0,5	12000	60000	240000	1200000
0,3	20000	100000	400000	2000000
0,1	60000	300000	1200000	6000000

Minimum Viscosity (mPa.s) value in function of speed for LV1 to LV4 spindles

Done for 10% spring compression

Max. Torque : 0,0673 mNm

Speed RPM	Spindle number			
	LV-1	LV-2	LV-3	LV-4
200	3	15	60	300
100	6	30	120	600
60	10	50	200	1000
50	12	60	240	1200
40	15	75	300	1500
30	20	100	400	2000
20	30	150	600	3000
12	50	250	1000	5000
10	60	300	1200	6000
6	100	500	2000	10000
5	120	600	2400	12000
4	150	750	3000	15000
3	200	1000	4000	20000
2,5	240	1200	4800	24000
2	300	1500	6000	30000
1,5	400	2000	8000	40000
1	600	3000	12000	60000
0,6	1000	5000	20000	100000
0,5	1200	6000	24000	120000
0,3	2000	10000	40000	200000
0,1	6000	30000	120000	600000



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