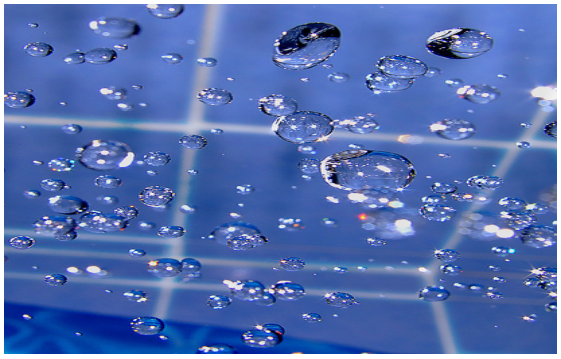
Fungilab

EXPERT SERIES
Rotational Viscometer

Instruction Manual



EXPERT SERIES
Rotational viscometer

Software version: 1.0

Instruction Manual

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0. Table of Contents

1. Introduction

Thank you for acquiring the EXPERT rotational viscometer model from Fungilab, SA.

The EXPERT is a rotational viscometer, based on the measurement of the torque of a rotating spindle in a sample at a specified velocity. Three different models, as well as various accessories, allow it to cover a wide range of viscosity measurement.

2. Safety Instructions

- It is not the purpose of this manual to outline all of the safety instructions recommended for the use of the rotational viscometer, its accessories, and samples. It is the responsibility of the user to establish health and safety practices and to determine the application's limits before use.

- Fungilab, S.A. guarantees the satisfactory operation of the viscometers and its accessories only if there have not been any unauthorized adjustments to the mechanical pieces, the electronic components, and the software.

- The operator should follow all of the warnings and instructions of this manual to ensure the safe and proper operation of the equipment.

- Do not use the equipment for any other purpose that is not described in this manual.

- Do not use any accessory that is not supplied and approved by Fungilab, S.A.

- Do not use the viscometer or its accessories if there is any suspicion of malfunction. Do not use the equipment in situations or conditions that can provoke personal injuries or material damage.

The rotational viscometer is **not** an inflammable, non-hazardous instrument and therefore should not be used in areas where there is an explosion risk.

Before using the viscometer, carefully read and observe the following precautions: those who do not follow them may cause serious harm or personal injuries.

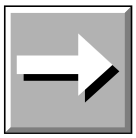
To avoid an electric shock:

- Do not use the rotational viscometer without a solid connection to the ground.

3. Symbols used in this manual

The following symbols are used in this instruction manual:

This symbol warns us of an operational, practical, or similar procedure that, if it is not carried out properly, may damage the equipment.



This arrow indicates additional information that should be used by the user.

This symbol warns us of an operational, practical, or similar procedure that, if it is not carried out correctly, may irreparably damage the equipment. Do not proceed further unless the indicated conditions are fulfilled and have been perfectly understood.

4. Conditions for use

- Indoor use
- Maximum altitude 2000 m.
- Surrounding temperature range: from +5 to 40ºC
- 80% maximum relative humidity for up to 31ºC, and going as low as 50% of relative humidity for up to 40ºC.
- The power source fluctuations should not surpass ±10% of the nominal voltage
- Installation category II
- Pollution level II

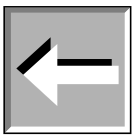
5. Maintenance

- Always clean all of the parts after each use! Clean the spindles and the spindle protector well, and then immediately dry them. Make sure that there is not any sample remaining especially in the delicate zones like the spindle connector.
- Detergents or solvents to clean the spindles and the protector:
    - For food samples, use lukewarm water and if necessary, use soft detergents (like those which are used at home)
    - Other solvents that generally give good results are acetone, gasoline, or something with a high percentage of alcohol
    - If you use any other solvent, make sure that it does not corrode the spindles or the protector. The spindles are made in AISI 316.

***Warning**: Handle the volatile and inflammable solvents with extreme care. It is the user's responsibility to establish safety conditions at work.*

- Regularly check the spindle's thread and the viscometer shaft.
- During the working life of the viscometer, the equipment will require certain check-ups. In this case, please contact the local distributor.
- Regular maintenance is important. We recommend an annual check-up by the service technician of your local distributor.

6. Equipment presentation



- When the equipment package is received, verify and confirm the delivery note. If some discrepancy or problem is found, immediately notify the supplier.

- Check that the model corresponds to the equipment that was ordered.

- Carefully read the use instructions.

- All modifications, eliminations, or lack of maintenance of any of the machine's mechanisms, defy directive 89/655/CEE and the manufacturer is not responsible for any damages that may result.

In the attached photograph (Figure 1) you see the position of each piece inside the equipment's carry-case. Please, keep the carry-case in a safe location. In the case of needing to transport the equipment or store it for a long period of time, always use the carry-case by placing each part as shown in the drawing. In the case of incorrect packing, where any of the pieces of equipment could suffer some damage, this damage will not be covered by the manufacturer's guarantee. FUNGILAB recommends using the carry-case provided with the equipment for making any kind of delivery.

Parts included with the equipment for standard delivery:

- Viscometer head with serial number
- Foot or base, 3 height adjustable knobs for the base
- Nut
- Indented rod
- Standard spindles
- Spindle protector
- Spindle support
- PT100 probe
- Power cable
- USB Cable
- Software Datalogger provided on a CD
- Carry-case
- Calibration Certification
- Instruction manual

Standard spindles
Model L: L1, L2, L3, L4
Models R y H: R2, R3, R4, R5, R6, R7

Fig 1. Viscometer in its carry-case

7. Equipment Description

Fig. 2 Frontal view of the equipment

1. Screen
2. Certified keyboard
3. Nut
4. Spindle Protector
5. Fastening rod
6. Temperature probe
7. Spindle
8. Sample container (not included)
9. Base (viscometer support)
10. Height adjustable knob

Fig. 3 Back view of the equipment

1. Serial number label
2. Level
3. Switch
4. Power cable slot
5. Temperature probe connector
6. USB Connector

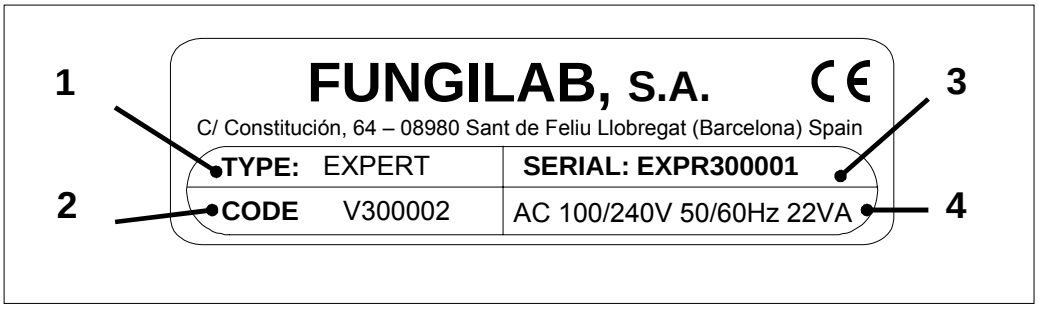


Fig. 4. Equipment identification label

Description of the equipment identification label:

1. Viscometer model
2. Viscometer code
3. Serial number of the equipment
4. Voltage, frequency, and power of the equipment

7.1 Equipment set-up

- Remove all of the parts from the carry-case. Note the figure below (fig 5).
- Correctly place the three height adjustable knobs (B) on the Y-shaped base(A).
- Mount the fastening rod (C) with the holding screw (D) at the base (A).
- Attach the nut (F) to the fastening rod. The viscometer should be connected to the nut (F) by means of its rod (E).

Note:

The following process should be done carefully in order to harm to the shaft of the viscometer. Immediately remove the shaft's plastic protector before beginning to use the viscometer.

- Insert the horizontal rod of the viscometer (E) into the nut (F).

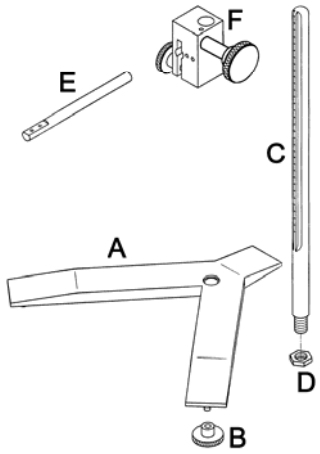


Fig. 5 Set-up for the viscometer base

- The viscometer should be placed on a stable laboratory table or on a stable surface free of vibrations (i.e. caused by other machines or equipment). Do not put the viscometer in direct contact with sunlight or in the middle of any air flow (the temperature of the sample can be easily influenced by the surrounding conditions). The viscometer has been designed to work indoors!
- Turn the height adjustment knobs until the height of the viscometer (located in rod E) is correctly adjusted.
- Plug the power cable into its correct slot located on the back of the equipment (Fig. 3 position 4) and plug it into the power source.

WARNING:

The socket by which the viscometer will be connected should have a ground. Always use a power cable with a ground connection! Verify that the voltage and the frequency coincide with the specifications for the viscometer (look at the identification label Fig. 4, for more information). Before turning on the machine, let it sit for some time so that it acclimates to the surrounding temperature in order to avoid a short-circuit caused by condensation. The fluctuations of the power source should not surpass ±10% of the nominal voltage.

7.2 The keyboard and screen

Before starting up the machine, one should become familiar with the viscometer controls seen in the previous section. The instrument has a 12 key certified keyboard (number 2 Fig. 2) and a 6-lined Vacuum Fluorescent Display screen (number 1 Fig. 2) on the frontal part ready to use and they allow the user to interact with the machinery. The screen always shows the operations that the user is carrying out by showing menus that will be explained later on. The measurements collected by the instrument will also be explained in this manual. The keyboard gives the user the mobility throughout all of the menus, the selection of different options, and the creation and/or modification of viscosity measurement configurations to suit the user's needs.

The keyboard has the following configuration:

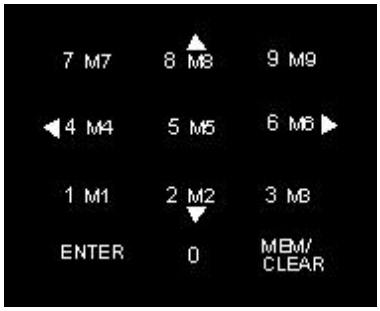


Fig. 6 The keyboard for the EXPERT viscometer

The twelve keys available have many assigned functions depending on the operations that need to be carried out. Some of these functions or operations can be carried out from any screen.

The different numbered keys will always allow you to type in the proper numerical value (if a modifiable field has been selected).

Key	Function
'Δ'	Go to the previous option; increase a value when a field has been selected.
'∇'	Go to the next option; decrease a value when a field has been selected.
'►'	Change the selected field on some menus.
'◄'	Return to the previous screen.
'ENTER'	Accept an option or value in a field. It also allows editing to fields that can be modified. Access to special functions.
'MEM/CLEAR'	Stop the motor during measurements. Return to the main menu screen.
'0'/ON	Stop/ Start the motor during measurements. It allows recording in the log.

Keys 1M1 to 9M9 are used for recordings and their functions are detailed in section 8.4 of this manual.

In the following sections, the function of each key in the corresponding menus will be explained in full detail, including the exceptions to the general operation.

7.3 Start-up

Turn on the switch on the back of the machine (number 3, Fig. 3). If after doing this, the machine does not turn on:

- Verify that the power cable is connected to the equipment (back part, number 4, Fig. 3) and that the power cable is connected to the power.

The machine will beep, indicating that it has started and it will show the following screen:

FUNGILAB S.A
V.1.0
EXPERT SERIES
English

The screen informs the user of the version and the instrument model in addition to the selected language. After a few seconds, the Start-up screen will disappear and the Main Menu screen for the viscometer is shown (section 8.1 of this manual).

The equipment initially comes configured with:

- English
- Temperature units in Celsius (ºC)
- Viscosity units in centipoises (cP).

If these are not the desired basic configurations, the equipment can be configured and changed to meet the user's needs. The method of configuring the apparatus by varying these and other parameters is explained in detail in a later section of this manual called 'Configuration menu' (section 8.2). Any changes made to the machine will stay configured to the last modification made at the configuration menu and will not return to the factory settings after a restart.

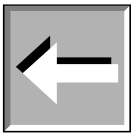
Once the configuration information is given will submit the system to a test-run.

7.4 Autotest

The Test-run menu allows you to verify the operation of the viscometer in a way that allows detection of motor malfunctions in a simple and practical way.

The following message will appear on the screen:

AUTOTEST
Remove the
Spindle and
press <ENTER>



VERY IMPORTANT: The Test-run should be carried out without a spindle.

Once this message is shown on the screen, we should confirm that the spindle is not connected. Afterwards, hit 'ENTER' and the auto-check process will begin. While this test is running, the screen will show this message:

Testing
...

The dots that appear below the Word ¨Testing¨ will continue to appear and reappear in a progressive manner every half second.

If the Test-run is allowed to finish, two possible messages will appear, depending on the type of diagnostic test that was run.

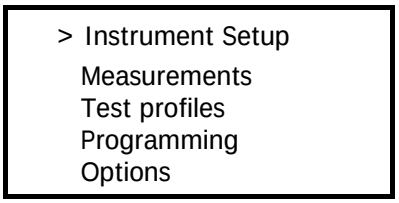
If the instrument detects an anomaly, it will show the following message on the screen:

AUROTEST-RUN ERROR
The system is not
working properly,
press <ENTER>

If this message appears, the machine will let off a whistle and a service technician from the supplier or manufacturer should be contacted. To get the manufacturer's contact information, press the <ENTER> key and it will appear in the following format.

If it is a system error, the equipment will stay blocked, meaning the motor will not function. If the machine is turned off and restarted, the same screen will reappear..

In the case of a successful check, the machine will beep once it is finished and the main menu, as shown below, will appear.



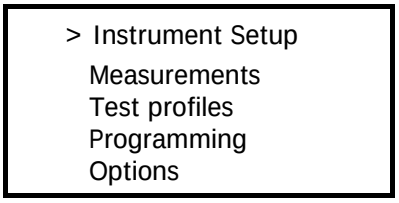
8. Menu system

8.1 The Main Menu

Fungilab viscometers work with a simple system of menus that allow the user to go through the instrument in a quick and simple way. The basic actions in the menus are: moving through the options ('Δ' and '∇' keys), selecting an option ('ENTER' key) or returning to the previous menu ('MEM/CLEAR' key).

The main menu is the one that appears after the opening screen. It is accessed by turning on the machine normally, and after a satisfactory result from the test run.

The main menu screen will show:



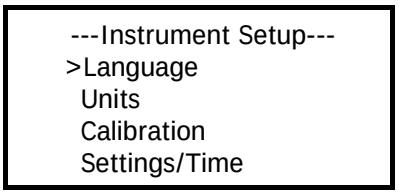
By default, the cursor '>' is placed on the 'Configuration' option.
The menu can be navigated with the 'Δ' and '∇' keys, with which you select the desired option and hit 'ENTER', which takes the user to the desired submenu (for more information about each function in particular see the corresponding sections).

The first time the machine is used, it is advisable to access the 'Configuration' option as the first step in order to establish the values for certain parameters of the viscometer such as language and measurement units.

In the following sections, each of the 5 submenus of the main menu can be seen beginning with the configuration submenu.

8.2 Instrument Setup menu

The configuration menu contains those functions that are not standardized and that modify the state and/or operations of the instrument. Once the 'Configuration' option is selected by pressing the 'ENTER' key, the following screen will appear:



Move through the options using the '∆' and '∇' keys and select a submenu with the 'ENTER' key. By hitting the 'MEM/CLEAR' key, the user can return to the main menu and by pressing the '◄' key, the user can return the previous screen.

The main menu provides the possibility of:

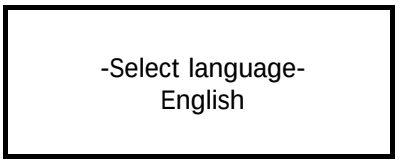
- Changing the working language
- Selecting the measurement units (viscosity and temperature)
- Carrying out calibrations (the machine comes calibrated from the factory, therefore it is not necessary to do any calibrations when the machine is received)
- Adjusting the date and time.

The language, time, and units should be selected by the user before beginning to work with the equipment so that it functions properly.

8.2.1 Language (language change submenu)

Once the configuration menu has been accessed, the first option that the cursor '>' points to is 'Language'. To make a change to the language, this option must be selected by pressing the 'ENTER' key.

When we enter in this submenu, the viscometer will show a screen like the following one:



By using '∆' y '∇' the different working languages for this equipment can be seen, which are:

English
French
German
Italian
Japanese
Portuguese
Spanish
Dutch
Polish
Catalan

Once the language has been selected, hit 'ENTER' and it will automatically change the language of the menus and return to the configuration main menu screen.

If the user wants to leave without changing the language, the 'MEM/CLEAR' keys will take him to the main menu or the '◄' key will take him to the configuration menu.

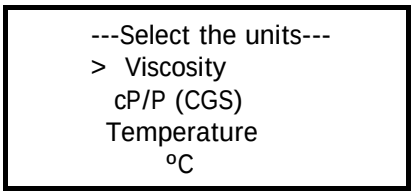
8.2.2 Units. (Unit change submenu)

The PREMIUM-type viscometer allows the user to select the units that are used for measuring viscosity and temperature.

The possible choices for temperature units are:
- Celsius (ºC)
- Fahrenheit (ºF)

And those of dynamic viscosity are:
- International system of units (Pa·s or mPa·s)
- Centimetre-gram-second system of units (Poise or centipoises)

When the cursor key, '>', points to the units submenu, it can be accessed by pressing the 'ENTER' key and the viscometer will show the following screen:



By default, this submenu screen for 'Units' comes configured with the viscosity unit's field selected. To change this selection for the temperature units one, it is only necessary to hit the '►' key.

Once the desired field has been selected, the units to be used with the viscometer can be varied, with both temperature and viscosity, by using the 'Δ' y '∇' keys to switch the options.

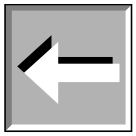
After the desired units have been selected, hit the 'ENTER' key to save the changes and return to the configuration main menu screen. In this case, the '◄' key has the same function as the 'ENTER' key.

If the 'MEM/CLEAR' key is hit, it will cancel the new selections made for viscosity and temperature, returning back to the previously used settings.

8.2.3 Calibration (Calibration submenu)

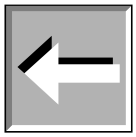
This submenu contains the viscosity and temperature calibration options that the user can exploit to recalibrate his equipment.

IMPORTANT:



The viscometer contains a default calibration element, which is installed during the manufacturing process. It is for this reason that it is unnecessary to calibrate the equipment when using it for the first time. Nevertheless, certain norms of quality recommend that the equipment be recalibrated once a year, which is why we offer the user the possibility of realizing this calibration without needing to send the viscometer back to the usual provider, or to FUNGILAB.
FUNGILIAB, S.A. cannot be held responsible for the measurements taken by an independently recalibrated viscometer, and it is essential to follow the instructions given by Fungilab to the letter when recalibrating.

Calibration Norms:



- To execute a viscosity calibration it is necessary to have on hand at least a little standard calibration oil and a thermo statization system to maintain the sample at a constant temperature. If you do not possess this equipment then you will not be able to guarantee good post-calibration measurements. FUNGILAB, S.A. provides upon request the standard oils necessary for the calibration, as well as the accessories need to thermo-statize the oils.
- There are two types of calibration:
    - Calibration of reference spindle: These spindles are coaxial spindles, with which the accessories APM or APM/B must be used. By calibrating these spindles, you're changing the calibration of all of the viscometer's spindles. Reference spindles:
        - Model L TL7
        - Model R TR11
        - Model H TR9
    - Calibration of the rest of the spindles: The calibration of any spindle, which is different from the reference spindle, will only modify the values of that individual spindle. The rest of the equipment's spindles will not be affected by this calibration. If you want to calibrate more than one spindle and you don't do it with the reference spindle, the spindles will have to be calibrated one by one. The oils used for each spindle will also be different, so for calibration you should have standard silicon oil for each spindle you're calibrating.
- Tables 6 and 7 (pp.61 and 62) specify the standard oils necessary for each spindle.

This submenu is accessed through the main configuration menu, by choosing the Calibrate menu and pressing 'ENTER'. Once at the submenu, the following screen will appear:

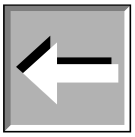
```
      ----Calibration----
>  Reset
   Viscosity
   Temperature
```

Using the '∆' and '∇' keys, you can select the different options of this submenu, placing the '>' cursor over each option and pressing 'ENTER' to chose it. Using the '◄' key, you can return to the previous screen and with the 'MEM/CLEAR' key you will return to the main menu. If you hit 'ENTER', you will select the option indicated by the cursor.

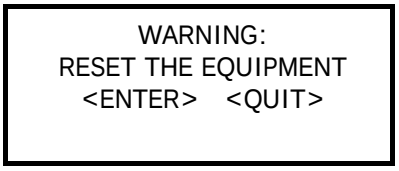
8.2.3.1 Reset

This submenu contains the equipment's RESET option.

Resetting the equipment's configurations implies recuperating the different calibrations present in the equipment at the factory stage. Thus, after resetting, the equipment will recuperate the original viscosity calibration.

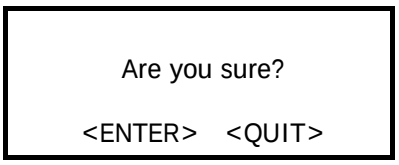


Upon entering this submenu, the following screen will appear:



If you want to continue with this process, press 'ENTER' and you will be brought to the following screen. Otherwise, press the 'MEM/CLEAR' key, which will bring you back to the main menu. In this submenu, the keys 'Δ', '∇' and '►' have no function.

Once the 'ENTER' key is hit, a second confirmation will be solicited by way of a security measure. The following screen will appear:

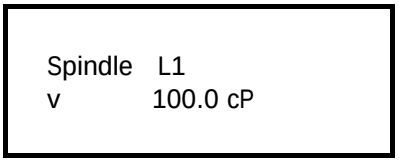


If you press 'ENTER' here, the factory-stage calibration will be restored (calibration, language), the memory will be erased as well as the programming and you will return to the main configuration screen. If you press 'MEM/Clear', you will return to the main menu and by pressing '◄', no configuration will be restored and you will also return to the main configuration screen.

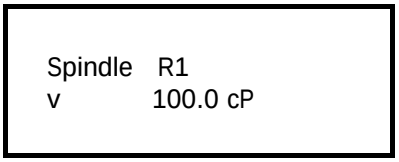
8.2.3.2 Viscosity (Viscosity calibration)

If you select the viscosity option (moving through the menu with the 'Δ' and '∇' keys and press 'ENTER' you will access the following screens, depending on the model of your viscometer:

Model L



Models R and H



Upon entering this screen, the spindle field will be blinking. In the EXPERT equipment, the spindle selection has been streamlined, because of its length.

By pressing 'ENTER' and the '1 M1' key you select the first-group spindles (table 1, p. 59).
By pressing 'ENTER' and the '2 M1' key you select the second-group spindles (table 2, p. 59).

By pressing 'ENTER' and the '3 M1' key you select the third-group spindles (table 3, p. 60).
By pressing 'ENTER' and the '4 M1' key you select the forth-group spindles (table 4, p. 60).

Once this field is selected and situated in the list of corresponding spindles, you can select the spindle that you wish to calibrate using the 'Δ' and '∇' keys.

The list of possible spindles to use depends on the model of your viscometer (L, R or H). Thus, in tables 8 through 18 (page 61 on) you can see the different spindles available for each model.

Once you've selected your spindle, chose (using the '►' key) the field associated with the viscosity and introduce, using the numerical keyboard, the value of the viscosity of the standard oil used for calibration (the standard oils provided by FUNGILAB provide viscosity tables according to different working temperatures.). You should press 'ENTER' to be able to modify this field and 'ENTER' again to confirm the modification.
Next, press '0N' and the following screen will appear:

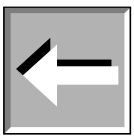
Attach the spindle and press <ENTER>

Once the spindle is in position in the device, press 'ENTER' again and the following screen will appear:

Delay time: 00h 00m 00s

In this screen it is necessary to introduce the time required from the moment you give the command to start the calibration to the moment the device begins the calibration process. This time lapse is frequently used to allow the whole of the sample and spindle to arrive at thermal stability before starting the actual calibration.

NOTE: *When the digits of this field are not selected, the whole line will be blinking. When the field is selected using the 'ENTER' key, only the place of the digit to be modified will be blinking*



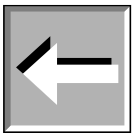
To modify the value, press 'ENTER' once and the field will stay selected. Now you have to use the numerical keyboard. When you start the value modification the cursor is situated on the left of the possible digits. Each time that you hit a number key, this new number will replace the blinking one and the device will automatically jump to the following digit place. This means that if you want to modify a digit, without changing the rest, you would have to go over the digits again, re-entering the same value in the digits you don't want to change to move over to the one you do want to change. Once the right value is entered, hit 'ENTER'. Hitting the '0' key will start a countdown back to zero.

The spindle must already be submerged in the liquid once you confirm the start time.
When the countdown gets to zero, the viscometer will start the calibrating sequence. While the equipment is calibrating, the following screen will appear (example):

Calibrating 1/11 ...

On this screen, each step of the calibrating process is displayed. When the process is over, information on the values of the angles and curvatures of the calibration are displayed. If the curvature is lower to 2%, press 'ENTER' to confirm the calibration and you will be taken back to the main calibration screen.
The exit keys 'MEM/CLEAR' and '◄' allow us to exit to the main menu or the previous screen, respectively, but never while calibrating (never while the screen looks like the example just above).

NOTE: *Exiting mid-calibration denies the equipment a proper calibration and therefore it cannot guarantee accurate results.*



8.2.3.3 Temperature calibration

If you select the temperature option (by moving through the menu using the '∆' and '∇' keys) and press 'ENTER', you'll be brought to a screen resembling this one:

Remove the PT100 probe and connect the 0ºC gauge press <ENTER>

Connect the temperature simulator, using a type B USB connector, to the back of the viscometer simulating the indicated temperature (in this case 0ºC).
The viscometer's screen will show the instructions to follow to achieve the calibration of the probe that measures temperature. You'll have to connect the PT100 simulator generating an impedance equivalent to PT100 at 0 degrees Celsius. Once the gauge is connected press 'ENTER', and the following screen will appear:

Calibrating ...

After a few seconds, and once the temperature is calibrated to 0 degree Celsius, a second screen of instructions will appear, containing the following information:

Replace the 0ºC gauge with the 30 ºC gauge press <ENTER>

Now, you'll have to connect the PT100 simulator generating impedance equivalent to a 30ºC PT100. With the gauge connected and pressing the 'ENTER' key, this screen will appear:

Calibrating ...

After a few seconds, a second screen of instructions will appear, containing the following information:

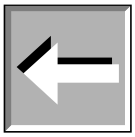
Replace the 30 ºC gauge with the 100 ºC gauge press <ENTER>

Now, you'll have to connect the PT100 simulator generating impedance equivalent to a 100ºC PT100. With the gauge connected and pressing the 'ENTER' key, this screen will appear:

Calibrating ...

After the calibrating is done, the equipment will bring you back to the calibration menu.
The exit keys 'MEM/CLEAR' and '◄' allow us to go back to the main menu or to the previous screen, respectively, though never while calibrating (never while the screen looks like the example just above this paragraph.)

NOTE: *Exiting in mid-calibration denies the equipment a proper calibration and thus cannot guarantee accurate results.*



8.2.4 Time Settings

When the cursor ">" is placed over "Adjust date/time", press the 'ENTER' key to select this option and the viscometer will display the following page:

---Time settings--- > Date Time

At this point you must choose either the date or the time using the 'Δ' and 'Δ' keys to move through the options and 'ENTER' to choose the desired field. The 'MEM/CLEAR' and '◄' keys fulfil their functions as exit keys, allowing you to return to the main menu without saving the changes or return to the previous screen, respectively.

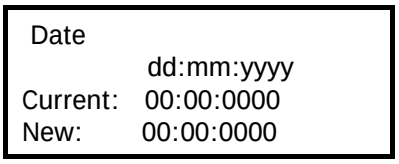
If you choose the 'time' option, the following screen will appear:

Time hh:mm:ss Current: 00:00:00 New: 00:00:00

In the third line you can see the equipment's current time, which is presented as information only and cannot be modified. In the forth line you can modify the time (New Time). To change the time, press 'ENTER' once and the whole field will be selected. Now you must use the numerical keyboard to enter the values desired. When you start the value modification the cursor is situated to the left of the possible digits. Each time that you hit a number key, this new number will replace the blinking one and the device will automatically jump to the following digit place. This means that if you want to modify a digit, without changing the rest, you would have to go over the digits again, re-entering the same value in the digits you don't want to change to move over to the one you do want to change. Once the right value is entered, press 'ENTER'.

If you press the 'MEM/CLEAR' key the modification will be cancelled and the previous field value will be restored. By pressing 'MEM/CLEAR' again, you will be brought back to the main menu. The '◄' key allows us to go back to the previous page in which you chose between modifying the date or the time, but not before pressing 'ENTER' and thus saving the modifications.

The date change functions in much the same way as the time change. Once this option is selected, the following screen will appear:



In the third line you can see the equipment's current date, which is presented as information only and cannot be modified. In the forth line you can modify the date (New Date). To change the date, press 'ENTER' once and the whole field will be selected. Now you must use the numerical keyboard to enter the values desired. When you start the value modification the cursor is situated to the left of the possible digits. Each time that you hit a number key, this new number will replace the blinking one and the device will automatically jump to the following digit place. This means that if you want to modify a digit, without changing the rest, you would have to go over the digits again, re-entering the same value in the digits you don't want to change to move over to the one you do want to change. Once the right value is entered, press 'ENTER'.

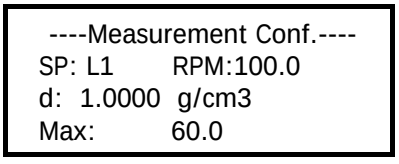
If you press the 'MEM/CLEAR' key the modification will be cancelled and the previous field value will be restored. By pressing 'MEM/CLEAR' again, you will be brought back to the main menu. The '◄' key allows us to go back to the previous page in which you chose between modifying the date or the time, but not before pressing 'ENTER' and thus saving the modifications.

8.3 Measurement Configuration

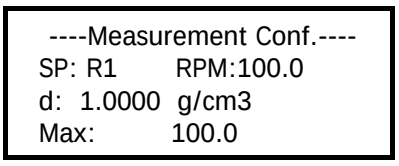
The measurement configuration menu allows access to the basic functions of the device: measuring fluid viscosity. From the main menu screen, with the '>' cursor over the 'Measurements' field, press the 'ENTER' key to choose this option.

After choosing this option, you will see one of these screens, depending on the model viscometer you have:

Model L



Model R and H



To move through the fields cyclically use the '►' key and with the 'ENTER' '∆' and '∇' keys you can proceed to edit each one of the fields. Let's first look at what each field represents and how to modify it.

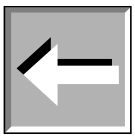
- SP: the field that indicates which spindle we use for the measurement.
- RPM: the field indicating the working speed.
- D: indicates the density of the sample
- Max: Maximum viscosity to be determined with the speed and the spindle selected.

The SP field together with the selected speed will determine the maximum and minimum viscosity values (from 8 to 18, from page 62, on), as well as the existence of a shear stress measurement (if you're using coaxial spindles). To modify the spindle, you first need to select the field using the 'ENTER' key. The viscometer will only show the spindles that are compatible with your model. Once the spindle field is selected, we use the same direct selection method previously explained in the section about viscosity calibration.

By pressing 'ENTER' and the '1 M1' key you select the first-group spindles (table 1, p. 59).
By pressing 'ENTER' and the '2 M1' key you select the second-group spindles (table 2, p. 59).
By pressing 'ENTER' and the '3 M1' key you select the third-group spindles (table 3, p. 60).
By pressing 'ENTER' and the '4 M1' key you select the forth-group spindles (table 4, p. 60).

Once this field is selected and situated in the list of corresponding spindles, you can select the spindle that you wish to use, using the '∆' and '∇' keys.

IMPORTANT: *Selecting a spindle that doesn't correspond to the ones adapted to your model will cause measurement problems.*

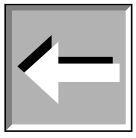


The RPM field (revolutions per minute) indicates the speed at which the test will be done.
The EXPERT series incorporates 54 pre-determined speeds: 0.01, 0.03, 0.05, 0.07, 0.09, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 1.1, 1.2, 1.4, 1.5, 1.8, 2, 2.5, 3, 4, 5, 6, 7.5, 8, 10, 12, 15, 17, 20, 22, 25, 30, 35, 40, 45, 50, 60, 70, 75, 80, 90, 100, 105, 120, 135, 140, 150, 160, 180, 200 RPM.
The viscosity of the liquid and the spindle used determine the speed (refer to tables 8 to 18).

Speed modification: once the corresponding field is selected using the '►' key, you can move through the pre-established speed using the '∆' and '∇' keys. If you want to keep the selected speed, press the '►' key to change parameters.
You also have the option of configuring a stock of personalized speeds to facilitate operations. This option is detailed in section 8.5.2 of the manual.

'd' (density): Indicate the density of the fluid being measured. By default we consider the density of water as a reference point, but you can select any other value. The units will be Kg/m^3 if you've selected units from the International System (IS) or g/cm^3 [s] if you use the Centimetre-gram-second system of units (CGS). To modify density, follow the same editing method as anywhere else: hit 'ENTER' to edit the field selected and using the numerical keyboard, introduce the value desired.

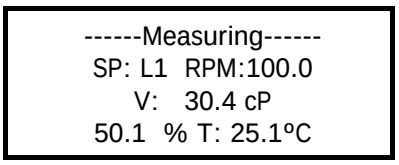
NOTE: *If you modify the density, the viscometer will give its measurements in cSt (centiStokes), whereas if you conserve the initial density (considered the density by default), the measurements will be in cP (centipoises), P (Poise) or mPa·s, Pa·s.*



If, once the values of all of the fields are confirmed, you hit the '0' key, you will go on to the measurement screen. If instead you press the 'MEM/CLEAR' key, you'll return to the main menu screen, losing all of the data introduced in measurement configuration. If you press the '◄' key, you will also lose the values entered, returning to the initial screen.

8.3.1 Measurement screen

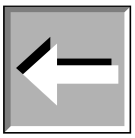
You can access this screen by pressing the '0N' key after the introduction of the measurement parameters. The viscometer will start moving the spindle, which means that the equipment is ready to start collecting data. We will now see an example of the data presented on screen at this stage:



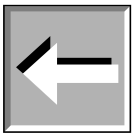
As the equipment goes about collecting viscosity data (one piece of data for each rotation of the spindle), the information on the screen will be updated. On the screen you will see:

- SP: Current spindle. Selected on the previous screen.
- RPM: Revolutions per minute. Value selected on previous screen.
- V: Viscosity. Value expressed in cP or mPa·s, or cSt (in the case that a density different from the default one is introduced).
- %: Certain percentage of the base scale. Percentage value of the curvature of the spring in relation to the base of the same scale.
- T: Temperature of the sample (ºC or ºF).

NOTE: *The speed field will be blinking until the motor speed is stable.*



NOTE: *Depending on the selected speed, it is possible that the speed reading will take a few seconds or minutes to appear. It's important that the viscometer has made at least five rotations (which equals five measurements) before considering the measurements to be valid, as the device needs that time to stabilize. It's also important to only take into account the temperature of a stable sample.*

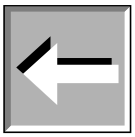


In addition to visualizing measurements made on the sample, the user can also do other things from this screen.

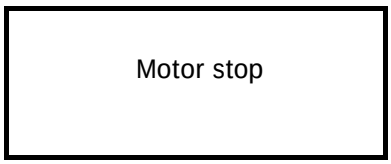
Using the 'Δ' and '∇' keys, you can increase or reduce the speed of the spindle's rotation (RPM). When you hit one of these two keys, the rotation speed increases or decreases, respectively, from the previous speed.
This way, we can comfortably modify the turning speed without having to leave the measurement screen.
When you make a speed change, the field will start blinking again until the motor speed stabilizes.

To make a unit change, whether it's in viscosity or in temperature, the equipment will have to take into account the stabilized rotation (speed field (RPM) not blinking). With the '►' key, the viscosity field will blink for five seconds. If you then use the 'Δ' and '∇' keys, you can vary the units (SI and CGS).
To save the changes, press 'ENTER'. If you do not do this within five seconds the changes will go unsaved.
The units in the temperature field (ºC and ºF) can be modified using the same process but you will have to use the '►' key again when you've selected the viscosity field (it will be blinking).

IMPORTANT: *When the certain percentage of the base scale is lower than 15% or is as high as 100%, the measurement cannot be considered valid and the equipment will emit a warning beep with every rotation made under these circumstances.*



With the '0N' key you can stop or start the motor, which allows for momentary pauses in an experiment. We you hit this key, the equipment will show the following message:

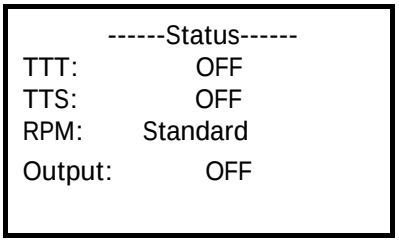


If you press the 'MEM/CLEAR' key when you see the message above, the viscometer will abandon the measuring and return to the main screen.

If you hit the '0N' key, the equipment will restart the measurements with the same configuration.

In this measurement section, other screens give us additional information about the experiment and the measurements obtained.

If you press the '5 M5' key, the following screen will appear:



This screen only shows us the general equipment configuration. There is nothing to modify here. To modify these fields, see sections 8.5 and 8.6 in which the general programming of the equipment is explained.

Screen functions:

TTT: Time to Torque. You must set a torque value (%), at which the viscometer will have to stop the measurement. The screen will show the obtained viscosity at this moment in the torque. (see section 8.5)

TTS: Time to Stop. You must set a time for the experiment, and a time for the viscometer to stop. Once the device has arrived at the determined time, the equipment will stop and display the value of the viscosity (see section 8.5)

RPM: Speed program. There are two working speed systems:

STANDARD: The viscometer works with the 56 pre-established speeds.
CUSTOM: The user has programmed some different speeds from the viscometer's standard ones (see section 8.5.2)

Output: Output and data recording. This function is defined when the user wants to store data from an experiment, for later use, in an Excel file (see section 8.6.1)

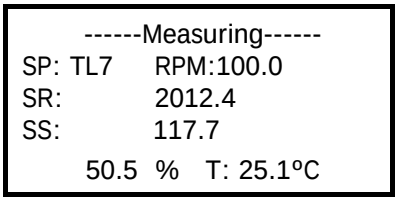
Screen information:

- TTT: ON means activated OFF means deactivated
- TTS: ON means activated OFF means deactivated
- RPM: STANDARD CUSTOM
- Output: ON means activated OFF means deactivated

By pressing the '5M5' or the '◄' key, you return to the main measurement menu.

If you have the graphic mode activated (on 'ON'), by pressing the '1M1' key you can see a graphic approximation, which is constantly updated, as the experiment goes on (real-time graphics). Press the '1M1' or the '◄' key to return to the main measurement screen.

SHEAR RATE determinations and SHEAR STRESS:
If you're using coaxial spindles (TL or TR) or the low-viscosity spindle (LCP/SP) you can access the other measurement information screen.
By pressing 'ENTER' in the main measurement screen, the following screen will appear:



By pressing the '0N' key from this screen, we stop the motor, and by pressing it again, the measurements start back up (in the same way as previously described).

The fields shown here cannot be modified form this screen. For information on modifications see the 'Programming' (section 8.5) of this same manual.

The fields we can see here are:

- SP: Selected spindle.
- RPM: Spindle speed in revolutions per minute.
- SR: Shear Rate.
- SS: Shear Stress.
- %: A certain percentage of the base scale. Percentage value of the curvature of the spring in relation to the same base scale.
- T: Temperature of the sample (in ºC or ºF)

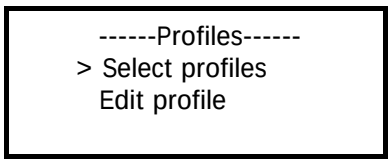
By pressing the 'ENTER' key or the '◄' key, we can return to the main measurement screen.

It is not necessary to always return to the main measurement screen. The keys 'ENTER', '5M5' and '◄' all allow you to return to the previously described screens.

8.4 Test Profile

FUNGILAB viscometers incorporate a group of programmable logs that allow configurations to be saved in order to speed up use of the machine when carrying out measurements of a certain frequency.

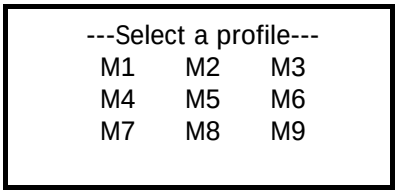
From the main menu screen, select the Logs option by using the '∆' y '∇' arrows and hit the 'ENTER' key to accept. The viscometer will show the following screen:



The first option will start a measurement with some configurations already recorded in the instrument's log and the second is for saving the measurement options of a new configuration. Select one field or the other by using the 'ENTER' key.
By pressing the 'MEM/CLEAR' and '◄' keys the equipment will return to the main menu screen.

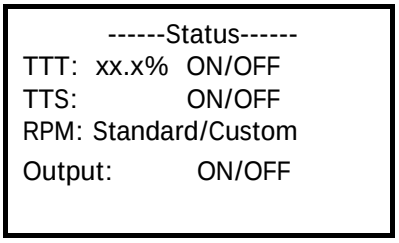
8.4.1 Select Profile

If the user wants to use some of the machine's logs, the 'ENTER' key should be hit once the cursor ">" is positioned on this option and the following screen will appear:



To choose one of the log options, hit the log key corresponding to the desired log setting (for example 1 M1, would select log M1). The names correspond to symbols on each key on the viscometer's keyboard. After that, hit the 'ENTER' key to validate the option. If more than one of the log keys is hit before pressing 'ENTER', the equipment will select the last log key hit. To represent this, the log that is being chosen at the moment will blink on the screen.

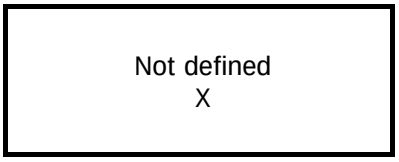
Once the log is chosen and the 'ENTER' key hit, the following screen will appear (In the sample figure all of the possibilities are shown. Only one of the two words, ON/OFF, will appear depending on which function is active):



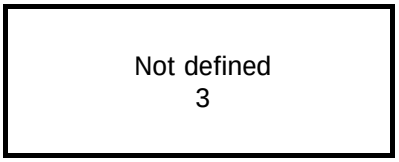
This screen is the same one as the auxiliary screens of the measurements for this machine. The information shown will not be able to be modified under any condition, it is only shown to inform the user. Once the user has this information on the screen, by hitting the '0' key the measurement can begin and then the user must go to the measurement screen. If the 'ENTER' key is hit the measurement configuration page is accessed and if the key is hit again, the status page appears. The key '◄' takes the user to the log selection screen and the 'MEM/CLEAR' key would take the user back to the main menu of the machine.

Once on the measurement configuration screen, its details can be seen but not modified. Now if the '0N' key is hit, the measurement can begin. If the '◄' key is hit, it goes to the log selection screen and the 'MEM/CLEAR' key would take the user back to the main menu of the instrument.

If by error a log is selected that has not been recorded on previously (the viscometer comes from the factory with empty logs), and if the 'ENTER' key is hit, a screen like the following will appear:

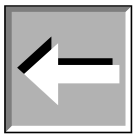


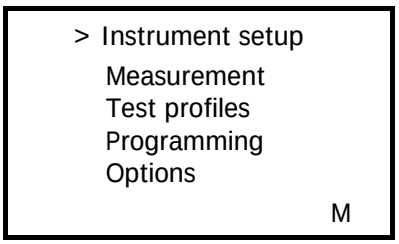
"X" being a log number from 1 to 9. If the following screen is visualized:



the slot M3 would have been selected and it would be there without having been recorded on (empty). By pressing the 'ENTER' key again, the log selection screen will reappear to be able to select another log. The 'MEM/CLEAR' and '◄' keys continue fulfilling their habitual functions by carrying the user to the main menu screen o the previous screen, respectively.

NOTE: *There exists a way to select the log through fast access. When the user is on the main screen of the viscometer, the 'MEM/CLEAR' key can be hit and a letter M will appear on the lower part of the screen giving this view:*

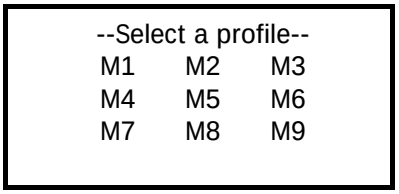




When this M is on the screen the keyboard function has been activated, the user can directly select one of the nine logs. Hit one of the nine keys with a keyboard log symbols (for example 3 M3). It takes the user directly to the log information screen and the user can proceed as was explained before. In the same way, if an empty log is selected (without having been recorded on), it will show the empty slot screen.

8.4.2 Writing Test Profile

To select this option, the 'ENTER' key should be hit when the cursor ">" is placed on the "Recording log" option line. The viscometer will show the following screen:



To choose one of the logs, press the corresponding key for the log that is desired. The names correspond to the symbols that there are on each of the keys on the apparatus´ keyboard (for example pressing the key '6 M6' selects log M6). From there, press the 'ENTER' key or the '0' key to validate the option. If more than one of the log keys is hit before pressing 'ENTER' (or the '0N' key), the equipment will select the last log key hit. To represent this, the log that is being chosen at the moment will blink on the screen.

In the log recording there are three option blocks that you must to configure once the desired log has been chosen. We will now explain viscometer programming, output conditions and specific configurations for the measurement.

8.4.2.1 Viscometer programming

Once the log is chosen, the following screen will appear:

For the selection of one of the two options, scroll between the options by using the 'Δ' y '∇' keys and press the 'ENTER' key on the one that is desired. The exit keys, 'MEM/CLEAR' and '◄', continue to fulfil their habitual functions by bringing the user to the main menu screen or the previous screen, respectively. In the case of 'MEM/CLEAR', it will proceed without having saved the changes.

On this screen, these two fields can be configured. Once they are configured, the '0N' keys should be hit in order to access the next block of log configurations, the output options block which is detailed in section 8.6.1 of this manual.

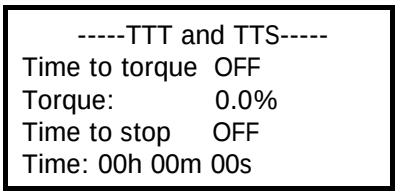
8.4.2.1.1 TTT and TTS

As stated before, these abbreviations mean:

TTT: Time to Torque. You must set a torque value (%), at which the viscometer will have to stop the measurement. The screen will show the obtained viscosity at this moment in the torque. (see section 8.5)

TTS: Time to Stop. You must set a time for the experiment, and a time for the viscometer to stop. Once the device has arrived at the determined time, the equipment will stop and display the value of the viscosity (see section 8.5)

If you choose the option 'TTT and TTS', the following screen appears:



The two fields to activate in this screen are the TTT and TTS.

To select a field, use the '►' key to go through the options cyclically. The field that is selected at each moment will intermittently show the necessary information.

TTT and TTS can only be ON or OFF. To change from one to the other you must have the field selected and use the 'Δ' or '∇' key to change modes.

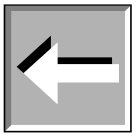
If neither mode is chosen, you cannot access the 'Torque' or 'Time' fields. These fields need to be activated ('ON' in the fields TTT and TTS, respectively) in order to access them.

Once the 'Time to Torque' field is activated, you can access the 'Torque' option by pressing 'ENTER'. Using the numerical keys you should enter the desired value and hit 'ENTER' again to save the changes (it should be a numerical value between 15 and 95). This value will remain saved even if the option is deactivated ('OFF').

'Time' is modified in a similar way. You should have the 'TTS' option activated (hitting the '►' key to change the mode to 'ON'). Once it is selected, hit 'ENTER' and enter the desired value in the field. The selected field will be blinking on the screen until it is modified, and you can modify using the numerical keyboard and introducing the desired value one digit by one. After each digit the viscometer will automatically jump to the following digit place. Hitting 'ENTER' again saves the changes and these will be saved until the next modification by the same procedure. If we deactivate the 'TTS' option, the value will remain saved in the memory.

The exit keys 'MEM/CLEAR' and the '◄' key continue to fulfil their traditional functions, bring us to the main menu screens or the previous screen, respectively. With the 'MEM/CLEAR' key, the changes will go unsaved.

NOTE: *It is impossible to select both the TTT and TTS functions at the same time.*



8.4.2.1.2 Speed settings

The FUNGILAB EXPERT series viscometer has a pre-set speed with a total of 54 RPMs (revolutions per minute) and well as speeds in which the RPMs can be set manually.
In some cases, when the work speeds are repetitive, the user can personalize these speeds, configuring a profile for the measurement.

This way, there are two methods of working with different speeds: selecting speeds directly out of the pre-set group (Standard option) or creating a personalized profile which includes the speeds most frequently used. This 'personalized' profile will allow you to select up to 18 speeds.

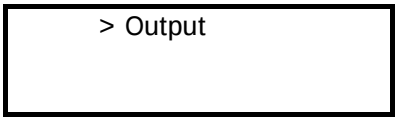
Section 8.5.2 explains how to program your personalized profile.

The exit keys 'MEM/CLEAR' and the '◄' key continue to fulfil their traditional functions, bring us to the main menu screens or the previous screen, respectively. With the 'MEM/CLEAR' key, the changes will go unsaved.

8.4.2.2 Options

By pressing the '0N' key from the previous speed configuration screen, the viscometer will show you the following screen:

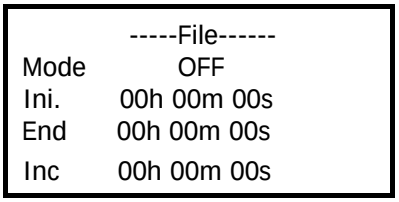
------Options------



In this screen you can also access two configuration options which you can access using the '∆' and '∇' keys and selecting with 'ENTER'. Using the 'MEM/CLEAR' and '◄', you can return to the main menu screen and the previous screen respectively, without saving the changes with 'MEM/CLEAR'. With the '0N' key you jump to the next set of measurement configurations- log writing (section 8.4.2.3).

8.4.2.2.1 Output

If you choose the output option you will be activating experiment recording or recording measurements in the memory log. For this, you will be led to the following screen:



The default mode is 'OFF'. To activate this option, use the '∆' or '∇' to turn it 'ON' and vice versa.

While the option is deactivated ('OFF'), we cannot select the time fields that regulate this function.

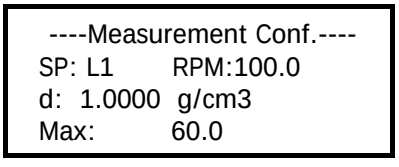
- Ini: record start time, 'Beginning'
- End: data record end time.
- Inc: the increments by which samples are taken.

Once the field in active, you can select different fields, jumping for one to another using the '►' key. To modify each field, hit 'ENTER'. The selected field will blink on the screen until it is modified, using the numerical keypad and introducing the desired values in the digital places this way. Upon digit entry the viscometer will automatically jump to the next digit place. To save the changes hit 'ENTER', which will unselected the field and save the values entered.

The exit keys 'MEM/CLEAR' and the '◄' key continue to fulfil their traditional functions, bringing us to the main menu screens or the previous screen, respectively. With the 'MEM/CLEAR' key, the changes will go unsaved.

8.4.2.3 Measurement Configurations

When you're in the 'options and output configuration' screen (as we will now see), you can begin the configuration of the measurement or experiment.
The '0' key will bring you to a screen resembling this one:



The modification on this screen has already been explained in detail in section 8.3 Measurement configuration menu.

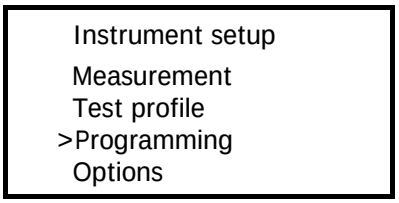
Once the measurement parameters are configured, hit the '0' key to save it to the memory log. The equipment will move on to the next screen, and the recording process will be finalized.

To make sure that the memory has been accurately recorded you can check the process in 'Use Log'

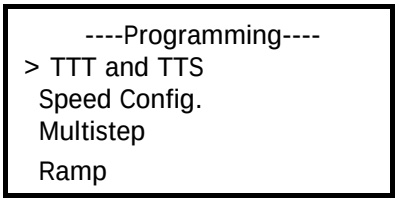
8.5 Programming

The Programming menu contains the functions that allow some optional applications to be programmed for the measurements. The TTT (Time to Torque), TTS (Time to Stop) and the Speed Configuration are applications that are complementary to the normal measurements. Contrarily, the options 'Ramp' and 'Multistep' are applications, which function independently of the ordinary measurements. These run through the normal programming of the viscometer.

From the main menu screen you must place the cursor ">" on "Programming", as seen in the following diagram:



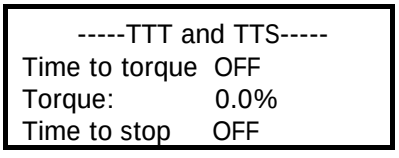
By hitting "ENTER", you will see the following screen:

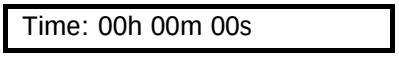


The exit keys 'MEM/CLEAR' and '◄' will continue to perform their normal functions, bringing you to the viscometer's main menu screen.

8.5.1 TTT (Time to Torque) and TTS (Time to Stop)

Select this function, pressing the 'ENTER' key when the cursor ">" is on the 'TTT and TTS' option, and the viscometer will show you the following screen:





This screen will allow us to activate and configure the 'Time to Torque' (TTT) and 'Time to Stop' (TTS) options that we will currently explain:

- Time to Torque (TTT): the viscometer's spindles measure viscosity using a spring, by measuring the degree to which the spring opens. The 'Time to Torque' field tells us how much the viscometer can tolerate. If at any time the overture is greater than the degree previously introduced into the viscometer the measuring will stop. When the viscometer stops because the program is finished, the viscosity measurement is displayed on the screen.
- Time to Stop (TTS): the 'Time to Stop' field is where we program the amount of time we want the measurement or experiment to last. Programming this field with a time limit will define the maximum duration of the viscometer's measurement. When the viscometer stops because the program is finished, the viscosity measurement will be displayed on the screen.

To select the field that we want to activate (TTT or TTS) we use the '►' key, and we can jump from field to field cyclically. The selection of fields will start in 'Time to Torque'. The field that is selected will be intermittently displayed for further information.

The options for the two fields TTT and TTS can only either be 'ON' or 'OFF'. To vary this option we need to have the right field selected and use either the '∆' or '∇' keys to jump from option to option.

If the 'Time to Torque' or 'Time to Stop' fields are not activated (on the 'ON' position), than the 'Time' and 'Torque' fields cannot be accessed.

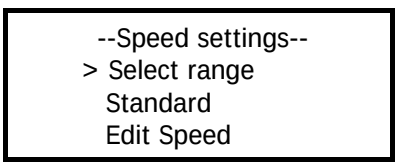
Once the 'Time to Torque' field is activated ('ON' position), we can access the 'Torque' field by typing the '►' key. The field should begin to blink. We hit 'ENTER' to proceed to the modifications. By using the numerical keys we can introduce the desired torque value (between 15.0 and 95.0), and by hitting the 'ENTER' key again, we can keep this amount. This number will remain saved, unchanged, even if the 'Time to Torque' option is deactivated (by changing the field option to 'OFF').

The 'Time' field works in a similar way. We need to first activate the 'Time to Stop' option (on 'ON' position) and select it using the '►' key. Once the field is selected we need to hit the 'ENTER' key and enter the desired numerical amount into the 'Time' fields. Hitting the 'ENTER' key again saves the changes and these will remain unchanged until a new amount is entered in the same way. If we deactivate the 'Time to Stop' option (in 'OFF' position), the value will be saved.

The 'MEM/CLEAR' and '◄' exit keys will continue serving their normal functions, bring us to the main menu screen or the previous screen, respectively. If you use 'MEM/CLEAR', changes will not be saved.

8.5.2 Speed settings

If we select the ´Speed Configuration' option, hitting the 'ENTER' key, when the '>' cursor is placed on this option, the following screen should appear:

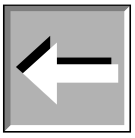


The Fungilab EXPERT series viscometer has a pre-set speed with a total of 54 RPMs (revolutions per minute) and well as speeds in which the RPMs can be set manually.
In some cases, when the work speeds are repetitive, the user can personalize these speeds, configuring a profile for the measurement.

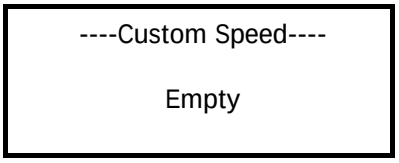
This way, there are two methods of working with different speeds: selecting speeds directly out of the pre-set group (Standard option) or creating a personalized profile which includes the speeds most frequently used. This 'personalized' profile will allow you to select up to 18 speeds.

The viscometer provides a default speed, through the 'standard' option. To change this field, you must use the 'Δ' and '∇' keys to place the cursor on 'choose position' and hit 'ENTER' to choose it.
Using the same 'Δ' and '∇' keys, you can change the method to 'personalized' and hit 'ENTER' to confirm.
This change does not allow you to create a speed profile, but it must be selected if you want to use a personalized profile.
To create the profile, you must hit 'ENTER', when the cursor '>' is on the 'Edit Speed' option on the speed configuration screen.

NOTE: *To create a profile it is not necessary that the 'Choose position' on the speed configuration screen be set to 'personalized', but this setting IS necessary if you want to use the profile.*



To create the personalized profile you place the cursor on the 'Edit Speed' field and hit the 'ENTER' key.
You can only have one personalized profile, so if you aren't programmed yet, you will see the following screen:

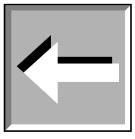


If you already had a personalized profile programmed, you would see a screen with the speeds that you could add to your programmed ones (with a maximum of 18).

In both cases the 'MEM/CLEAR' and '◄' exit keys will continue to serve their normal functions, bringing you to the main menu or previous screens, respectively.

By hitting the 'ENTER' key from the 'programmable speeds' screen (irregardless of whether the profile has already been programmed) you will start the creation of a new profile.

NOTE: *If you have a personalized profile and you access the editing option of a new profile, all the speeds saved with your existing profile will be erased, prioritizing the creation of a new speed program.*



The personalized profile can have up to 19 speeds; 18 programmable by the user and one primary speed which is 0 rpm by definition. At the end of the profile editing all of the programmed speeds, with the exception of speed 0 will be displayed on the screen.

When you start the creation of a new personalized profile, the viscometer will display the following screen:

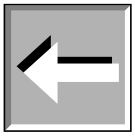
```
----Custom speed----

RPM:    0.01
Num. Position:  1
```

When this screen appears, the speed field will be blinking. You can use the '∆' and '∇' keys to change the speed, moving through the pre-established speeds.
By hitting the 'ENTER' key, you enter the 'speed editing' stage, which will be in the field showing '00000' By using the '∆' and '∇' keys, we increase or reduce the numbers (from 0 to 9 and also '.' as a decimal comma, and the '►' key will bring you, from left to right, from one digit to another. To confirm the speed, you must hit 'ENTER' once again.

Once the speed is confirmed, you must hit the '►' key to position yourself on the 'step' field, and to confirm, hit 'ENTER' once again.
The viscometer's screen will now show the following step number, and the speed field will blink to show that it is ready to be introduced.
If, instead of hitting 'ENTER' when you are in the step field, you hit the '►' key again, the speed field (RPM) of the same step will be activated again.

If you hit the '0' key, the profile will be saved (until the last confirmation of the speed, by hitting 'ENTER') and the modifications will be considered complete (even when all of the positions of the possible speeds are not filled out), returning to the speed configuration screen.

NOTE: *The speeds that can be programmed in the personalized profile must follow a positive progression, meaning that any value can be equal or greater than the previous speed but never less. Speed 1 cannot be repeated in any other position.*



The 'MEM/CLEAR' and '◄' exit keys will continue to serve their normal functions, bringing you to the main menu or previous screens, respectively. With the 'MEM/CLEAR' key, changes will not be saved.

8.5.3 Multistep

The Multistep application is one of the multiple options offered in the Fungilab PREMIUM viscometer-programming menu. This application allows you to increase the viscometer's spindle turn speed non-linearly at a determined time and at a progression that doesn't have to be either constant or positive.

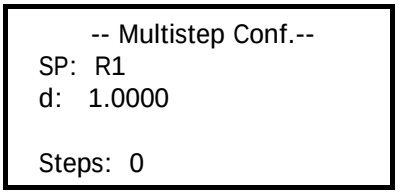
To access this option from the programming screen, the cursor must be on the 'Multistep' option, and you must hit 'ENTER' to select it.

By default, the viscometer functions independently of any Multistep programming, which is why the following screen looks like this:

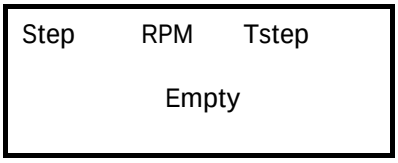
For L models:

```
    --Multistep Conf.--
SP:  L1
d:   1.0000

Steps:  0
```

For R and H models:

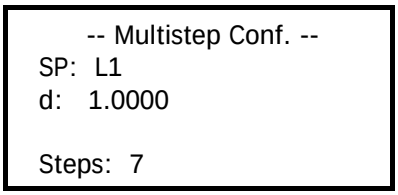


Click ‘ENTER’ to access the following screen:

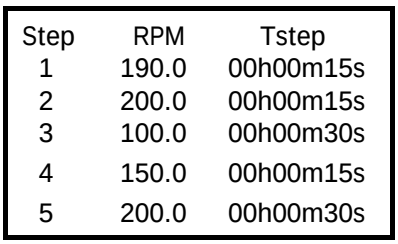


Press ‘ENTER’ to access Multistep programming (details further on).

If the Multistep program has already been programmed, the set will show on the following screen (for example):



This screen shows the set’s Multistep program configuration. In this case , it shows that the L1 spindle is being used and that 7 steps are configured in the program.
By hitting the ‘►’ or ‘ENTER’ key, you will access a screen where the different configured steps are listed (example screen):



Multistep’s programmed speeds will be displayed five by five by hitting the ‘►’ key.

The following information is obtained on this Multistep example screen:

- Position 1. Speed 190.0 rpm, experiment time 15 seconds.
- Position 2. Speed 200.0 rpm, experiment time 15 seconds.
- Position 3. Speed 100.0 rpm, experiment time 30 seconds.
- Position 4. Speed 150.0 rpm, experiment time 15 seconds.
- Position 5. Speed 200.0 rpm, experiment time 30 seconds.

This means that the viscometer will have a first measuring at 190.0 rpm for 15 seconds, then for another 15 seconds will take another measurement at 200.2 rpm, drop t to 100.2 rpm and speed 30 second measuring at this speed, then take another 15 second measurement at 150.0 rpm, to return to 200.0 where it will measure for another 30 seconds.

The Multistep program will have as many steps as shown in the Multistep configuration information screen, with a maximum of 10 steps.
In the example, the experiment has 7 steps. Which means that the first five will be seen in the first screen, and the last two can be visualized by pressing the '►' key.

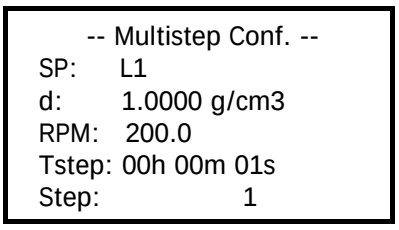
Here is an example screen of the different configured steps listed. When you are here,

Step	RPM	Tstep
1	190.0	00h00m15s
2	200.0	00h00m15s
3	100.0	00h00m30s
4	150.0	00h00m15s
5	200.0	00h00m30s

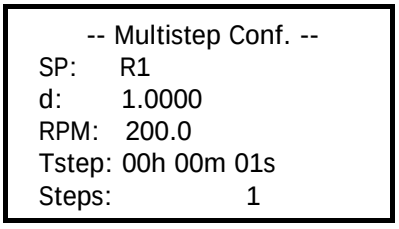
if you press 'ENTER' you can access the application configuration edition. If you hit the '0N' key, the viscometer will start measuring as according to the Multistep specifications.

Once you've press 'ENTER' (from either one of the two options, with complete programming or without), you will see the following screen:

For L models:



For R and H models:



Here you can configure all of the measurement parameters. You should introduce the spindle (SP) (according to model; details in tables 1, 2, 3, 4), the density (d) (as in the measurement configuration, this should only be introduced if you want to obtain the results of the viscosity in cSt. Otherwise, you should leave the viscometer with its 1.0000 by default), the revolutions per minutes (rpm) of each step and the length of time each step should last (Tstep).

Upon entering this option the SP field (spindle) will be selected by default, and will be blinking. Using the '∆' and '∇' keys, you can vary the spindle; the viscometer only shows the possible spindles to be used with each set (tables 1, 2, 3, 4).

By pressing 'ENTER' and the '1 M1' key you select the first-group spindles (table 1, p. 59).
By pressing 'ENTER' and the '2 M1' key you select the second-group spindles (table 2, p. 59).
By pressing 'ENTER' and the '3 M1' key you select the third-group spindles (table 3, p. 60).
By pressing 'ENTER' and the '4 M1' key you select the forth-group spindles (table 4, p. 60).

Using the '►' key you can change the selected field. Once you've introduced the modifications in the spindle field, the next field to modify is the Density (d). To modify the density, you must hit 'ENTER' and you will enter a mode in which the field is numerically alterable. The field will stop blinking; only the place of the digit to be modified will blink, so you can modify the number using the digital key on the set, which allow us to introduce the desired numbers, digit by digit. By entering a digit the viscometer will automatically move on to the next digit place, so it is unnecessary to hit any other key. To save the changes, hit 'ENTER'.

Using the '►' key, you can access the speed (RPM) field, which will start to blink. From here you can modify the speed, moving up or down in value using the '∆' and '∇' keys. You select the speeds from amongst the viscometer's standard speeds. Once you've chosen, hit the '►' key to move on to the next field (Tstep).
If you want a different speed from the standard ones, hit 'ENTER' and you will be presented with the option of introducing the speed. The field will appear as '00000'. Using the '∆' and '∇' keys you can increase or reduce the speed and move over from one digit to another, use the '►' key. By hitting 'ENTER', you confirm the speed entered in the speed field, and by hitting the '►' key, you will pass over into the next field.

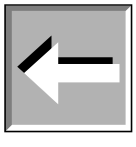
Once you've accessed the 'Tstep' field, it will start to blink until you hit 'ENTER' to select it and modify the values. You can modify the step time (Tstep) using the numerical keys on the equipment, which allow you to introduce the desired numbers in the place of each digit. By entering a number the viscometer will automatically move over to the following digit; you don't need to press any additional keys. To save your changes hit 'ENTER' and the field will go back to blinking.

The 'step' field only gives us information about the step number, and cannot be modified by the user.

With the '►' key, you can go down to the step field, which will start blinking. By hitting 'ENTER', you're in step 2, and from now on only the speed option (RPM) will blink, as it is the only field subject to modification.

If, instead of 'ENTER', you hit the '►' key, you'll end up back at the beginning of the step (spindle field, 'SP') and will be able to modify any one of the fields.

NOTE: *The 'Multistep' speeds do not have to be linear, or even follow a positive graduation. The user can program any progression type (growing, decreasing, rising and declining, etc.).*



Using the '◄' key, as always, you will return to the initial screen of 'Multistep' programming.
The 'MEM/CLEAR' key will bring you to the main menu without saving the changes.

Once all of the steps are validated with the 'ENTER' key, by pressing the '0' key, you start the measurements according to the programmed steps. If you press the '0' key without having

validated a step with the 'ENTER' key, the viscometer will not keep it in memory and will proceed to measure without the non-confirmed step.

Here is a model of the following screen:

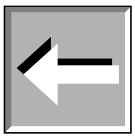
```
      ------Measuring------
SP:  L1    RPM: 6.00
v:          310.1  cP
Time:  04h 58m 33s
31.5  %    T:24.9ºC
step:  1/ 2
```

When the application is finished, the following screen will appear (example):

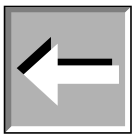
```
      ------Measuring------
SP:  L1    RPM: 12.00
v:          315.1  cP
          End of program
64.0  %    T:24.9ºC
step:  2/ 2
```

By pressing the '◄' key you'll go to the configuration screen at the beginning of Multistep and by pressing the 'MEM/CLEAR' key, you'll be brought to the viscometer's main menu screen.

***NOTE:**. Once the '0' key is pressed, the viscometer's axle will start turning but the countdown will not be initiated until the rotation speed is stabilized. The blinking of the step field will indicate this.*



***NOTE:** While one measurement is being taken it's possible to make a unit change, as much in the viscosity as in temperature. For this, you must be in the process of measurement and with a stabilized speed (speed field NOT blinking) and press the '►' key. The speed field will blink for five seconds. If we then press the 'Δ' and 'V' keys, we can vary the units. To save the changes you must press 'ENTER'. If you don't do this within five seconds the equipment will remain as it was before initiating the process. The temperature field can be modified using the same process, unit by unit, but you have to press the '►' key again when you have the viscosity unit field selected.*



8.5.4 Ramp

The Ramp application is one of the many options offered in the Programming menu of the Fungilab PREMIUM viscometers. This application allows us to program the viscometer to increase linearly the spindle turn speed in a determined time and with a positive speed graduation.

We select this option by pressing the 'ENTER' key with the cursor ('>') is on the 'Ramp' option on the programming screen. The equipment will then show on the screen:

For the L models:

```
      ---- Ramp Conf. ----
SP: L1
d:    1.0000   g/cm3
RPM INIT:    0.01
RPM END:     200.0
Time:  00h 00m 00s
```

For the R and H models:

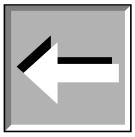
```
      ---- Ramp Conf. ----
SP: R1
d:    1.0000   g/cm3
RPM INIT:    0.01
RPM END:     200.0
Time:  00h 00m 00s
```

Upon entering this option the SP field (spindle) will be selected by default, and will be blinking. Using the 'Δ' and '∇' keys, you can vary the spindle; the viscometer only shows the possible spindles to be used with each set (tables 1, 2, 3, 4).

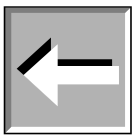
By pressing 'ENTER' and the '1 M1' key you select the first-group spindles (table 1, p. 59).
By pressing 'ENTER' and the '2 M1' key you select the second-group spindles (table 2, p. 59).
By pressing 'ENTER' and the '3 M1' key you select the third-group spindles (table 3, p. 60).
By pressing 'ENTER' and the '4 M1' key you select the forth-group spindles (table 4, p. 60).

Using the '►' key you can change the selected field. Once you've introduced the modifications in the spindle field, the next field to modify is the Density (d). To modify the density, you must hit 'ENTER' and you will enter a mode in which the field is numerically alterable. The field will stop blinking; only the place of the digit to be modified will blink, so you can modify the number using the digital key on the set, which allow us to introduce the desired numbers, digit by digit. By entering a digit the viscometer will automatically move on to the next digit place, so it is unnecessary to press any other key. To save the changes, press 'ENTER'.

NOTE: *The density that appears by default is 1.000 g/cm^3. You should only modify it if you want to obtain the viscosity readings in cinematic viscosity (cSt). For dynamic viscosity readings (cP or mPa·s), it is unnecessary to change this value.*



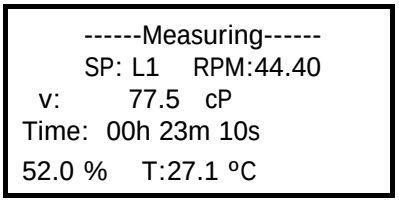
To select the initial speed (RPM Beg) you use the '►' key and the speed field will start blinking. Once the blinking starts, you can change the values using the 'Δ' and '∇' keys and by pressing the '►' key again you will be brought to the final speed (RPM End) which will start blinking. Here again, you use the 'Δ' and '∇' keys to alter the final speed.



NOTE: *The final speed (RPM FI) can never be inferior to the initial speed (RPM INI) because the ramp must be positive in its progression.*

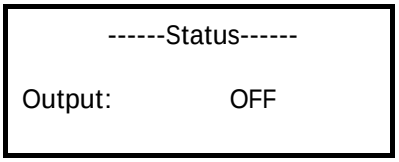
Using the '►' key, you can proceed to select the time, and once this has been accessed, this field will start blinking. To modify it, you use the viscometer's numerical keyboard to introduce the desired number in each of the digit places. As you enter the digits the viscometer will automatically jump to the next digit place without any command being pressed. To save the changes, press 'ENTER', which will leave the field and save the values changed.

The '0N' key will key the Ramp program running. The viscometer will show the following screen (example):



In the 'Time' field, we can see that the countdown indicates to us the time left before the process concludes.

By pressing the '5 M5' key, you access the status screen, which informs of the operative state of the output possibilities (example screen).

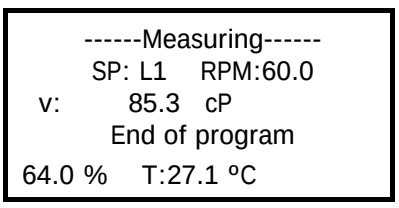


This 'Output' mode and the 'Graphic mode' can be activated as explained in section 8.6.1 of this same manual.

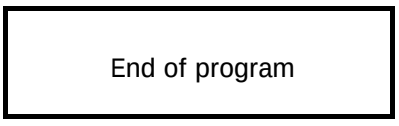
The 'MEM/CLEAR' key and the '◄' key interrupt the application and bring you to the main menu screen and the previous screen, respectively.

If you let the ramp program terminate its process you will see two possible screens at the end:

If when the process ends you're in the main measurement screen, you will see a screen similar to the following example:

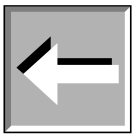


If instead you are in the status screen or in the graphic mode screen, at the end of the process you will seen this screen:



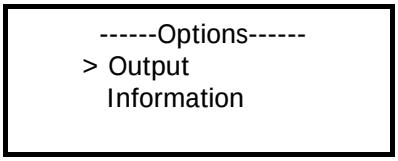
The 'MEM/CLEAR' key and the '◄' key bring you to the main menu screen and the previous screen, respectively.

NOTE: *While a measurement is being taken it's possible to make some unit changes, whether in viscosity or temperature. For this we have to be in the process of measuring and with a stabilized speed (speed field NOT blinking) and press the '►' key. The viscosity field will blink for five seconds, during which you can alter the values using the 'Δ' and '∇' keys. To save these changes you need only to press ' ENTER' and the program will execute the changes. After the five-second window the values will remain as before. Units using the same process can modify the temperature field but you would have to press the '►' key again when the viscosity field is selected.*



8.6 Options

The Options menu contains the information and output options that can be set in the Fungilab Viscometers. When the '>' cursor is on the 'Options' field of the main menu, you must select it by pressing 'ENTER'. The viscometer will show the following screen:

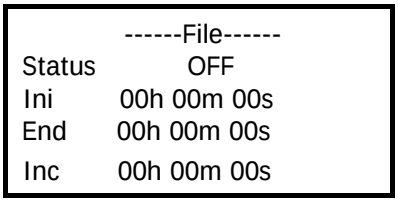


Using the 'Δ' and '∇' keys, we can move our cursor through the options in a cyclical way and to choose one of them, the '>' cursor must be on the field when you press 'ENTER'.

The 'MEM/CLEAR' key and the '◄' key will continue to fulfil their traditional functions, both bringing you to the main menu screen.

8.6.1 Output

If you choose this option, you will be activating the option of recording an experiment or past measurement saved in the Viscometer's memory. For this we will see the following screen:



By default, the 'State' field will be inactive (in the OFF position). To activate it you need to use either the 'Δ' or the '∇' keys to switch the status to ON or back to OFF as desired.

While the 'State' field is deactivated (in the OFF position) you cannot select the time fields that regulate this function.

Once the 'State' field is activated (in the ON position), you can select the different field, jumping from one to another using the '►' key. The selected field will remain blinking on the screen until it is chosen for modifications. To modify each field you must press 'ENTER' once the field is selected and then introduce the values using the numerical keyboard to enter a number in each digit place. Upon each entry of a number in one digit place the viscometer will automatically jump to the next digit place. To save the changes, press 'ENTER', whereupon the field will be unselected and the changes saved.

Screen Information:

- Beg: Begin time of recording.
- Fin: End time of data recording.
- Inc: By which increments of time a sample is taken.

The 'MEM/CLEAR' key and the '◄' key will continue to fulfil their traditional functions, bringing you to the main menu screen and the previous screen, respectively. Without saving the changes in the case of 'MEM/CLEAR'.

8.6.2 Information

If you select the 'Information' option, you will be brought to a screen in which the contact information of the manufacturer will be displayed, resembling this:

Fungilab
Tel: 34 93 685 35 00
sales@fungilab.com
www.fungilab.com

This option is incorporated as a means of security in the case of loss of the present document or the displacement of any reference to the company in technical support or on paper.

9. Important rheological information

To obtain precise results it is necessary to know the most important rheological properties of the sample.

Newtonian fluids
The viscosity of these fluids does not depend on the shear rate meaning that at any speed the viscosity is the same. Only temperature affects the viscosity; changes of 1ºC can provoke a change in the viscosity of up to 10%.

Non-Newtonian fluids

The viscosity of this type of products changes with the speed variable. Due to this inconsistency, the term *Apparent Viscosity* is habitually used.

Within the classification you can find two different groups:

Time-independent non-Newtonian fluids
Time-dependent Newtonian fluids

Time-independent non-Newtonian fluids

The viscosity of a time-independent non-Newtonian fluid depends on the temperature and the speed gradient.

Pseudo plastic Fluids:
The viscosity diminishes when the speed gradient increases.
Practical examples: paints, shampoos, fruit juice concentrate, adhesives, polymers, grease, starch, etc.

Dilatants-Fluids:
The viscosity increases with the speed gradient.
Practical examples: clay, sweets components, etc.

Plastic Fluids:
These fluids only start to flow after having been submitted to a certain force (shearing force). They behave like solids in static conditions.
Practical example: Ketchup.

Time-dependent non-Newtonian fluids.

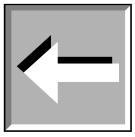
The viscosity of time-dependent non-Newtonian fluids is dependent on the temperature, on the speed gradient and on time.

Tixotropical fluids:

In these substances the viscosity diminishes with time when the fluid is subjected to a constant speed gradient. These substances tend to return to their previous viscosity once the speed gradient ceases to be applied.
Practical examples: Many products in industrial food production (yogurt, etc.)

Reopectic fluids:
In these fluids, the viscosity increases with time when the fluid is subjected to a constant speed gradient.
These substances tend to return to their previous viscosity once the speed gradient ceases to be applied.
These fluids are not very common.

NOTE: *The turbulent behaviour of a fluid can produce falsely high results in viscosity tests. Normally, turbulent behaviour is due to an excessively high rotation speed in relation to the viscosity of the sample (see detailed Warning further on).*



FACTORS AFFECTING VISCOSITY

There are many variables that affect the rheological properties of products, so it is very important to take the following factors into account.

Temperature
Temperature is one of the most obvious factors affecting rheological behaviour.
It is essential to consider the effects of temperature on viscosity in the evaluation of materials that are subject to changes in temperature during its use or other processes. Some examples of this are motor oils, greases and adhesives.

Shear Rate
When a fluid is subjected to variations in the speed gradient during its process or use, it is essential to know its viscosity at the projected speed gradients.
Examples of materials, which are subjected to and affected by important variations in speed gradient during its process or use, are: paints, cosmetics, liquid latex, some food products such as ketchup, and blood in the human circulatory system.

Measurement conditions
The measurement conditions of a material during its viscosity reading can have a considerable effect on the results of this measurement. Consequently, it is important to be careful and control the environment and conditions of any sample subjected to analysis.
Variables such as the type of viscometer, the speed/spindle combination, the sample's container, the absence or presence of a spindle protector, the temperature of the sample and the sample preparation techniques, etc, can affect not only the precision of the reading but also the real viscosity of the sample.

Time
Ageing under the same speed gradient conditions affects tixotropical and reopectical fluids.
In some fluids the action of time combined with the proportion of the shear is very complex. In these cases, one can observe, with time, a return to the original fluid state.

Previous conditions
The conditions that the sample is subjected to before the viscosity reading can significantly affect the results, especially with heat-sensitive fluids or ageing.
Thus, the storage condition and the sample preparation techniques should be conceived to minimize effects on the viscosity measurements.

Composition and additives
A material's composition is a determining factor in its viscosity. When the composition is altered, whether this is by changing substance proportions that compose it or adding other substances, important changes can be observed in their viscosity.
For example, adding solvent to printing ink reduces the viscosity of the ink, and other types of additives are used to control the rheological properties of paints.

VISCOSITY MEASURING PROCEDURES

Data history
We recommend documenting the following information each time you take a viscosity measurement:

- Model or type of viscometer
- Spindle (and accessory)
- Rotation speed
- Sample container
- Sample temperature
- Sample preparation procedure (if existent)
- Spindle protection use

The process is necessary in the event of comparison of results with other organizations, in the interest of being able to guarantee the possibility of reproduction of the results obtained.

The spindle and its protection
Examine each spindle before using it. If it's damaged or eroded in such a way that its dimensions are changed, it will provide false results for your viscosity reading.

The spindle protector (provided with every Fungilab rotational viscometer) protects the spindle and the viscometer axle, and it is important for the reading of low viscosities with standard spindles. The protector should always be used. In the event that it is not used, its absence must be reported in the measurement procedure notes.
The protector isn't used with most of the accessories.

Speed selection and spindle
If there is no described work procedure, the best method for the selection of the spindle for each speed is "trial and error". The objective is a torque reading between 15 and 95%, according to the type of product in question, and a percentage higher than 50% is recommendable.
If you know the fluid's approximate viscosity, the quickest spindle/speed selection method is referring to the tables of maximum approximate viscosity.
When you do tests at different speeds, you should select a spindle with which all of the speeds show a torque reading of between 15 and 95%

GENERALLY:

RPM INCREMENT $\Rightarrow$ READING PRECISION INCREMENT

SPINDLE SIZE-REDUCTION $\Rightarrow$ READING PRECISION INCREMENT

(Except for the non-Newtonian fluids that change their viscosity value when the rotational speed is modified. In these cases we recommended measuring with a determined speed and using a comparison method.)

Size of the sample container
For measurements using the Fungilab viscometer, we recommend working with containers with an interior diameter of 83 mm or more. The usual container is a 600 ml precipitation vase.
If a smaller container is used, the viscosity values could be greater, especially with low-viscosity fluids.

Sample conditions
The sample should be free of air bubbles.
It should be exposed to a constant and uniform temperature. Before doing the viscosity readings, make sure that the spindle and its protection are the same temperature. Usually, thermostatic baths are used to maintain the sample at the desired temperature.
The sample should have the properties of a homogeneous liquid; this means that it cannot have particles capable of being precipitated, deformed by the shear rate or decomposed into smaller particles.
The measured substances shouldn't be subject to chemical or physical changes during the measurement.

Other essential conditions
Experiments in conditions in which turbulent behaviour can be encountered should be avoided. The condition should be that of stationary fluid. Accelerations or retarding processes are excluded from the parameters of measurement.

Spindle immersion
The standard spindle should be submerged to the halfway mark in the axle. An erroneous immersion can compromise the result of the viscosity measurement.
With the disc spindles you should avoid the creation of air bubbles, which could remain under the disc. To this end you should insert the spindle laterally and smoothly, and bring it over to the centre of the sample. Once it is there, attach it to the viscometer's axle.

Precision and Repetition
FUNGILAB viscometers guarantee a precision of $\pm 1\%$ from the bottom of the speed/spindle combination scale, and a repetition of $\pm 0.2\%$.

Getting a viscosity reading
Before working with the viscometer you should make sure of the following points:
The viscometer is properly fastened to the stick and level.
Both spindle and speed are selected. (read attentively the section about speed and spindle selection).
The spindle is carefully placed and fastened.
The instructions and necessary parameters for obtaining a viscosity reading have been carefully read in the user's manual.
Once the readings have been initiated, allow some time for stabilization, the length of which will be in function of the rotational speed during the measurement.

IMPORTANT WARNING
When you wish to obtain viscosity reading with FUNGILAB rotational viscometers, there are two considerations to take into account:

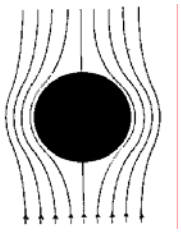
The obtained viscosity results must be between 15% and 100% of the torque range, for whichever spindle/rotational speed combination.
The viscosity reading must be executed under laminar flow condition, not turbulent flow conditions.

The first consideration is linked to the precision of the instruments. All of the FUNGILAB rotational viscometers guarantee a precision of (±) 1% from the bottom of any spindle/rotational speed combination scale.
Working with less than 15% of the bottom of the scale is not recommended due to that the potential (±) 1% error in the viscosity is relatively big compared to the equipment reading.

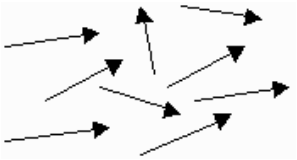
The second consideration has to do with fluid mechanics. All of the rheological measurements of fluid flow properties must be taken under laminar flow conditions. Laminar flow is when all of the movements of the fluid particles are in sheets, directed by an external applied force.

The flow lines represent speed and fluid flow direction.

Laminar flow: "straight" flow lines. Relatively easy to predict. Generally slow.



Turbulent flow: "non-linear" flow lines. Impossible to predict the exact movement of the fluid.



Very quick.

For rotational systems, this means that the fluid's movement must be circumferential. When the internal forces of a fluid end up being too great, the fluid can become a turbulent flow, in that the particles that make it up become unpredictable, making it impossible to analyse it with standard mathematical models.
This turbulence creates a false reading which is a lot higher than the real one, without linear growth and totally unpredictable.

For the following geometries, these transition points have been found to be approximate to turbulent flow:

1) Spindle L1: 15 cP to 60 rpm
2) Spindle R1: 100 cP to 50 rpm
3) Adaptor LCP: 0.85 cP to 60 rpm

Turbulent flow conditions will always exist in these conditions as long as the RPM/cP ratio exceeds the values listed above.

10. Accessories

10.1. Low viscosity adapters (LCP and LCP/B)

Low viscosity adapters (LCP y LCP/B) do not come with the standard delivery. Any of these two versions (with or without thermo station jacket) must be ordered as an additional accessory. Both LCP and LCP/B accessories are supplied complete with a spindle.

Low viscosity adapters allow more precise measurements than using the standard spindle. The viscometer can measure very low viscosity levels, from 1 cP (when using the L model).
Thanks to its cylindrical geometry shape, it is possible to get Shear Rate determinations and Shear Stress.
Only a small quantity of a sample is needed (16-18 ml.)

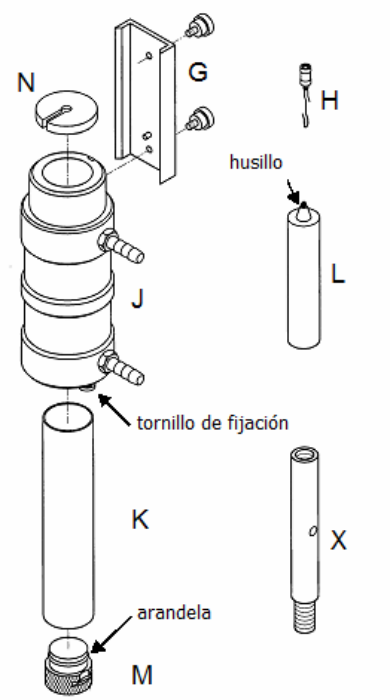


Fig. 7: LCP Spare parts

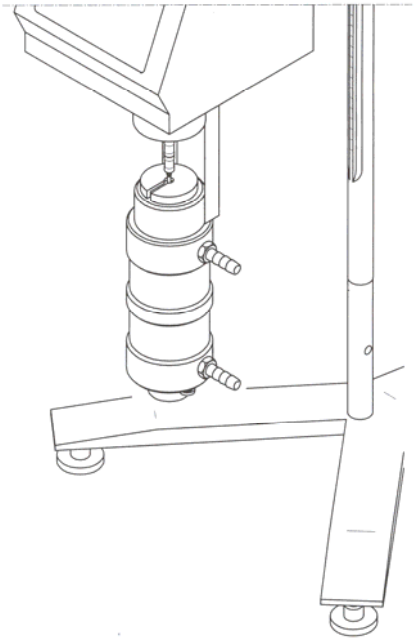


Fig.8: LCP Adapter assembled in viscometer

10.1.1 Mounting

The mounting process is the same for both types of low viscosity accessories (LCP and LCP/B). The sketches here only show the LCP.

- Unplug the viscometer.
- Attach the extension (X) between the base Y shaped (A) and the rib (C). Use a 19 mm adjustable spanner in order to fasten the nut (D).
- Assemble the viscometer again starting with the base. The extension (X) is necessary because of the length of the LCP adapter. Without this extension the assembly of this accessory would be difficult, especially the assembly of the spindle.

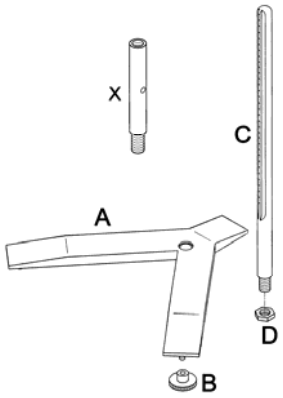


Fig. 9: Mounting the LCP adapter extension.

- Fasten the circulation jacket (J) to the connector (G) (figure 7).
- Fasten the connector (G) to the hole in the back of the viscometer's metallic base.
- Connect the hook (H) and the spindle (L)
- Insert the spindle (L) in the circulation jacket, and screw it with the viscometer axle by turning it clockwise.
- Close the sample (K) container with the stopper (M).
- Fill the sample container with a 20 ml syringe, or less, and fill the 16-18 ml sample container.
- Insert the container (K) to the lower part, in the circulation jacket (J).

Important:
Do this slowly since the spindle must be inserted correctly in the sample. When working with a more viscous sample be careful to avoid pulling the spindle upwards. Hold the spindle connector.

- Insert the sample container (K) by turning it gently. Fit the spindle together with the lower stopper (M).
- Check the level of the sample. It should be approximately in the middle of the cone, which is connected to the spindle connector(H). Figure 10 shows more information about this
- Place the upper stopper (N) over the sample container.

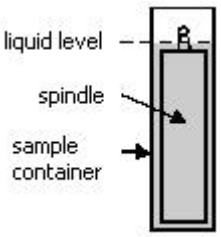


Fig. 10: Full LCP adapter.

NOTICE:
Before starting with the measurements, make sure the viscometer is correctly balanced (check it with the bubble level). The spindle that should be selected is 'LCP/SP'.

10.1.2 Dismounting and cleaning

- Place the viscometer upright. Remove the upper stopper (N).
- Unscrew the spindle of the viscometer axis and lower the spindle slowly in the sample container (K).
- Unscrew the bottom stopper (M) and remove the container(K) from below the thermo station jacket (J). Once the container is removed, remove the spindle carefully (L).
- Remove the container, wash it or use compressed air. Wash the circulation jacket too if necessary.

Important:
Do not use any cleaner or tool that can damage the metallic surface. Make sure you only use liquids that agree with the LCP adapter material!

Solvents that can be used: water, ethanol or high concentrations of alcohol. For other solvents, check the chemistry compatibility table.

10.1.3 Technical specifications for LCP accessories

Measurements rank:
- Sample L: 0.9*) until 2 000 mPa.s or cP
- Sample R: 3.2**) until 21 333 mPa.s or cP

*) Limited by turbulences
**) For the measurements that represent 10 % of the base scale

Sample volume: 18.0 ml

Shear rate factor for the LCP spindle: 1.2236 x RPM ***)

***) Shear rate is calculated based on the features of Newtonian liquids.

Temperature rank of the circulation jacket & thermo station conditions:
- Temperature rank allowed: -10 a +100°C (14 a 212 °F)
- Use a thermo station wash with demineralised water or special refrigeration liquid. Change thermostat liquid regularly. Recommended flow: 15 l/min.

Materials:
- The metallic parts are made of stainless steel; the leads are made of black delrin plastic. The parts that come into contact with the sample (sample container and spindle) are made of AISI 316 and are suitable for the food industry.
- The lead inferior washer is made iwith black delrin. It is designed to withstand a maximum temperature of 100ºC (212 ºF)
- The circulation jacket is made of acetyl and Delrin.
- The O-ring on the plastic stopper (M) of the LCP Adapter is made of delrin.
  The softening point is 110 °C (230 °F).

10. 2. Small sample adapters APM and APM/B

NOTICE:
Small sample adapters (APM and APM/B) do not belong to the standard delivery. Any of these two versions (with or without thermo station jacket) must be ordered as an additional accessory. APM and APM/B accessory are not supplied with a spindle. Special spindles (TL or TR) are used according to the viscometer sample (L, R or H).

Small sample adapters allow more precise measurements than the standard spindles. The measurement rank of a viscometer can get lower viscosity levels.

Thanks to its known cylindrical geometry shape, it is possible to get Shear Rate and Shear Stress determinations. Only a small quantity of a the sample is needed.

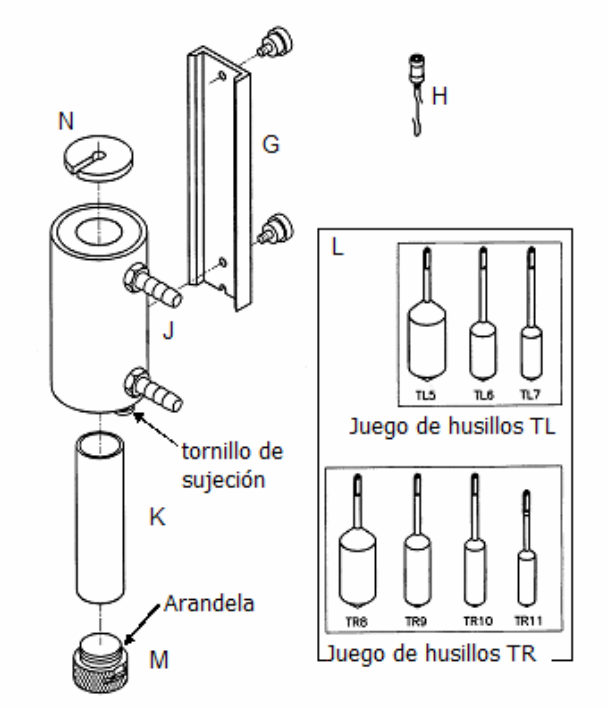


Fig. 11 APM accessory parts

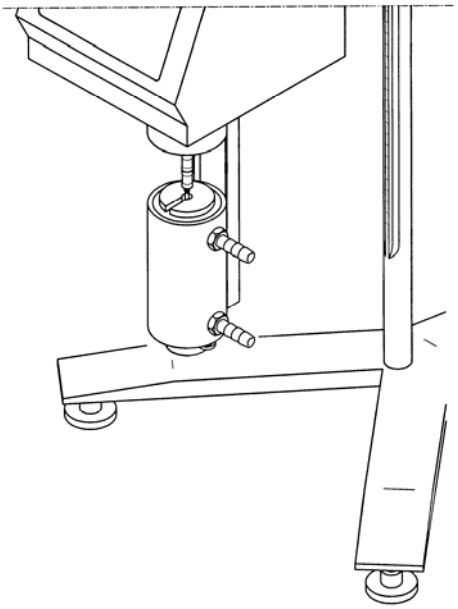


Fig. 12. Set APM

10. 2. 1 Assembly

NOTE:
The assembling process is the same for both types of low viscosity accessories (APM and APM/B). The sketches here only show the APM.

- The digital viscometer must be correctly fastened to the base.
- Fasten the circulation jacket (J) to the connector (G) (figure 11).
- Fasten the connector (G) to the hole at the back of the viscometer metallic vase.
- Connect the hook (H) and the spindle (L).
- Insert the spindle (L) in the circulation jacket, and screw it in to the viscometer axle by turning it clockwise.
- Close the sample (K) container with the bottom stopper (M).
- Fill the sample container with a 20 ml syringe, or less, and fill the container with the necessary sample quantity in proportion with the spindle (16 to 13 ml).
- Insert the sample container (K) by turning it gently, in the circulation jacket (J). Insert the screw (L) in the lower stopper (M), and screw it to the viscometer axle by turning it counter-clockwise.
- Make sure that the spindle is correctly submerged (the level in the sample must be above the upper part of the spindle). If necessary, add some more of the sample.
- Place the upper stopper (N) over the sample container.

NOTE:
Before starting with the measurements, make sure the viscometer is correctly balanced (check it with the bubble level).

10. 2. 2 Dismounting and cleaning

- Place the viscometer upwards. Remove the superior lead (N).
- Unscrew the spindle of the viscometer axis and lower the spindle slowly into the sample container (K).
- Unscrew the bottom stopper (M) and place the container (K) below the thermo station jacket (J). Once the container is removed, remove the spindle carefully (L).
- Remove the container, wash it or use compressed air. Wash the circulation jacket too if necessary.

Important:
Do not use any cleaner or tool that can damage the metallic surface. Make sure you only use liquids that agree with with the LCP adapter material!

Solvents that can be used: water, ethanol or high concentrations of alcohol. For other solvents, check the chemistry compatibility table.

10. 2. 3 Technical specifications of APM and APM/B

Measurement rank:

- Sample L: 1.5*) until 200 000 mPa.s
- Sample R: 25*) until 3 300 000 mPa.s
- Sample H: 0.2*) until 26 660 Pa.s

*) Measurement represents a 10 % of the full scale.

Spindles features and APM filling:

- L Sample & TL spindles

Spindle	Shear rate [s^{-1}] *)	Sample volume [ml]
TL5	1.32 x RPM	8.0
TL6	0.34 x RPM	10.0
TL7	0.28 x RPM	9.5

- R sample or H & TR spindles

Spindle	Shear rate [s^{-1}] *)	Sample volume [ml]
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

*) Shear rate is calculated based on the features of Newtonian liquids.

Temperature rank of circulation jacket and thermo station conditions:

- Permitted temperature rank: -10 a +100°C (14 a 212 °F)
- Use a thermostatic bath with demineralised water or refrigeration special liquid. Change the liquid form the thermostat regularly. Recommended flow: 15 l/min.

Materials:

- The metallic parts are made of stainless steel, the leads are made of plastic in Delrin Negro. The parts in contact with the sample (sample container and spindle) are made of AISI 316 suitable for food industry.
- The lead inferior washer is made in black Delrin. It is designed to get a maximum temperature of 100ºC (212 ºF)
- The circulation jacket is made of acetyl and Delrin.

- The O-ring on the plastic stopper (M) of the LCP Adapter is made of Delrin.
  The softening point is 110 °C (230 °F).

10.3 HELDAL UNIT – Helicoidal Movement Unit

NOTICE:
The Heldal adapter doesn't come with the standard delivery. It can be ordered as an accessory. The unit is supplied complete with T-shaped spindles, in this case.

The Heldal accessory is used with substances that do not flow by themselves (like ice or pastas). Is engine moves the viscometer slowly in a vertical movement and at the same time the spindle makes the rotation movement. This generates a helicoidal movement that makes that the T-shaped spindle is always in contact with the sample.
The measurements obtained with Heldal do not measure absolute viscosity! They are only comparative measurements with the same geometry as T-shaped spindles.

Fig. 13 Heldal Unit in its case

10. 3. 1 Heldal unit Mounting

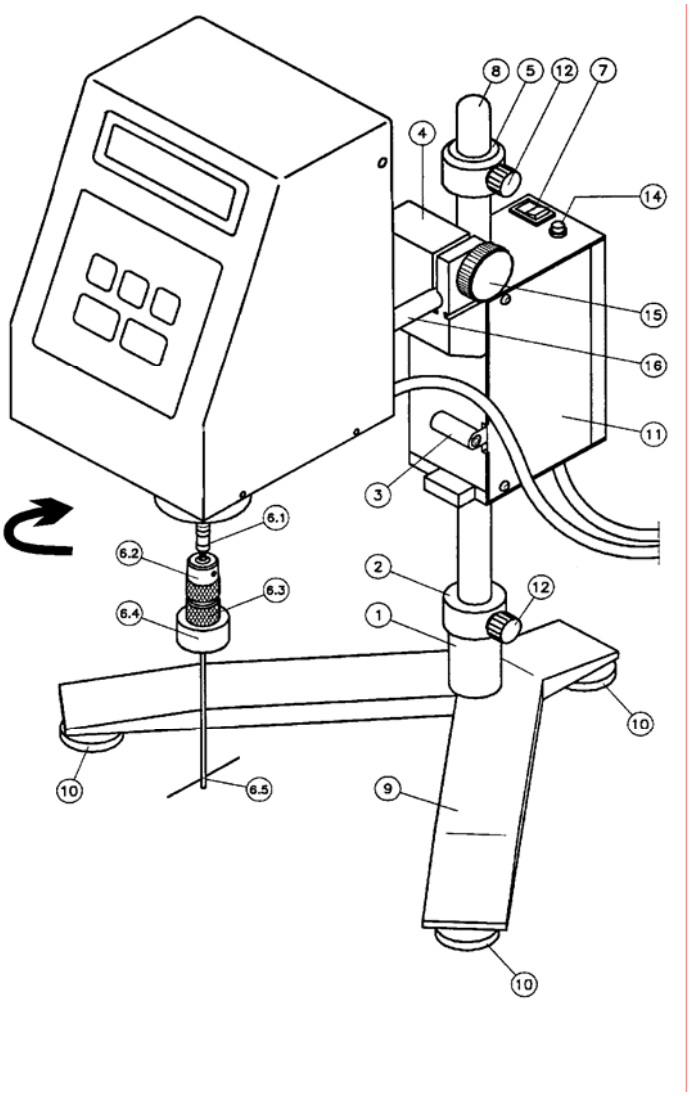


Fig. 14 Heldal unit set in the viscometer

1. Rib joint	9. Base
2. Lower stop ring	10. Levelling knobs
3. Displacement command	11. Heldal engine unit
4. Viscometer fastening bolt	12. Knobbed fastening rib
5. Upper stopper ring	14. Functioning pilot
6. Heldal fastening group	15. Nut bolt
7. ON/OFF switch	16. Viscometer fastening rib
8. Fastener	

6.1 Spindle connector
6.2 Upper spindle receptor
6.3 Lower spindle receptor
6.4 Counterweight, spindle connector
6.5 Spindle

- Place the fastener (8) facing the short end of the Y-shaped base (9).
- Place the safety shell (1) over the fastening rib (8) on the base of the viscometer (9).
- Place the lower ring in the fastener (8) as explained in the sketch, and fasten it with the knobbed fastening rib (12).

Important:

Do not fasten the stop rings to the fastening ribs (12) too tightly. They are plastic pieces and they can be damaged. Both stopper rings (upper and lower) look exactly the same, and can be changed.

- Place the Heldal engine (11) in the fastener(8) while pressing the displacement command (3).
- Connect the upper stop ring to the fastener (8) and fasten it with the fastening rib (12).
- Insert the viscometer by placing the fastening rib (16) in the Heldel bolt (4), and fasten it with the nut bolt (15).
- Balance the viscometer – Heldal set with the balancing knobs (10).
- Fasten the T-shaped spindle (PA to PF samples) to the viscometer. In order to choose the right one, look at the selection tables (T.3).

  - Screw the counterweight (6.4) in the lower part of the spindle receptor (6.3).
  - Insert the spindle receptor (6.5) between both upper and lower parts of the spindle receptor (6.2 and 6.3). Do not separate these two parts.
  - Fasten the spindle and screw in the lower part of the receptor (6.3) until it is completely fastened.

Important:
Do not fasten the spindle tighter than necessary. There should always be a small hole between both parts of the receptor.

- Fasten the spindle receptor and the spindle to the axis of the viscometer, by connecting the thread.
- Place the sample container under the viscometer and insert the spindle into the sample fluid by pressing the displacement button (3).
- The stopper rings limit the vertical movement of the spindle. Therefore, these two rings must be fastened correctly and in their correct positions.

Important:
Placement of stopper rings as explained here:

- Upper ring: the spindle should be kept in the same fluid
- Lower stopper ring: The spindle must not touch the edge of the container. If so, the viscometer's axle can be damaged and the results can be wrong.
- Once the rings are fastened, connect the viscometer and the Heldal to the power point. Switch the viscometer on and insert the speed and the spindle, as always.
- Set the Heldal unit on with the ON/OFF switch (7). Check if the pilot is on. If not, check the mains connection.

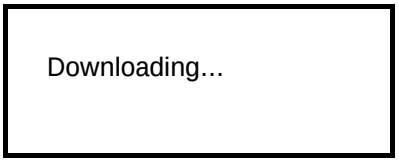
OPERATION:
The Heldal unit (which moves helicoidally) is moved up and down between the two stopper rings. When the engine touches one of them, the unit changes direction.
The Heldal unit will keep moving, until turned with the ON/OFF switch (7).

11. Remote control options

Viscometer EXPERT allows the transfer of saved experiment data to PCs.

The viscometer is supplied with software called Datalogger. Its job is to transfer the last file kept by the EXPERT when getting the sample data, to the PC.

When the viscometer is transferring data, it shows the following information:



NOTA: In the A appendix there is a description of the Datalogger software.

12. Model/Spindle correspondence tables

Standard Spindles + R1 (Table 1):

Viscometer model	Spindle
EXPERT L	L1
	L2
	L3
	L4
EXPERT R	R1
	R2
	R3
	R4
	R5
	R6
	R7
EXPERT H	R1
	R2
	R3
	R4
	R5
	R6
	R7

SPECIAL SPINDLES (Table 2):

Viscometer model	Spindle
EXPERT L	TL5
	TL6
	TL7
EXPERT R	TR8
	TR9
	TR10
	TR11
EXPERT H	TR8
	TR9
	TR10
	TR11

SPECIAL HELDAL SPINDLES (Table 3):

Viscometer model	Spindle
EXPERT L	PA
	PB
	PC
	PD
	PE
	PF
EXPERT R	PA
	PB
	PC
	PD
	PE
	PF
EXPERT H	PA
	PB
	PC
	PD
	PE
	PF

SPECIAL SPINDLES (Table 4):

Viscometer model	Spindle
EXPERT L	LCP/SP
EXPERT R	LCP/SP

13. Model/spindle/oil calibration tables

MODEL L (Table 5):

Spindle	Standard oil
L1	RT50
L2	RT500
L3	RT1000
L4	RT5000
TL5	RT50
TL6	RT500
TL7	RT500
LCP	RT5

MODEL R (Table 6):

Spindle	Standard oil
R1	RT50
R2	RT500
R3	RT500
R4	RT1000
R5	RT5000
R6	RT5000
R7	RT30000
TR8	RT500
TR9	RT5000
TR10	RT5000
TR11	RT5000
LCP	RT50

MODEL H (Table 7):

Spindle	Standard oil
R1	
R2	
R3	
R4	
R5	
R6	
R7	
TR8	
TR9	
TR10	
TR11	

Table 8. EXPERT L standard spindles selection

Maximum guideline values in cP (mPa·s)

RPM / SP	L1	L2	L3	L4
0,01	600K	3000K	12M	60M
0,3	20K	100K	400K	2000K
0,5	12K	60K	240K	1200K
0,6	10K	50K	200K	1000K
1	6K	30K	120K	600K
1,5	4K	20K	80K	400K
2	3K	15K	60K	300K
2,5	2,4K	12K	48K	240K
3	2K	10K	40K	200K
4	1,5K	7,5K	30K	150K
5	1,2K	6K	24K	120K
6	1K	5K	20K	100K
10	600	3K	12K	60K
12	500	2,5K	10K	50K
20	300	1,5K	6K	30K
30	200	1K	4K	20K
50	120	600	2,4K	12K
60	100	500	2K	10K
100	60	300	1,2K	6K
200	30	150	600	3K

ATENTION:
K Indicates miles. Example: 7,8K = 7.800
M Indicates Millions Example: 1,56M = 1.560.000

NOTE:
It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

Table 9. EXPERT L special spindle selection

Maximum guideline values in cP (mPa·s)

RPM / SP	TL5	TL6	TL7
0,01	300K	3M	6M
0,3	10K	100K	200K
0,5	6K	60K	120K
0,6	5K	50K	100K
1	3K	30K	60K
1,5	2K	20K	40K
2	1,5K	15K	30K
2,5	1,2K	12K	24K
3	1K	10K	20K
4	750	7,5K	15K
5	600	6K	12K
6	500	5K	10K
10	300	3K	6K
12	250	2,5K	5K
20	150	1,5K	3K
30	100	1K	2K
50	60	600	1,2K
60	50	500	1K
100	30	300	600
200	15	150	300

ATTENTION:

K Indicates miles. Example: 7,8K = 7.800

M Indicates millions Example: 1,56M = 1.560.000

NOTE:

It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

Table 10. LCP Adapter with EXPERT L

Maximum guideline values in cP (mPa·s)

RPM	LCP
0,01	60.000,00
0,3	2.000,00
0,5	1.200,00
0,6	1.000,00
1	600,00
1,5	400,00
2	300,00
2,5	240,00
3	200,00
4	150,00
5	120,00
6	100,00
10	60,00
12	50,00
20	30,00
30	20,00
50	12,00
60	10,00
100	6,00
200	3,00

NOTE:
It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

Sample Volume = 18 ml.
Shear Rate = 1,2236·rpm

Table 11. EXPERT R standard spindle selection

Maximum guideline values in cP (mPa·s)

RPM / SP	R1	R2	R3	R4	R5	R6	R7
0,01	1M	4M	10M	20M	40M	100M	400M
0,3	33,3K	133,3K	333,3K	666,6K	1,3M	3,33M	13,3M
0,5	20K	80K	200K	400K	800K	2M	8M
0,6	16,6K	66,6K	166,6K	333,3K	666,6K	1,6M	6,6M
1	10K	40K	100K	200K	400K	1M	4M
1,5	6,6K	26,6K	66,6K	133,3K	66,6K	666,6K	2,6M
2	5K	20K	50K	100K	200K	500K	2M
2,5	4K	16K	40K	80K	160K	400K	1,6M
3	3,3K	13,3K	33,3K	66,6K	133,3K	333,3K	1,3M
4	2,5K	10K	25K	50K	100K	250K	1M
5	2K	8K	20K	40K	80K	200K	800K
6	1,6K	6,6K	16,6K	33,3K	66,6K	166,6K	666,6K
10	1K	4K	10K	20K	40K	100K	400K
12	833	3,3K	8,3K	16,6K	33,3K	83,3K	333,3K
20	500	2K	5K	10K	20K	50K	200K
30	333	1,3K	3,3K	6,6K	13,3K	33,3K	133,3K
50	200	800	2K	4K	8K	20K	80K
60	166	660	1,6K	3,3K	6,6K	16,6K	66,6K
100	100	400	1K	2K	4K	10K	40K
200	50	200	500	1K	2K	5K	20K

ATTENTION:
K Indicates miles. Example: 7,8K = 7.800
M Indicates millions Example: 1,56M = 1.560.000

NOTE:
It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

Table 12. EXPERT R Special spindle selection

Maximum guideline values in cP (mPa·s)

RPM / SP	TR8	TR9	TR10	TR11
0,01	5M	25M	50M	100M
0,3	166,6K	833,3K	1,6M	3,3M
0,5	100K	500K	1M	2M
0,6	83,3K	416,6K	833,3K	1,6M
1	50K	250K	500K	1M
1,5	33,3K	166,6K	333,3K	666,6K
2	25K	125K	250K	500K
2,5	20K	100K	200K	400K
3	16,6K	83,3K	166,6K	333,3K
4	12,5K	62,5K	125K	250K
5	10K	50K	100K	200K
6	8,3K	41,6K	83,3K	166,6K
10	5K	25K	50K	100K
12	4,16K	20,83K	41,6K	83,3K
20	2,5K	12,5K	25K	50K
30	1,6K	8,3K	16,6K	33,3K
50	1K	5K	10K	20K
60	833,3	4,16K	8,3K	16,6K
100	500	2,5K	5K	10K
200	250	1,25K	2,5K	5K

ATTENTION:

K Indicates miles. Example: 7,8K = 7.800

M Indicates millions Example: 1,56M = 1.560.000

NOTE:

It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

Table 13. LCP Adapter with EXPERT R

Maximum guideline values in cP (mPa·s)

RPM	LCP
0,01	640.000,00
0,3	21.333,00
0,5	12.800,00
0,6	10.666,00
1	6.400,00
1,5	4.266,00
2	3.200,00
2,5	2.560,00
3	2.133,00
4	1.600,00
5	1.280,00
6	1.066,00
10	640,00
12	533,00
20	320,00
30	213,00
50	128,00
60	106,00
100	64,00
200	32,00

NOTE:
It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale

Volume of the sample = 18 ml.
Shear Rate = 1,2236·rpm

Table 14. EXPERT H Standard spindle selection

Maximum value guidelines, in units of poise

RPM/SP	R1	R2	R3	R4	R5	R6	R7
0,01	8M	32M	80M	160M	320M	800M	3200M
0,3	2,6K	10,6K	26,6K	53,3K	106,6K	266,6K	1,06M
0,5	1,6K	6,4K	16K	32K	64K	160K	640K
0,6	1,3K	5,3K	13,3K	26,6K	53,3K	133,3K	533,3K
1	800	3,2K	8K	16K	32K	80K	320K
1,5	533,3	2133	5,3K	10,6K	21,3K	53,3K	213,3K
2	400	1,6K	4K	8K	16K	40K	160K
2,5	320	1,28K	3,2K	6,4K	12,8K	32K	128K
3	266,6	1066	2,6K	5,3K	10,6K	26,6K	106,6K
4	200	800	2K	4K	8K	20K	80K
5	160	640	1,6K	3,2K	6,4K	16K	64K
6	133,3	533,3	1,3K	2,6K	5,3K	13,3K	53,3K
10	80	320	800	1,6K	3,2K	8K	32K
12	66,6	266,6	666	1,3K	2,6K	6,6K	26,6K
20	40	160	400	800	1,6K	4K	16K
30	26,6	106,6	266	533	1066	2,6K	10,6K
50	16	64	160	320	640	1,6K	6,4K
60	13,3	53,3	133,3	266,6	533	1,3K	5,3K
100	8	32	80	160	320	800	3,2K
200	4	16	40	80	160	400	1,6k

ATTENTION:

K Indicates miles. Example: 7,8K = 7.800
M Indicates millions Example: 1,56M = 1.560.000

NOTE:
It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale**.**

Table 15. EXPERT H special spindle selection

Maximum value guidelines, in units of poise

RPM / SP	TR8	TR9	TR10	TR11
0,01				
0,3	13,6K	66,6K	133,3K	266,6K
0,5	8K	40K	80K	160k
0,6	6,6K	33,3K	66,6K	133,3K
1	4K	20K	40K	80K
1,5	2,6K	13,3K	26,6K	53,3K
2	2K	10K	20K	40K
2,5	1,6K	8K	16K	32K
3	1,3K	6,6K	13,3K	26,6K
4	1K	5K	10K	20K
5	800	4K	8K	16K
6	666	3,30K	6,6K	13,3K
10	400	2K	4K	8K
12	333	1,6	3,3K	6,6K
20	200	1K	2K	4K
30	133	666	1,3K	2,6K
50	80	400	800	1,6K
60	66	333	666	1,3K
100	40	200	400	800
200	20	100	200	400

ATTENTION:
K Indicates miles. Example: 7,8K = 7.800
M Indicates millions Example: 1,56M = 1.560.000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale

Table 16. HELDAL's special spindle selection for EXPERT L

Maximum guideline values in cP (mPa·s)

RPM/SP	PA	PB	PC	PD	PE	PF
0,01	1,87M	3,75M	9,37M	18,46M	46,86M	93,73M
0,3	62,4K	124,8K	312K	624K	1,56M	3,12M
0,5	37,44K	74,88K	187,2K	374,4K	936K	1,872M
0,6	31,2K	62,4K	156K	312K	780K	1M
1	18,72K	37,44K	93,6K	187,2K	468K	936K
1,5	12,48K	24,96K	62,4K	124,8K	312K	624K
2	9,36K	18,72K	46,8K	93,6K	234K	468K
2,5	7,488K	14,976K	37,44K	74,88K	187,2K	374,4K
3	6,24K	12,48K	31,2K	62,4K	156K	312K
4	4,68K	9,36K	23,4K	46,8K	117K	234K
5	3,744K	7,488K	18,72K	37,44K	93,6K	187,2K
6	3,120K	6,24K	15,6K	31,2K	78K	156K
10	1,872K	3,744K	9,36K	18,72K	46,8K	93,6K
12	1,560K	3,12K	7,8K	15,6K	39K	78K

ATTENTION:

K Indicates miles. Example: 7,8K = 7.800
M Indicates millions Example: 1,56M = 1.560.000

NOTE:
It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale**.**

Table 17. HELDAL's special spindle selection for EXPERT R

Maximum guideline values in cP (mPa·s)

RPM/SP	PA	PB	PC	PD	PE	PF
0,01	20M	40M	100M	200M	500M	1000M
0,3	666,6K	1,3M	3,3M	6,6M	16,6M	33,3M
0,5	400K	800K	2M	4M	10M	20M
0,6	333,3K	666,6K	1,6M	3,3M	8,3M	16,6M
1	200K	400K	1M	2M	5M	10M
1,5	133,3K	266,6K	666,6K	1,3M	3,3M	6,6M
2	100K	200K	500K	1M	2,5M	5M
2,5	80K	160K	400K	800K	2M	4M
3	66,6K	133,3K	333,3K	666,6K	1,6M	3,3M
4	50K	100K	250K	500K	1,25M	2,5M
5	40K	80K	200K	400K	1M	2M
6	33,3K	66,6K	166,6K	333,3K	833,3K	1,6M
10	20K	40K	100K	200K	500K	1M
12	16,6K	33,3K	83,3K	166,6K	416,6K	833,2K

ATTENTION:

K Indicates miles. Example: 7,8K = 7.800
M Indicates millions Example: 1,56M = 1.560.000

NOTE:
It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale**.**

Table 18. HELDAL's special spindle selection for EXPERT H

Maximum guideline values in poise

RPM/SP	PA	PB	PC	PD	PE	PF
0,01						
0,3	53,3K	106K	266,6K	533,3K	1,3M	2,6M
0,5	32K	64K	160K	320K	800K	1,6M
0,6	26,6K	53,3K	133,3K	266,6K	666,6K	1,3M
1	16K	32K	80K	160K	400K	800K
1,5	10,6K	21,3K	53,3K	106K	266,6K	533,3K
2	8K	16K	40K	80K	200K	400K
2,5	6,4K	12,8K	32K	64K	160K	380K
3	5,3K	10,6K	26,6K	53,3K	133,3K	266,6K
4	4K	8K	20K	40K	100K	200K
5	3,2K	6,4K	16K	32K	80K	160K
6	2,6K	5,3K	13,3K	26,6K	66,6K	133,3K
10	1,6K	3,2K	8K	16K	40K	80K
12	1,3K	2,6K	6,6K	13,3K	33,3K	66,6K

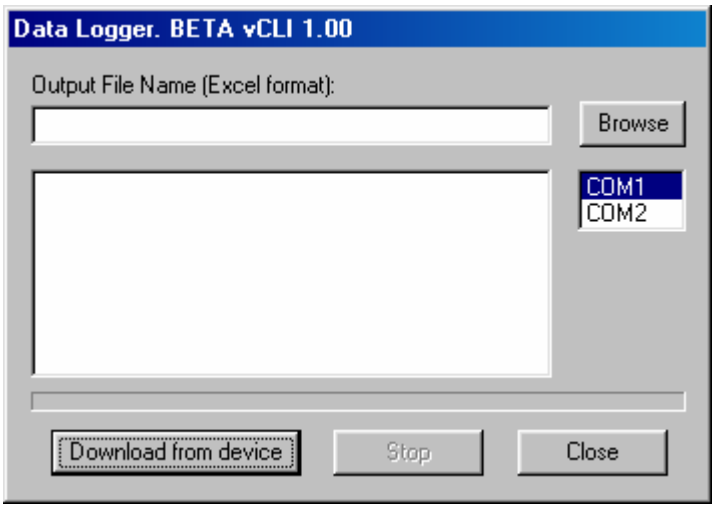
ATTENTION:

K Indicates miles. Example: 7,8K = 7.800
M Indicates millions Example: 1,56M = 1.560.000

NOTE:
It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale**.**

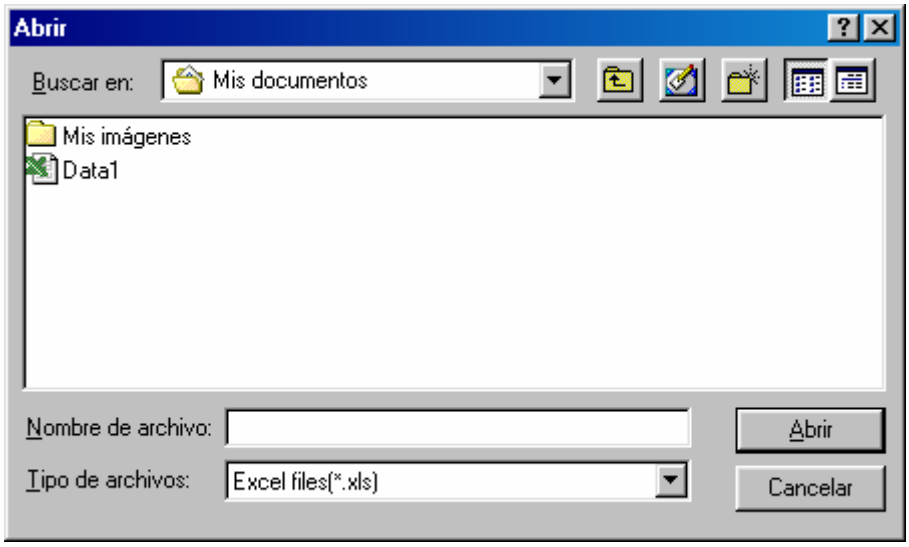
Appendix A. Software ‘Datalogger’ for PC.

The Datalogger application is provided free of change with EXPERT. The objective of this software is the transfer of data from the stored file in the viscometer to the PC, assuming that the latter disposes of the adequate input/output configuration. When the data is received, the program will generate a Microsoft Excel-compatible file containing the received data. At the start of the program, you will see the following window:

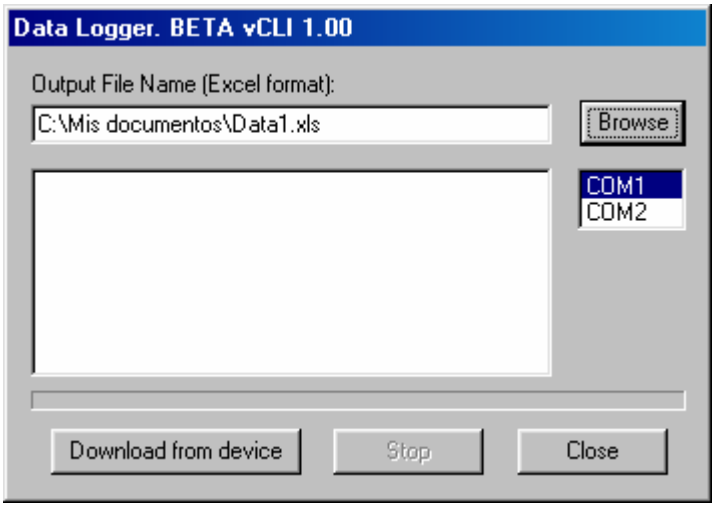


In the first figure you can see different controls and edition lines. Starting from top to bottom, you can see an edition line where you should edit the name of the file where the data from the viscometer will be saved. It will be necessary to introduce the complete path for the file, which should have the extension *.xls.

If you want to see the standard window for file selection, click the Browse bottom. If you select the name of the file through this window, the extension *.xls will be added automatically.

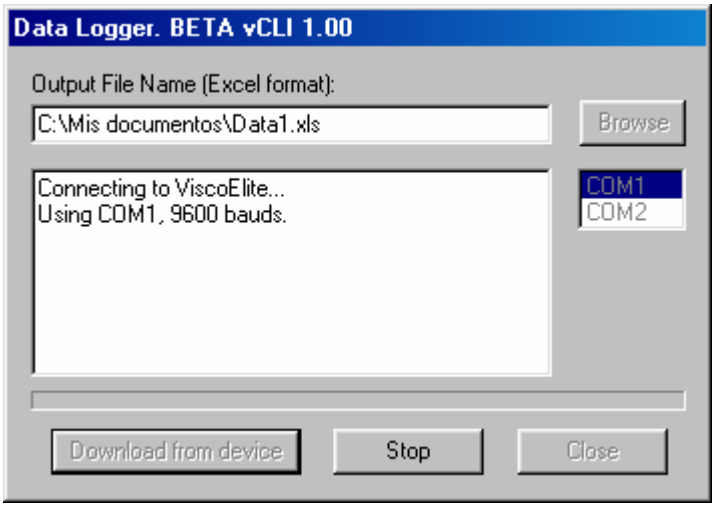


Once the file with the data that you wish to use is selected, you will have to choose the communication port through which you will make the connection. You can choose either COM1 or COM2, to select port series 1 and 2, respectively.

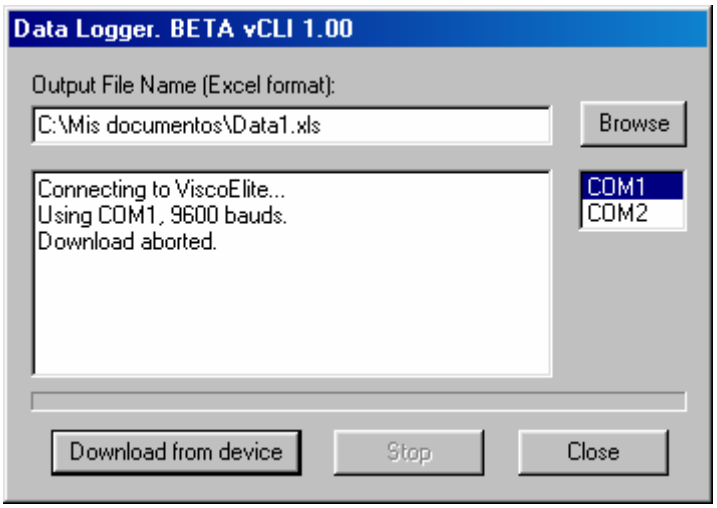


Once the port series you wish to use is selected, you can proceed to download the information from the viscometer. To execute this download you will have to press the 'Download from device' bottom. Upon doing this for the first time you will see that the majority of commands in the main window will be deactivated (Browse, Close and even Download from device), while the Stop command will become active and information messages about the progress of the importation process will appear.

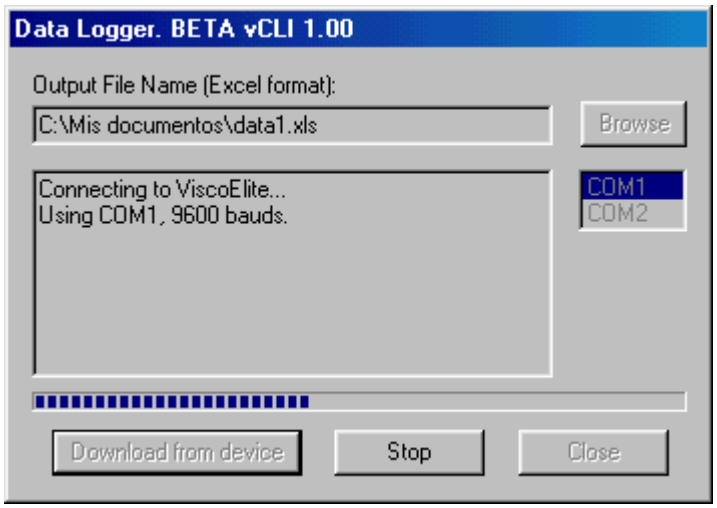
The first messages are about the connection status, as you can observe in the following figure. The program will indicate the port and the connection speed used with the equipment.

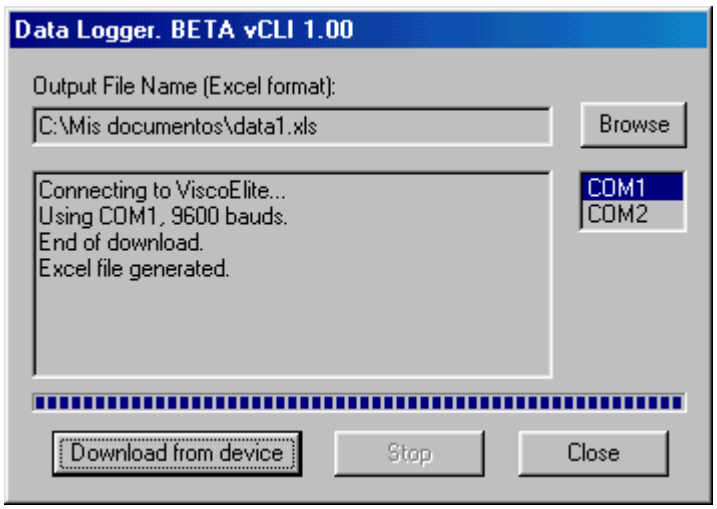


If the user sees that the connection is not satisfactory, the user can always interrupt the transmission by clicking the Stop command. In this case, the window stays in its initial state, reactivating the commands, which are deactivated during transmission, and deactivating the Stop command. In the information window, the information concerning the interruption of the downloading process will be displayed.



In the case that the connection is satisfactory, the program will start the data download from the set. The program user will see the percentage of data received and its progress through the status bar on the lower-screen command bar. When the bar shows 100%, the program will generate the exit file with the path originally indicated. In the following figure you can observe the progress of the exit bar and the file generation process.



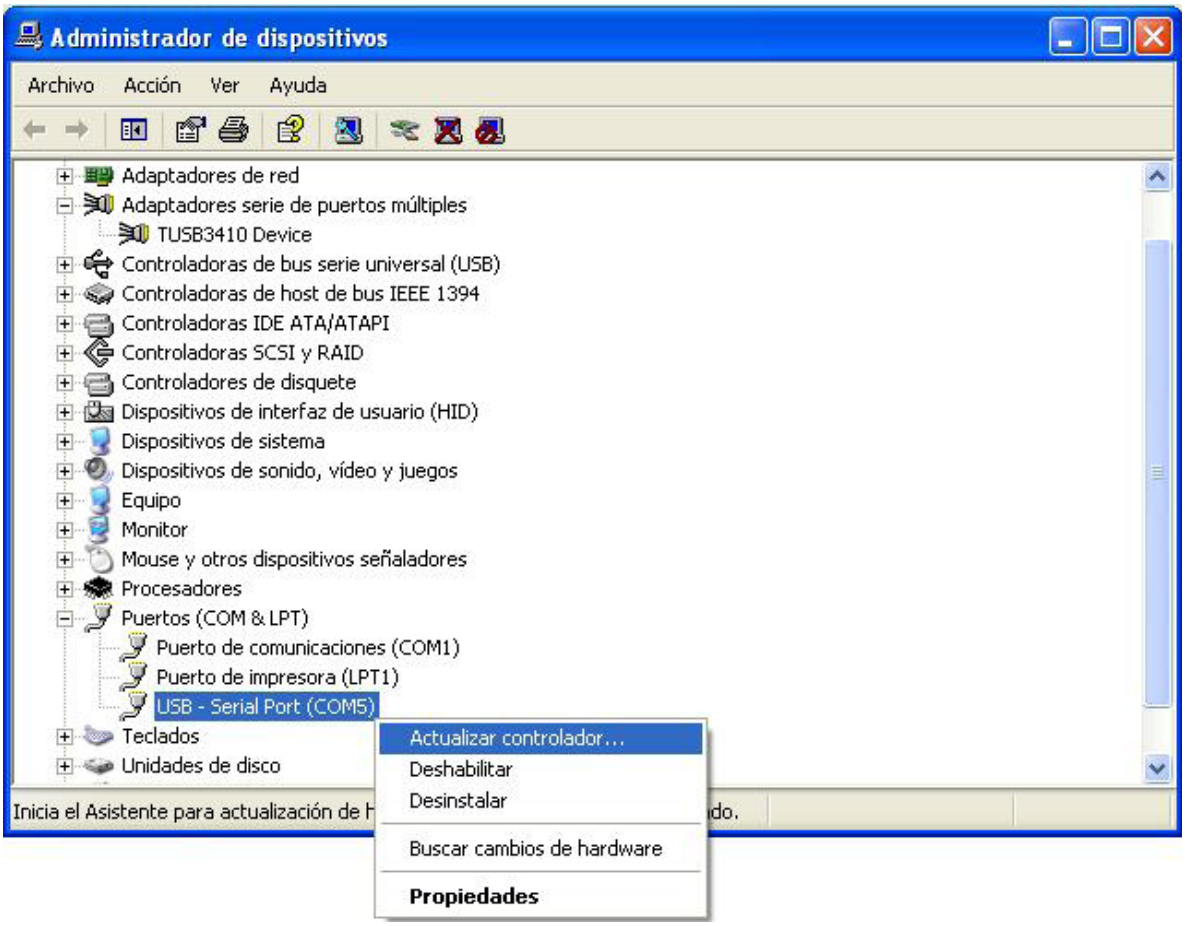


Appendix B. Installation Guide - USB DRIVER

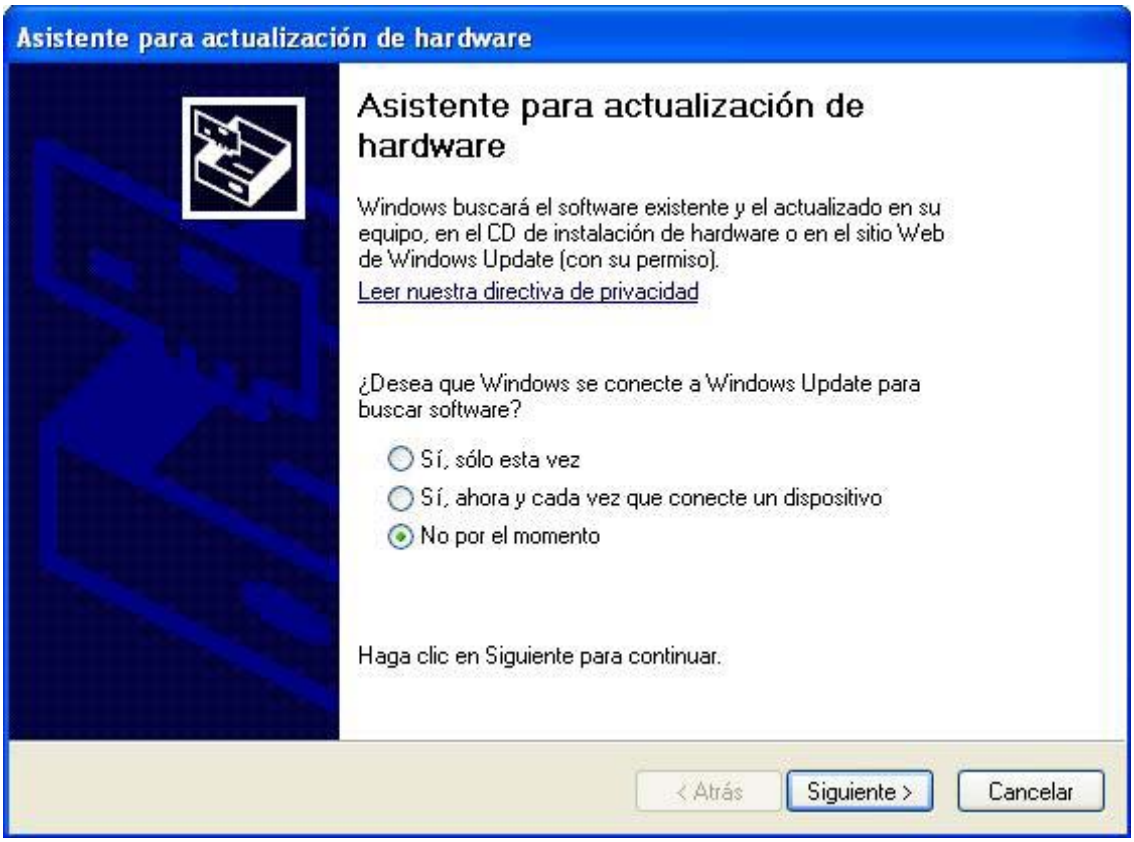
In this simple guide you will find step-by-step instructions for properly installing the USB driver for the Fungilab measurement device.
Please following these instructions (before connecting the USB cable):
1) Find the folder containing the TUSB3410 drivers and execute T1341Inst.exe

2) In some cases, a warning window will appear when you install a driver that isn't certified by Windows. Press continue and wait until the same warning appears again. Once you've accepted the two warnings, you can connect the device using the USB cable and, once this is done, turn the machine on.

3) If no screen appears, you will have to go manually to the Device Manager. (Start menu – Execute – devmgmt.msc), locate the USB – Serial Port and activate the installation from there.



An exclamation mark usually appears next to the USB – Serial Port icon, indicating that the driver is missing.



On the next screen, you will tell the computer not to look in Windows Update. Following...

4) Choose “Install software automatically” and continue.

5) If you have already executed T13410Inst.exe, located in the USB driver folder, Windows will begin to install the “Multi-Port Adaptor series” automatically (if the Windows certification warning appears again, click ‘Continue’).

6) When the process is finish, wait until Assistant re-appears, and go over the same steps again, which this time will install the ‘USB- Serial Port (COM X)’ device.

7) The PC is now ready to use any program connected by USB to the equipment.

The COM number is different in each case. Any program connected through this port must be configured according to the number found in the Device Management window (this COM number can be changed in ‘Properties’ for the ‘USB – Serial Port (COM X)’ device.

If a problem occurs during the installation of the drivers, clean the record by looking for the TUSB3410 entries and eliminating each one of them. If you see a folder with contents referring to the drivers that you cannot eliminate, right-click on the folder and select ‘Permissions’. Once the ‘Allow Total Control’ option is selected for the corresponding user, you will be able to erase that folder.
Once the record is clean, re-start the computer and start the process again.