MADD TECHNOLOGIES SARL

Instruction manual
EasyFlow

MADD TECHNOLOGIES SÀRL – Avenue des Sports 42 – CH-1400 Yverdon-les-Bains – Switzerland
Tel: +41 24 445 31 16 – Fax: +41 24 445 21 23 – Email: info@madd.ch – www.madd.ch

Contents

Contents 3
Warranty 3
Gauging method by tracer dilution 4
Principle 4
Cooking salt as tracer 4
Presentation of the device 5
General information 5
Technical characteristics 5
Switch on the device 5
Functions of the buttons 6
Main menu 6
Replacing the batteries 6
Multimetre mode 7
Visualisation of the last measurement 7
Calibration of the probe 8
Cleaning of the probe 8
Preparing the calibration 8
Calibration 8
Data acquisition on site 10
Before starting the acquisition 10
Quantity of injected salt 10
Measuring interval 10
Beginning of the acquisition 10
End of data acquisition 11
Display of the results 11
End of acquisition due to errors 11
Software EasyViewer 12
Description 12
Installation 12
Data transfer to PC 13
Practical tips 14

Contents

At the delivery of a device **EasyFlow**, the package contains the following staff:

- A bag with shoulder strap
- Device **EasyFlow** with probe and 3 alkaline batteries 1,5V
- 3 calibration doses of 20 millilitres
- A CD "EasyFlow" contening:
  - The software **EasyViewer**
  - The instruction manual of the device **EasyFlow**
  - An application note about the gauging method by tracer integration
  - A demo video of a gauging with the device **SalinoMADD**
- A serial cable for the communication between **EasyFlow** and a PC
- A plastified quick start guide

The device is delivered **ready to use** and **calibrated**.

Warranty

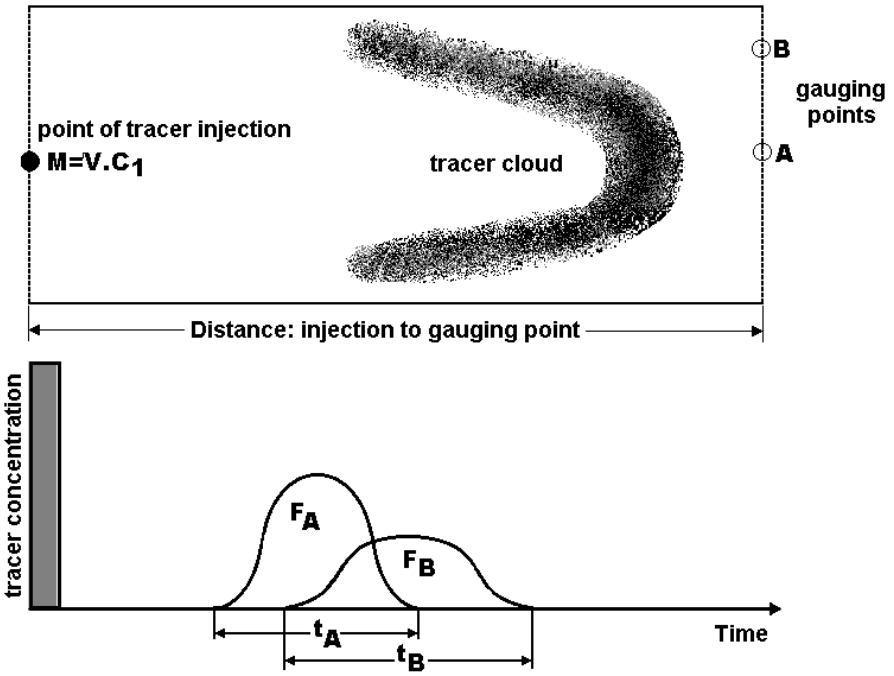
The device is delivered with a factory warranty for one year from the date of the invoice. Repairs are made in our workshop; no further benefit can be taken into account without written confirmation of MADD Technologies. It is understood that this warranty is available only if the device **EasyFlow** was used in conditions for which it was expected, as described below. Any other manipulation should be done at risk and peril of the user.

Gauging method by tracer dilution

The device **EasyFlow** uses the tracer dilution method to determine the stream flow of the measured watercourse.

Principle

The main principle of this method consists to inject into a watercourse a concentrated solution of tracer. Downstream, at a distance large enough from the injection point for a good mix with the river water, the tracer concentration is measured during the passage of the tracer could. This dilution is a function of flow rate, assumed constant along the section concerned during the measurement time.



The following conditions are necessary for the application of the dilution method:

- The flow of the river should remain roughly constant during the measurement;
- The tracer must pass totally through the gauging sector;
- At the measuring point, the mixture should be such that at each point of the section of the river must spend the same amount of tracer.

According to the above conditions, this method is especially adapted in case of low depths, very high speed or in presence of turbulences that does not guarantee a stable speed, like rivers or streams. As against, it is not suitable for measuring flow in concrete channels which does not permit the mixing of the water.

Cooking salt as tracer

The cooking salt, sodium chloride (NaCl), is an ideal tracer: it is very easy to find, cheap and has a high degree of dilution in water. Furthermore, it is not harmful to the fauna and flora at the concentrations used and it is few absorbed by vegetation and materials of the bed of the river. Finally, it is very easy to measure its concentration with a conductivity probe.

In this case, the operator injects into the river a known mass of salt M diluted in a volume of water of the river. Downstream, is placed a conductivity probe that will measure the electrical conductivity of water throughout the duration T of passage of the cloud of salt. A linear relationship exists between the conductivity of water and dissolved salt concentration. The concentration curve can therefore be deduced in function of time C_t. The flow Q is then obtained by integrating the concentration over time:

$$Q = \frac{M}{\int_0^T (C_t - C_0)\, dt}$$

Q : flow of the water course [l/s]
M : mass of the injected tracer [mg]
C_t : water salinity at time t [mg/l]
C_0 : basic water salinity [mg/l]
T : duration of gauging [s]

Presentation of the device

General information

The device **EasyFlow** is delivered in a very useful carrying bag with shoulder strap, so it can be taken away on the field in best conditions. It is recommended to replace the device and the probe in the bag after its use; this will guaranty its protection. Although it has been designed to withstand rough working conditions, it is a high precision instrument which should be protected from shocks. Used with a minimal of care your **EasyFlow** will be reliable and long lasting work tool.

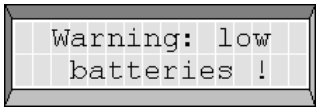
Technical characteristics

Device	
Gauging range	0,1 l/s to 99'900 l/s
Gauging accuracy	< 5 % (with optimum mix of tracer)
Gauging repeatability	± 1%
Tracer type	Cooking salt (NaCl)
Tracer quantity	10 g to 100 kg of salt
Tracer ideal mix	Between 5 and 20 g of salt per l/s of estimated flow. (Ex : ~300 l/s -> 2 kg)
Supply	3 x 1,5V alkaline batteries, AA, LR6 type
Autonomy	About 100 hours under normal conditions
Communication	Serial link RS-232
Dimensions / weight	Complete bag : 260 x 190 x 130 mm / 1240 g Device with probe : 230 x 150 x 80 mm / 620 g
Waterproof	IP65

Salinity	
Measuring range	0 to 3200 mg/l
Sensitivity	1 mg/l
Precision	< 1 %
Temperature	
Measuring range	0 to +40 °C
Precision	± 0,2 °C

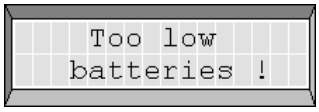
Switch on the device

When pressing the **ON/SELECT** button the **EasyFlow** is switched on and this display (on the right) appears after 2 seconds. It contains the version of the device and actual batteries tension.



If this tension is under 3.3V this message appears and the batteries should be replaced. Press **ENTER** to continue.

If the tension is under 3V, this message is shown during 5 seconds, then the device shutdown. It is here necessary to change the batteries before working with the **EasyFlow**. (See previous chapter)



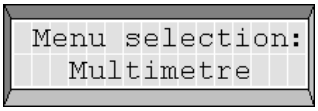
Functions of the buttons

The device **EasyFlow** possesses two buttons placed on the front panel:

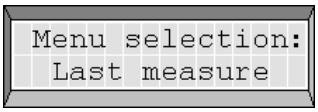
- The button **ON/SELECT** permits to switch on the device and to change the selection in the menu.
- The button **ENTER** permits to enter into a menu or to go to the next step.

Main menu

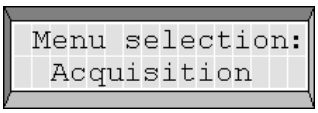
2 seconds after the presentation of the version and the batteries tension, the main menu appears. It is the possible to select one of the seven menus by pressing the button **SELECT**. To enter into the selected menu, press on **ENTER**.



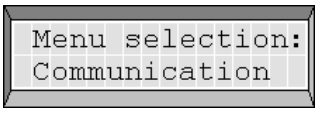
Menu **Multimetre**. This menu permits to do instantaneous and continues measurements of the salinity in milligrams per litre and the temperature in °C.



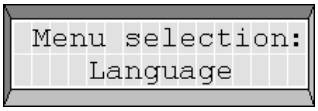
Menu **Last measure**. In this menu is presented the value of the last calculated and saved flow rate.



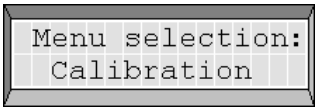
Menu **Acquisition**. This menu permits to effectuate the gauging of a river, on the field.



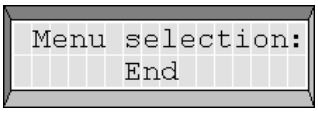
Menu **Communication**. This menu permits to transfer the data from the device to a PC via the serial cable.



Menu **Language**. This menu permits to change the language of the display. Choose between French, German and English.



Menu **Calibration**. In this menu it is possible to recalibrate the salinity probe to correct eventual drifts.



Menu **End**. This menu permits to switch off the device **EasyFlow** after 1 second.

Replacing the batteries

The batteries are reachable inside the device. Unscrew the six screws at the bottom, open carefully the housing and open the batteries compartment. Replace the 3 old cells respecting the indicated polarity. Close the housing and tighten screws.

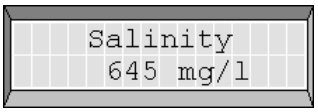
New batteries deliver a voltage of 4.5 volts. This tension is displayed at the start of the device. When the tension goes down 3.3 volts, it is recommended to change the batteries and under 3V, the device is automatically shutdown after a warning message. The autonomy is about 100 hours in normal conditions of use with alkaline cells 1.5V type LR6, AA, UM3

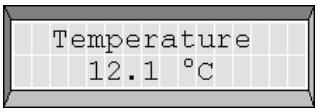
Multimetre mode

This function permits to use the **EasyFlow** for punctual water quality measurements.

From the main menu, choose with the button **SELECT** the mode **Multimetre** then press the button **ENTER**. At this moment the device measures continuously the salinity and the temperature. Press on **SELECT** to switch from salinity measurements to the temperature.

To go back to the main menu, just press on **ENTER**. In this mode, without touching any button, the device will automatically shut down after 1 minute.

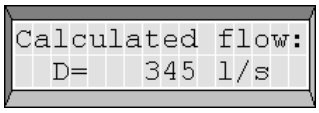




Visualisation of the last measurement

After a gauging, it is always possible to visualise the value of the last computed flow rate. Select **Last measure** in the main menu.

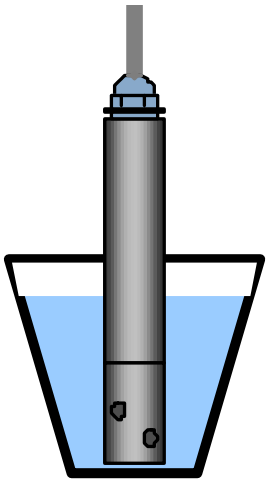
The button **ENTER** permits to return to the main menu.



Calibration of the probe

Cleaning of the probe

Ensure that the probe is clean before starting calibration. Clear the electrodes from calcareous deposits using a specific cleaning agent (Durgol, cleaning vinegar etc.). To do so, remove the protective cap covering the glass tube around the electrodes for easy access. Pour cleaning agent into a recipient up to the level necessary for complete immersion of the probe's glass part which should remain in the cleaning liquid for about 20 minutes. Rinse the probe thoroughly in order to clear off completely the cleaning liquid, let it dry and then place it into previously prepared half-litre of pure water.



Preparing the calibration

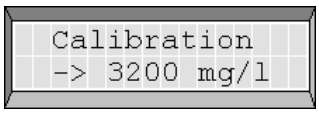
Following preparation is necessary before calibrating the probe for salinity gauging.

Prepare very precisely 100 ml of demineralised water with a maximum conductivity of 10 μS (or a resistivity of at least 100'000 Ω). Place this water in a cleaned 1 litre plastic measure. For maximum measurement accuracy, it is also possible to weight the water (**100 grams of demineralised water**). Place the probe of the **EasyFlow** into the water.

Prior to the actual calibration the probe should have the waters temperature, which can be checked by setting the **EasyFlow** in **Multimetre** mode and ensuring that the temperature remains stable. Once all parameters meet the conditions laid down the actual calibration, taking only a few seconds, can be carried out

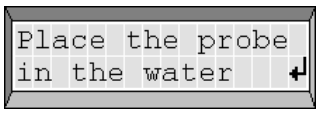
Calibration

From the main menu, choose **Calibration** then **Calibration -> 3200 mg/l** with help of the buttons **SELECT** and **ENTER**.

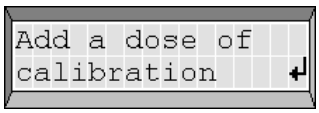


The calibration of the salinity probe is done in 5 points: at 0 mg/l, 2200 mg/l, 1200 mg/l, 629 mg/l and 321 mg/l. Just follow the instructions that appear on the display

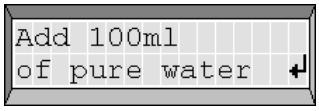
1. Place the probe into 100 ml of demineralised water (see instructions on previous page, chapter 4.2). Be sure that the probe is well in water and press **ENTER**.



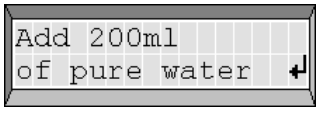
2. Poor a calibration dose of 20 ml into pure water and use the probe to stir it well in order to get a homogenous mixture. At this moment the solution contains 2200 mg of salt per litre of water. Press **ENTER**.



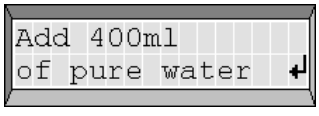
3. The third point of the calibration is obtained by adding 100 ml of pure water to the solution. So the salinity reaches 1200 mg of salt per litre. Well stir and press **ENTER** when the solution is homogenous.



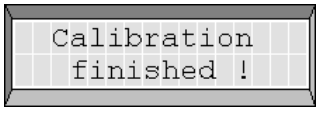
4. Adding 200 ml of pure water to the solution to obtain the fourth point of the calibration. Now the salinity reaches 629mg of salt per litre. Well stir and press **ENTER** when the solution is homogenous.



5. The calibration of the fifth and last point is done by adding 400 ml of pure water to the solution. The final salinity is at 321 mg/l. Stir well the solution and press **ENTER** when the solution is homogenous.



6. The device will automatically calculate the precise values of the 5 calibration points. It will furthermore determine the non-linearity of the probe and compute the necessary corrections.



At the end of the calibration, it is still possible to abandon the calibration procedure by pressing **SELECT**. If the calibration was done correctly, press **ENTER** to save the calibration parameters in non-volatile memory, so these values will be maintained during the replacement of the batteries.

Remark: Be careful, the operator has only 5 minutes between each operation!

Data acquisition on site

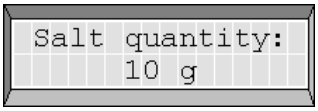
Before starting the acquisition

Before starting the acquisition, make sure that the probe has reached the water's temperature. The water salinity is directly dependent on the water temperature which is measured to correct the salinity and thus bring it to a standard 20° C. Just use the **Multimetre** mode to control the temperature stability.

Quantity of injected salt

For good results, this fine instrument requires a salinity increase of 10% or at least 15 mg per litre compared with the natural salt content of the water course. The acquisition of a complete measurement curve ensures good gauging. The quantity of salt to be injected should be known with precision since it is a factor for the water flow calculation.

The quantity of injected salt should be well known because it will be used to calculate the flow rate. The recommended quantity of 5 to 20 g per litre/second of water flow depends on the distance to point of injection necessary for a good mixture. The longer the distance, the bigger the tracer dilution and then the smaller the increase in salinity in the gauging area.



The **EasyFlow** allows salt injection from 10 g to 100 kg. The available salt quantities are the following:

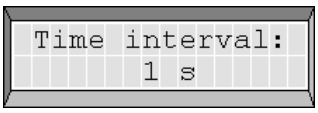
10, 20, 50, 100, 200 and 500 g, 1, 2, 5, 10, 20, 50 and 100 kg.

Select the salt quantity with the button **SELECT** and confirm by pressing **ENTER**.

Measuring interval

After the salt quantity, the button **SELECT** permits to choose the interval between measurements.

Choosing the interval between 1, 2, 4 or 8 seconds is directly related with the laps of time the salt cloud needs to completely pass by the gauging site. The total disposable memory for one gauging site being 1000 measurements the interval may allow data acquisition during ¼ hour, ½ hour, 1 hour or 2 hours.

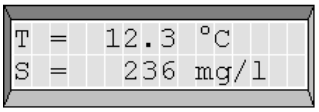


It is important to adapt the interval to the characteristics of the water course. Rapid and turbulent waters mixing and spreading the tracer rapidly allow rapid data acquisition and the injection of the tracer at shorter distance from the gauging area. In this case a shorter interval is chosen. If instead the volume of the water flow is high, the distance to the tracer injection point will be long and the time for the tracer cloud to pass by the gauging site will be longer. The interval will have to be longer as well. Experience in gauging with tracers will make the choice of sites and gauging parameters easier. Once the choice has been made, press **ENTER**.

At this moment all necessary parameters for a good gauging has been introduced in the device and the acquisition can begin.

Beginning of the acquisition

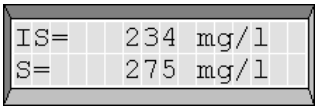
After the start of the data acquisition, the **EasyFlow** begins the measurements according to the programmed interval. At each measurement, salinity and water temperature are displayed on screen. These measurements are checked to detect the arrival of the salt cloud.



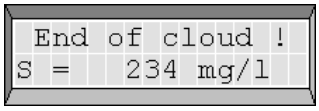
For correct operation, the device should do **at least 30 measurements before the arrival of the salt cloud**.

In case where more than 100 measurements have been done before the arrival of the salt cloud and to prevent wasting memory space, the device will only conserve the last 100 measurements. So, the memory cannot be full before the arrival of the salt cloud.

As soon as the salt cloud has been detected, the display shown here appears. Instead of the now useless temperature indication, the initial salinity "**IS**" is displayed. At the end of the acquisition procedure, the salinity should have reached again this initial value. On the second line is always displayed the actual salinity "**S**".



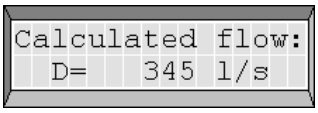
End of data acquisition



During the whole measuring procedure, the **EasyFlow** keeps trying to detect the end of the salt cloud. The operator will follow the evolution as well. When the water salinity comes back to its initial value, the display will normally say **End of cloud**.

The operator will ensure that the salinity has dropped to its initial value. If so he can stop the procedure by pressing **ENTER**. The **EasyFlow** does not switch off automatically unless the memory is exhausted. At this moment or when pressing touch **ENTER**, the measurements are saved in memory and then begin the flow rate computing. For this last one all measurements until the pressure on the button **ENTER** will be used.

Display of the results



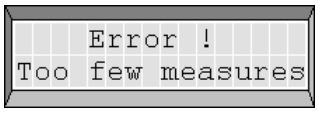
The procedure having run normally, the module having detected the beginning and the end of the salt cloud, it will now display the result as shown here at the right. If at the moment of the display shows **End of cloud** the measurement of salinity has reached its initial value, we may take it for granted that all the injected salt has passed though the gauging area.

It may happen that the **EasyFlow** does not detect the end of the cloud despite favourable conditions and that the operator interrupts the procedure. The estimated value should in fact be quite correct since the beginning of the cloud had been detected correctly by the module and the end by the operator.

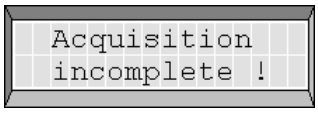
To verify that the gauging was well done and to eventually correct the flow calculation it is recommended to transfer the data to the PC. (See next chapter)

End of acquisition due to errors

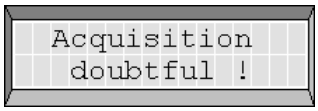
If the **EasyFlow** has not been in a position to acquire a sufficient amount of measurements or if an anomaly has been produced during the gauging, one of the following errors could appear.



Causes: Insufficient amount of measurements (<30) before the arrival of the salt cloud.
Solution: Wait longer before injecting the salt into the water course.



Causes: Abrupt salinity variation (external adding of dirty water, probe out of water …), too early manual stop.
Solution: Start again in a more stable site.



Causes: Manual stop before the end the salt cloud, change of the basic salinity, exhausted memory …
Solution: Verify the gauging curve on the PC, increase the measurements interval.

Software EasyViewer

Description

The software **EasyViewer** permits the visualization of the gauging curve done with help of the device **EasyFlow**. The data are loaded from the device into the PC via the furnished serial cable and then presented as graph.

The software also permits to:

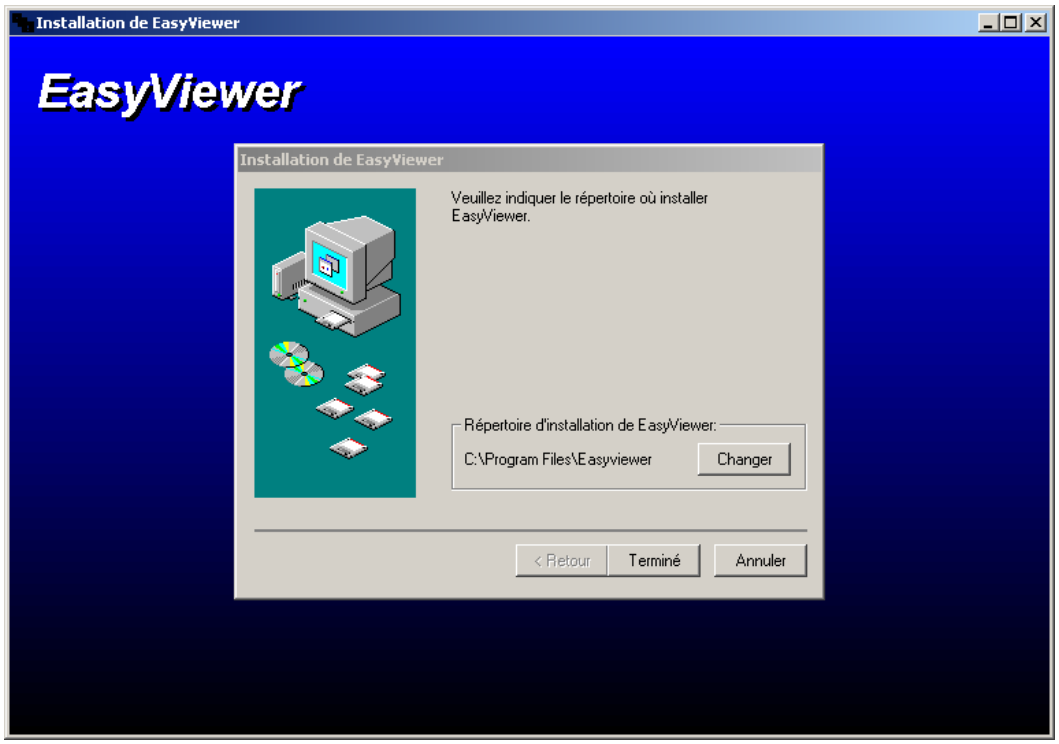
- Save the data in **EVW** file.
- Modify the gauging parameters as the quantity of salt or the measurements interval.
- Recalculate the flow rate value by acting directly on the graph.
- Add information about the gauging
- Print the gauging curve
- Reload old data from **EVW** file

Installation

The installation of the software **EasyViewer** is launch from the delivered CD. This software needs at least Windows 2000© and a serial port. If your PC doesn't have a serial port, an USB-serial adapter can be used.

Installation procedure:

1. Introduce the CD in the drive.
2. The following windows should appear. If not, launch the installation from ***D:\EasyViewer\Setup.exe***.



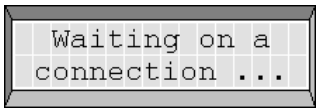
3. Select the installation folder and click **Finish**.

Data transfer to PC

The data transfer from the device **EasyFlow** to the PC is done with help of the serial cable furnished with the device.

Procedure

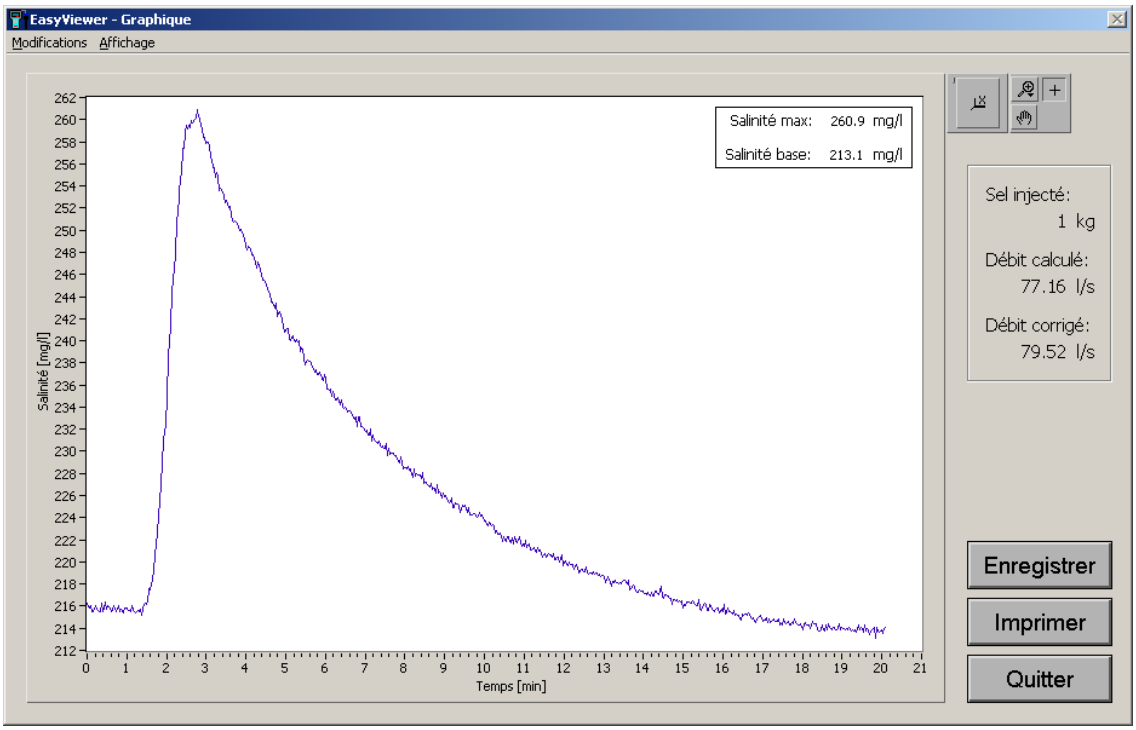
1. Connect the serial cable to a serial port of the PC and at the connector of the **EasyFlow**.
2. Launch the application **EasyViewer** and verify that the configured serial port is the good one.
3. Switch on the device **EasyFlow**, select the **Communication** menu with the button **SELECT** and press **ENTER**. The device is now waiting on a communication from the PC. It is always possible to quit this menu by pressing **SELECT**.



4. In the software **EasyViewer**, select "**Load the data from EasyFlow**" and click **Ok**. The progression of the transfer is showed on the screen of the **EasyFlow**. The transfer normally takes only few seconds.

5. Once the transfer terminated, press **ENTER** to return to the main menu. In case of error, verify the connection and the serial settings and try again.

If all was done correctly, a window with a graph appears on the PC. For any further question about the use of the software **EasyViewer**, please consult the online help of the software



PRACTICAL TIPS

- Upon arrival at the measurement site, place immediately the probe into the water. It will then reach fast the water temperature.

- Try to position the probe in a place where the water course is not too turbulent. Always avoid the phenomenon of cavitation around the probe. It can perturb the measurements and cause air bubbles between the probe's electrodes.

- Before starting an acquisition, verify that the probe is at the waters temperature.

- Don't forget that the **EasyFlow** must record at least 30 measurements prior to the arrival of the salt cloud. The time needed for these measurements is proportional to the gauging intervals as shown below:

INTERVAL	RECORDING BEFORE CLOUD ARRIVES
1 second	30 seconds
2 seconds	1 minute
4 seconds	2 minutes
8 seconds	4 minutes

- It is preferable to dilute the salt in water taken from the river to be gauged and then inject the total mixed solution at once into the water course (max. 300 g of salt per litre). Avoid not yet dissolved salt to sink to the bottom of the riverbed.

- The most important point for successful gauging is in fact the good dissolution and mixture of the salt in the water course. Some turbulence caused by a few stones or tiny waterfalls favours the mixing process. In a straight and flat riverbed or a canal placing some stones can help the mix.

- Small side streams of the water course and basins may slow down part of the current which does not favour the mixing process.

- A higher speed of the current is a positive factor for the mixing process and a rapid passage of the salt cloud favours the measuring since the threshold of natural salinity varies very little.

- Gauging in tunnels, straight canals with a current speed of 1 meter/second gives good results even at long distances (e.g. more than 3000 m) from point of salt injection.