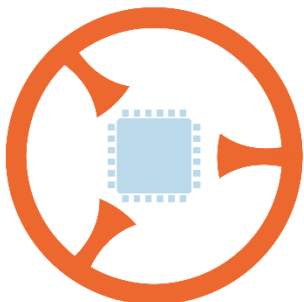
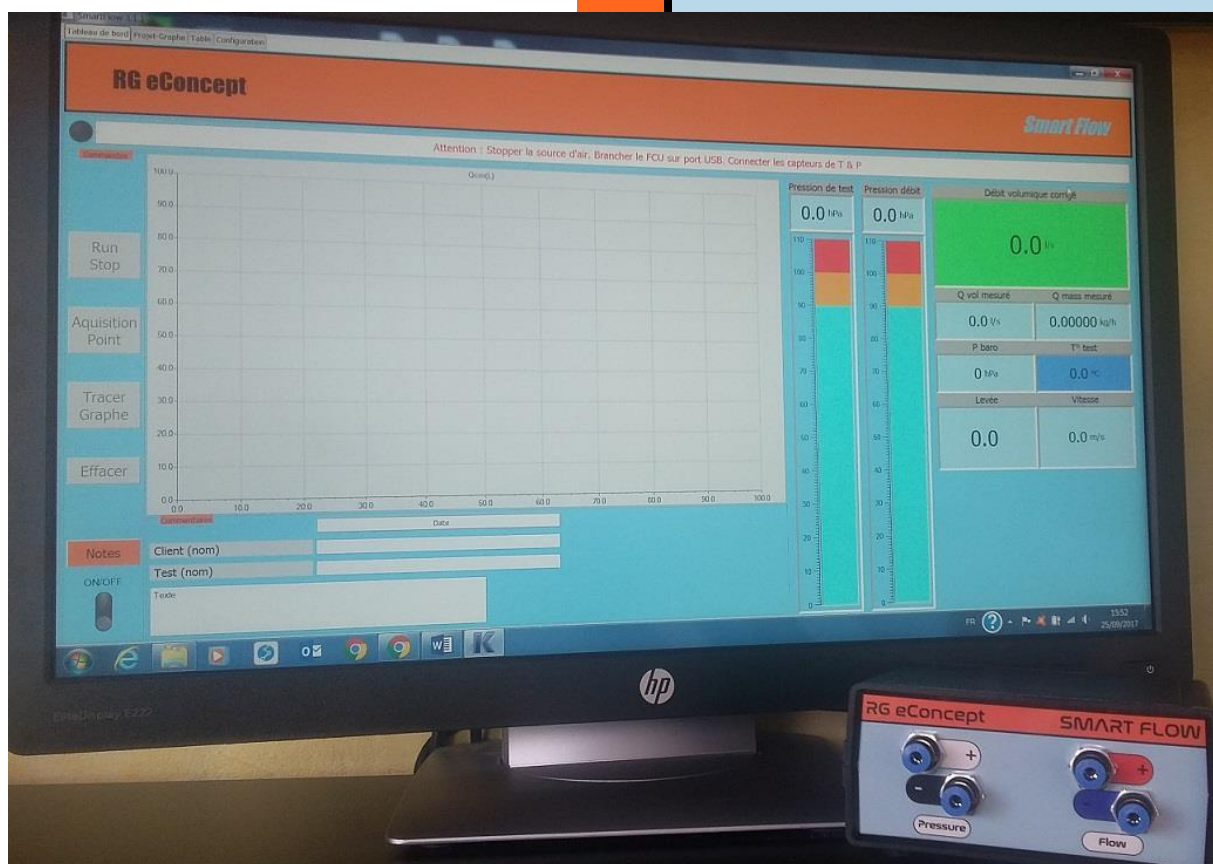


User's manual

SmartFlow-SC1



RG eConcept
Smart Motorsport

rgeconcept.com

StFw-UM

Revision	Comment	Date
1.0	Initial version	10/01/2018
1.1	Version with new GUI	25/01/2018
1.2	English version	28/02/2018
1.3	§ Install SW	11/03/2018
1.4	Added FCU-2 option	30/08/2018
1.5	Mention of the Help tab (>= V3.8.4) and the creation of the Doc and Example folders. Diagram for single curve or curve session explanation	21/11/2018
1.6	Added filtering of fluctuations in Configuration	27/11/2018
1.7	Addendum « mode de sauvegarde »	22/04/2020
1.8	Ajout de l'option FCU4-régulation de pression de test	14/08/2020
1.9	Addendum « L - L/D »	18/09/2020
1.10	Ajout option « angle » du débitmètre	10/03/2021
1.11	Addendum « Delta » Onglet Projet-Graphe	30/11/2021
1.12	Combo box Pression standard (25''H2O ajouté)	14/01/2022
1.13	Addendum V4.16 = config param moteur fichier.mok	06/04/2022

1. Implementation instructions

Flowmeter mounting

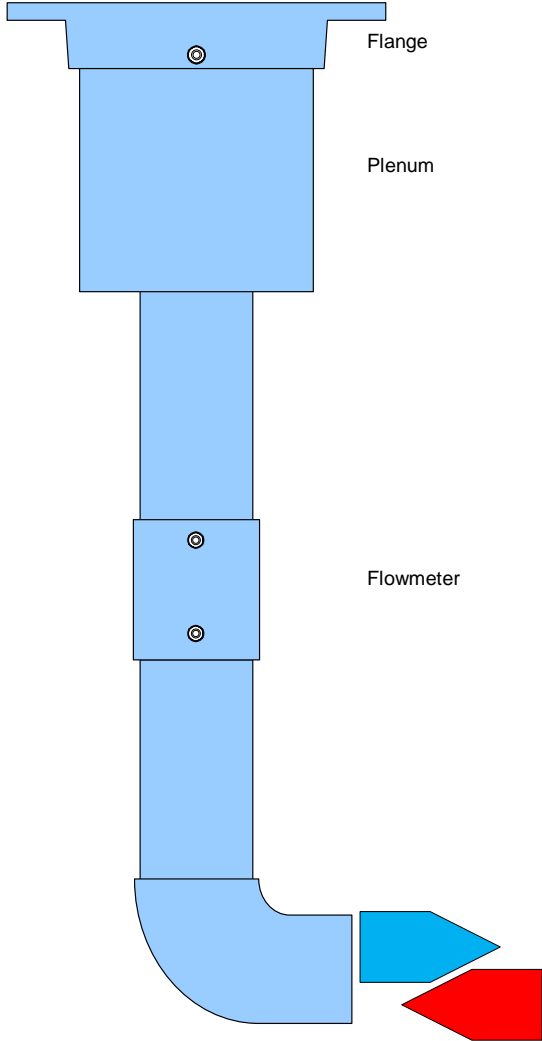


Figure 1 Schematic view of the tubing assembly

- Mount the whole flowmeter by means of the mounting flange with the round flat gasket under the test table using bolts M5 (x4).

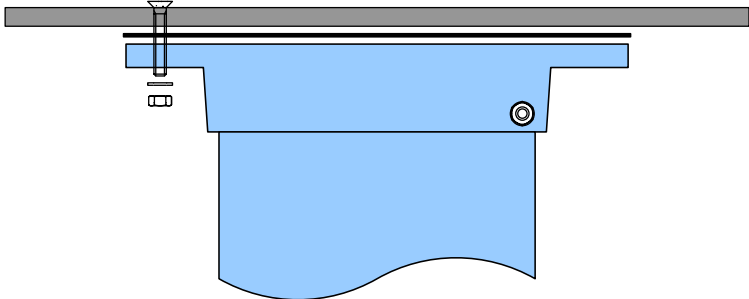


Figure 2 Mounting with flange

Flowmeter-FCU connection

- Connect the pressure inlets of the FCU to the flowmeter through the colored pipes corresponding to the direction of flow chosen: intake or exhaust.
 - Intake mode:
 - FCU «pressure» BLACK (-) at the plenum pickup on the fixing flange. With the black hose.
 - FCU «flow» red (+) at the HIGH side pickup of the flowmeter. With the red pipe.
 - FCU «flow» blue (-) at the LOW side pickup of the flowmeter. With the blue hose.
 - Exhaust mode:
 - FCU «pressure» white (+) at plenum pickup on the fixing flange. With the black hose.
 - FCU «flow» red (+) at the LOW side pickup of the flowmeter. With the red pipe.
 - FCU «flow» blue (-) at the HIGH side pickup of the flowmeter. With the blue hose.

It is in fact to cross the inputs either on the FCU or on the flowmeter. The “push in” connectors make it easy to change the position of the pipes.

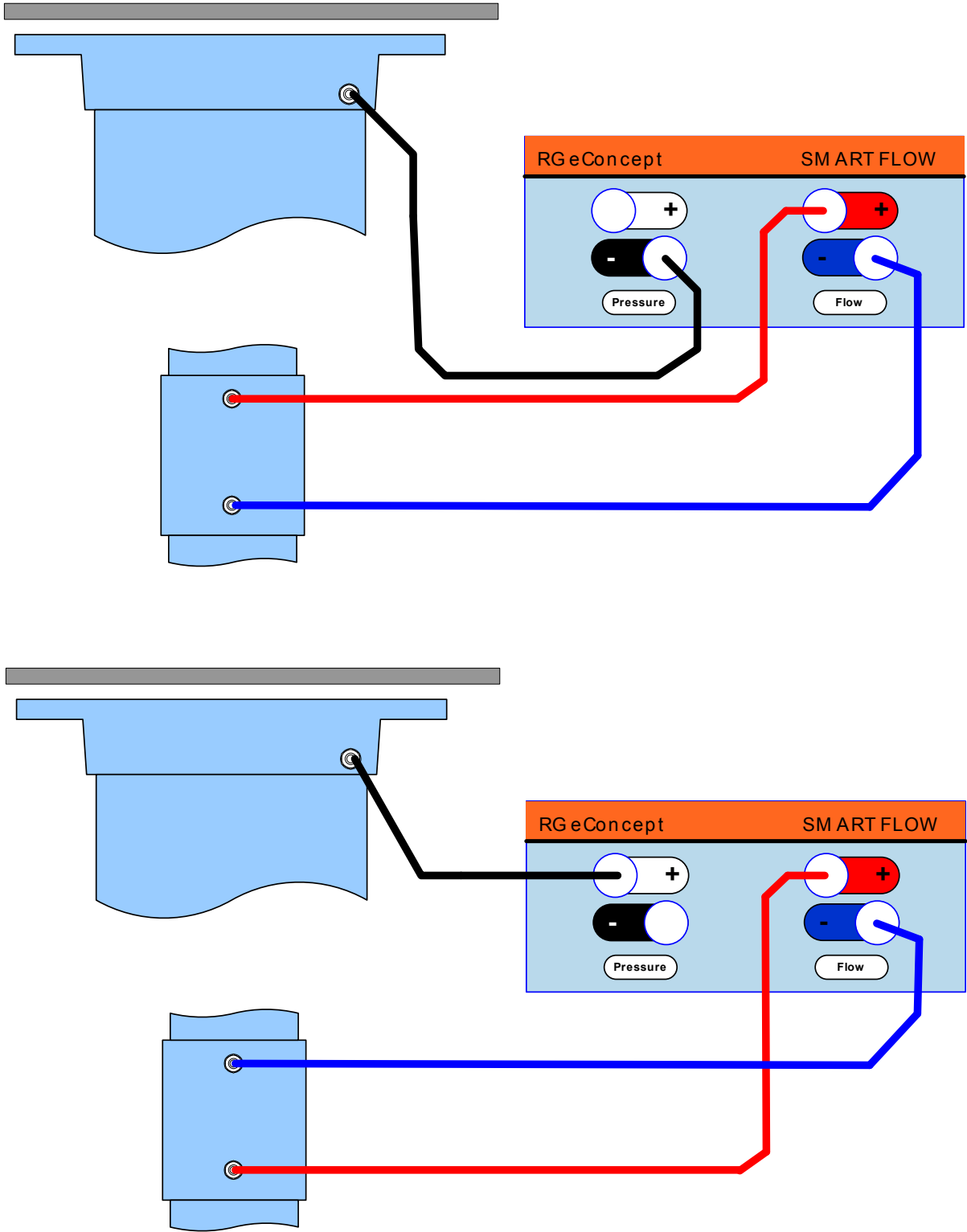


Figure 3 Intake (top) and exhaust (bottom) modes.

- Connect the temperature inputs of the FCU to the flowmeter with the dedicated cable «double RCA/Jack 3.5».
 - Jack 3.5 on the rear panel of the FCU.
 - The red RCA on the red (lower) RCA socket of the flowmeter.
 - The black RCA on the black (higher) RCA socket of the flowmeter.
- Connect the FCU to the PC computer via the USB cable. Mini-B socket on the rear panel of the FCU.
- Connect the air source with its hose via adapter 40-63.

Your SmartFlow SC1 flowbench is ready to operate and controlled by the SmartFlow software

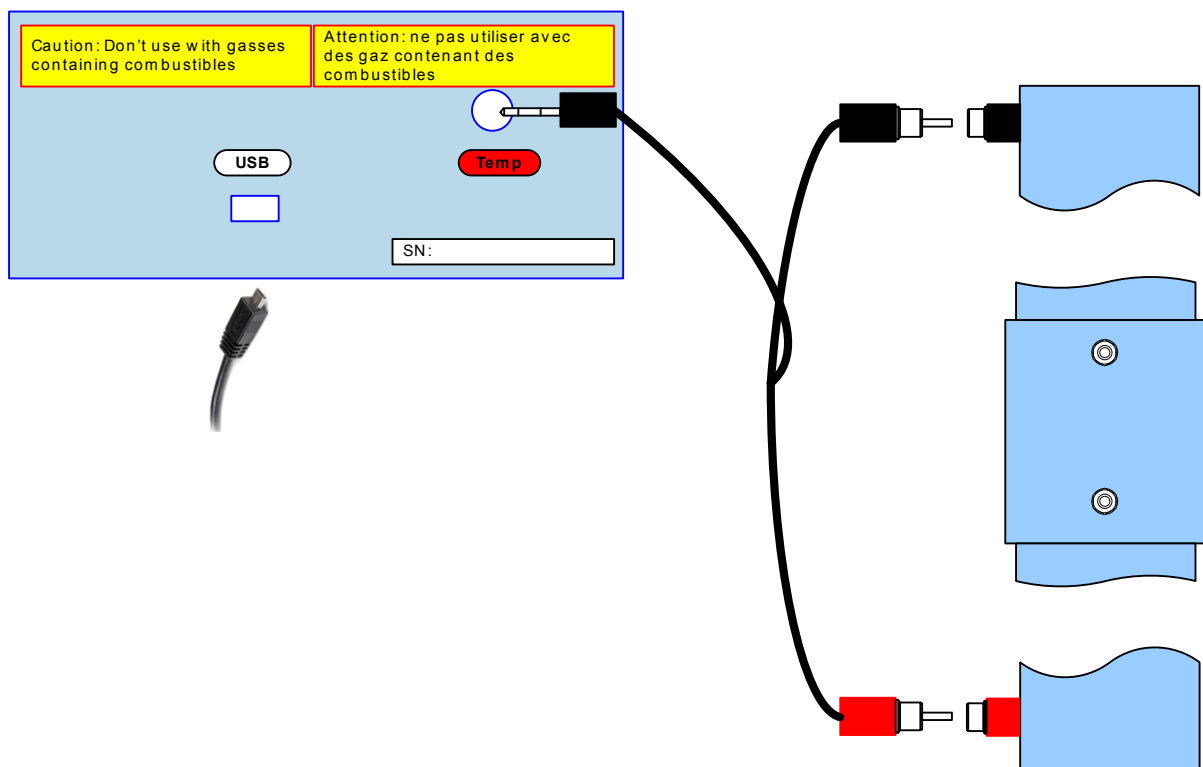


Figure 4 Sensor cabling T° and USB.

Option FCU-2

The FCU-2 is equipped with a power jack output controlled by SmartFlow software. This is a dry relay contact for switching solenoid valves to automatically cross the pipes to the pressure sensors and switching valves to reverse the air flow.

This output is open for " intake " flow mode and closed for " exhaust " flow mode. By default the contact is open when the FCU is switched on and the flow mode is " intake ".

The contact specification is: 3A / 30V DC.

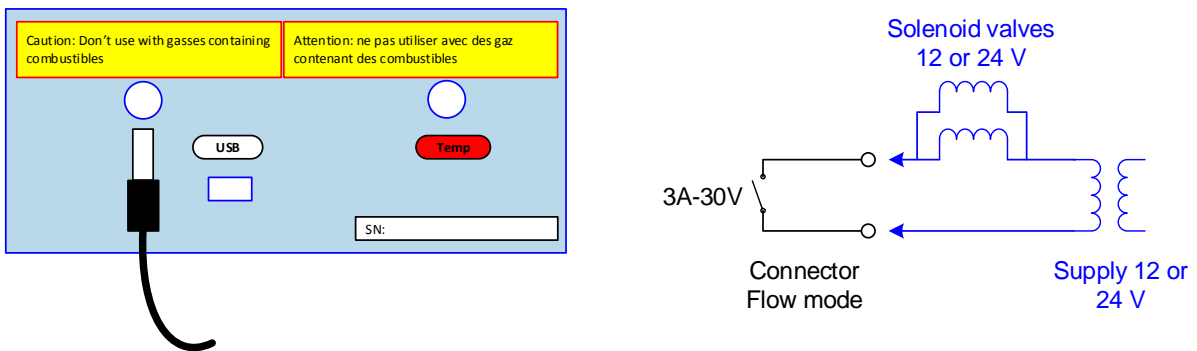


Figure 5 Electrical diagram for automatic flow control

Option FCU-4 Test pressure regulation

The FCU-4 is equipped with a power jack socket for the 220-12V power supply to supply the motor of the valve. It is also equipped with a DIN audio socket that receives the cable that connects the FCU to the motorized valve casing.

The valve must be inserted into the inlet pipe of the air source with the help of a T.

The automatic detection by the software of the presence of the option validates the "Pressure regulation" part in the "flow meter" frame of the "Configuration" tab. The detection takes place at start-up by "ON/OFF" (see chapter 3).

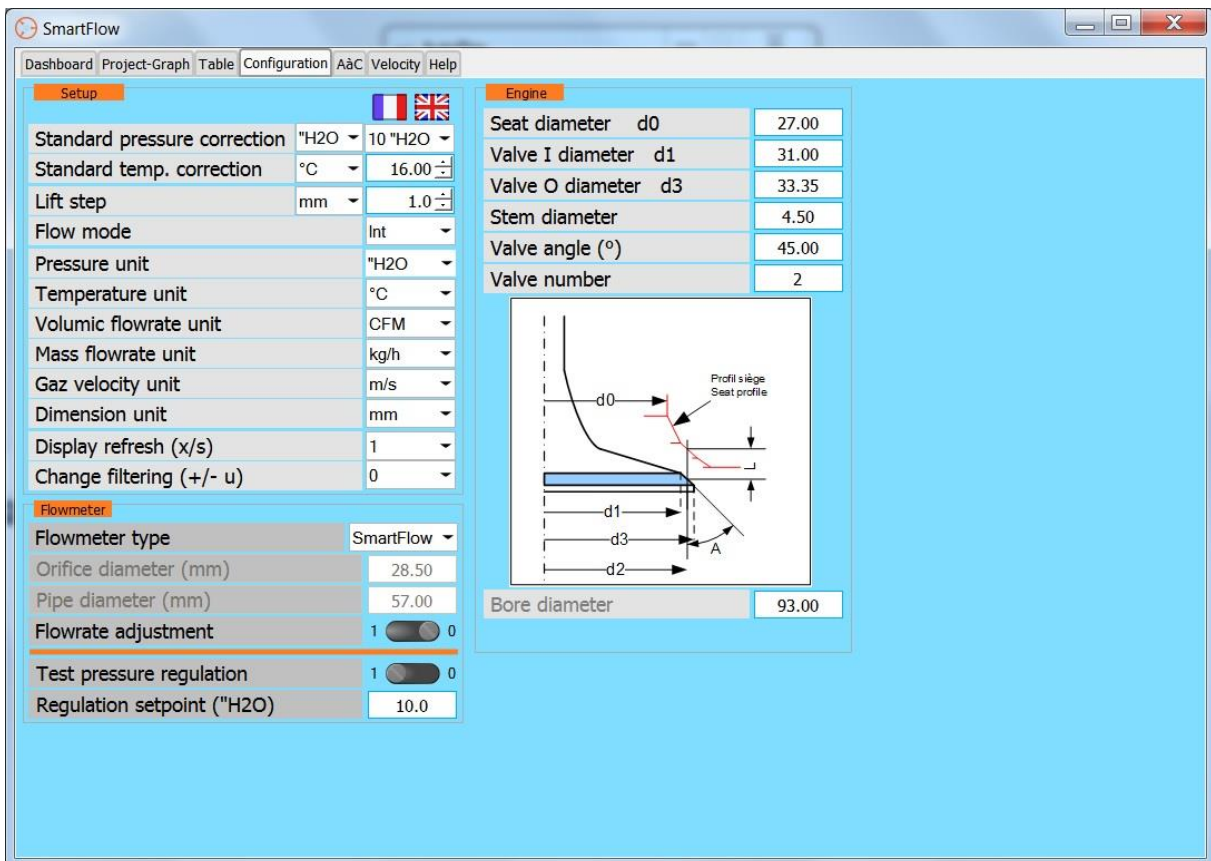


Figure 6 Validated regulation option

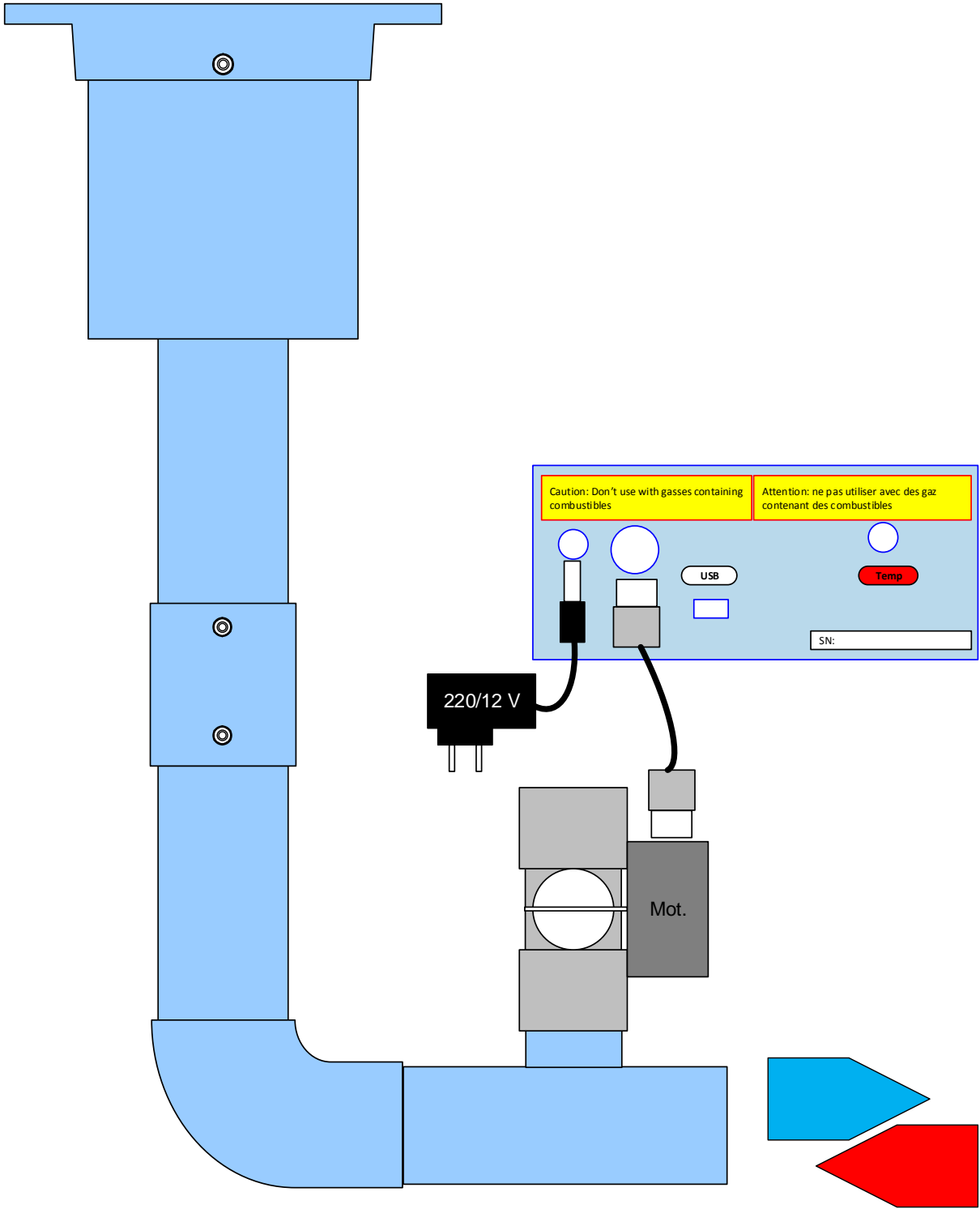


Figure 7 Implementation of the valve and its supply

2. Installing the software

SmartFlow

In Windows 7 or 10, decompress the supplied file "SmartFlow_xxxPro.zip" then the software installs itself by running the execution of the file «SmartFlow_xxxProSetup.exe» contained in the folder «SmartFlow_xxxPro» (xxx being the version number).

The installation will automatically create a **C: DataSmartFlow** folder where all test results files are located.

The installation will also automatically create folders:

C:\Program Files (x86) \SmartFlow_xxxPro\project\Doc

Where to find this "User's Manual" document that will be available for reading in SmartFlow under the "Help" tab (available from SmartFlow version 3.8.4 onwards)

C:\Program Files (x86) \SmartFlow_390-17Pro\project\Example

Where you can find examples of recorded sessions that give an overview of the results obtained with SmartFlow.

USB driver

The connection to the FCU is via a COM/USB port. The driver installs itself by running the execution of the file «stlink_winusb_install.bat» in the file «en.stsw-link009l.zip».

3. Presentation of the control software

The SmartFlow interface has 4 tabs. The software can communicate with the FCU, measure, display measurements graphically and digitally and manage data as files (backup/playback). The window can be reduced and enlarged to full screen size. The optimal resolution is 1920x1080.

Help (since V3.8.4)

The "User Manual" button provides direct access to this document while being able to use the SmartFlow control software.

Dashboard

When SmartFlow is launched, the «Dashboard» tab screen is displayed, it contains 4 zones:

Information frame:

At the top, for messages that give an indication of the SmartFlow status and a «LED» light off at launch.

Frame « Commands »: on the left side, with all buttons inactive at launch.

- « ON/OFF »: starts and stops SmartFlow.
- « Run Stop »: starts and stops flow measurement.
- « Single Acquisition »: acquires the values of a measuring point.
- « Plot Graph »: completes the acquisition of a curve.
- « Cancel »: to delete a measuring point.
- « Text box »: enlarges/reduces the graphics area by hiding or not the comments area (which will not be deleted).

Frame « Comments »: below, to describe the test performed.

- « Date »: automatically loaded to ON by «ON/OFF».
- « Customer name »: explicit.
- « Test name »: will be repeated on the graph as the curve name.
- « Text »: Free text for the user.

Measurement display area:

All measurement parameters and the graph currently being measured as a function of the lift.

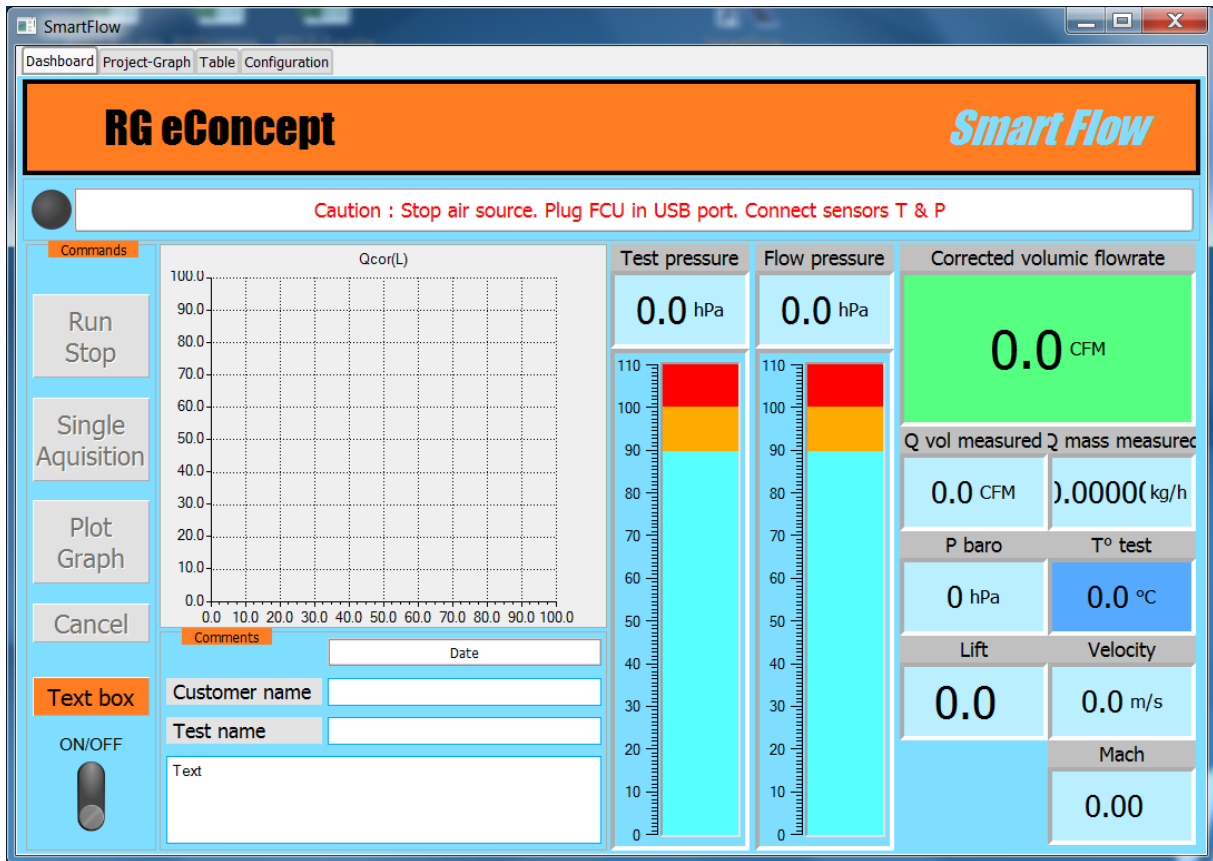


Figure 8 Main screen: dashboard.

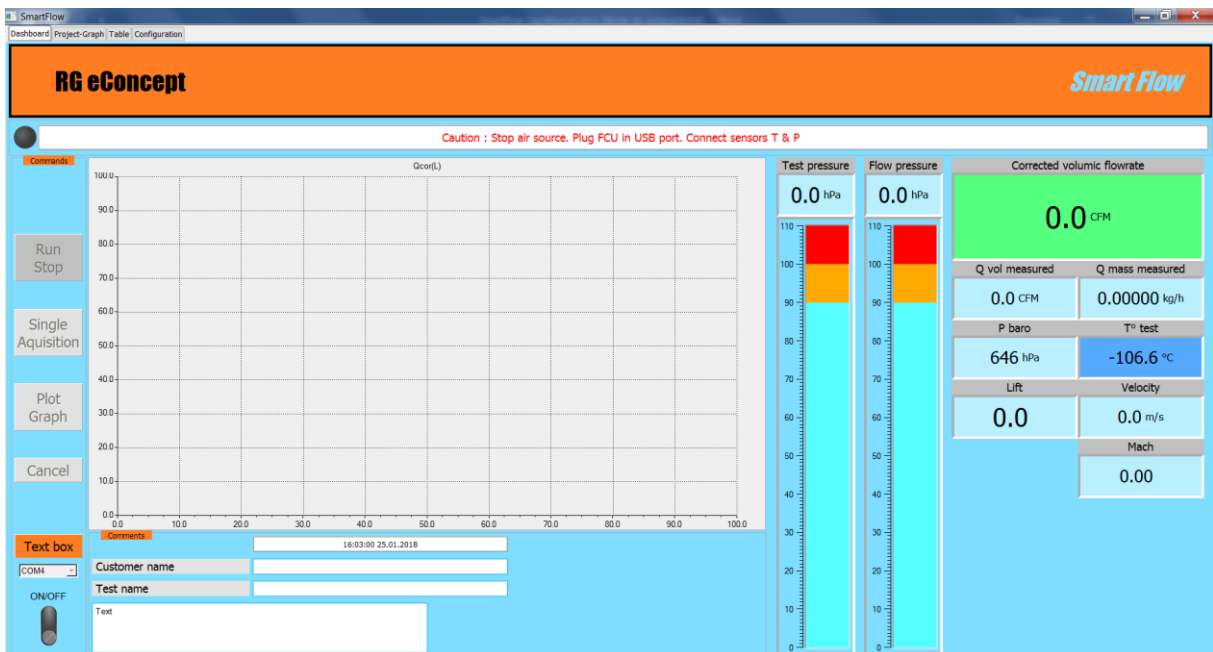


Figure 9 Full screen 1920x1080

Configuration

The «Configuration» tab allows you to choose different options that will be saved by the software.

Frame « Setup »:

- Choice of language: French/English
- The standard correction pressure is the constant pressure at which the test would be performed. The industry's 3 choices are 10, 25 or 28 inches of water (10"H₂O/25" H₂O/28" H₂O) or 25 hPa (mbar) 63 hPa (mbar) and 70 hPa (mbar) respectively. (Reminder: SmartFlow uses a floating air source and standard pressure-corrected flow rate).
- The standard correction temperature: unit and value are selectable. That's the temperature at which the test would be done.
- The lift step: unit and value are selectable.
- Flow mode: inlet or outlet in accordance with the configuration of the pressure tapping pipes. Recall the mode with the background color of the temperature display on the dashboard (Blue: Intake/Red: Exhaust).
- Units of physical quantities: metric or imperial.
- Frequency of refreshing data on the screen. From 3 times per second to 1 time every 2 seconds.
- Filtering of fluctuations of the corrected flow rate. The value in flow unit determines the limits (+/-) at which the flow rate must change before being updated in the display. Helps to make the display steady in case of turbulence or pressure fluctuation.

Frame « Flowmeter »:

It is possible to use the software with another diaphragm flowmeter whose dimensions can be set here

- Flowmeter type: SmartFlow (default) or «customized» or «corner». The «corner» type allows the use of a diaphragm whose tappings are picked up against the sides of the diaphragm.
- Diameters: default or custom diameters.
- Flow adjustment: option that allows a screen to appear in the specific «Dashboard» to adjust the flow rate on a standard orifice and obtain an adjustment coefficient (see paragraph «[Flowmeter calibration](#)«).
- Regulation mode or not if FCU-4 present.
- Test pressure setpoint: from 5 to 30 inches of water.

Frame « Engine »:

Includes design features useful for indicative calculations of valve gas velocity and theoretical reference flow rate.

These fields are saved. Remember to fill them in for each session if the tested system changes.

- Seat diameter
- Inner diameter of the valve seat
- Outer diameter of the valve seat
- Stem diameter
- Valve angle
- Valve number

Includes features for «memory» but not used in the software (grayed out).

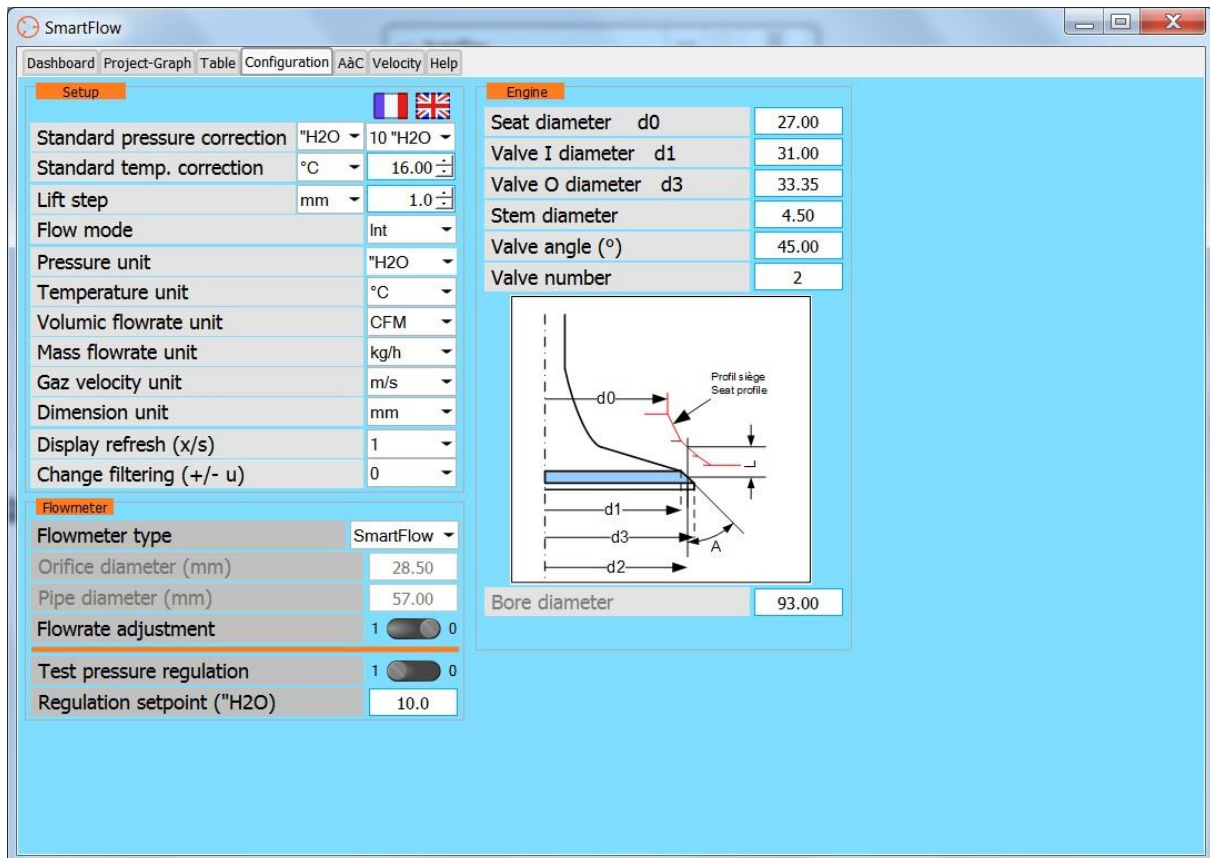


Figure 10 Configuration screen.

Addendum V4.16

From this version the user interface is improved by the addition of the possibility to save and recall the "Engine" configuration in a specific file with extension ".mok". In addition to the general configuration, it is possible to save the parameters of the "engine" frame to facilitate the filling of the fields of these parameters. As a reminder, these parameters are used to calculate the theoretical flow rate as well as the speed of the gases in the valve's passage section according to the lift.

The "Save" button allows the values entered in the input fields to be saved in a file with the chosen name.

The "Open" button allows the reading of the desired file which will fill the fields.

The name of the file read is written as a reminder in the top field of the frame.

If there is no specific file, then the modified fields are saved in the general configuration file, as in older versions.

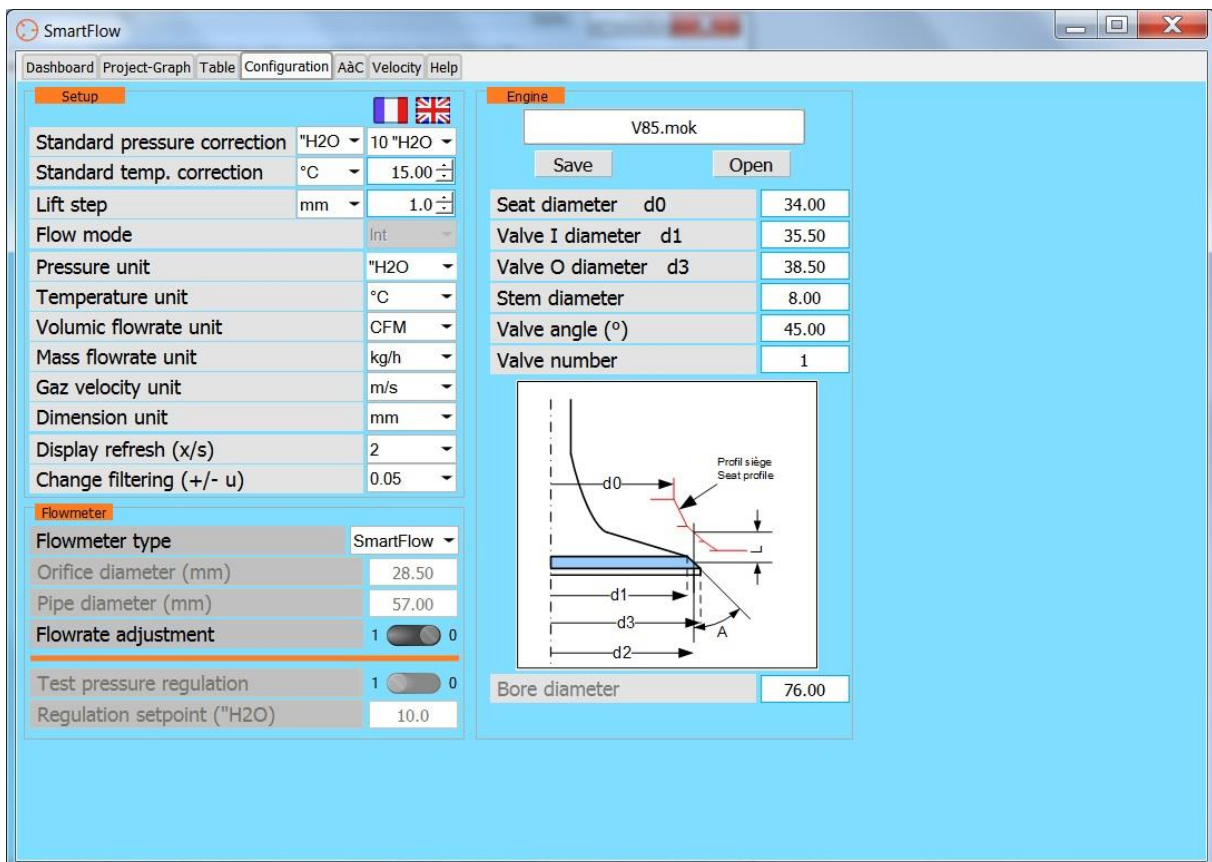


Figure 11 Save/recall engine parameters.

Project-Graph

The tab «Project Graph» is the project/file manager based on graphs obtained during measurements.

Frame « Files »:

Includes commands for saving, reading and printing projects. It is possible to open a file and then a second one in order to compare two test projects.

Note: The data are also saved as CSV type. See paragraph «[CSV files](#)».

Display and selection:

The curves are displayed on the graph part and it is possible to select the curves with the selection box on the right part.

At the top is the window with the name of the opened project.

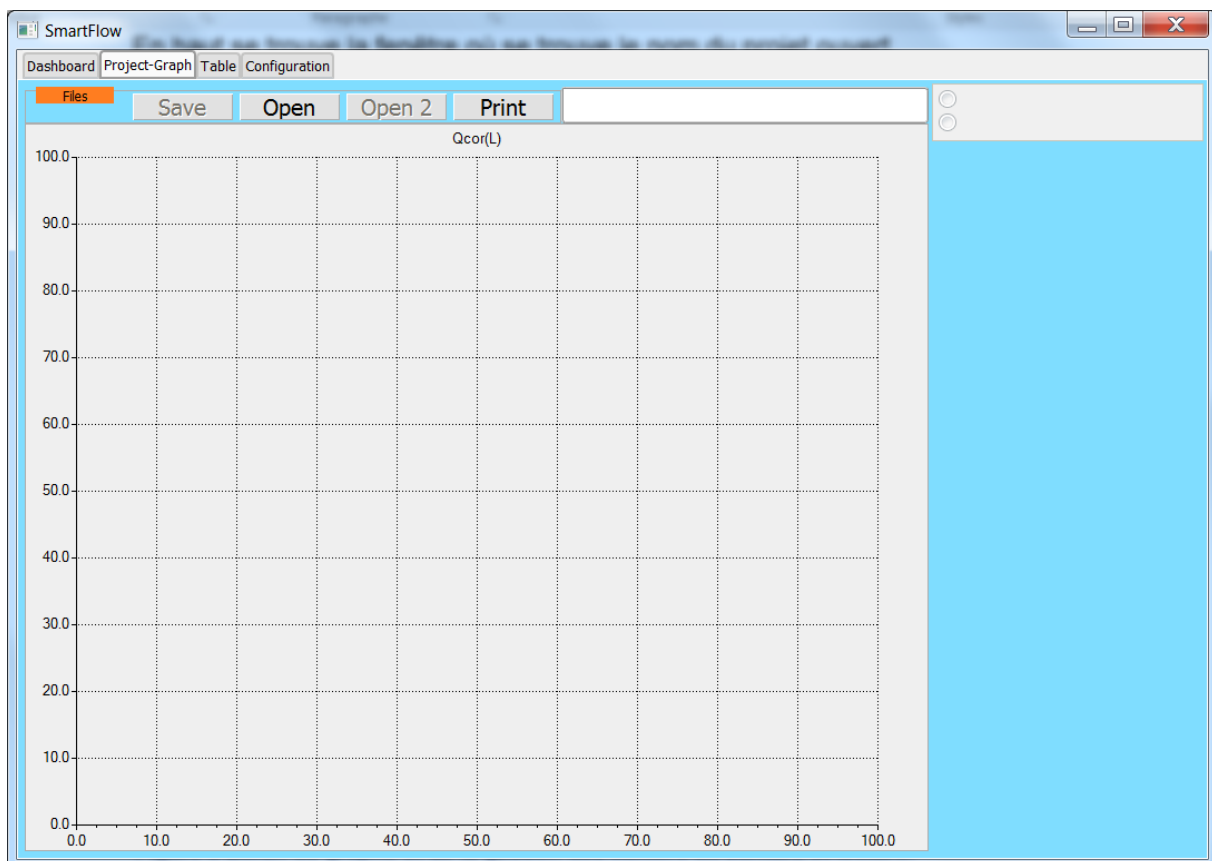


Figure 12 Graph and file management screen for writing and reading files.

Table

The «Table» tab allows you to visualize the data relating to the last plotted graph.

The table group is either the group of tables associated with the last plotted graph or a group of tables from the graphs read and chosen in the tab «Project - Graph».

Frame «Files»:

Includes the print command for project tables.

Display and selection:

The selection of the table to be displayed is done by the selection box on the right side.

All parameters of the test performed are present in the table including comments entered before the test.

At the top of the window where the name of the opened project can be found.

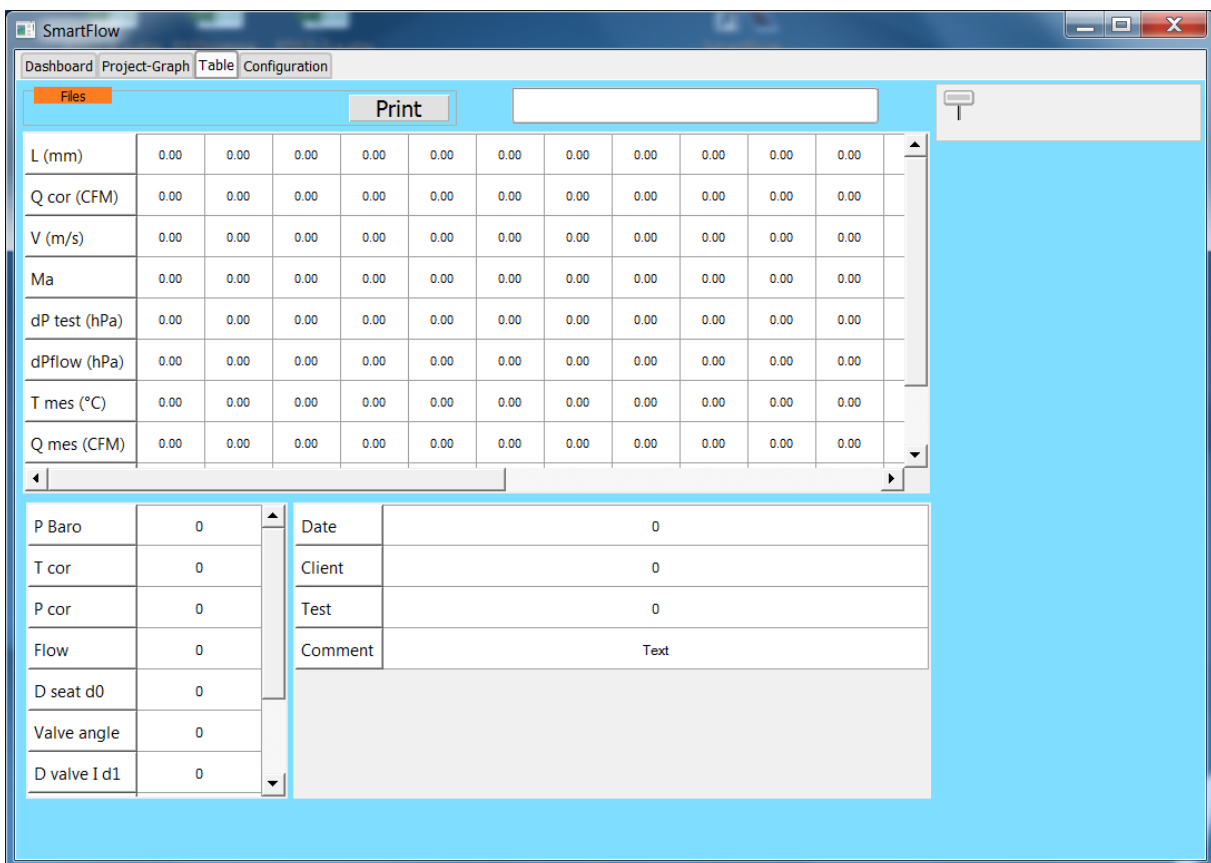


Figure 13 Data table screen.

4. Using the control software

Startup

- Click on the «ON/OFF» switch.
- A list of COM ports to select appears in the «COM Sel» window if there are several such devices available on the PC.
- Select the port of the FCU (by successive tests). The selected COM is displayed.
- The light turns green and all 4 controls are enabled except «Plot Graph».

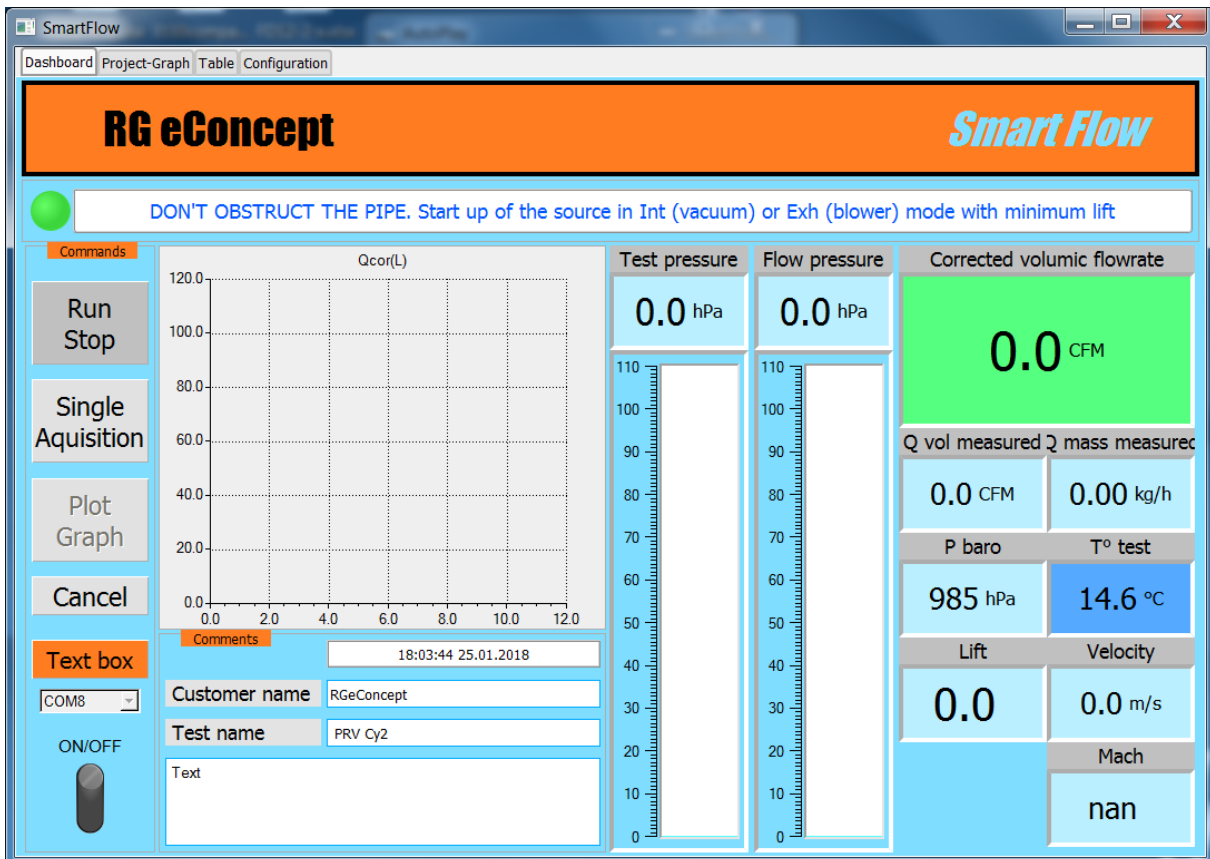


Figure 14 Startup and connection to FCU.

As a precaution for the sensors it is recommended to start the air source with a minimum flow rate.

It is recommended not to exceed 100 hPa test pressure to avoid incorrect flow rate results.

In the event of a temperature sensor fault SmartFlow can operate with the standard correction value in place of the actual measured temperature after clicking OK.

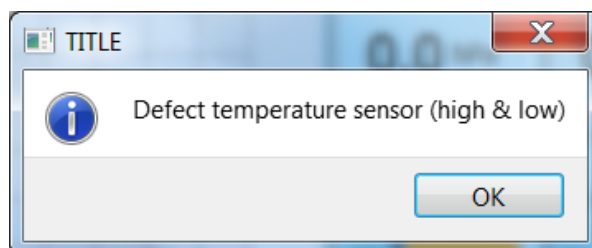


Figure 15 T° sensor fault message

Comments

The date and time are automatically entered in the “comments section”. It is the user's responsibility to fill in the fields available for their test documentation.

Real-time measurement

- Start the air source with the measuring piece on the SC1 flowbench.
- Start measurement: Click on «Run Stop». The button changes to green background. The measurements are displayed at the frequency indicated in «Configuration».
- Stop measurement: Click on «Run Stop». The button changes to red background.
- Pressures are displayed in their respective digital window and on their gauge:
 - The test pressure.
 - The pressure difference at the flowmeter.
 - The atmospheric pressure.
- The test temperature is displayed on a blue background for intake mode, red in exhaust mode.
- The flow rates are displayed in their respective window.

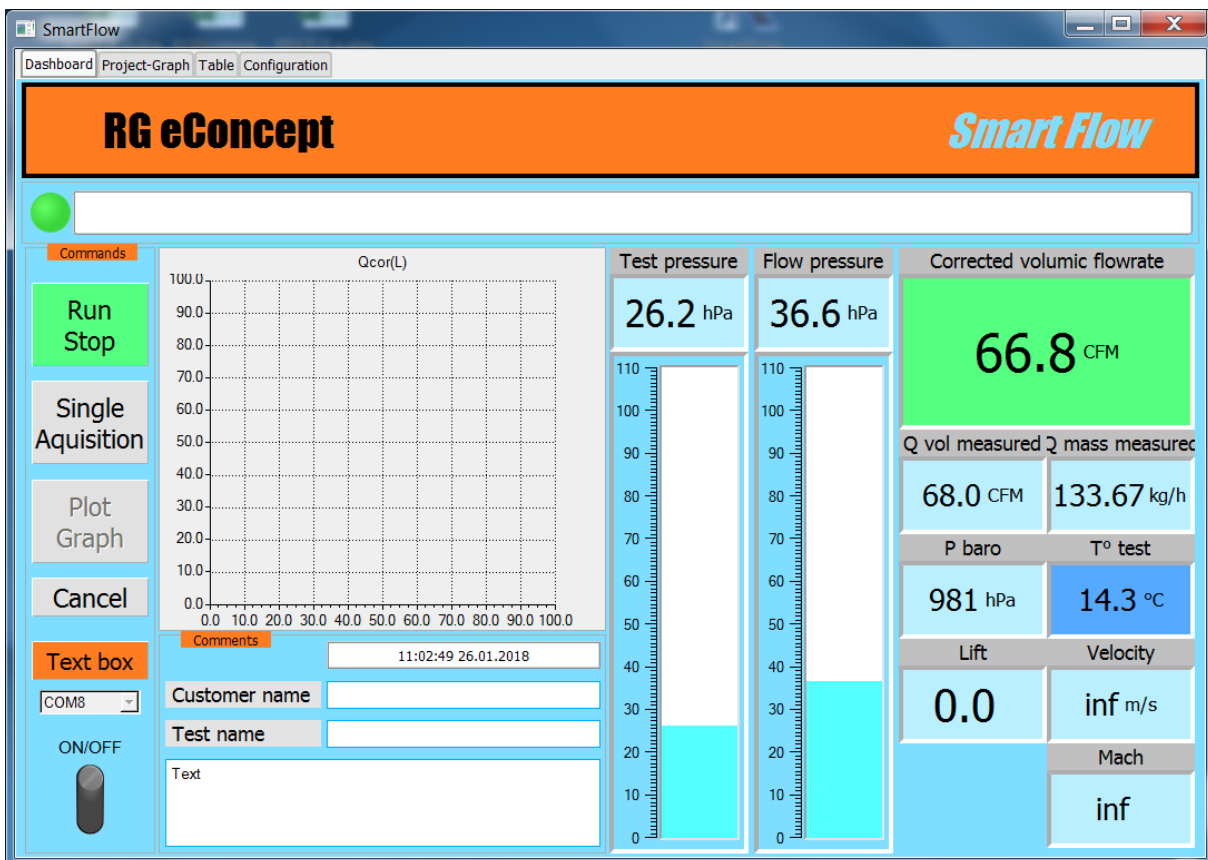


Figure 16 Real-time display of measurement parameters.

Cylinder head measurement as a function of lift

- The step of the lift will be the one indicated in «Configuration».
- Start the air source with the measuring piece on the on the SC1 flowbench.
- Start measurement: Click on «Run Stop» the button will turn green. The measurements will be displayed at the frequency indicated in «Configuration».
- Apply the first lift to the head.
- Click on «Single Acquisition», the 1st point of the curve is measured and displayed in the current graphic area «real time».
- The lift is displayed in its window.
- Browse all the lifting points for each step.
- To complete the acquisition of the curve obtained click on «Plot Graph».

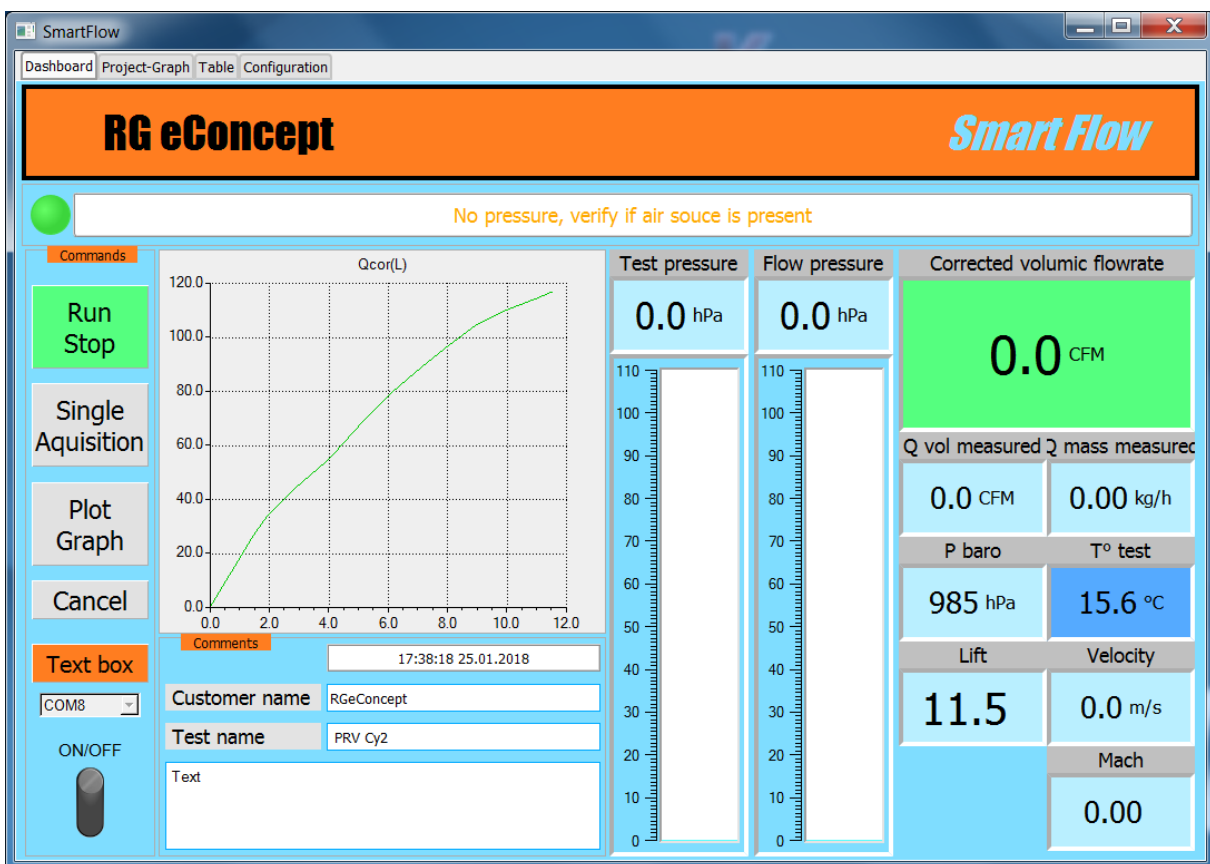


Figure 17 End of acquisition: max lift reached and full real-time graph.

Note:

The lifting step can be not constant, i.e. it is possible to apply a different step at each measuring point.

Example:

Lift step = 1.5;0.5;1;1... giving a lift value of: 1.5;2;3;4...

Note:

In order not to saturate the low lift measurement with a test pressure in the red zone (> 100 hPa) the above option can be used (minimum lift without saturation different from other lift steps).

Another possibility:

- Add a leak on the vacuum cleaner hose (some are equipped)
 - Use a speed variator to decrease the vacuum cleaner motor speed and therefore test pressure.
- Automatically the «Project-Graph» screen appears with the curve on the graph and the name of the curve in the selection box.

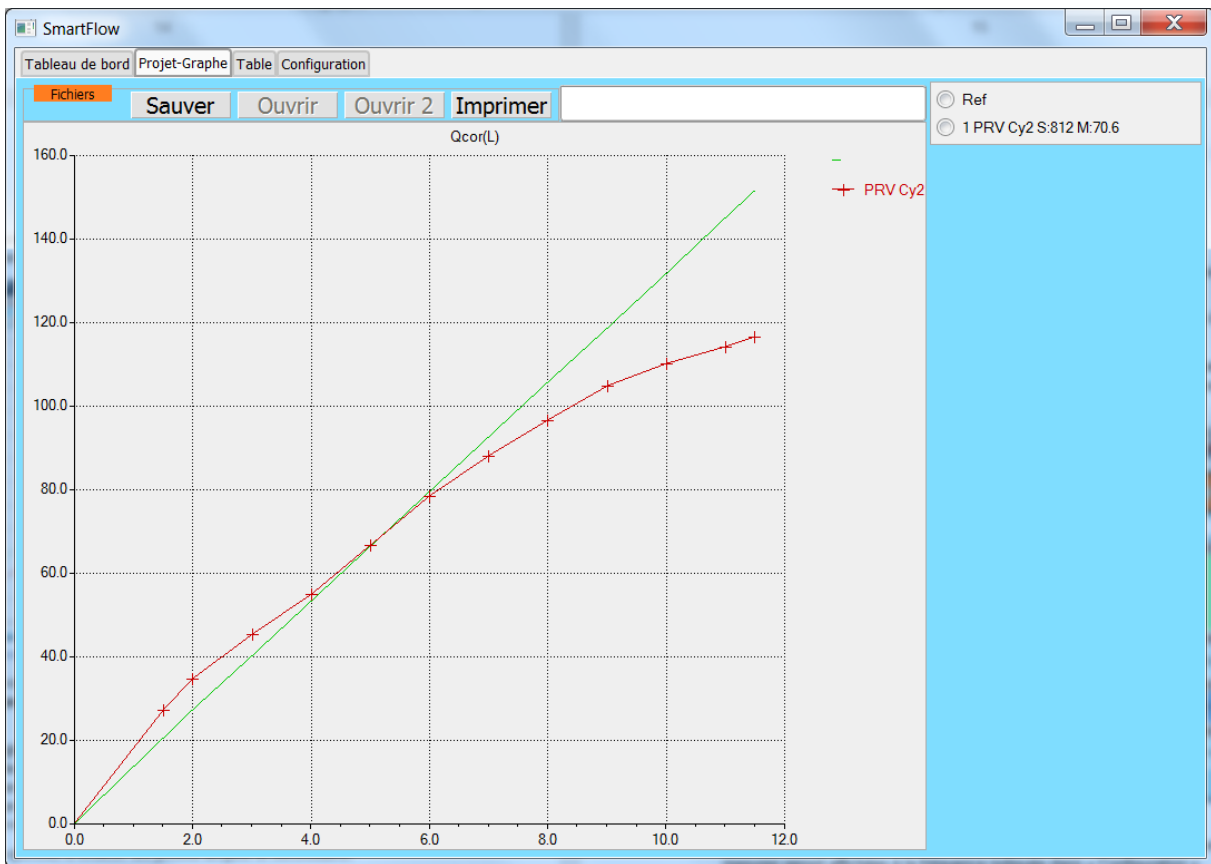


Figure 18 Graph of the curve obtained and reference curve. Screen before backup.

The name of the curve contains the values «sum» and «average» from an integral calculation. This makes it possible to see in figures the area of the flow curve and the average flow value.

- Returning to the tab «Dashboard» allows you to restart operations for another curve to be measured (another tract for example).
- When the session of a set of curves is finished click on «Save» to drop your project in the C: DataSmartFlow space. The saved files are those of the graph and data table.

The «Cancel» button allows you to delete the acquired points if necessary.

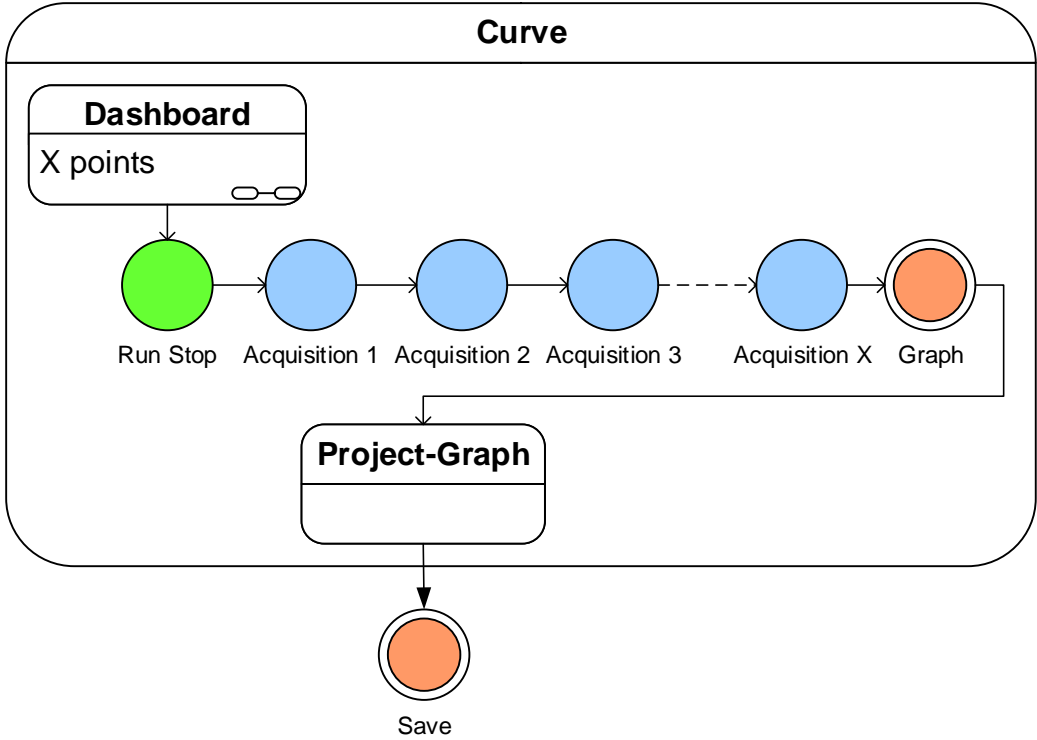


Figure 19 Steps to create a single curve

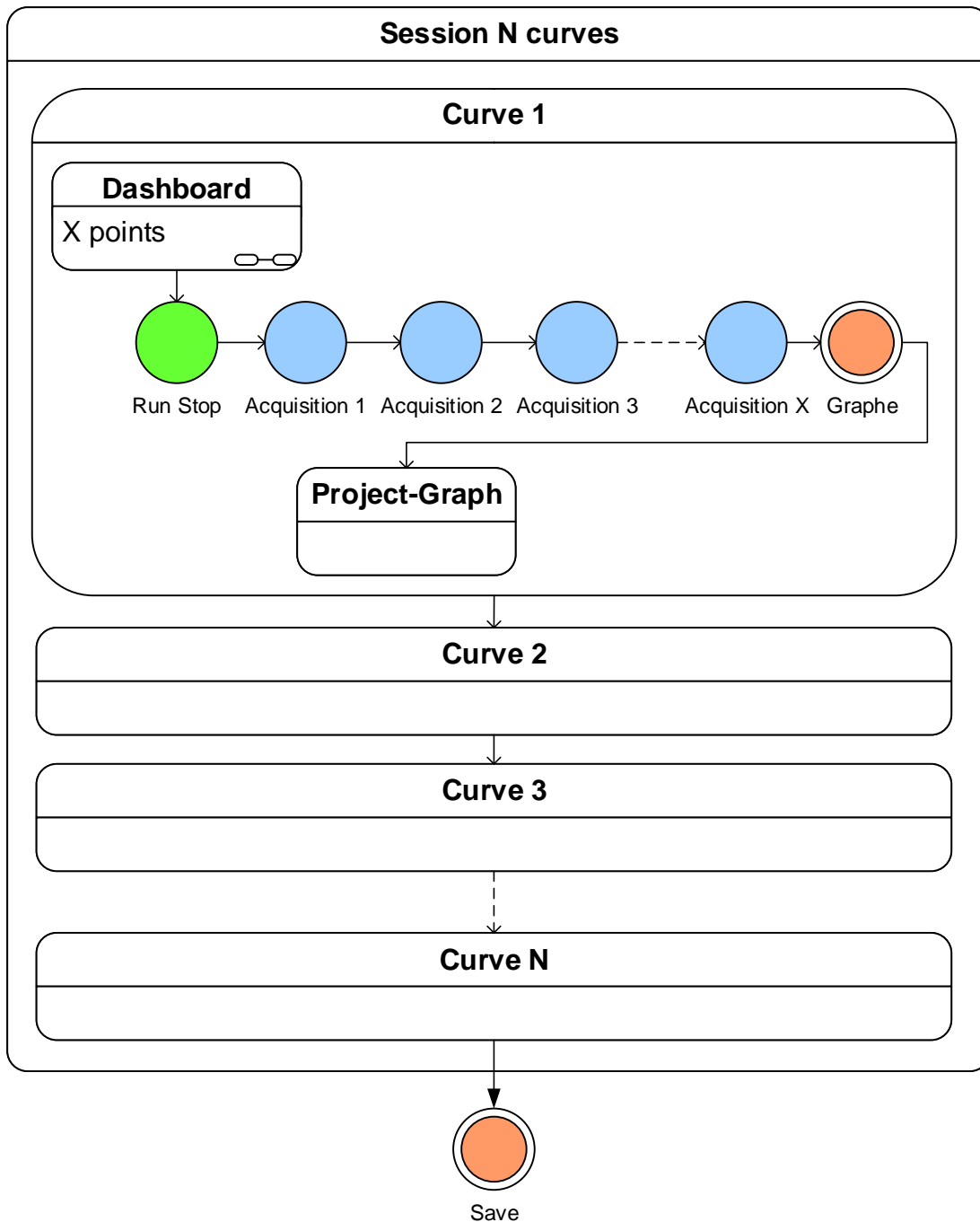


Figure 20 Steps to create a session with several curves

Note: A «reference» curve of the theoretical ideal flow rate is drawn based on the passage section and the selected standard test pressure.

This geometrical conical trunk section is $S = \pi \cdot d_2 \cdot l \cdot \sin A$ which gives a good approximation of the section. Where d_2 is the mean diameter of the seat, l the lift and A the half angle of the valve as shown in the «Configuration» diagram.

This passage section is limited to $S = \pi \cdot (d_0^2 - d^2) / 4$. Where d_0 is the seat diameter and d is the diameter of the valve stem.

Saving mode (Addendum version higher to V446/456)

Saving is now ensured by 2 buttons:

- " Save ", simple mode, which allows to save the graph and the data table being displayed and then to erase this content
- " Save X ", multiple mode, which allows to save the graph and the data table currently displayed without erasing this content. This allows you to continue acquiring additional sessions and save the accumulated sessions

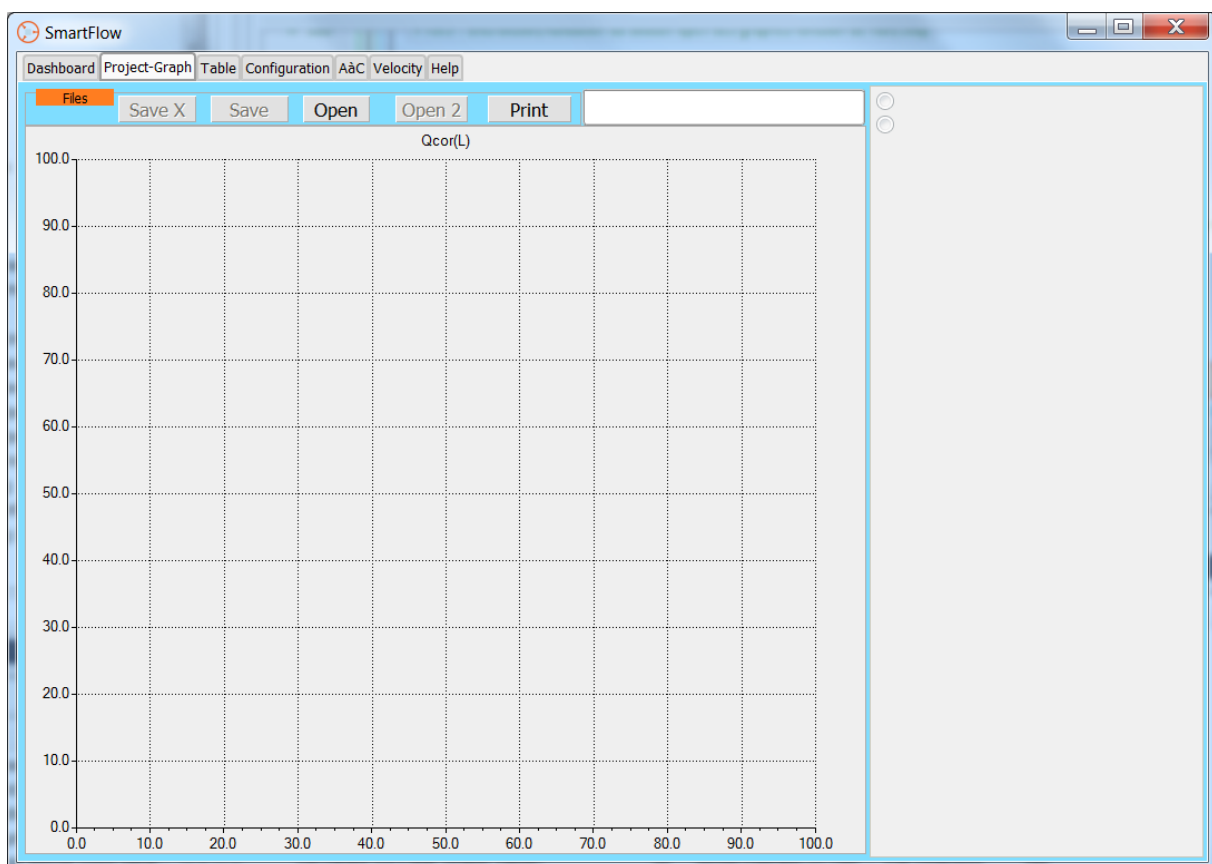


Figure 21 Saving mode

Measurement of a part without lifting

The case of a part measured several times to obtain a set of points can be interesting.

The lifting step indicated in «Configuration» will then be the abscissa step of the curve or the number of the measured point. The value «1» is indicated.

In this case, to obtain the correct sum and average values, start the curve by «deleting» the first value and click on «Cancel». The acquisition starts in -1 instead of 0 but the curve starts in 0.

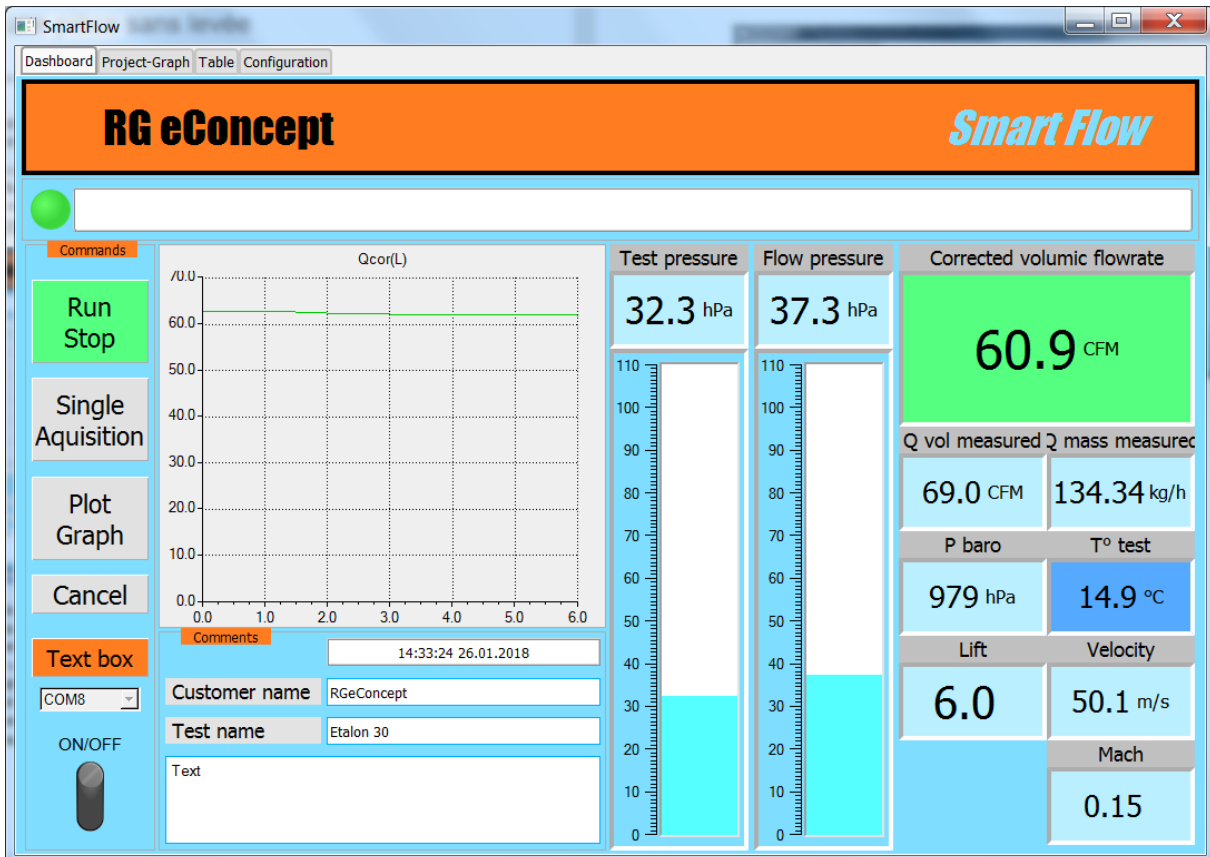


Figure 22 Real-time display of a part without lifting.

- Start the air source with the measuring piece on the SC1 flowbench.
- Start measurement: Click on «Run Stop» the button will turn green. The measurements will be displayed at the frequency indicated in «Configuration».
- Click on «Single Acquisition», the 1st point of the curve is measured and displayed in the current graphic area «real time».
- Lift is the number of the measured point.
- Make the desired number of points.
- To finish the acquisition of the curve obtained click on «Plot Graph».

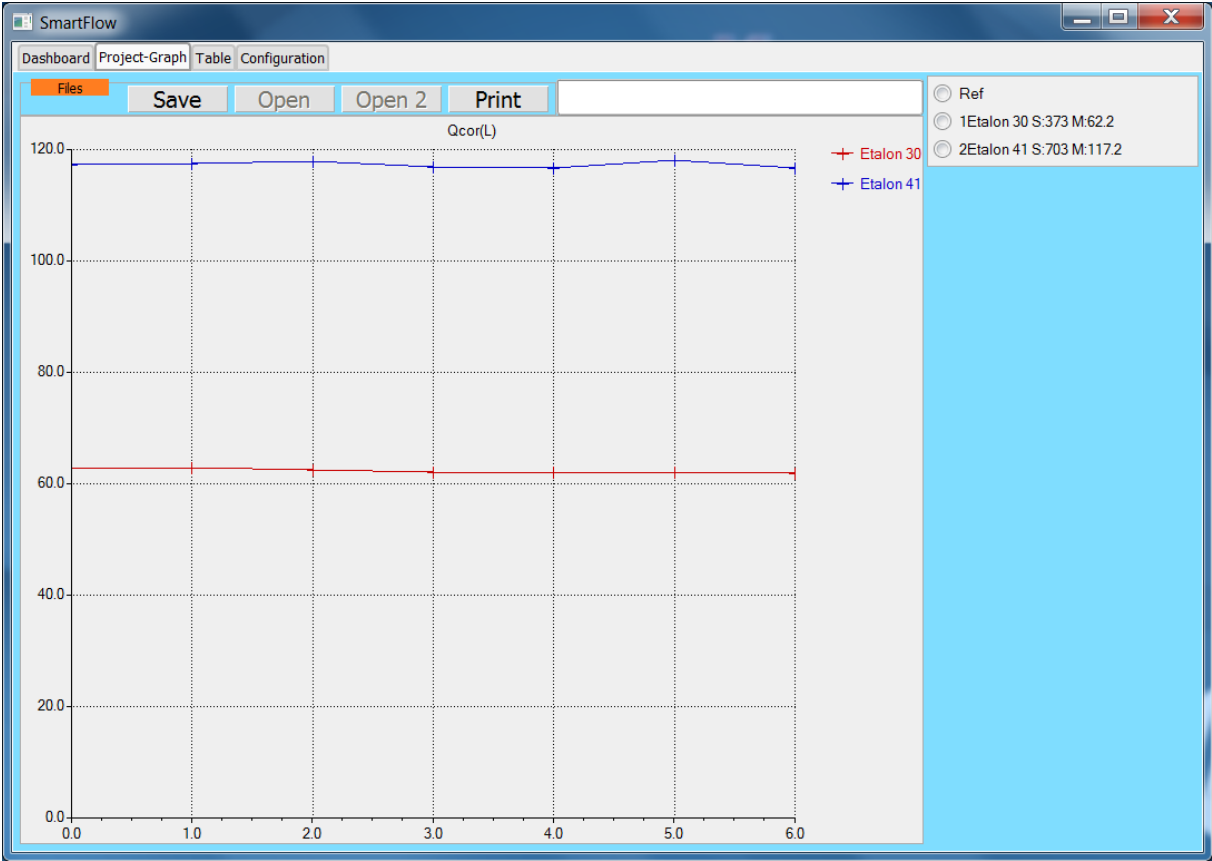


Figure 23 Two measurements of different standard plates without lifting. Before backup.

Reading/comparison of projects/graphs

- In the «Project Graph» tab
- Project reading: click on «Open», select the desired file.
- Comparison of 2 projects: click on «Open», select the 1st project then «Open 2» and select the 2nd project.
- Reminder of open project names in the top window.
- All curves of the project (s) are displayed with the possibility to select curves in the selection box.

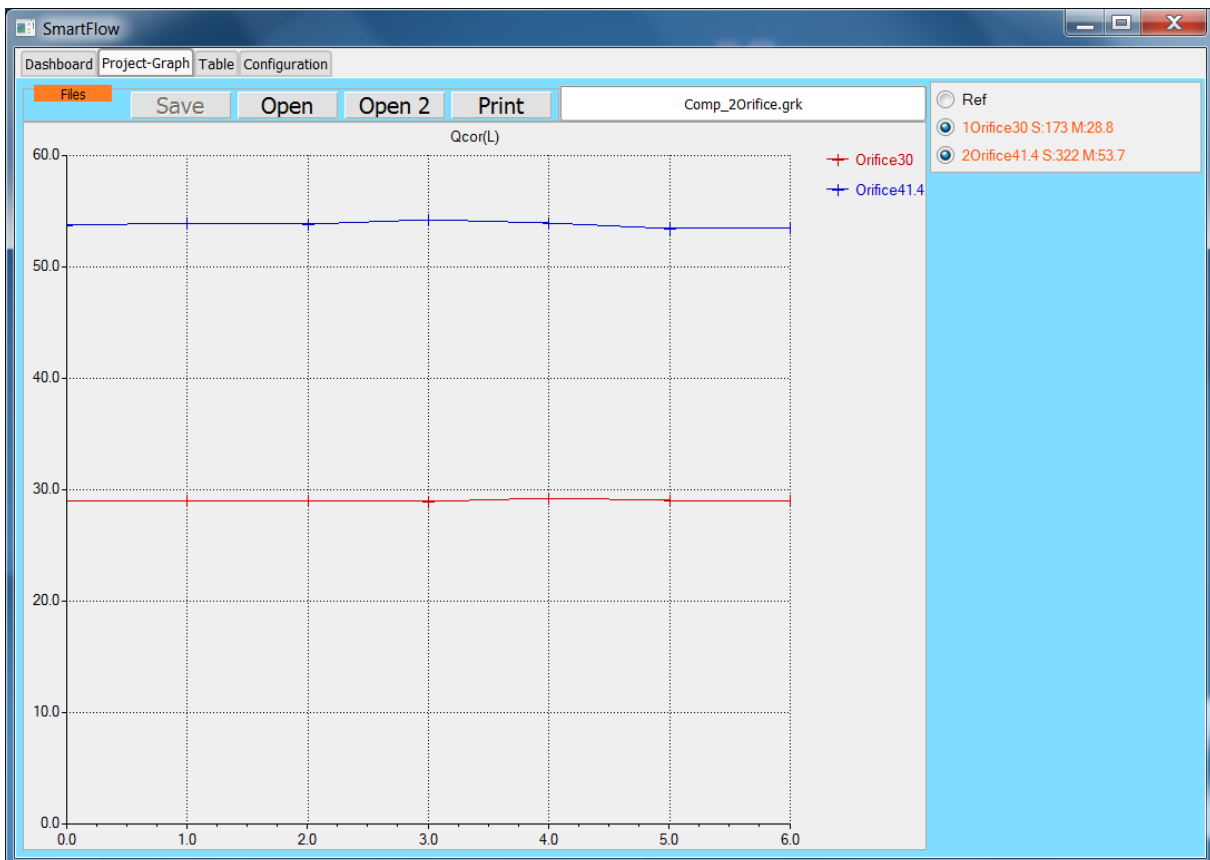


Figure 24 Reading a project with 2 curves. Selection of 2.

Addendum from version V4.11.8 onwards

It is possible to compare cylinder heads with different valve diameters by viewing the curves with the L/D dimensionless abscissa. L/D being the ratio between lift and valve diameter. This feature is available if 2 files are opened by displaying a "switch" that allows to select the L or L/D mode to obtain the flow rate according to the lift or the L/D ratio.

In the following example comparison of D = 35 mm (purple curve) and D = 45 mm (red curve).

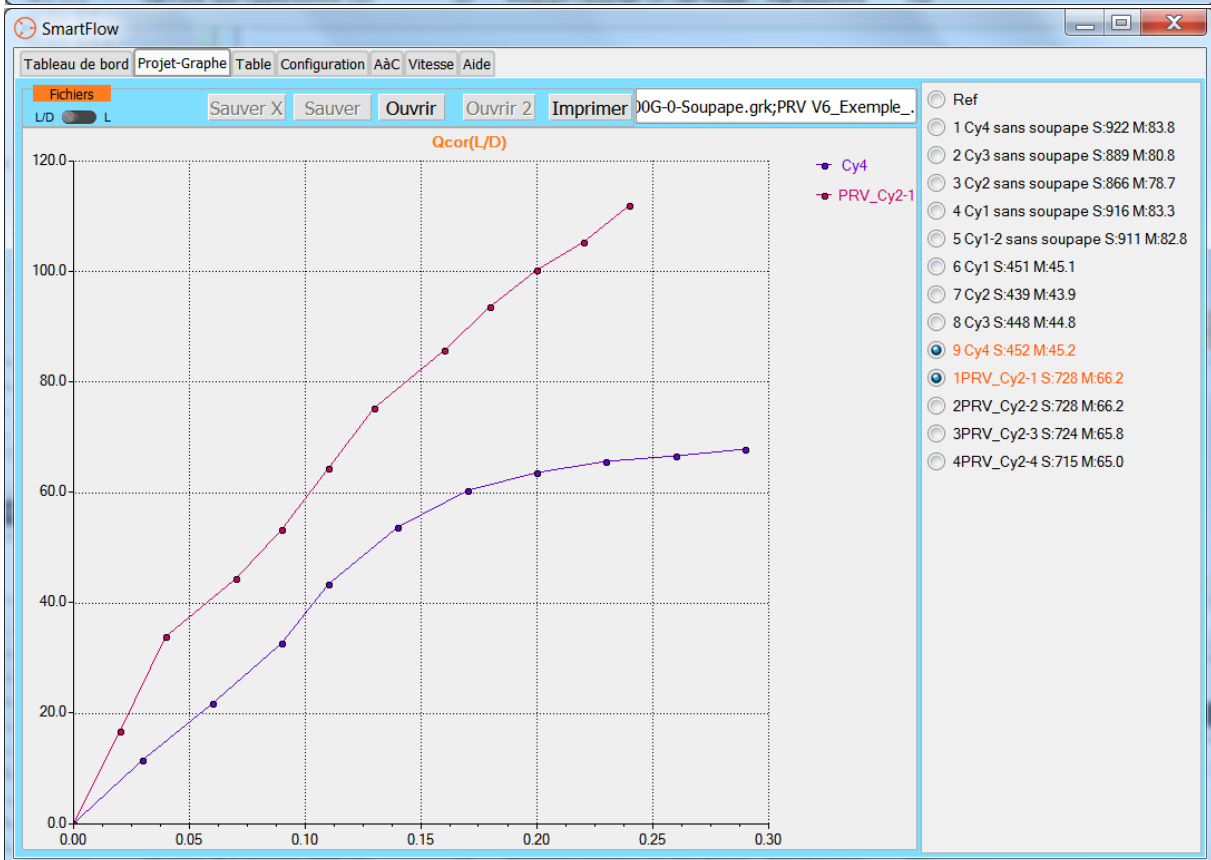
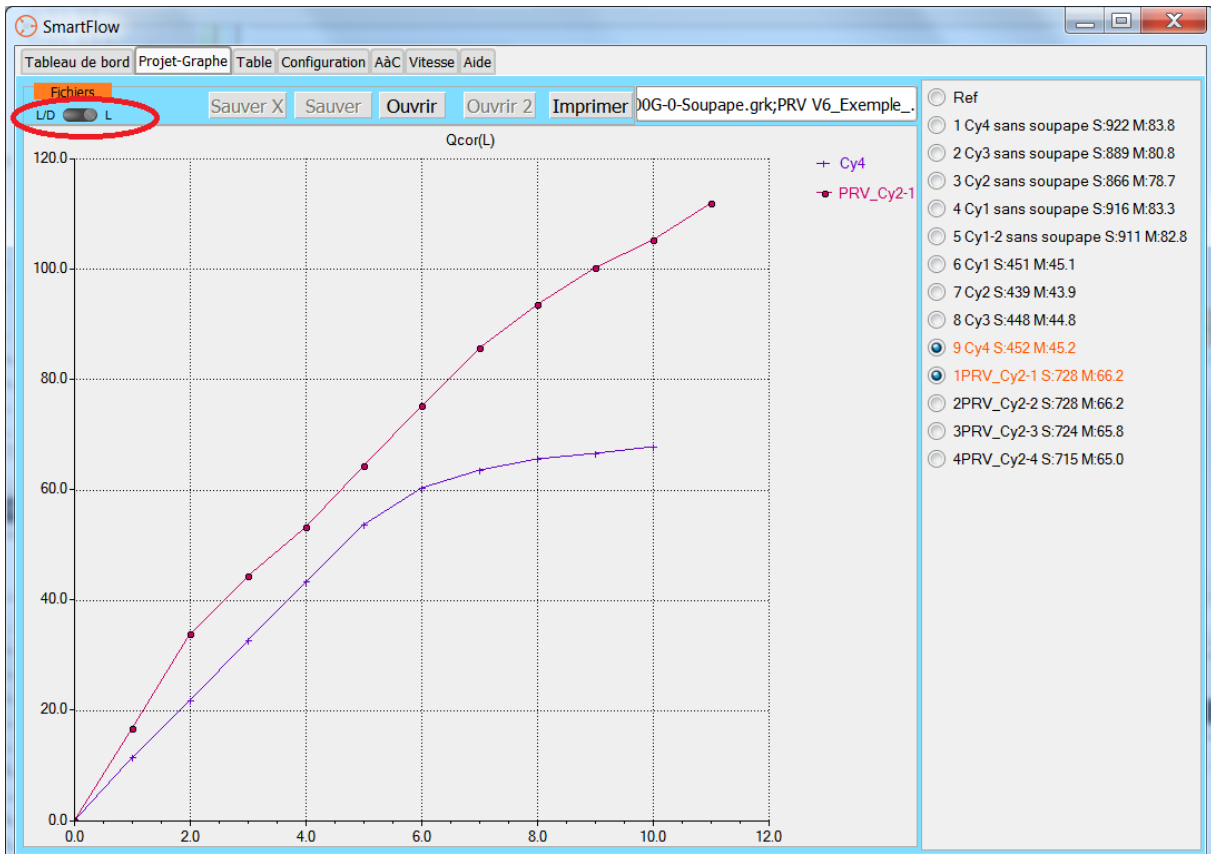


Figure 25 The possibility of viewing the curves according to the lift L or L/D

Addendum from version V4.14.3

It is possible to obtain the difference in average flow rates between 2 curves. These average flows are already present in the names of the curves. After selecting 2 curves, the "Delta %" button is validated, by clicking on it, the percentage of positive increase between the 2 curves is displayed next to the button.

It is thus convenient to obtain the difference in percentage between 2 tests.

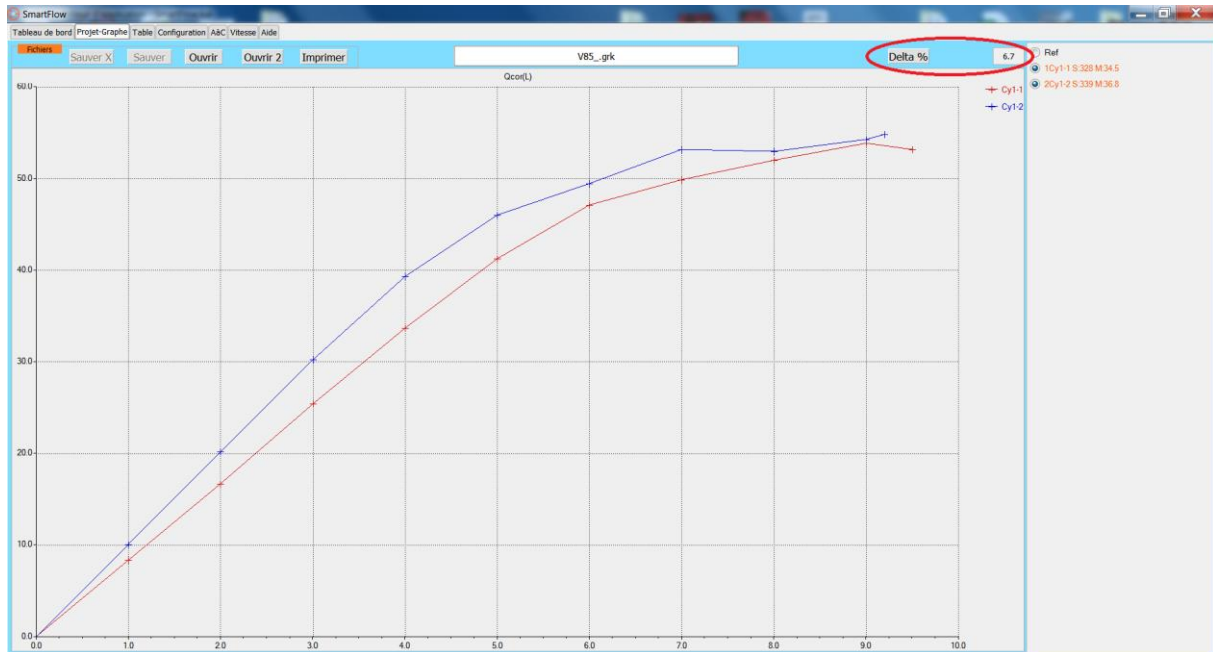


Figure 26 Example of difference between 2 tests

- In the «Table» tab
- Reminder of the names of previously opened projects in the top window.
- All tables of the project (s) can be displayed with the possibility to select a group of tables from the set in the selection box.

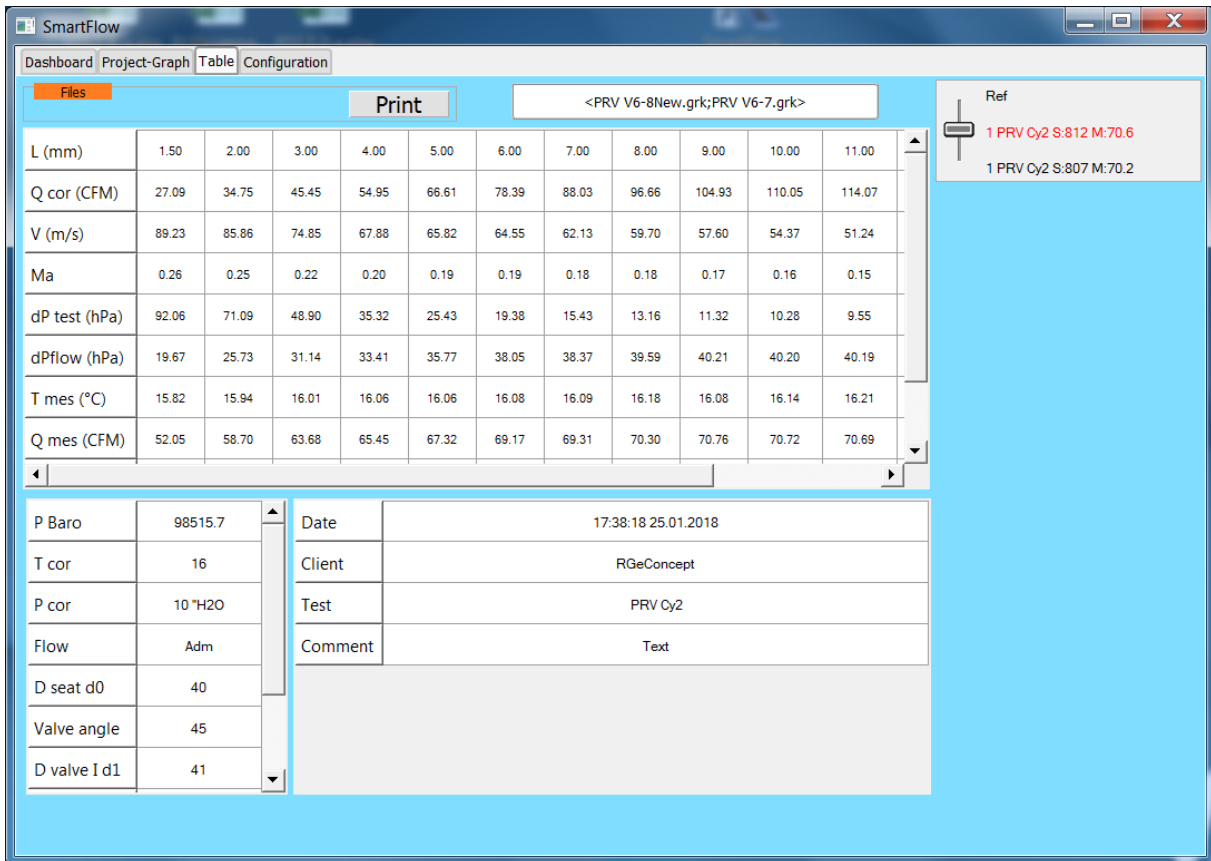


Figure 27 Reading a table of a project with 2 curves. Selecting/Viewing the 1st.

Printing projects/table

For each of the above functions printing is possible on a printer or file (. PDF for example). "Print" button.

5. Advanced function of the control software

Flowmeter calibration

Calibration of the flow meter is possible. By measuring a flow rate of a known standard plate it is therefore possible to calibrate the flowbench. Mainly if a custom flowmeter is used.

In the «Configuration» tab click on «Flowrate adjustment».

- The dashboard graph window changes for an adjustment slider.
- Change the value by measuring the flow rate obtained and desired.
- The value will be saved as configuration parameters.

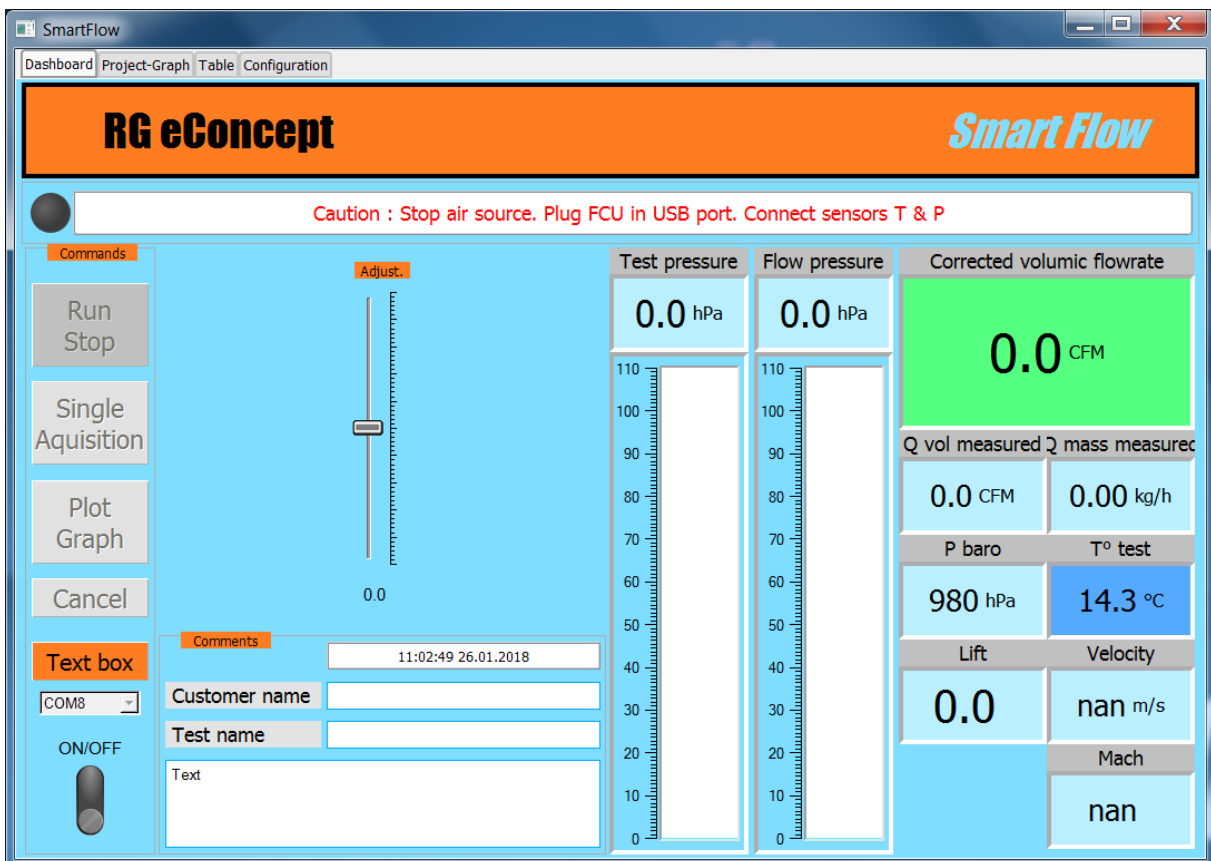


Figure 28 Flowmeter adjustment.

CSV files

The CSV data file (Excel compatible) uses the format of the tables viewed by SmartFlow. This file can be used for calculations outside SmartFlow if desired.

You should not modify the CSV file, otherwise SmartFlow will not be able to read the files associated with the test. Open it with Excel and save it in XLS format to work with

The example below shows the data format. A Cn tag precedes each dataset for a curve.

In the 1st line we find successively: Atmospheric pressure Patmo, Correction temperature Tcor, Correction pressure Pcor, Flow mode Int/Exh, Seat diameter, Valve angle, Inner diameter of the valve, Outside diameter of the valve, Stem diameter, Valve number.

In the 2nd line you will find successively: Date and time, Customer name, Test name, Free text.

Then the points of the measured curve with the names of the measurement parameters in the header:

Lift, Corrected flow, Valve speed, Number of Mach, Test pressure, Differential pressure, Temperature, Measured flow, Valve ideal theoretical flow rate, Lift, Ratio of lift to valve diameter.

C1

	97976.2	16	10 "H2O	Adm	40	45	41	45	8	1
	14:33:24		Etalon							
	26.01.2018	RGeConcept	30	Texte						
					dP test	dPflow	T mes	Q mes	Q th	
L (mm)	Q cor (CFM)	V (m/s)	Ma	(hPa)	(hPa)	(°C)	(CFM)	(CFM)	L/D	
0	62.9	inf	inf	31.67	39.13	14.64	70.59	0	0	
1	62.79	310.22	0.91	31.63	38.97	14.69	70.44	13.34	0.02	
2	62.31	153.94	0.45	31.88	38.67	14.77	70.2	26.68	0.04	
3	62.05	102.2	0.3	31.97	38.44	14.73	69.99	40.02	0.07	
4	62	76.58	0.23	31.79	38.16	14.78	69.74	53.36	0.09	
5	62.04	61.3	0.18	32.14	38.64	14.78	70.17	66.71	0.11	
6	61.75	50.85	0.15	32.4	38.56	14.78	70.12	80.06	0.13	

C2

	97959.5	16	10 "H2O	Adm	40	45	41	45	8	1
	14:33:24		Etalon							
	26.01.2018	RGeConcept	41	Texte						
					dP test	dPflow	T mes	Q mes	Q th	
L (mm)	Q cor (CFM)	V (m/s)	Ma	(hPa)	(hPa)	(°C)	(CFM)	(CFM)	L/D	
0	117.24	inf	inf	9.92	43.73	14.97	73.71	0	0	
1	117.36	579.84	1.7	9.88	43.64	14.93	73.63	13.19	0.02	
2	117.83	291.09	0.86	9.85	43.84	14.88	73.79	26.38	0.04	
3	116.73	192.24	0.56	9.96	43.53	14.93	73.54	39.58	0.07	
4	116.63	144.06	0.42	10	43.61	14.94	73.61	52.78	0.09	
5	118.04	116.64	0.34	9.76	43.61	14.9	73.6	65.96	0.11	
6	116.56	95.98	0.28	9.95	43.35	14.92	73.39	79.16	0.13	

6. Recommendations to avoid errors

Preparing parts takes a lot of effort. The tests performed are valuable, to avoid errors that can slip into the test procedures check the following points:

- Avoid leakage by using a good seal on each surface (cylinder table/adapter and cylinder head/cylinder head adapter).
- Avoid leakage at valves that remain closed.
- Mount the spark plug.
- If flexible valve springs are used, check that the valve is not sucked in and opened by suction during intake tests (frequent at low lift).
- Use the same radiused flow guide on the inlet side (rounded plasticine ring).
- Use the same cylinder adapter.

The electronics and software make an **automatic zeroing** of the pressure sensors. The test temperature is read by sensors, so temperature compensation is ensured. However, a wait for stabilization of the order of one minute when the FCU is switched on is welcome. This will be masked by the test implementation time if the FCU is connected to the PC first.