![Elveflow logo] **ELVE FLOW** an **ELVESYS** brand

MUX RECIRCULATION VALVE 6/2

6-ports/2-positions

USER GUIDE

Table of contents

Introduction

The MUX Recirculation valve is a 6-ports / 2-positions microfluidic valve. When paired with the OB1 MKIII+, this device allows to:

- recirculate fluids in a closed loop
- inject small samples in a buffer stream

Coupled with the ease of use of the ESI control and automation software, this versatile valve makes long-term experiments easier to automate and run.

Main Features & Benefits

- Switch between 2 flow configurations in less than 180ms, thanks to a fast & precise valve motor
- Work in total confidence thanks to the robust and biocompatible materials used (PTFE, PCTFE)
- No dead volume[1] and low carryover volume[2] (0.5µL), for the best solution usage efficiency.
- Easy ¼-28 connection enables for a leak-free operation and quick connection using standard fittings.

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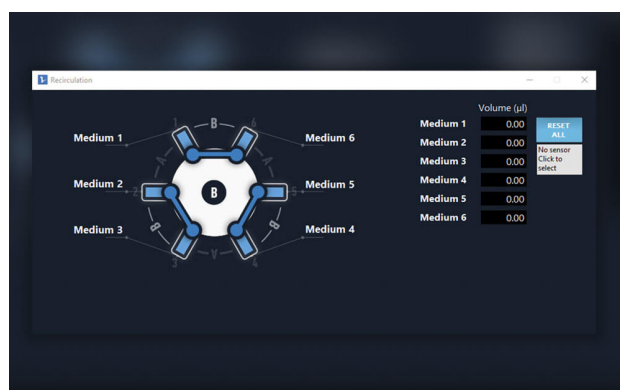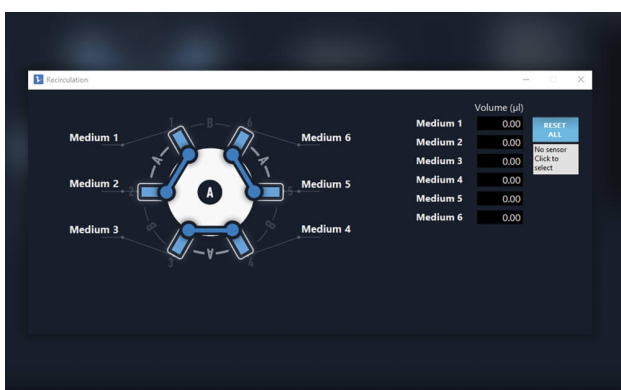
[1] Volume that is stuck in the system (dead end), which is not clearly swept and relies on diffusion to clear out.

[2] Volume of liquid that will be mixed with the next liquid. It is not stuck, but will be swept next time a liquid passes.

Applications example

- Fluid recirculation
- Cell culture on chip
- Drug screening
- Controlled microfluidic sample injection
- Sample injection
- Stem cells assays
- Organ on chip
- SPR or TIR imaging coupled with microfluidics
- Toxicity tests

Instrument description
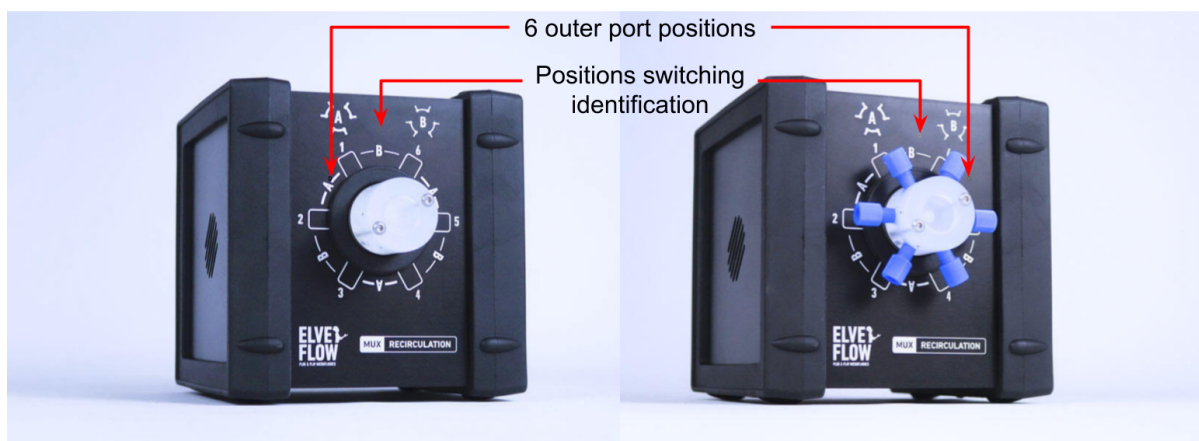
Description

Figure 1 Front view of the MUX Recirculation: The outer ports positions are marked from 1 to 6. Additional marking allows for the quick and easy identification of the 2 switching positions (A and B).
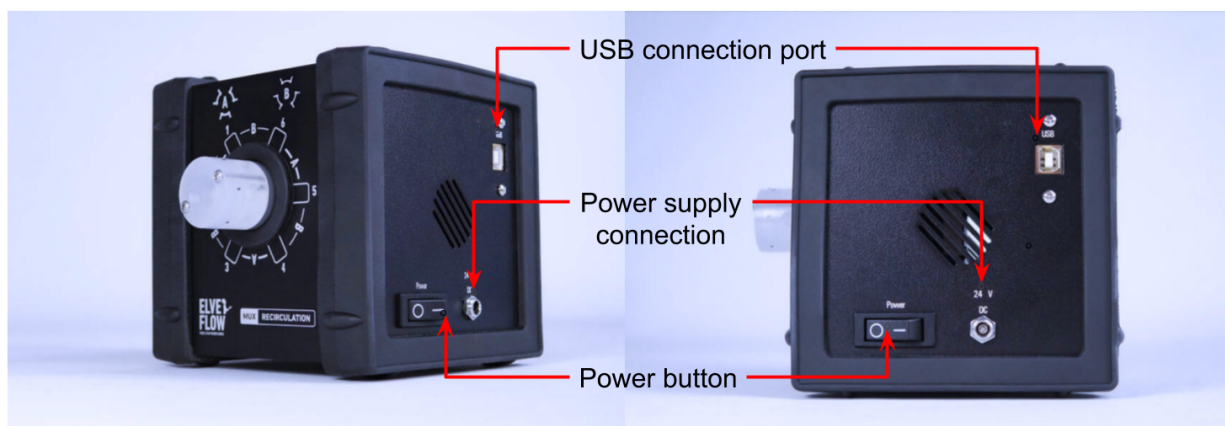

Figure 2. Side view of the MUX Recirculation. The USB and power supply connection ports can be found on the side of the device, along with the power button.

Technical Specifications

Performances	**Port to port switching time (ms)**	180 ms
	Max recommended pressure	7 bar
	Internal diameter	0.5 mm
	Internal volume [3]	2.5µL
	Carryover volume [4]	0.5 µL
	Dead volume [5]	None
	Wetted materials	PCTFE, PTFE
	Number of ports	6
	Number of positions	2
Electrical	**Input voltage range**	100V to 240V
	AC supply frequency	50 Hz to 60Hz
	Power supply voltage	18-24V DC
	Max current consumption	2A peak
	Power consumption (max)	36W
	Connection type	USB
Mechanical specifications	**Fluidic connectors**	Standard 1/4-28 UNF, flat-bottom
	Operating temperature	5-40°C
	Operating Humidity	20-70% non condensing
	Dimensions (without connectors)	133x156x133 mm
	Weight	1.12 kg
Software	**Computer specifications**	USB 2.0 port, Intel Pentium II 500 MHz, 1 Go Hard Disk space, 2 Go RAM Windows XP and newer, 2/64 bit. - LabVIEW® 2011 is required when using LabVIEW® libraries. - ESI installation is required to use SDK.
	Provided software	Elveflow Software Interface
	Software development kit	C++, Python, MATLAB® and LabVIEW® libraries

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[3] Volume inside the system from entrance to exit.

[4] Volume of liquid that will be mixed with the next liquid. It is not stuck, but will be swept next time a liquid passes.

[5] Volume that is stuck in the system (dead end), which is not clearly swept and relies on diffusion to clear out.

Product package contents

Before setting up your MUX Recirculation valve, please check the package contents to verify that you have received the items below:

- the instrument
- a USB cable
- a power supply unit

In addition to the above items. The user should have the necessary fluidic accessories, tubings and fittings to connect the inlets/outlets to the rest of the setup.

Installation & use

In order to use the MUX Recirculation, the device must be connected to the fluidic setup and to the computer.

Fluidic connections

For connecting each port, you need these necessary accessories:

- ¼ -28 connectors for 1/16 inch tubing
- ¼ -28 plug for unused ports
- 1/16 inch OD tubing
- Flat bottom ferrules

Connect each port as described in the following illustrations:

1. Cut the tubing to the appropriate length. Ensure a straight section.
2. Slide the ¼ 28 connectors into the tubing.
3. Put the ferrules into the tubing. The flat side facing the instrument ports. Leave only a few mm between the ferrules and one end of the tubing.
4. Connect the tubing to the instrument ports and tighten the connector to prevent any leaks. Be careful not to tighten too much the connector to prevent any damage on long term use.

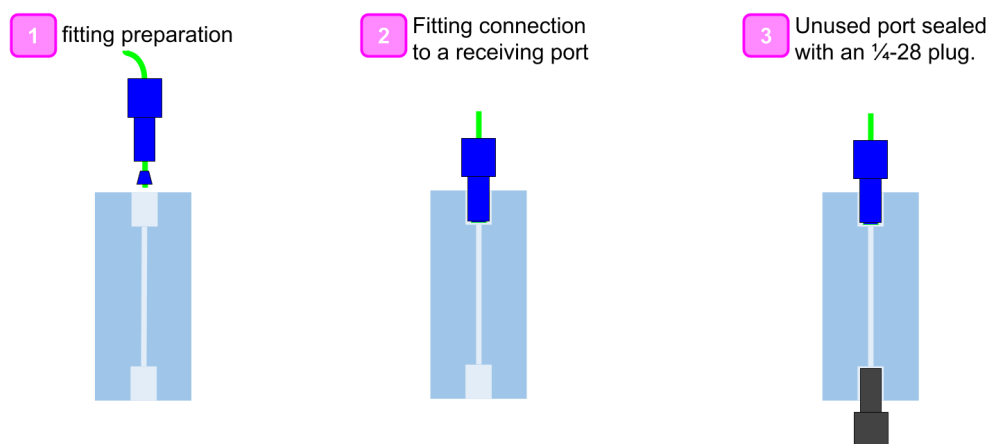   Note: Please remember to seal the unused ports with an ¼-28 plug.

Figure 3. Fittings connection principle: this device uses standard ¼-28 fittings for quick and easy connection, and leak-free operation. Remember to close any unused ports (if any) with an ¼-28 plug.

Electrical connections

1. Connect the power supply to the DC adapter socket.
2. Connect the USB cable to the computer running the ESI software.
3. Use the power button to turn on the instrument.

Software installation:

You are now ready to use your Instrument. It can be either controlled by the Elveflow® Smart Interface software or by software development Kit (C++, Python, MATLAB® and LabVIEW® libraries). The Elveflow® Smart Interface's and the SDK main features and options are covered by specific guides.

Please refer to the ESI user guide for a detailed description of the software controls.

1. Download the <u>latest ESI version from the Elveflow website.</u>
2. Open the Elveflow folder.
3. Run Install.exe.
4. Follow the instructions presented by the installation assistant.
5. Restart your computer when prompted to finish the installation process.

Note: The MUX Recirculation 6/2 is supported from version V3.05.02 up. Please update your software if you're using an older version.

Getting started: learning with an example

The section below "Getting Started" describes a typical application of the MUX Recirculation so you can learn how to use it with an example.

How to perform fluid recirculation with an Elveflow MUX Recirculation valve ?

Setup :OB1 MK3 pressure controller + MUX Recirculation + Flow Sensor + microchip (e.g. Organ-On-Chip)

The MUX Recirculation is a bidirectional 6-port / 2 position valve allowing you to perform switches between two set-up configurations. One application is to make a recirculating set-up with a flow rate always going through the chip in the same direction. In this application note, we walk you through the steps of setting up a unidirectional fluid recirculation through a semipermeable membrane.

The injection loop consists of a network of inputs/outputs that can be connected to each other in two configurations.
The MUX Recirculation has 6 inputs and two configurations shown on the image below.
Each input is connected to a neighbor output, either on the right or the left depending on the configuration.

Elements required

This section explains how perform fluid recirculation at a controlled flow rate in the device of your choice (microfluidic device, perfusion chamber etc...) using the following equipment:

- *Setup :OB1 MK3 pressure controller*
- *MUX Recirculation*
- *Flow Sensor*
- *Microchip (e.g. Organ-On-Chip)*

We are using here an organ on a chip-like configuration to showcase the recirculating setup.
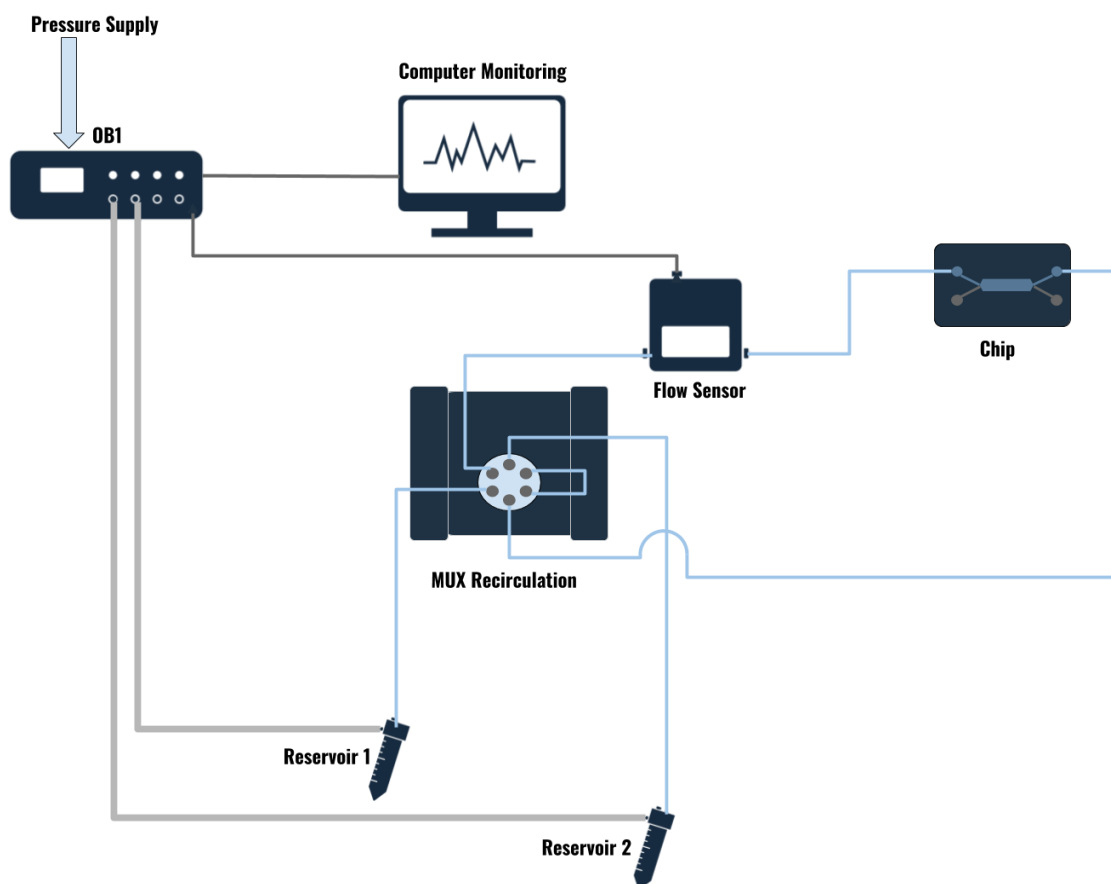

Figure 4: Example of a setup used for fluid recirculation with an Elveflow MUX Recirculation valve.

This chip is a two input two output chips. It consists of two channels, one upper channel and one above channel, separated by a semi permeable membrane. The idea of the experiment is to have a continuous and constant flow of for instance cell nutriment in the upper channel. This nutriment is recirculating during a given period of time. In the below channel, there is a continuous flow (for instance, of cells) which is not a recirculating flow.

This experiment showcases how nutriments diffuse through the membrane and which amount of the initial quantity of nutriment has been consumed by the cells. We are here using a blue dye to mimic the nutriment.
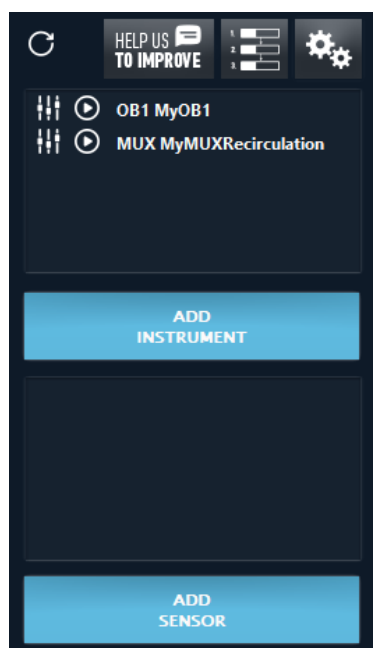
Tips : For a faster switch, place your microfluidic chips as close as possible to the Mux Distributor. It also allows a more accurate volume control with less liquid in the tubing.

Programming a flow recirculation automated sequence

1. Open the Elveflow Smart Interface and add the OB1, and the Mux Recirculation.
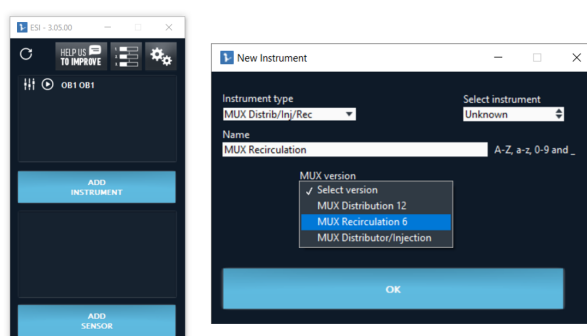

2. When both instruments are added, launch them!

3. In this example, we are using 3 channels of the OB1:
- Channel 1 is always on and corresponds to the continuous flow
- Channels 2 and 4 are alternatively on and correspond to two recirculating lines. Set some pressure into these channels.

This is the first configuration with channels :#1. and #2 on and channel #4 off.

4. Here is the second configuration with channel 4 on and channel 2 off.

The flow sensor on Channel 2 shows the flow in the microfluidic chip. In both configurations, you will see that this flow is always positive.
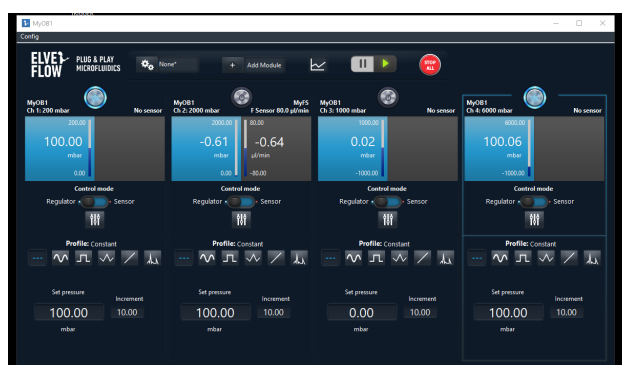

5. You can save these configurations. It allows to switch faster between two configurations. You can for instance use the scheduler to automate the recirculation.
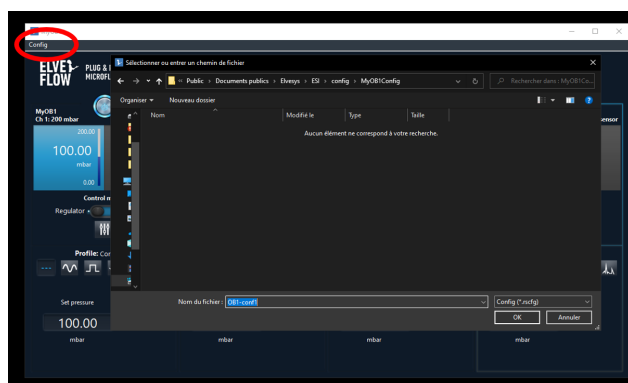

6. Open the injection valve panel. You can rename the inputs and outputs to get a more readable setup. You are first in position 1. In this first position, the liquid flows from the first reservoir to the second one.
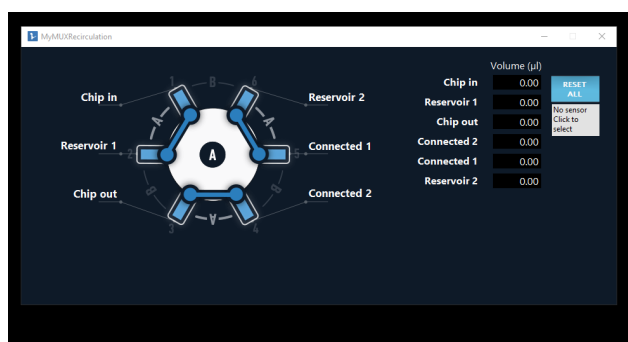
7. When you want to recirculate from the second reservoir, click on the valve drawing to switch position and switch the pressure configuration. In this second position, the liquid flows from the second reservoir to the first one. The flow through the chips has the same direction as in the first configuration, though.
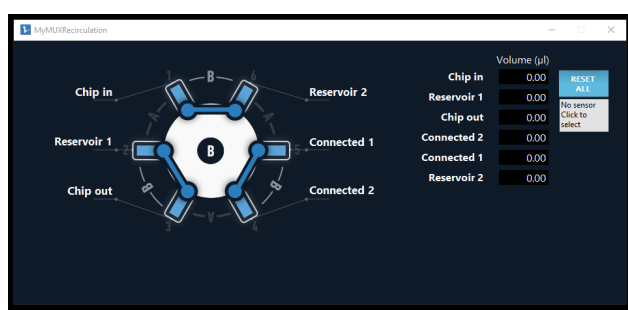
10. To perform this switch automatically, you can create a sequence using the scheduler. If you created two configurations for the 081 (as advised previously), you can use them in the sequence. Otherwise, you can use the button "Use actual configuration ".
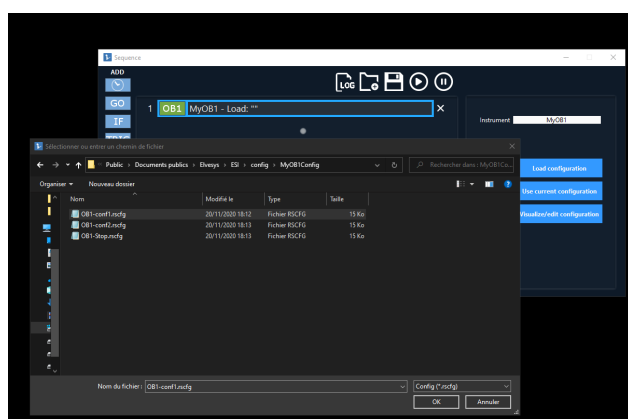
12. In this example, the sequence first puts the ob1 and the valve in configuration 1, wait 1 minute, put them in configuration 2, wait 1 minute and repeat these steps 20 times before stopping the pressure.
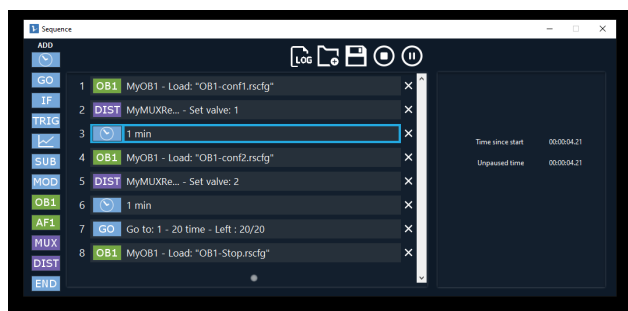
Congratulations, you can now run your experiment and perform continuous fluid recirculation with an accurate flow regulation!

A dedicated product: the recirculation pack

Elveflow developed a full system for continuous unidirectional recirculation experiment called the Recirculation Pack, that has the following feature and benefits:

- Unidirectional liquid flow: the liquid stream flows continuously in the same direction
- No more media depletion: don't be limited by your sample volume: recirculate your medium
- Uniform shear stress: same flow direction ensures no variations in shear stress
- Week-long experiments for automated experiments over time
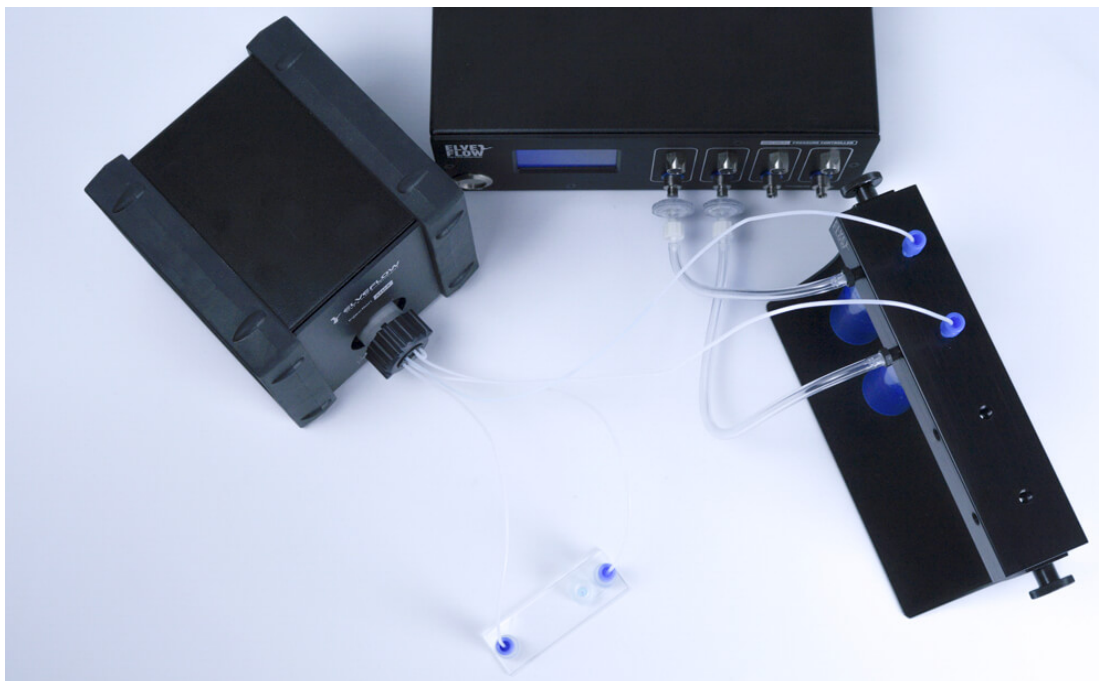
Discover it on elveflow.com !

Tips & tricks - Recommendations

Cleaning Procedure

A cleaning procedure should be performed at the end of each day or in between two different experiments. For an effective cleaning, pass one of the solutions below (depending of your application) at least twice in each tube connected:

· **Bleach solution** to kill microorganisms : 1% chlorine bleach and deionized water
· **Detergent solution** to remove debris: 1% detergent (Mucasol for example) and deionized water.

Note: 2% RBS 25 can also be used. For blood or plasma manipulation, you may use 1% Alconox. For the valve, you can make this washing step into an ultrasonic bath after a long period of using it.

· **Rinsing water** to prepare the valve for your next experiment: deionized water.

Note: Before the rinsing step with the deonized water, you can add a washing step with a solvent such as IPA or 70% ethanol (same manipulations as for the rinsing step). Thanks to the small internal volume, each cleaning cycle is extremely efficient. These solutions can be directly added to your system for automatic cleaning between experiments.

Note — Additional cleaning :
If your experiment creates precipitates, a more extensive cleaning cycle may require Elveflow to manually remove and clean the valve head. Please contact us for further details.

Flow rate controlled recirculation requires a tuned flow sensor

If you would like to perform the recirculation at a specific flow rate, a Flow Sensor should be used. Then the tuning of this flow control should be performed.
If you want to go further in the understanding of this flow control tuning, check out our dedicated tutorial: Set a Flow Control Feedback Loop (Resistance and PID tuning).

Do not use Elveflow equipment in a humid environment

Damages caused by humidity, either due to an improper fluidic connection causing leakage, or by the use in a humid environment (e.g. cell culture incubator) can cause damage to this equipement, that would not be covered by warranty.

Troubleshooting

Below, are the most common events that can happen during an experiment.

The valve head is leaking?

If the valve is leaking, it is most likely due to improper fluidic connection. Please check the following:
The ferrules are put in the right direction (follow the fluidic connection section)
The ¼-28 connectors are not tightened properly

Unused outputs are not sealed

I cannot add or detect the instrument in the ESI software?

Please check that you added the instrument properly. Reminder: the instrument falls under the category "rotative valve".

Your instrument might be already added to the software. Launch the ESI software again and click on the refresh button.

Linked products
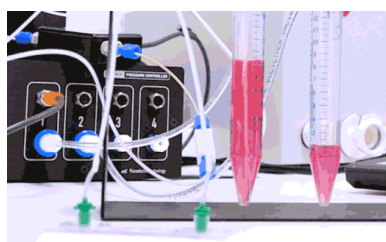
[Recirculation Pack](#)
An all-in-one solution for continuous unidirectional injection of liquids.

[OB1 MK3+ Flow Controller](#)
The most responsive and stable flow controller on the market

[MUX series](#)
MUX Distribution, MUX Wire, Individual valves...

Customer Support

You are welcome to browse through the Elveflow Support Portal accessible online anytime (https://support.elveflow.com/support/solutions). You can find lots of guidance on how to use our product line. It is most likely that the answers you're looking for are already here.

In case there are still some questions and you'd like further clarification, please don't hesitate to let us know by email at customer@elveflow.com.

We are always happy to help.