

Lab instructions: Microfluidic

Winter 2021

University of Ottawa

Marianne Fenech

Co-flow analysis

Note: the text is written with red & blue colours as an example, but you may have got other colours in your envelope pack

Experiment

Following the [video](#) instructions, flow the 2 coloured water in the Y channel. Make several attempts with a different high of the coloured fluid as shown in the [video](#). **Estimate the high of each fluid** (e.g. H_{red} and H_{blue} , H_{out}) in the inputs and output (if applicable) pipette tips for each attempt and take a close picture of the channel. Estimate **the relative width of the coloured bands*** (e.g. w_{red}/w_{blue}).

* use your cell phone to have a close picture, usually works pretty well! **Save the picture, use a software** of your choice to do precise measurement as shown in the [video](#) . My favourite is [ImageJ](#), it is an open-source software widely used in biomedical research.

Experiment modelling

To model the experiment you can assume that the 2 fluids flow side by side between two plates (2D), the fluids are Newtonian, immiscible and have the same viscosity. The flow rates can be adjusted by changing the high of the fluids in the input pipettes tips as shown in the video. The goal of the analysis is to determine the **relative width of the coloured bands** w_{red}/w_{blue} **function of the relative flow rate** Q_{red}/Q_{blue}

Make a clear sketch of the setup. Precise your nomenclature and where is the origin of your referential. Stick to that all long through!!!

Theoretical analysis

1-Flow rate prediction. The input pressure is being set by the height of the coloured fluids in the inlet pipette tips (P_{red} and P_{blue}) the pressure at the entrance of the main channel P_{in} is the same for both fluids and the pressure at the output of the main channel is P_{out} ($=P_{ATM}$ if you let the output hole free from tip else it is set by the height). Knowing the dimensions of the chip and using the Poiseuil equation for the rectangular channel (below) found the relationship between the flow rates and the height of the coloured fluids in the inlet pipette tips: $Q_{red}(H_{red}, H_{blue})$ and $Q_{blue}(H_{red}, H_{blue})$. Discuss the range of relative Height that would work (i.e. for which both channels are flowing)

$$\Delta p = \frac{12\mu L}{wh^3} Q \quad \text{for} \quad h \ll w$$

2-Velocity profiles. Solve the conservation equations in order to obtain the velocity profiles for each fluid. Precise your assumptions simplifications and boundary conditions clearly. The equations can be solved by hand but you're welcome to use symbolic math tools like Maple, Matlab symbolic or Mathematica.

3-Found the theoretical relation relative width of the coloured bands w_{red} / w_{blue} function of the relative flow rate Q_{red} / Q_{blue}

DELIVERABLE:

Write a report including Introduction, Material and Method (analytical and experimental) , Results (analytical and experimental), and Discussion sections. When presenting your experimental data: we want to see pictures!!!!. Do an error analysis. Compare your experimental data to the theoretical prediction: Ideally plot the analytical prediction w_{red} / w_{blue} function of the relative flow rate Q_{red} / Q_{blue} , along with experimental points. Discuss.