ME-474 Numerical Flow Simulation

Assessment #2

Fall 2024

I. Guidelines

For this second assessment, you will use Fluent to perform a full CFD study going through all the steps of the simulation workflow: pre-processing, setup, simulation, post-processing and analysis.

You have two options:

1. choose a topic of your own,
2. choose one of the topics suggested below.

For option 1, it is advised that you send me by email a short description of what you plan to study (you can use for instance the "specification template" available on Moodle). It will not be graded; the aim is to make sure early enough that your topic is suitable for the scope of this assessment, and have enough time to react otherwise.

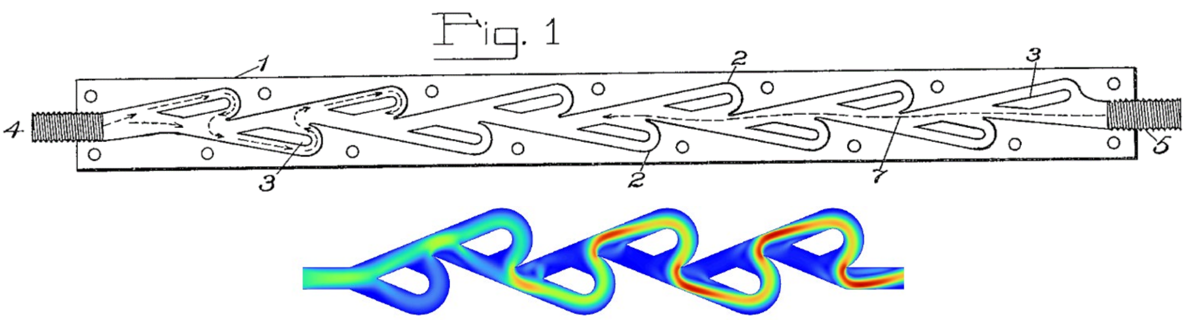
In any case, follow the guidelines presented in the lecture slides of week 1 (e.g. 2D or axisymmetric problem, no solid thermal conduction, no two-way coupling fluid-structure interaction, etc.).

Write and submit one single report per group (one single pdf file) by **January 3, 2025**. You may use the report template available on Moodle (which will be presented later during one of the lectures).

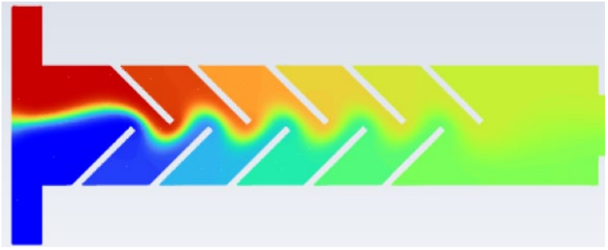
II. Examples of topics

1. Tesla valve (fluidic diode)

Study how the relationship between flow rate and pressure drop depends on the flow direction (and possibly on the geometry, number of cells etc.).

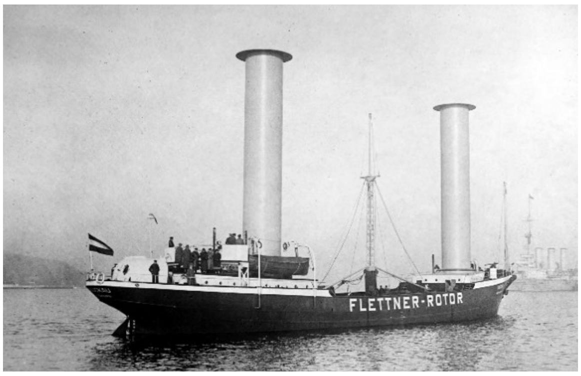


2. Laminar mixing device



Compare two (or more) geometries of devices aiming at mixing two miscible fluids in the laminar regime, without moving parts or external forces. Typical application: mixing of biomedical/chemical fluids at small scales.

3. Flettner rotor (Magnus effect of a rotating cylinder)



Study the aerodynamic coefficients of a rotating cylinder at different rotation rates. You may compare potential theory, inviscid CFD and viscous CFD. Typical application: ship propulsion.

4. Paraglider wing

Study the aerodynamic coefficients of a paraglider wing at different angles of attack (and possibly different speeds). Investigate the admissible operating conditions to avoid not only stall (like conventional rigid airfoils) but also wing collapse.

5. Airfoil in ground effect

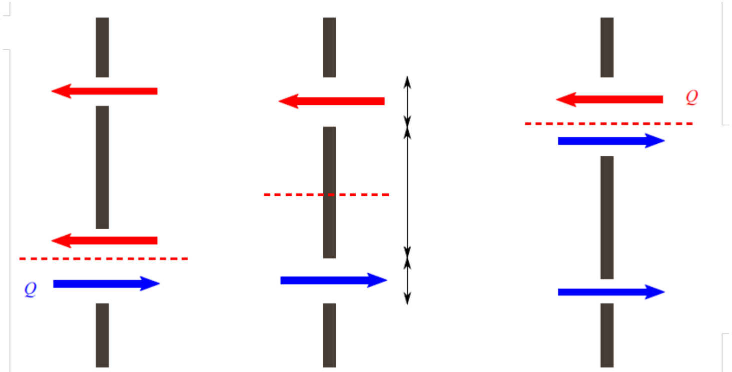
Study the aerodynamic coefficients of an airfoil in ground proximity. Compare different values of ground clearance (distance between ground and airfoil), including an infinite clearance (no ground). Typical applications: race car, airplane landing/takeoff.

6. Pitching/heaving airfoil

Study the aerodynamic coefficients of an airfoil that flaps in a pitching, heaving, or combined motion. Typical applications: insect/bird/fish propulsion, small unmanned aerial vehicles.

7. Ventilation efficiency of sash windows

Common in northern Europe, sash windows have two vertical sliding panes that create openings at the top and/or bottom, and are thought to be more efficient for ventilation than windows with a single opening. When the interior and exterior temperatures T_{in} and T_{out} are uniform but different, pressure differences through each of the two openings (resulting from the different vertical pressure gradients dp_{in}/dz and dp_{out}/dz) drive the air in and out. Three flow regimes are possible, depending on the height of the neutral level where $p_{in}=p_{out}$. You can explore how the ventilation flow rate depends on the size of the two openings, and compare in particular with single-opening windows.



8. Heater

How fast does the air temperature increase in a room when using a heater? How uniform is the temperature distribution? What is the influence of the heater position, for instance close to a window or far from it?

9. Mixing/cooling of a cup of tea/coffee

- **Mixing**: when milk/cream is added to tea/coffee, without stirring, how fast does the mixture become homogeneous? Does the initial temperature difference have any influence?

- **Cooling**: to cool down a cup of hot tea/coffee by adding a given amount of milk at room temperature, is it faster to add the milk (i) immediately, or (ii) after a few minutes, once the tea/coffee has already cooled down a little?