Indian Institute Of Technology Kanpur

AE 351A

Experiments in Aerospace Engineering 2020-21

Semester II

Experiment 5B
2-D Dye Flow visualization using Hele-Shaw Apparatus

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1. **Objectives**

   To study the potential flow patterns over streamlined and bluff bodies.

2. **Introduction And Theory**

   Hele-Shaw flow is defined as Stokes flow between two parallel flat plates separated by an infinitesimally small gap, named after Henry Selby. Hele-Shaw, who studied the problem in 1898. Hele-Shaw apparatus produces streamlines in a laminar, steady flow. The equipment consists of a channel formed between two glass plates. Water flows along the channel at a low Reynolds number.Two separate tanks are available at the top of the apparatus where water and die can be stored separately. Tiny holes at the bottom of the tank allows the dye to flow down through the channel forming streamlines. The fluid can be poured out of the apparatus with the help of the value and pipe connection. The dimensions of this apparatus is dimensions 2mm × 85mm × 100mm.

3. **Equipment's**

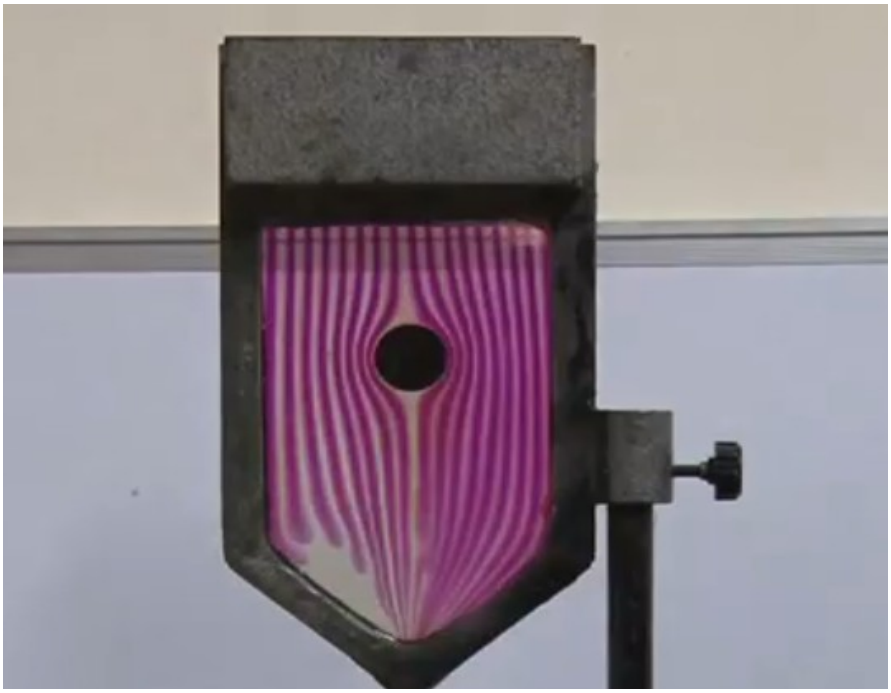
   - Hele-Shaw Apparatus
   - Dye and water
   - Beakers
   - Model: Thin plastic models of various shapes including: 2D Circular cylinder, Symmetric airfoil and Cambered airfoil.

4. **Procedure**

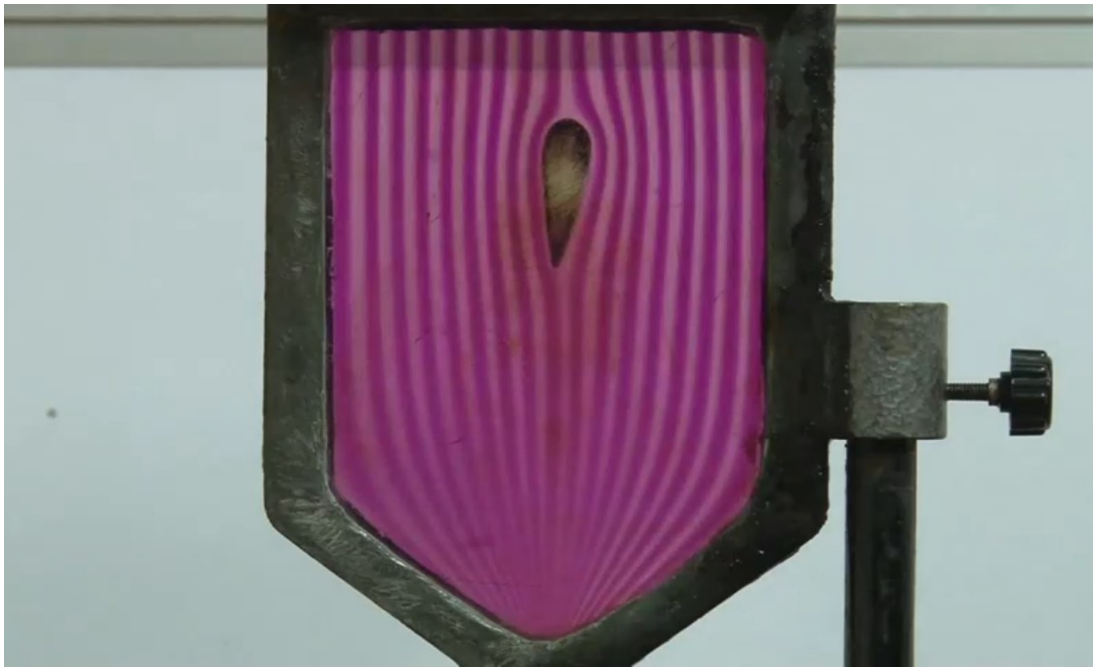
   - Placed the model in test section as required.
   - Filled water in the reservoir.
   - Once the channel was filled with water with no bubble formation inside channel, poured dye in the reservoir.
   - Opened the valve at the bottom as required to allow dye to form streamlines.
   - Observed the flow around the model.
   - Repeated the process with different flow rates and models.
   - Cleaned the apparatus after completing the experiments.

5. Observation

*Flow Over a Cylindrical airfoil (**bluff body**)*



*Flow over symmetrical airfoil at 0degree AOA (**streamline body**)*



Flow over symmetrical airfoil at some Angle of Attack

6. Results

- In this exeperiment, for a bluff body or streamline body, we get two stagnation point that we can’t visualize in 2D smoke flow exeperiment .
- As we increase angle of attack of an airfoil, the stagnation point at leading edge and trailing edge shifts downward and upward resspectively.

- Potential flow never separates from a surface, as separation only happens in a viscous fluid. However the streamlines in the Hele-shaw apparatus show regions of adverse gradient. If the problem is where the pressure decreases in the same direction as the flow, the streamline pattern for a real fluid is similar to that in potential flow.

Potential Flow	Real Flow
Irrotational (i.e. the fluid particles are not rotating).	Rotational (after flow sepration vortices generate)
Inviscid (i.e. frictionless)	Viscous
Incompressible	Incompressible or compressible

7. Precautions

- Level of dye should be less than water in channel
- Be careful during pouring dye in channel
- Clean the appartus before leaving the lab