FLOW VISUALIZATION LAB REPORT

THEORY

For many years, scientists have struggled to observe the movement of fluid particles. This is because fluids are generally invisible and are therefore difficult to observe, analyse and draw accurate conclusions from.
To solve this problem, scientists devised various methods to render the flow of a fluid, e.g. air, around a body visible. This is done by making the streamlines apparent. In most cases, these streamlines coincide with the trajectories of the individual fluid particles.

Using the smoke generator as a method for flow visualization falls under analytical methods that analyse a given flow and show properties like streamlines, streaklines, and pathlines. With the use of various models, observers are expected to classify flow into laminar, turbulent and transitional.

PRINCIPLE OF OPERATION OF SMOKE GENERATORS
(Insert diagram of smoke generator here)

The tunnel is an open-circuit design, powered by a small variable speed electric fan. The fan pulls air from the room through a turbulence screen into the lower compartment. The speed of the flow in the test section is controlled using the dial located at the bottom right corner of the equipment.

Kerosene is passed from the fuel chamber into the heater and then to the condensed bottle which goes into the smoke tunnel. The vapor is piped via the perforating comb where the equally spaced holes introduce smoke filaments into the flow.

The light knob regulates the brightness of the bulbs on either side of the tunnel while the draught fan evacuates the smoke.
The smoke generator highlights the flow pattern around various models such as aerofoil, turbine blades and bulbs.

Post Lab Assignment

i. Describe with the aid of sketches the flow pattern around each object.

Ans:

(This should be noted in the observation. It's the same thing. You have pictures right?)

Turbine blades -

Aerofoil - Laminar but turbulent sideways

Vane- laminar and then turbulent sideways

Bulb - Transitional

Triangular model -

Also note that the shape and the angle of the model determines the type of flow.

ii. Compare the flow pattern around a cylinder to that predicted by ideal theory.

Ans:

The potential flow around a circular cylinder is often studied in fluid mechanics. Firstly, the cylinder is placed in a two-dimensional (or three-dimensional), incompressible, inviscid, uniform flow.

The upstream flow is uniform and has no vorticity. The flow is inviscid, incompressible and has a constant mass density . Thus, the flow remains without vorticity and is said to be irrotational.

The flow pattern and the drag on a cylinder are functions of the Reynolds number, based on the cylinder diameter D and the undisturbed free-stream velocity.

In ideal theory, differences in lengths of the streamlines are observed, but all particles begin at the same time on the left side and arrive at the same time on the right side.

This does not typically happen in real life experiments due to skin friction and drag and lift forces observed when the fluid is viscous.

Instead, turbulent flow occurs beyond the cylindrical model as opposed to the perfect laminar flow in ideal theory.

Under what condition is the observed flow pattern expected to be similar to that predicted by potential flow theory?

Ans:

uniform and unidirectional, inviscid and incompressible flow.