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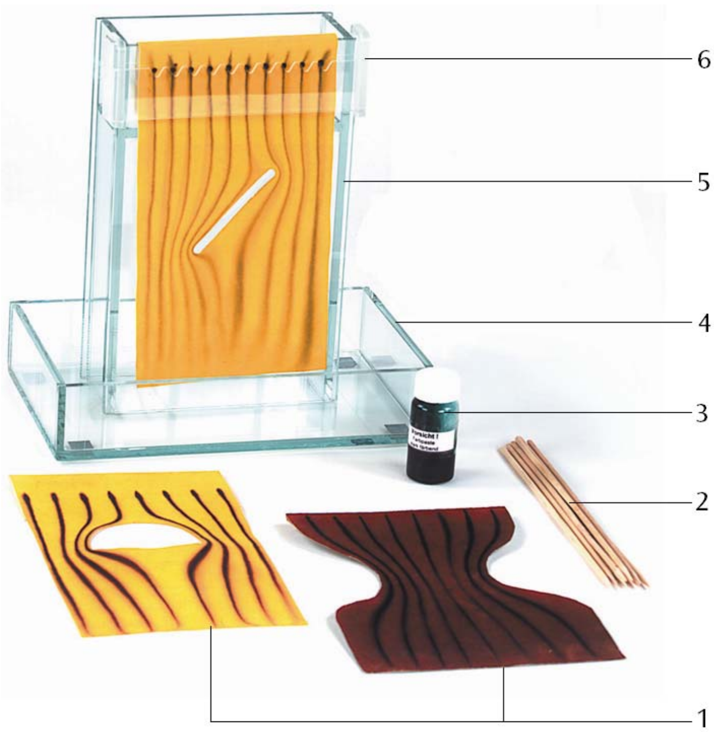
Laminar Flow Apparatus

1006784 / U8404248

Instruction Sheet

02/12 ELWE/ALF



1 Sheets of velour paper
2 Swad for the dye
3 Flask with dye
4 Acrylic glass basin, bottom
5 Acrylic glass basin, top
6 Mask

1. Description

The laminar flow apparatus can be used to demonstrate and examine the laminar flow in water.

It enables experiments which focus on the following subjects:

- Development of flow in water
- Streamline curve of a linear laminar water flow
- Streamline curve around objects with various shapes
- Streamline curve around a wing of an aeroplane with different angles of attack
- Streamline curve at a narrow point

The laminar flow apparatus consists of two cuboid acrylic glass containers. The large container has a separate floor, so that its top part can be filled with water. The bottom container collects the overflowing water. The water flows along rectangular sheets of velour paper, whose top ends point into the large container. The velour paper sheets have cut-outs, which allow you to generate various flow curves. A mask is put onto the velour paper. It contains cut-outs which allow you to evenly mark the flow with colour.

2. Equipment supplied

2 Acrylic glass basins

1 Mask

20 Sheets of velour paper with cut-outs

1 Mini-flask with dye

Swab for dye

Rubber gloves

3. Technical data

Dimensions:	approx. 220x140x240 mm3
Weight:	approx. 1 kg

4. Operating principle

Due to the capillary effect and the weight of the water, it is sucked out of the top container, slowly and constantly flowing down the velour paper. At the bottom end of the paper it drops down and is collected in the flat bottom container. In order to be able to observe and record the streamline curve, the water flow is marked with colour at regular intervals near the top edge of the container filled with water. When the flow is frequently coloured at these points, the streamline curves are marked by the developing colour lines. At the cut-outs in the velour paper, the streamlines change. Due to the colour, the respective paths of the flowing water are made visible. The streamlines have their initial shape behind the blocking object. Due to the thin water layer and the flow resistance of the fibres in the velour paper, the flow velocity is limited to approx. 2 mm/s. It is therefore possible to easily observe how the streamline images of the laminar flow develop. The equipment is distinguished by its simple testing method, its easy handling and a safe testing performance. It has the special advantage that the developing streamline images can be made permanent by drying the velour paper sheets for later use.

5. Operation

- Fill the top part of the large glass container with water up to a few millimetres below the top edge.
- Then select the required velour paper sheet.
- Soak it with water by either letting water flow over the paper or by completely dipping it into a flat container filled with water.
- Bend back the top part of the velour paper, with the velour side facing the observer.
- Suspend the folded part of the paper over the edge of the wall of the acrylic glass vessel such that it reaches well down into the water.
- Smooth out the front of the velour paper with your hand to remove possible air bubbles between the wall and the paper.
- Then put the mask over the velour paper sheet onto the top container (refer to fig. 1).

Fig. 1

- Insert the swab into the bottle with the colour solution. Then subsequently apply the colour to the cut-outs on the mask. If there is not enough colour, repeat this procedure.
- When using dyes be careful not to splash them on clothing, for example.

Step by step, the respective streamline image develops on the velour paper.

- Then remove the mask, take the velour paper out of the container and dry it, for example, by hanging it on a horizontal cord.

Note: You may easily cut shapes yourself into the respective pieces of velour paper. Any shape and position for the object is possible. The velour paper should be of a light colour.

6. Sample experiments

6.1. Streamline curve of a linear laminar flow

- Use the velour paper sheet without cut-outs.

The colour lines run vertically at regular intervals (refer to fig. 2).

Result: In a linear laminar flow, all the streamlines are parallel to each other. The direction and the velocity of the flow are constant at any point.

6.2 Streamline curve around objects with various shapes

- Use sheets of velour paper with cut-outs in the form of a circle, semi-circle and a rectangle one after the other.

In front of the object, the flow splits. The streamlines move around the sides of the object. The intervals between them reduce. The flow reassembles behind the object. The individual streamlines run at regular intervals, as in front of the object (refer to fig. 3 a, b, c).

Result: The flow object causes the flow to change its direction in its close proximity. The velocity of the flow increases and the streamlines move closer to each other. Behind the object, the velocity of the flow reduces. The interval between the streamlines increases. Finally, the lines are parallel.

6.3. Streamline curve around a wing profile of an aeroplane

- Carry out the experiment using a sheet of velour paper with a wing-shaped cut-out.

Above the wing, the streamlines change their directions greatly and are compressed. Therefore, the flow velocity is high. Below the wing, the flow velocity only increases slowly. Repeat the experiment with the velour paper sheet, on which the angle of attack is larger than zero. In the top area, the directions of the streamlines change greatly. Below the wing profile, the streamlines initially run in its direction and are then drift down (refer to fig. 4 a, b).

Result: The streamline image of a wing profile shows a great increase of velocity above the profile due to the narrow streamlines. Below the wing, the fluid flows in the direction of the wing when the angle of attack is positive and then drifts down.

6.4. Streamline curve at a narrow point

- Use the velour paper sheet with the cut-outs on both sides.

When the flow reaches the narrow point, its velocity increases. The streamlines move together. After passing the narrow point, the streamlines move apart, so that the flow shows its initial streamline curve (refer to fig. 5).

Result: At a narrow point, the interval between the streamlines reduces. The flow velocity increases greatly. After the narrow point, the intervals between the streamlines increase. The flow velocity reduces.

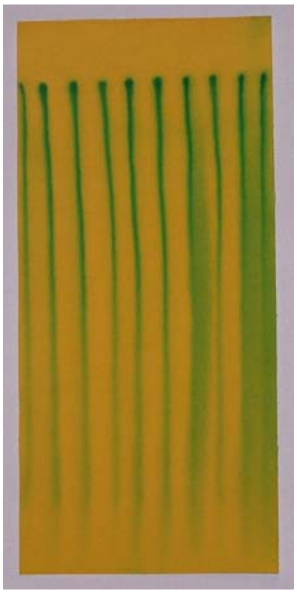


Fig. 2

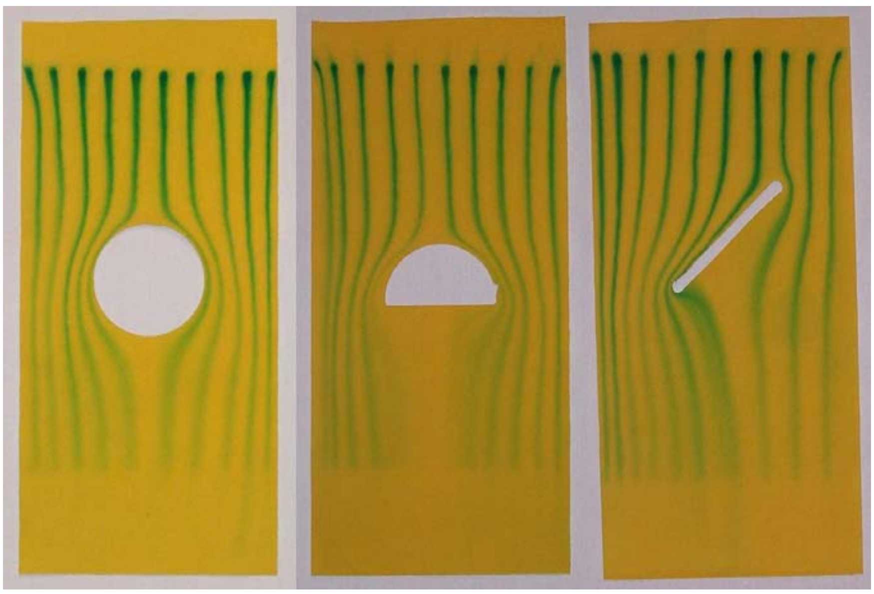


Fig. 3 a, b c

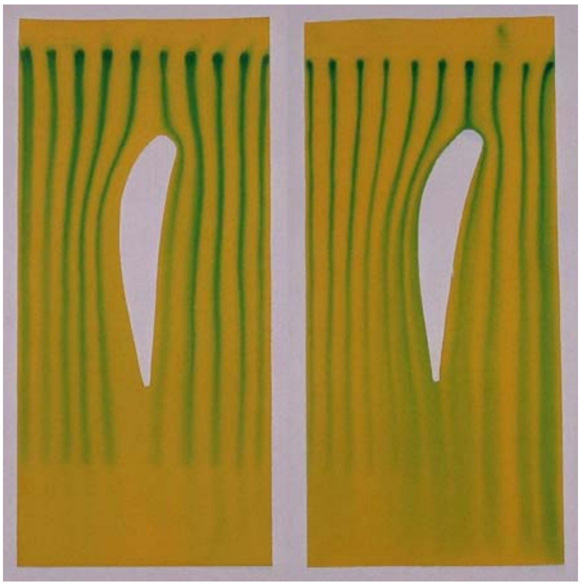


Fig. 4 a, b

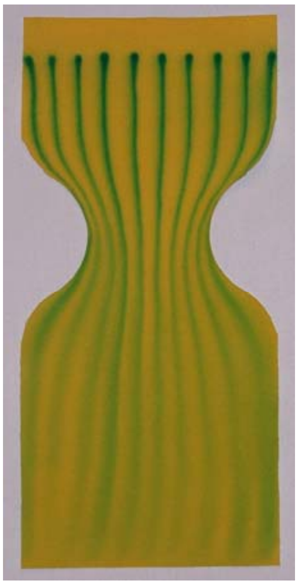


Fig. 5