

Flow visualization

When an object moves through a fluid, air or water for example, we are normally unable to see the complex pattern of the fluid around those objects. Flow visualization is a technique that allow us to see the flow around objects and help us understand fluid motion. There are many different flow visualization techniques, like colouring dyes, adding seeding particles, tufts of wool, etc. In this experiment we are going to visualize the flow using cocoa powder in a glass of milk.

For this experiment you will need:

- Milk
- Cocoa powder
- A glass
- A knife
- A spoon

Pour warm milk into the glass, add some cocoa powder to it and stir it. Let the mix rest until it is not moving. In this experiment, the powder will help visualise the flow as it moves with it. Insert the knife in the mix and move it from one side of the glass to the other with the edge of the knife going forward first, what pattern do you see?

By changing the shape of the object you will see different patterns forming. You can do the same experiment with the flat side of the knife going forward first and with the head of a spoon in a way that the convex part moves forward first. How does the flow pattern change? You can see some results in the pictures below where the object, spoon or knife, was moved from the bottom to the top of the glass (as seen in the picture).

Can you explain why the different patterns occur?



Answers and follow-on activities

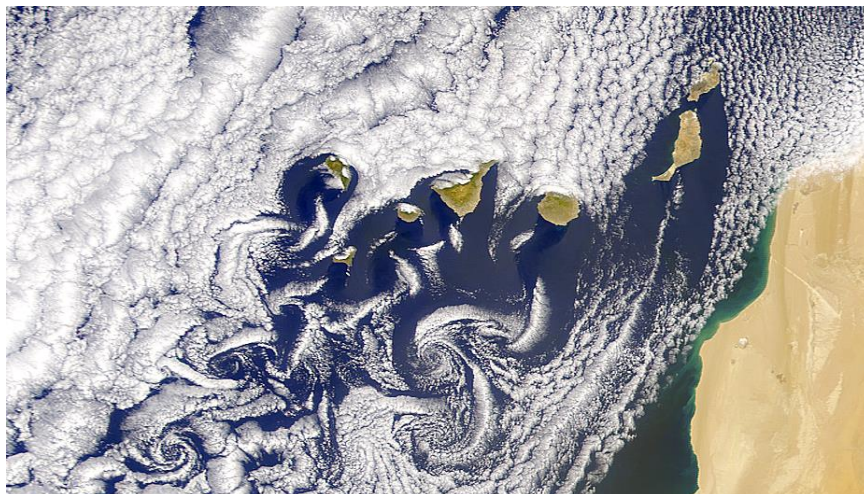
In the first case, when the edge of the knife leads the forward movement, the knife deflects the fluid over its surface gradually and the fluid *can follow the shape* of the knife. When fluid has to make a sharp turn, like in the case of the spoon and when the flat side of the knife moves forward first, the fluid *cannot follow the shape of the object* - this causes the swirling flow (called "recirculation") seen at either side of the object. This explanation of the flow behind an object can help to understand the difference in drag observed in the '**It's a drag**' activity.

The best part of this experiment is to drink the nice chocolate milk afterwards!

Follow-on activities:

There are some other simple ways to visualize the flow around an object. For example, we can deduce the wind direction by looking at tree leaves as they move with the wind. Also, if you mix some food colorant with water and stir it, you can see the beautiful process of mixing! Can you list some more?

On a very different scale, if we observed the Earth from space, we would be able to see mesmerising sights like the one below:



Source: NASA Visible Earth ([Canary Islands Vortex Street](#))

This is a picture of the Canary Islands, from NASA's Visible Earth catalogue ([NASA Visible Earth](#)). As the wind passes through the islands, the elevated ground acts as an object immersed in a fluid flow, very much like the spoon in your chocolate milk. In this case, the clouds allowed us to visualize the flow, just like the cocoa allowed us to see the flow pattern in our experiment. The elevated ground distorts the fluid and creates beautiful "vortical (swirling) structures" as the flow continues downstream. This flow pattern, with repeating vortices which alternate and rotate in different directions on each side of the object, is called a [von Kármán vortex street](#).