Team third: Dual Vortices visualization

Final photo showing the vortices.

Context and purpose

This picture shows a spectacular, symmetrical double vortex in a bowl of milk, into which green and blue food dyes have been swirled together. The symmetry in the vortices gives a dynamic sense of balance, while the contrasting colors highlight the movement of the fluid. The detailed, spiral-like flow patterns are due to the interaction between dyes, milk, and stirring motion in such a way as to create a dramatic visual effect. The overall ornate design of the bowl provides an aesthetic value, framing the fluid dynamics experiment as one combining science and art.

Experimental Setup

The experimental setup was that of a shallow, decorative bowl with milk as the fluid medium inside it. Two little drops of green and blue food coloring were added on opposite sides in the bowl. A thin object, like a toothpick or skewer, was used to stir the solution in a mild manner near the center; this initiated the swirling motion that eventually produced a double vortex.

Flow Dynamics Analysis

The image illustrates one of the classical examples of rotational flow: the fluid particles move along circular paths around a common axis. In this image, dyes visualize the flow patterns, acting simply as tracers. The double vortex is almost symmetrical since the stirring forces were applied symmetrically. Initially, the flow was laminar because the motion was smooth and orderly. As the dyes mixed and spread, some turbulence appeared near the edges of the bowl.

The Reynolds number for this configuration was computed based on the following equation:

$$Re = UL/\nu$$

Where:

- $U = 0.05$ m/s (estimated fluid velocity)
- $L = 0.10$ m (vortex diameter)
- $\nu = 2 \times 10^{-6}$ m²/s (kinematic viscosity of milk)

Substituting these:

$$Re = 0.05 \times 0.10 / 2 \times 10^{-6} = 2500$$

This Reynolds number represents a transition flow regime where laminar flow just begins to break into turbulence, as would be consistent with smooth but slightly chaotic dye patterns.

Visualization Technique

The milk gives a clean background on which the blue and green dyes become highly visible. Contrasting colors were chosen to accentuate rotational flow as well as outline the edges of the vortices in circulation. The bowl added a framing effect to this image, enhancing its aesthetic value. The setup was naturally lit to avoid any harsh shadows or reflective surfaces that might distract from the fluid patterns.

The original un-edited picture.

Photographic Technique

The image was captured using a smartphone's camera with the following settings:

- Camera: iPhone 12 Pro
- Lens: Built-in wide-angle lens
- Field of View: Approximately 15 cm
- Distance from Object: 20 cm
- Resolution: 1791 × 1828 pixels
- Exposure Settings: Auto mode

The image was cropped, contrasts were edited and warmth to visualize a colder effect that is more prominent.

Analysis of Image and Reflection

The picture effectively captures the symmetry and beauty of the double vortex pattern. The bright colors of the dyes contrast beautifully with the white milk, and the bowl's decorative rim frames the experiment as a piece of art. The gentle stirring formed very pronounced spiraling patterns that nicely demonstrated the fluid's rotational flow. This experiment represents a perfect combination of fluid dynamics with visual aesthetics. Future experiments could explore different color combinations or stirring techniques to create more complex or varied patterns.
Experimenting with the bowl's shape or adding external forces like another fluid or airflow could further diversify the flow dynamics.