

MCEN 4228 – Flow Visualization
Project 1: Get Wet

Potential Vortex Viewed in Water

The purpose for this image was to view the nature and phenomena of “still” water in an irregular cylinder. Although water can appear to be stagnant at times (i.e. the container is at rest and there is no outside force acting on it), some interesting motion is generated simply from the flow of the water when it filled the container. Although you perceive the water to be motionless, there is still some interesting movement present. This can sometimes be seen by tiny particles or air bubbles in the water, however upon the inclusion of a single drop of food dye, the effect becomes much more remarkable. It should be noted that the original intent was to view the entire column of swirling dye as it descended down the column. However, the final image was taken looking straight down the top of the cylinder instead of from the side as it seemed to produce a finer quality image both visually and scientifically.

The set up for this image can be seen in Figure 1. It consisted of a tall plastic tupperware container with a flat wall running the length of one side of the cylinder. The resulting flow of dye was relatively slow as it diffused through the column of water. There is no Reynolds number because there is now flow over or around an object. The cylinder was 11.1 inches tall with a diameter of 3.3 inches and the flat wall spanned the entire height at a width of 1.5 inches. The cylinder was filled with cold tap water at a high velocity and left to rest on a table for a few minutes. A single drop of green food dye was dropped into the center of the cylinder approximately 4 inches above the water’s surface.

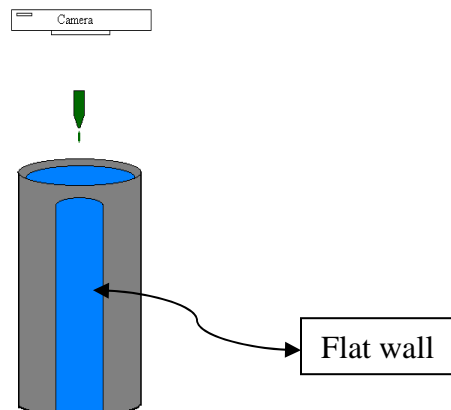


Figure 1: Schematic of Image Set Up

The visualization technique used was simply dye introduced into water. The dye was standard liquid food coloring with green chosen because it flowed nicely and photographed well. The cylinder was placed on a bathroom counter with seven 40-Watt vanity light bulbs shining three feet above and one foot behind the free surface. The resulting photograph was taken with flash off to prevent any glare or reflection in the water.

The camera was grabbed as soon as the drop was released and as many pictures as possible were taken to capture the progress of the motion. The distance from object to lens was approximately 1.5 inches. The camera specs are given below

- Camera Type: Olympus FE-340, 8.0 megapixel, 5x optical zoom
- Lens: AF ZOOM 6.3 – 31.5mm, 1:3.5-5.6 in a Macro setting
- Field of View: Approx 2.5 x 2 inches
- Shutter Speed: 50
- Focal length: 7.7 mm
- Aperture: f/4.0
- ISO: 100
- Resolution: from camera = 2415 x 2142, final image = 6708 x 5950

Photoshop was used to clean up the background and enhance the color and contrast. The clone stamp tool was used to clean up the background noise and the curves adjustment was used to increase contrast and lighten the overall image. A more familiar user of Photoshop could probably better enhance the image however all best efforts were attempted by a novice

The dye displayed a potential vortex with outwardly circular paths as the water gently swirled in the cylinder. The fluid mechanics displayed were very attractive and informative. The shape was almost reminiscent of a spiral galaxy. Personally I really enjoyed that aspect of the flow, along with the ominous “face” that appeared in the center of the vortex. I did not anticipate such a dramatic and visible vortex from such still water. On the other hand I would have liked to have seen a cleaner and sharper final image. This is probably attributed to the nature of the camera used and my lack of serious photograph-taking experience. In doing this a second time, I would like to take better care in my lighting environment and use a camera with a higher shutter speed and better/easier manual adjustments. Also a two-person team could make it much easier to capture.

Reference:

Smits, Alexander J., A Physical Introduction to Fluid Mechanics, Princeton
University Department of Mechanical Engineering. Wiley & Sons, Inc 2000