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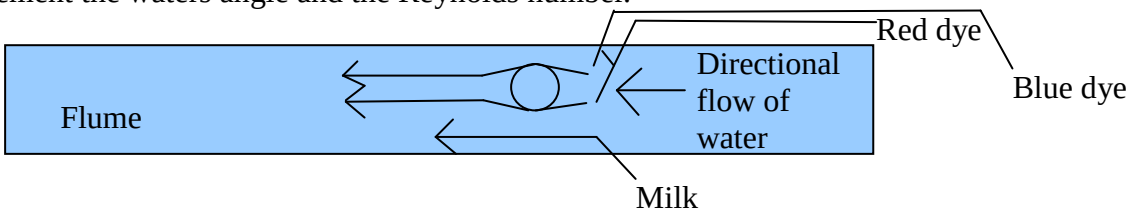
Team 5 Project 1 Report
Von Karman Vortex Street and Turbulent Jets

Group 5 project one, group working on turbulent jets and Von Karman vortex street in flume. The groups intention was to observe the Von Karman vortex street and turbulent jets through the use of dyes in water. By varying the rate of flow and the concentrations of the dyes we hoped to further understand the motion of fluid over a cylindrical object.

The setup that the group used for this project in order to visualize the von Kármán vortex street was done by injecting a food coloring dye and water mixture controlled through a syringe pump into a flume of moving water over a submerged obstacle. The water channel was 3 1/16 inches wide by 5 feet long and 230mm deep. A 38 mm diameter PVC pipe was used as a cylinder in order to create the disturbance necessary to initiate the vortices. The cylinder was cut to length such that it could be lightly wedged between the walls of the flume. Tubing was attached to the syringes in order to have the dye injected at a location of about 1 cm before the cylinder. Paper clips were then attached to the tubing to hold the tubes together and get them to inject the dye in the same direction of the flow. Two separate syringes were used for the blue and red dyes. A white plastic screen was used in combination with two halogen lamps in order to illuminate the flow from behind. A glass cleaner was also used to remove any smudges from the flume walls before it was filled. The syringe pump speed was adjusted so that it would match the speed of the surrounding flow in the flume. The flume speed was varied between different runs in order to see different vortices form at different Reynolds numbers. The flow used in the film was at a speed of 0.129 m/s using 25 drops/60 mL blue dye 23 drops/60 mL red dye with a water temperature at $\pm 2°C$. The turbulent jet portion of the film was shot using a single syringe with tubing injecting milk into the water. The speed of the flow was .14 m/s using 60 mL milk with a water temperature of $\pm 2°C$. A black background and blue lighting were used to capture this portion of the film. The shape and dimension of a wake vortex formed behind a tube varies depending upon the tubes arrangement the waters angle and the Reynolds number.[1]



Red and blue food coloring dye as well as water and milk were used to create this flow phenomenon. The milk used was 2% and the food coloring was diluted with 25 drops/60 mL blue dye 23 drops/60 mL red dye. The milk and food coloring were purchased at king soopers. Lighting varied from using a single 250 watt halogen flood light with a UV and blue filter (purchased at a hardware store) to using two 250 watt halogen flood lights (from the engineering building). I placed the light directly behind the area being captured on a stand 2.5 feet tall at a 45 degree upward angle. No flash photography was used during the process.

The photographic techniques used during this process varied for each image in the film. The majority of images were captured from a very close distance (2 feet to 6 inches). Most images were taken with an F-Stop of 2.8, ISO 80, with a shutter speed of 10/600 of a second, and a focal length of 4.8mm. The dimensions of the image files are 4000 (width) by 3000 (height) pixels. Images taken from the side of the flume were captured on a Panasonic Lumix DMC-FZ35 digital camera.

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1 . S. Umeda, W.-J. Yang, "Interaction of von Karman vortices and intersecting main streams in staggered tube bundles," Springer-Verlag Experiments in Fluids 26 pg 395 (1999).

Underwater images were taken by the HD Hero (rental) that captures video automatically at 1080p or 1920x1080 pixels. Some modifications were made to the image files including contrast correction, mirroring effects, and color inversion. Cropping, animating, and fading were also used to create this short film.

This image reveals the nature of moving fluid and its reaction to cylindrical surfaces in the current. I really enjoy the inverted images and the fluid's fire like qualities. I was not to impressed with the underwater capture quality of the HD Hero but it did provide a unique effect. I believe the fluid physics are shown nicely even though there is a considerable amount of turbulence. I believe the intent was fulfilled in this project. I would have liked a more controlled environment for lighting purposes and more objects to use to disturb the flow. I am also curious about different flow properties using thicker liquids and other substances.

Works Cited -

S. Umeda, W.-J. Yang, “Interaction of von Karman vortices and intersecting main streams in staggered tube bundles,” Springer-Verlag Experiments in Fluids 26 pg 395 (1999).