

Flow Visualization

Team 2 Report

Shawn Noland

4/8/2011

The objective of this project was to monitor the impact that velocity has on a fluid flow. In order to do this I took a flow through a log flume over a small triangular block of wood. I took five separate trials of the flume at 5 different flow velocities. I added a different color of food coloring to the base of the block for each separate flow. The food coloring allowed for a visual representation of the flow at a given velocity. I then edited these five trials together into one composite image so that the flows could easily be compared side by side.

The wooden block was roughly 1.5 feet long with a 15 and 30 degree slope on either side. The friction between the block and the water is what creates the notable boundary layer in most of the images. Under normal circumstances you would expect the height of the boundary layer to inversely relate to the velocity of the flow. In the case of the purple dye this is not true as the flow was so low as to not even form a noticeable boundary layer, hence why the purple flow seems to be so unique when compared to the other flows. The flow velocities scale in linear increments along the color spectrum from Red-Yellow-Green-Blue-Purple with the red flow being the fastest and purple being almost zero. I estimate the Reynolds number at the apex of the triangle for the red flow to be

$$Re = \frac{UD}{\nu} = \frac{.2 \frac{m}{s} * .16m}{1.004 * \frac{10^{-6}m^2}{s}} = 30000$$

This is a rather turbulent flow. The colors become progressively less turbulent as you move down the color spectrum.

The dye was simple house hold food coloring of varying brands (depending on the color). The dilutions varied from roughly 1 part per two hundred to roughly 1 part per fifty. The dilutions largely depended on the color, yellow was the least dilute as it is difficult to visualize such a light color against a beige backdrop. Purple being the most dilute as it is such a dark color that hardly any dye need be added at all by comparison. The lighting was largely ambient with a backdrop of two 100 Watt bulbs. The bulbs were very bright but they were shining through a piece plastic backdrop that filtered out most of the light. No flash was used.

I used a tripod to get a fixed angle on the fluid for each successive image. I used only a 5 mm focal length which resulted in a fairly nice focus. I had to decide on one set of settings before I even started shooting that way I could keep the same setting for all 5 images the comprised the composite. I used a 1/50 shutter speed from roughly one foot away from the flow. I also used an ISO of 80 since I had very bright lighting. In gimp I used the magic brush tool to cut and copy the four faster flows into the purple flow picture. This unfortunately left out some of the details of the flow as no level of sensitivity can capture all the minute aspects of the images but it still captured the gross aspects of the flow. I edited the colors once the

images had been cropped together to make the yellow and red more vibrant. I also had to blue many of the boundaries in order to remove artifacts of the cropping process.

I'm very satisfied with my project, though there are some issues with it. When I took and copied the images I couldn't notice that with each picture I took the camera moved slightly. This resulted in the flows being 3-5 pixels away from their original locations in the composite image. It still captures the majority of the flow but I would have liked to redo the project with a more stable camera. I also didn't realize until edited that since the flow rate in the purple image is so low the top of the water level is actually visible in the image. It results in a very obvious reflection of the flow that is not present in any of the higher flow images. It is still a neat effect but I would have liked to remove it as I find it distracting from the overall image.