Team Project #3

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Flow Visualization – MCEN 4151

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4/30/13
Team 3

This image was taken for the third team assignment for Flow Visualization, MCEN 4151. The intent of this image was to capture the way fluids of different colors interact with one another when manipulated by compressed air. Originally we tried to use washable paint designed for kids however the colors didn't mix well because the paint was too thick. We then tried food coloring because it has less viscosity, would flow faster a smaller volume would spread further, mixing more effectively. Working in at team allowed group resources and knowledge to be pooled to produce more captivating images and allowed a more difficult experiment to be undertaken. Jon Horneber, Matthew Bailey, and Patrick Cotter, participated in the creation of this image.

The image was set up by placing droplets of food coloring as shown in Figure 1 alternating yellow drops with blue and red drops. The drops were then blown across the page using compressed air through a handheld nozzle. The drops were first blown down the page, shown in Figure 1, with a sweeping motion from right to left. This spread the droplets out in parallel lines but did not mix them together. In order to induce color mixing the food coloring was blown from the side, as shown by the second air arrow in Figure 1. Blowing the fluid sideways resulted in the colors mixing and spreading perpendicular to the first streaks.

Food coloring has approximately the same density and properties as water. Assuming the food coloring was at room temperature It had a surface tension of 0.0728 N/m[1]. Surface tension can be defined as $\sigma = \frac{F_s}{l}$ [1] Where F_s is the stretching force necessary in Newtons and l is the unit length in meters. The unit length in this case is 1cm, the diameter of the drop of food coloring. Knowing the surface tension of the food coloring the force necessary to overcome the surface tension can be determined. In this case the stretching force is $7*10^{-4}$ Newtons of force. The force of the compressed air was greater than the stretching force to result in the spreading of the food coloring.

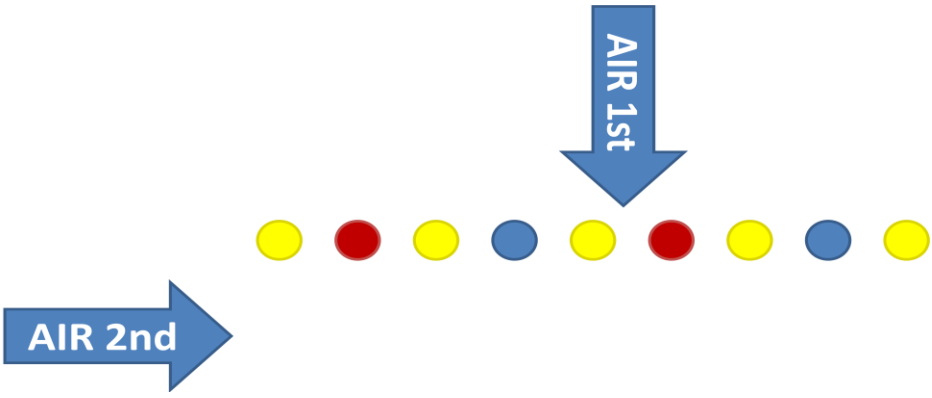

Figure 1: Set up: Drops of food coloring were dropped in a row in the pattern shown. Compressed air was blown in the directions shown by the arrows

In the photo I was trying to capture the interactions between the colors in a clear and crisp photo. To accomplish this I used an ISO of 200, a shutter speed of 1/40 sec., and an f-stop of f/32. The camera lens was approximately 18 inches from the food coloring and the streaks are approximately five inches long. The image was taken using a Canon EOS Digital Rebel XS at a focal length of 40 mm. The original and edited images were 3888 by 2592 and 2980 by 1480 pixels respectively. The original image, seen in Figure 2, was cropped to center the flow in the image and to bring attention to the mixing of the

colors. I also used curves in Photoshop to brighten the white portions of the image and to make the colors of the food coloring more vibrant. The photo is viewed upside down.

Figure 2: Original image

The image reveals how the colors interact with one another as well as how the surface tension of the drops of food coloring prevents the liquid from flowing in multiple directions rather than just one. I like how after the drops spread out and dry smaller drops exist and when they are pushed sideways their paths get thinner. I like the way the colors mix and the yellow and red make orange and how the blue and yellow make green. To further this experiment it would be interesting to look at different fluids and examine the different surface tensions and the forces necessary to produce similar motion in the different fluids.

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References

1. "Surface Tension." *Surface Tension*. N.p., n.d. Web. 30 Apr. 2013.