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Flow Visualization

MCEN 4151

“Get Wet” Report

As an introduction to Flow Visualization, a course based on the physics and art of fluid flow, the first image assignment gave students the artistic freedom to capture any image of a fluid they desired. The structure of the image was based on two requirements. First, the image needed to demonstrate the observed phenomenon, and second, the image must be a good picture.

The image I chose to capture was that of incense smoke rising out of my incense box. I decided to portray this fluid flow because I often burn incense while working at my desk at home, and enjoy not only the fragrance, but also watching the random movement of the smoke. In my preliminary research about the driving forces of this flow I learned that the buoyant force causes the smoke to accelerate upward and ultimately become turbulent. Therefore, I attempted to depict this phenomenon in my photograph.

The apparatus used to capture this image was fairly simple and is shown in Figure 1 below. I used a black 36” x 36” poster board that folded in on the sides for the background of the image. Because the sides of the poster board fold in, I was able to have the incense box sit on the poster board and have a seamless background to prevent distracting elements from the fluid flow. Moreover, the black background provides a nice natural contrast to the smoke that appears white with a camera flash. While the picture was the morning and there is ample light in my room, I used the flash of my camera to illuminate the particles of the smoke to ensure a stark contrast between the smoke and background

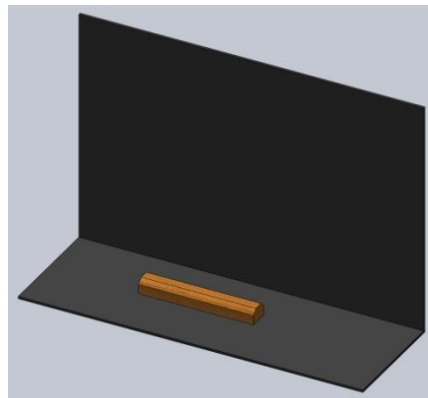


FIGURE 1: "GET WET" FLOW VISUALIZATION APPARATUS

The camera used to take this photograph was my FujiFil, FinePix s5100 and I used Adobe Photoshop to edit the image. In Photoshop, I first enhanced the contrast between the black background and the white smoke using the filters. Then, on another layer, I inverted the colors to make the smoke black and the background white. I did this because I wanted the flow to stand out and make a bold statement, which I believe was achieved better with a white background. I chose to not crop out the entire incense box, because it had an important role in making a thick stream of smoke as opposed to a thin stream often depicted from incense candles.

The fluid flow observed is a result of the buoyancy effect. With regards to gases, this effect occurs when there is one gas that is less dense than another and as a result of the unequal densities, the lighter gas will rise and the heavier gas will fall. In the scenario of the incense smoke, the tip of the incense candle is burning at a few hundred degrees, thus the smoke is much hotter than the surrounding air. As such, the incense smoke rises¹.

Another notable element of the flow is the transition from the smooth flow near the incense box to the wispy, sporadic flow at the top of the picture. This is a result of the buoyancy effect accelerating the smoke upwards and the transitional phenomenon is governed by the fluid's Reynolds number described in Equation 1.

$$Re = \frac{UD}{\nu}$$

EQUATION 1: THE REYNOLDS NUMBER [DIMENSIONLESS]

By examining Equation 1, it can be seen that the Reynolds number is directly proportional to the flow of the fluid. Therefore, as fluid velocity increases, Reynolds number increases and with greater values of Re there is more turbulence within the flow².

Overall, I am very happy with how my picture turned out. I was disappointed with the graininess that occurred at the edges of the smoke/background boundary as a result of the contrast filter in Photoshop. However, during my critique in class, my peers did not feel as though this was a problem. If I were to redo this picture, I would change my apparatus so that I used a filter on my flash to prevent the flash from reflecting on the background and creating a contrast in the background from the bottom left corner to the top right corner.

¹ Jones, John. "ENCS 100 Lecture 19." The School of Engineering Science. Simon Fraser University, 01 Nov. 2004. Web. 10 Feb. 2011. <<http://www.ensc.sfu.ca/people/faculty/jones/ENSC100/Unit19/lecture19.html>>.

² "Smoke Movement - Fire Dynamics: FESHE." Etudes Home. Aug. 2007. Web. 10 Feb. 2011. <<http://etudesproject.org/nonfpdata/cog/FS442/DOC0038.htm>>.