Kryztopher D. Tung

Professor Jeanne Hertzberg

MCEN 5151

Due: 4-6-2011

Team Project 2 Report

This image was taken for the "Team Project 2" project, and was unfortunately done alone due to being in Missouri for spring break. The intent of the project was to capture the effects of dropping mouthwash into a vial of scintillation fluid (ScintiSafe* Plus 50% Cocktail), which is a biodegradable, nontoxic, nonflammable fluid[1]. Scintillation fluid is used primarily in a laboratory setting with a scintillation counter to detect radiation; it fluoresces when struck by ionizing radiation. The scintillation counter has a photomultiplier tube and electronic amplifier that quantifies the quantity and amplitude of the signals produced, thus quantifying the amount of ambient radiation[2]. I honestly didn't know what to expect when first mixing mouthwash with scintillation fluid; the product details and other online information was very limited, the Fisher Scientific website simply mentioned that it was a very safe and inert chemical. The lab director that lent me the fluid when I mentioned I was looking for something that would create an interesting fluid flow told me that dropping mouthwash into the fluid would probably be my best bet. Curious from what the lab director said, I had to try it out for myself, and I was not disappointed.

The apparatus used in this experiment consisted of a glass vial, an eye dropper, scintillation fluid, and blue/green mouthwash. The setup was relatively simple, the glass vial was filled with scintillation fluid (figure 1) and an eye dropper was used to drip mouthwash into the scintillation fluid. Video was taken over the course of 1 minute and 11 seconds as mouthwash was dripped into the vial at varying rates and the flow was allowed to occur.

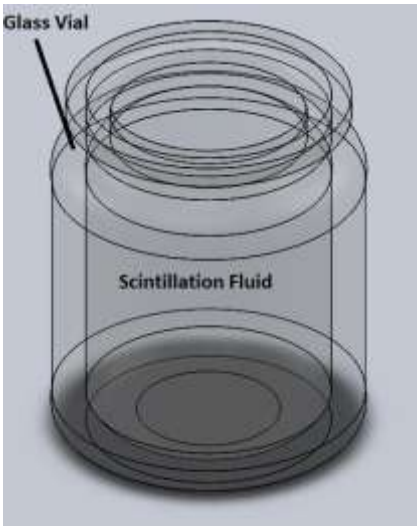

Figure 1. Glass vial containing scintillation fluid experimental setup.

The

The main mathematical issue is the Reynolds number [1]:

$$Re = \frac{\rho V D}{\mu} \quad (1)$$

Where:

$$\rho = density$$

$$V = fluid\ velocity$$

$$D = diameter$$

$$\mu = dynammic\ viscosity$$

The average flow velocity was extremely low, measured to be approximately 0.1875 in/s (0.0047625 m/s). The density of the ScintiSafe was listed as 1.06 Pa*s on the product info pamphlet[1]. The dynamic viscosity was not listed, so we will assume the dynamic viscosity of water at room temperature, which is 0.001 Pa*s. The average size of a drop falling in the vial was approximately 3.0 mm (0.003 m). Running all of these numbers through the Reynolds number equation, we get a value of 0.0151368; the number is expected to be low due to the fact that the velocity of flow is so low.

Additionally, there was an interesting effect I observed; a solid film seemed to form on the outside layer of the mouthwash drop once it hit the fluid surface. Unfortunately, I was unable to find any publications or information involving the mechanics behind this phenomenon, but my theory behind how it works is that some sort of reaction takes place between the ScintiSafe and mouthwash which causes a solid to form. The mouthwash leaves streak lines behind due to layers of the solid peeling off due to shear stress between the drop as it falls down and the scintillation fluid. As the drop continues to fall, though, new surface of liquid mouthwash is constantly being exposed to the surrounding fluid, making it seem like the surface is constant and always filmy. The drops also seem to increase in velocity when they combine. I am assuming this is due to the solid film being more dense than liquid mouthwash, so the velocity increase occurs due to two things: the drops combining results in an increase in the overall amount of solid in the new drop, and the surface of both drops get disrupted upon combining, which results in large amounts of mouthwash solidifying.

This video was taken in the basement of my home in Kansas City, Missouri on Saturday, March 26, 2011. A tripod was set up in front of a light box that contained the apparatus. The lighting was created by a high intensity lamp located outside of the light box shining at the wall. Once again, for aesthetic reasons as well as to fit my dark mood theme, blue/green mouthwash was used.

The field of view was approximately 3 in and the distance from the object to lens was approximately 1 ft. The lens focal length was 30 mm with an ISO speed of ISO-200. The data rate was 3075 kbps and the total bitrate was 3163 kbps with a frame rate of 29 frames/second. A Sony DSC-W180 (rated for 10.1 Megapixels) digital camera was used to capture the video. The frame width x height is 320 x 240.

Windows live movie maker was used to edit out the original audio and to introduce background music (Runaway Serenity by IIO and remixed by DJ Markus Moser & Nadia Ali).

I wanted to create an elegant and cool looking fluid flow, and this setup pulled that off perfectly; I personally get a feeling of weightlessness and floating in space when I see this. The music was added to kind of compliment that feeling as well. The most interesting aspect of the flow was the way some of the drops combined; they almost look like they are opening up and swallowing one another. The light box helped a lot, but I would have liked it to be a cool color rather than white, but unfortunately this was not available. To further develop this idea, it would be fun to see what happens in a longer shaft to see how fast the fluid flow accelerates to. Additionally, maybe see what happens if we perturb the fluid during flow?

References:

[1] Fisher Scientific. *ScintiSafe* Plus 50% Cocktail PXE-based (Phenylxylylethane) Product Information*. 2011.

[2] Curran, Samuel C., and J. D. Craggs. *Counting Tubes; Theory and Applications*. New York: Academic, 1949.

[3] Cengel, Yunus A., and John M. Cimbala. "4, Streaklines." *Fluid Mechanics: Fundamentals and Applications*. Boston: McGraw-Hill Higher Education, 2010. 133.