Flow Visualization: Get Wet Assignment Report

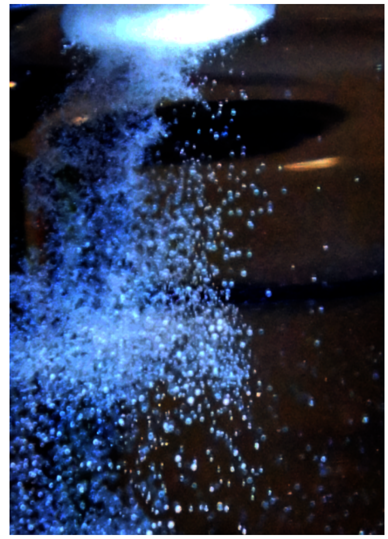

Figure 1: Gasses flowing from a mentos mint

The image seen to the right is a submission for the spring semester of Flow Visualization initial assignment, "Get Wet". As the first image submission in the course, students are tasked to explore interesting flow phenomena and record them using photographic or video capture techniques. In this particular case, a Mentos mint is submerged in a drinking glass filled with carbonated water. In this flow phenomenon, the mint's surface composition and irregular surface interact with the water to cause large amounts of gas to erupt and fizz upwards. The intent of this particular image was to image capture the gasses flowing to the surface in an induced vortex (via swirling the carbonated water). However, after several attempts, it became clear that the gasses would be extremely difficult to photographically capture in an obvious "tornado" of bubbles. The trouble when attempting to noticeably capturing the depth dimension in the image was most likely due to the sheer number and size of the bubbles traveling upwards. After several trials, the camera was able to capture the proper lighting and focus to show gas bubbles traveling at different speeds and directions.

The flow apparatus was set up utilizing a typical tall drinking glass (about 8 inches in height) and a Mentos mint. The following sketch illustrates some of the rough dimensions.

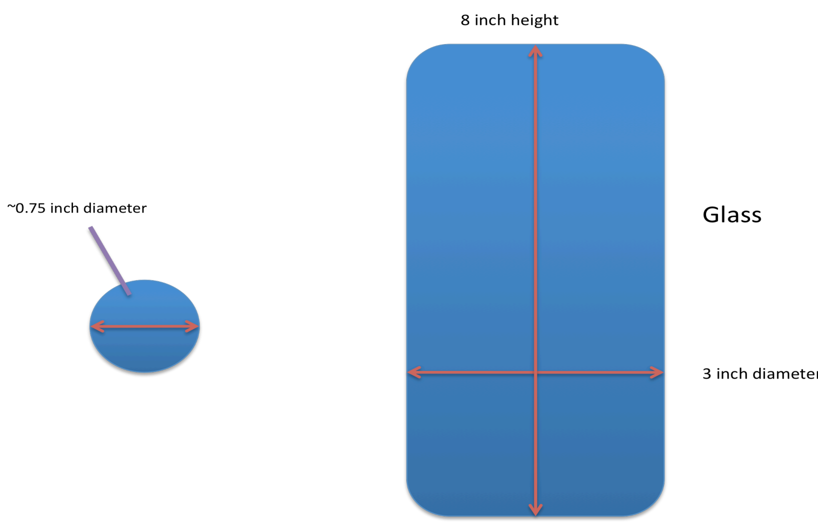

Figure 2: Rough dimensions of mentos mint and glass of carbonated water (not to scale)

The image itself has been inverted along the vertical axis and appears upside down. The gasses are flowing from the top of the image to the surface located past the bottom. The process in the image is a physical reaction caused by a combination of the Mentos mint's rough, chalky surface and water surface tension. The dissolving of the mint's surface greatly accelerates the gas bubble generation by disrupting the water's surface tension[1]. As the bubbles form, their lower density causes them to flow from the bottom of the glass towards the surface. To perform a brief analysis of the flow, the Reynolds number can be estimated. Reynolds number, Re, is length x speed divided by the kinematic viscosity. In the case of the image, the air (at ~70 degrees Fahrenheit) has an approximate kinematic viscosity of 1.64E-4 (ft^2/s) [2]. An estimated velocity can be determined based on small motion blurs created by the gas bubbles and a known camera shutter speed of 1/500 or 0.002 seconds (the distance of the motion streak can be divided by the shutter speed for approximate velocity).

Motion blur ~ 1 mm or 0.00328 ft. velocity = 0.00328/0.002 = 1.64 ft/s

Re = (0.25 ft)*(1.64 ft/s)/(1.65E-4 ft^2/s) = **2500**

The low Reynolds number describes laminar flow for the gas bubbles traveling to the surface. This conclusion is easily acceptable as the only force causing the bubbles to move is its difference in density with the water.

For future attempts to recreate the submitted image, an identical setup can be constructed easily. The apparatus involves the Mentos mint, glass filled with carbonated water (Seltzer water), ambient light, and a flashlight. The Mentos is dropped into the glass of water and highlighted utilizing the flashlight. The combination of this flashlight and ambient room lighting helps to make the gas bubbles more vivid in comparison the liquid and background. They should be enough (and were enough) for camera flash to be avoided.

The original image spanned approximately one and a half foot high by one foot wide, and in addition to not using the camera flash capability, a slew of default and custom camera properties were used in this image. The camera, a Sony SLT-A55V DSLR, was located approximately 4 inches from the glass. A focal length of 18 mm was selected in order to best focus the bubbles in the glass. Alongside the focal length, an F-number of 4.5, an exposure time of 1/500, and an ISO of 12800 were selected for the best combination of clarity and lighting. In regards to post production, a few Adobe Photoshop functions were used. The original, unedited image can be seen below. Its resolution is 3264 x 4912.

[1] General Chemistry Online. http://antoine.frostburg.edu/chem/senese/101/consumer/faq/mentos.shtml

[2] http://www.engineeringtoolbox.com/air-absolute-kinematic-viscosity-d_601.html

First, the image was rotated 180 degrees and cropped to focus attention to the fluid flow closest to the Mentos mint. In addition, a blue color mask was overlayed onto the image and its saturation levels were increased slightly. This both alleviated some of the brightness from the original and decreased the visibility of the background kitchen counter.

In conclusion, the original intent of the image was not entirely fulfilled due to a combination of setup difficulties and photographic inexperience. For any future attempts at recreating a similar image, several clear improvements can be made. Some of which include utilizing a single color background like a large white sheet of paper, altering the location of the Mentos to avoid light refraction from the glass, and further experimenting with camera settings for a crisper image that better illustrates the depth and number of gas bubbles. However, there is clear fluid flow and the proper tools/analysis was available to approximate Reynolds number. If there were to be additional renditions of this image after gaining further experience with both photographic technique and image editing software, it would be most interesting to be able to selectively alter the color of the gas bubbles. This would accentuate the bubbles and highlight the flow even more, and it would also add more artistic value to the image itself.

Works Cited.

Senese, Fred. "Why Do Mentos Mints Foam When You Drop Them into Soda Pop?" *General Chemistry Online*. 15 Feb. 2010. Web. 19 Feb. 2012. <http://antoine.frostburg.edu/chem/senese/101/consumer/faq/mentos.shtml>.

"Air - Absolute and Kinematic Viscosity." *Engineering ToolBox*. Web. 20 Feb. 2012. <http://www.engineeringtoolbox.com/air-absolute-kinematic-viscosity-d_601.html>.