Levey Tran

ME ID: 214-765

MCEN – 4228 – 002 Flow Visualizations

Get Wet Image Report

The image described in this report is one that completes the first individual picture of the class for the Get Wet image assignment. The purpose of this assignment was to create an image of fluid flow that both demonstrates the phenomenon being observed and is a visually stimulating picture. The image shows what happens when a fluid with a relatively low density and low viscosity gets injected into a fluid with a high density and very high viscosity. In this case, the low density, low viscosity fluid was vinegar and the high density, high viscosity fluid was corn syrup. The original idea for this picture was to observe the size and shape of the Worthington Jet that would appear when the vinegar was dropped into the thick corn syrup, but it was soon concluded that the corn syrup was too dense and much too viscous to interact accordingly with the much lighter vinegar; the vinegar would fall and form a layer above the corn syrup with no exciting motion or flow to be seen. When this action was reversed, having the vinegar injected into the bottom of the corn syrup, a much more interesting fluid flow occurred. This flow demonstrates Archimedes Principle.

The flow apparatus and set up can be seen below in Figure 1. The apparatus is relatively simple in that the fluid container used was a standard shot glass, and the injection device was a plastic straw. The corn syrup was placed inside the fluid container and the vinegar was sucked up into the injection device by an experimenter. When the camera operator was ready, the injection device was lowered into the bottom of the corn syrup and the experimenter would slowly blow the vinegar out. It was necessary to force the vinegar outward because of the effects of density not allowing the vinegar to naturally leave the outlet of the injection device and flow into the corn syrup. Immediately following of the vinegar being injected, the vinegar would rapidly rise upward through the corn syrup medium, effectively separating itself from the corn syrup. This image captures this action and what can be seen is the ‘bulb’ of vinegar, clearly not diffusing into the corn syrup, all connected and following a channel of vinegar up to the surface. Floating on the surface of the corn syrup is a layer of vinegar, which, due to the rapid rising and centralized channel, can be seen to experience an upward cavity or ripple of fluid. No bubbles are formed above the vinegar though, there was no air within the vinegar channel and the forces were not large enough to force the vinegar up and out of its own liquid layer to form splatter droplets above the surface. In the image, the width of the vinegar trail is approximately 1/10 inch at the smallest ‘neck’ of the channel, and the bulb in the center of the image is approximately 2/5 inch. This channel varies in width throughout the upward flow, but never disconnects. This flow can be described by the Archimedes Principle which states that “a body

immersed in a fluid is buoyed up by a force equal to the weight of the displaced fluid. The principle applies to both floating and submerged bodies and to all fluids, i.e., liquids and gases" (InfoPlease). The Archimedes Principle explains the rise of a balloon in air, or in this case, the rise of one fluid within another. The higher density fluid, corn syrup, will sink, and the less dense fluid, vinegar, will float. In this experiment, the denser corn syrup forces the vinegar within it to rise upward and float on the top. The Reynolds number for this flow is estimated to be Re = 95.6 at the bulb of the vinegar flow. Calculated by $Re = \frac{uL}{v}$, where u – velocity, L – characteristic length, and v – is kinematic viscosity. The Reynolds number predicts the flow to be laminar, which can also be observed in the image.

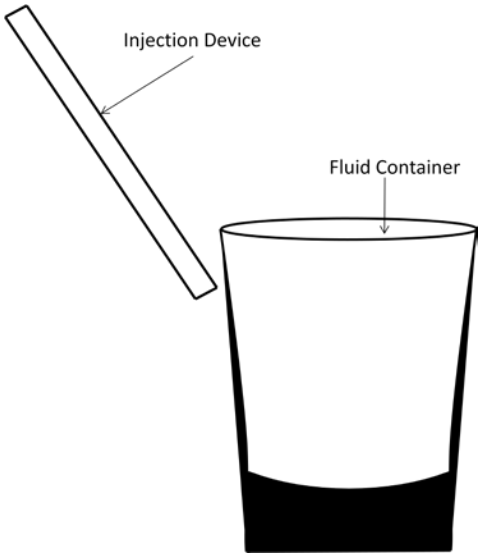

Figure 1: Schematic of apparatus used

A few techniques were used to better visualize what was occurring in the picture. First, the vinegar was dyed green in order to easily distinguish between the fluids. The dilution ratio was about 1:1 for the vinegar and dye. The injection device was an ordinary plastic straw, one that can be seen being used for drinks at restaurants. Also, to make a visually appealing background, a black piece of poster board was used. The board was laid in a fashion that covered the background and also curved from the back wall and covered the floor. This provided a nice soft background that did not reflect any light in order to make the user focus on the fluids rather than a distracting background. The lighting used was the typical overhead lighting on a stove top, as well as a desk lamp on the side, which was being shined above the fluid. No flash was used on the camera and there was no excessive sun lighting as well.

In order to acquire this picture, a Canon Powershot G10 was used. Several photographing techniques were utilized in order to achieve the original picture. The size of the field of view was approximately 4 in. wide and 2.75 in. tall. The distance of the shot glass from the lens was approximately 8 inches. From the camera data given in Photoshop, the focal length for the image was 15.673 mm, an aperture value of f/3.5 was used, 1/13 sec shutter speed, ISO speed rating of 200, lens specifications of 6.1 – 30.5 mm, and no flash was utilized. For the final

image the pixel dimensions were 1206 in the X direction and 2124 in the Y direction. The final image was manipulated in Photoshop by simply cropping the original photo, using the healing brush tool to try and fix some light reflections from the glass and spotty background, and also just brightening the image to make it easier to see the details.

This image demonstrates, in suspended action, the Archimedes Principle. The two fluids fail to diffuse, which allows for a clear separation line between the submerged vinegar. I really enjoyed the 'frozen in time' feeling I get when I view this picture. I also chose this picture because if one observes closely, an 'under water' view of an upward cavity and ripple can be seen at the interface of the corn syrup and dyed vinegar; the channel of the dyed vinegar can be seen rising and connecting to the middle of this upward cavity. I dislike this picture in the fact that when I cropped the picture to focus on the main components of the image, the picture seemed to be a little pixilated and not very clear. Also, there was a reflection of light off the left side of the shot glass, which can be seen in the picture. I dislike the fact that I feel that I need to explain the picture before someone might be able to truly appreciate it. Some people might look at it first off and just think that there is some dyed fluid floating in another fluid medium, but when I explain that the fluid was rising to the top and told them to look for the upwards cavity, I feel that the interest in my picture became greatly increased. For my next photographs, I would like to improve upon these issues: have an extremely fine and clear picture, become better at Photoshop to better manipulate my photo, also I would like to obtain a picture that would impress someone in the first couple seconds upon viewing, not after I explain what was done.

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