IV-1 Report

Flowing Smoke

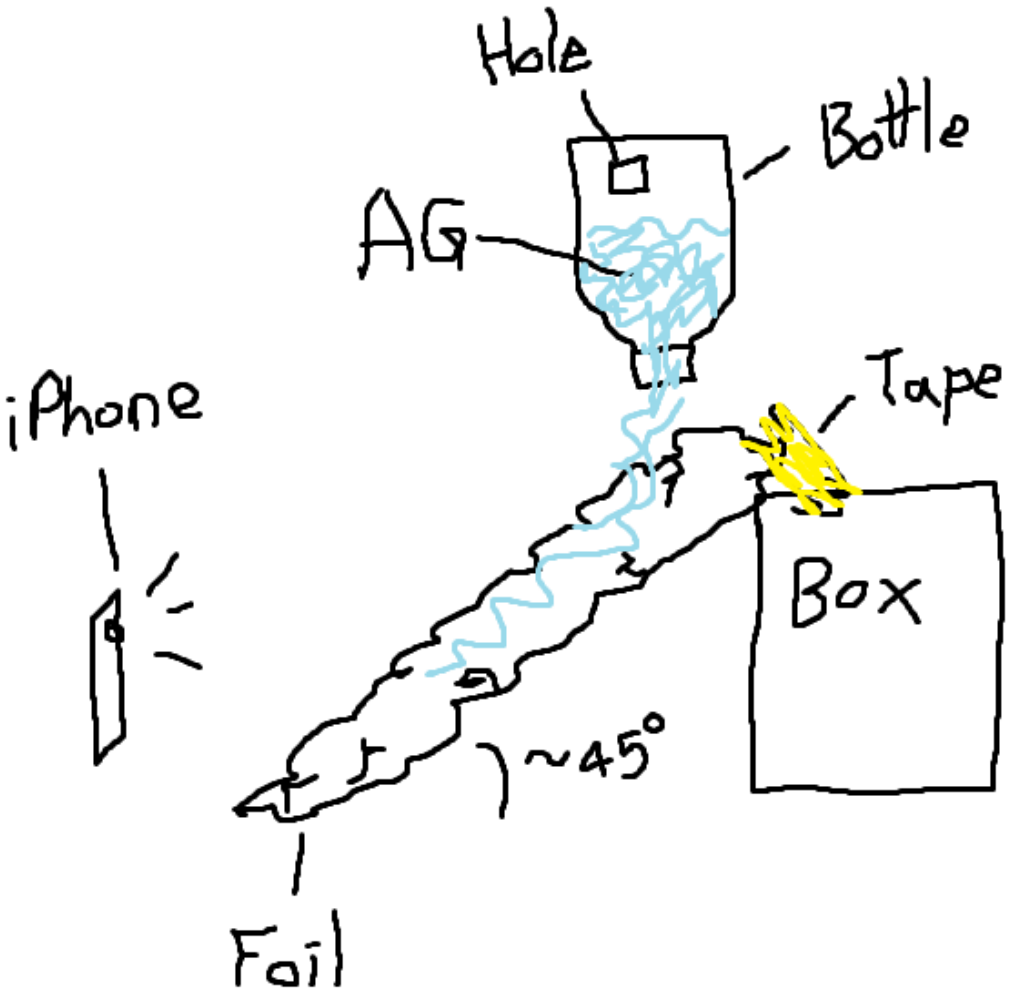
MCEN 4151 - Joel Carlson 09/29/2020

I. Experiment Purpose

For this experiment, the purpose was to examine and capture the fluid mechanics of atomized glycerin (AG) flowing over an angular surface. The motivation was to visualize a dense gas flowing in the less dense air and the interaction between the two. The goal was to capture a more Laminar flow rather than a highly turbulent flow. The inspiration came from waterfalls or streams flowing over rocks.

III. Experimental Setup

For this experiment I spray painted one side of a 1' by 2' sheet of aluminum foil matte black. I then gently crumpled up the aluminum foil to create wrinkles with a variety of sizes, the largest of which were about 3cm. To create the AG, I used an NJOY e-cig that I bought from the gas station for about $11. I then taped one end of the foil to a box and let the other end rest on the surface of the table. This created an angle of about 45 degrees from the surface. Next, I cut a 1x1 cm square hole in the bottom of a 12oz Gatorade bottle. With the lid off of the Gatorade bottle, I put the mouthpiece end of the e-cig in the small hole I cut. Then I blew into the other end of the e-cig until the gatorade bottle was full of AG and no longer easily see-through. I then removed the e-cig from the bottle and gently poured the AG out of the bottle onto the top of the painted foil. While pouring I used my other hand to photograph the AG with my iPhone 7. This was repeated about 12 times with around 20 pictures taken each time.



Professional render of the experimental setup

III. The Fluid Mechanics

This flow was primarily governed by gravity because AG at room temperature is more dense than air. Achieving a primarily laminar flow proved to be extremely difficult when using a gas as the fluid. Any minor disturbance would cause turbulent flow and the AG would quickly diffuse into the air. Breathing and sudden movements created enough disturbance to ruin the experiment. Laminar flow occurs when the Reynolds number of a fluid is less than 2000.

$$Re = \rho u L/\mu$$

In the Reynolds number equation above, the "*u*" represents flow speed. To keep *Re* low, controlling the flow speed was easiest. This was done by holding the bottle very close to the foil and not allowing for it to gain a lot of speed during the fall. The foil was also placed at an angle of 45 degrees which allowed for the AG to flow down it but it was not steep enough for the AG to gain too much speed and become turbulent before it reached the bottom. The actual Reynolds Number of the fluid is not able to be determined but from the images, it appears to be mostly laminar.

IV. Photographic Technique

An iPhone 7 Camera was used to capture the experiment. The camera was held about 8" away from the object. The picture was taken in the daytime with my blinds open to let in sunlight. In addition, two lamps were pointed towards white walls in my room to allow for more light diffusion. The original image was 3024 x 4032 pixels. The exposure time was 0.25 seconds and aperture was maxed. The post processing was done in GIMP and involved adjusting the exposure, contrast, brightness, colors, and applying a smoothing filter from the G'MIC-Qt plug-in.

The Original Image above

The Final Image above

V. Image Remarks

In the Image you can see that the AG is mostly laminar because of the long whipy lines. I think it turned out very well and did a decent job of capturing the idea I was going for. If I were to repeat this experiment I would use a better camera. I would also try to use a more brittle paint on the foil so the folds would crack and expose some of the aluminum underneath, I think that would look cool.