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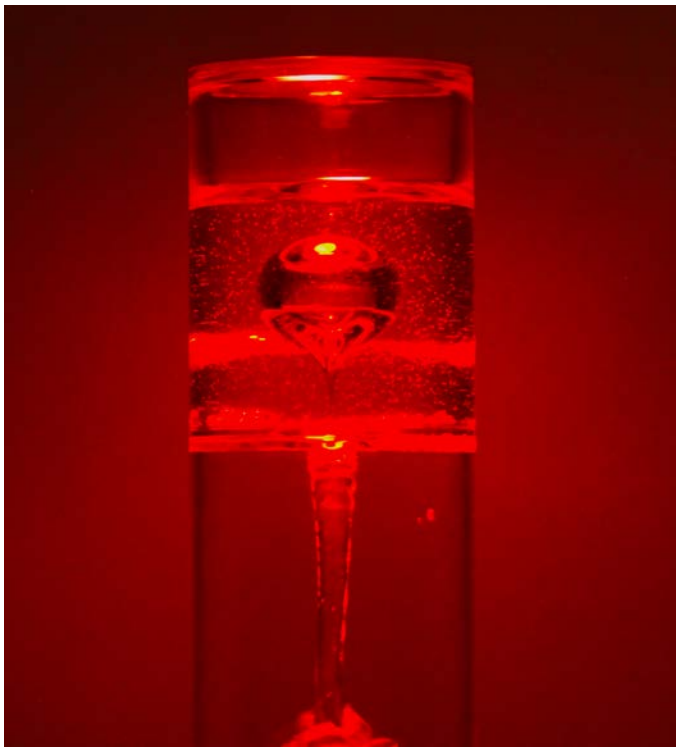
Flow Vis Team Report 1

Ooze Balloon

The image of the ooze tube was taken for my first project as a team. We used the ooze tube provided by Professor Hertzberg in our Flow Visualization class at the University of Colorado at Boulder. The intent of this image was to capture the stunning flow that the ooze tube creates with just the use of a viscous fluid, air bubbles, and gravity. I intended to capture the volume equality between the two chambers of the ooze tube and the flowing effects caused from that equality.



The ooze tube is a cylindrical tube 80.42 mm in diameter and 210 mm tall. The tube is filled half full with a very viscous liquid and divided in half by an acrylic barrier. The barrier has a hole cut in the center roughly 20 mm in diameter. With the liquid

in the bottom half of the tube you flip the tube over and gravity pulls the liquid down. While the density of the liquid is unknown since the liquid seems to be a proprietary substance, we can assume that its density is greater than the density of air, which is 1.29 kg/m^3 (1). This means the liquid will fall and due to the equality of volumes in the two chambers some air must raise, this effect can be seen in my picture above. There will also be compression of the air since a gas has very loosely space molecules. Eventually, enough pressure will be created and a bubble must form in order to maintain equality between chambers. Some interesting flow can be seen from the contraction of the stream as it falls. If you look closely at the falling stream you can see a rippling effect near the spout. This can be explained by friction at the hole as well as pressure build up in the bottom chamber. The shape of the air bubble in the picture forms a sphere like shape because of Laplace's law, which states that the tension on the wall of a sphere is the product of the pressure times the radius of the chamber and the tension is inversely related to the thickness of the wall (2).

This image was taken in the basement of the ITLL using a white backdrop to bring out the red liquid. It was then set on the edge of two tables and lit with a halogen light directly beneath the ooze tube. This gives the image the bright orange and yellow spots in the middle. The ooze tube was also lit by above lights in the ITLL.

For the photo we took over 250 pictures as the ooze tube flowed. Then from the selection of photos I chose the one with the balloon of air. We used a Nikon D80 with a Nikkor 18-135mm f/3.5-5.6G lens. The ISO was set at 640 with a focal length

of 75 mm. The f stop was 6.3 and a shutter speed of 1/60 second. This gives the perfect amount of light for the ooze tube and gives it somewhat of a glow. In Photoshop I cropped the image to get rid of any distracting elements. I also changed the curves to give it a little more of a red glow. The brightness and sharpness were adjusted slightly to get rid of any overexposure.

The image reveals a lot about the physics of a free falling and viscous liquid. I really like the shape of the air bubble as it rises, it reminds me of a hot air balloon. I am still curious about the ripples that are caused from the free falling stream. I tried to look up more info online but was unable to find information. I would also like to know the technical information of the liquid inside of the ooze tube to better estimate the physics going on in the ooze tube.

1. Cutnell, John D. & Kenneth W. Johnson. *Physics*. 3rd Edition, New York: Wiley. 1995: 315.
2. http://medical-dictionary.thefreedictionary.com/Laplace's+law