# Visualization of an Ooze Tube

## Purpose and Intent

The image shown is of an ooze tube, a liquid timer that can be used as a desk toy. When the apparatus is flipped, the liquid flows to the bottom, leaving cool bubble formations forming within the top half of the tube. The tube used for this set-up had a red color to it. The liquid has high viscosity, flowing really slowly through the opening in the cylinder. What really struck me about this flow is the teardrop shape of the bubbe within the ooze tube.

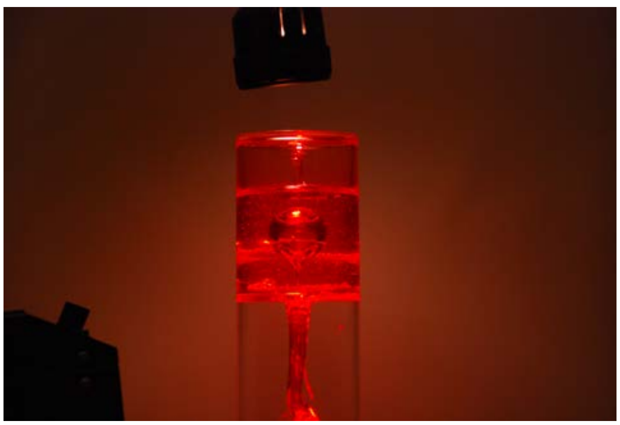

Figure 1: Original Image

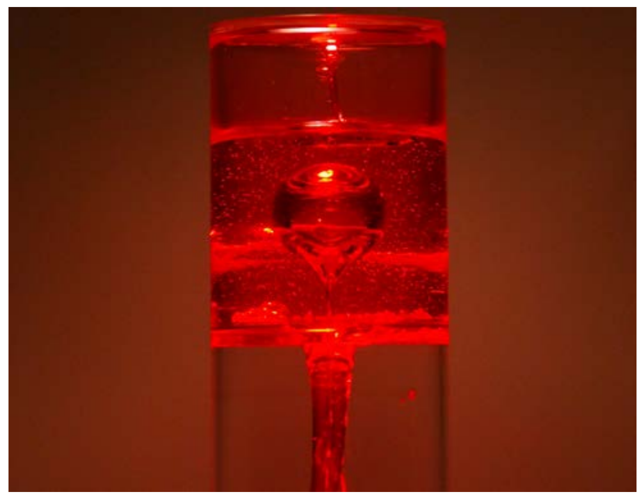

Figure 2: Photoshopped Ooze Tube

## Concepts and Theory

The flow is driven by gravity. When the toy is flipped over, the liquid flows through the small hole in the cylinder and collects in the bottom half of the cylinder. The mass of the entire tube was estimated at about 492 grams. The fluid is viscous and during testing, it was observed that it flowed more easily as it was heated up. Due to these concerns, the tube was kept at room temperature and there were concerns that the lamp lighting the apparatus from above would affect the visualization. The affect was minimal. Unfortunately, the liquid in the tube is proprietary and specifications were not readily available. The flow also exhibits a cool coiling effect in the bottom half.

A reasonable guess for this liquid would be something similar to gravi-goo, which is a gel that reacts to gravity strongly. Firefighters could also use it to cause water to collect faster, when they need it, as shown on *stevespanglerscience.* This gravi-goo can be made from Polyox or Polyethylene Oxide, which has a molecular weight of greater than 4,000,000, contributing to its "heavy" flow. There are extremely long polymer chains causing the reactions shown to the effects of gravity. It's similar to watching a chain of beads collecting in a beaker.

The teardrop bubble also exhibits an interesting fluid phenomenon, coming from the interaction of surface tension, viscosity, and gravity. The balance of these forces helps create the teardrop in the image above. The bubble is rising rapidly due to interactions between its buoyant rise force and drag force. The teardrop effect may be caused by vertical shear as the bubble rises due to its buoyant force while fighting the surface tension with the ooze liquid, causing the bubble to deform. Combining drag forces with buoyancy forces can be integrated using Stoke's Law or the Hadamard-Rybczynski equation. This equation may not be applicable as it applies to only spherical bubbles and the bubble shown is not.

The Reynold's number is a non-dimensional ratio comparing inertial forces to viscous forces and is laminar in this case, which means that using an estimate of pipe flow, the Reynolds number is less than 2300. The liquid is highly viscous and as the liquid is proprietary, the viscosity could not be found. However, both the weber number and Reynolds number will appear low.

## Experimental Set Up

The set up shown has a halogen lamp illuminating the ooze tube from above, in front of a white background in the ITLL with a Nikon D80 mounted on a tripod, using burst mode and a remote to reduce motion blur and shaking. Over a hundred pictures were taken to create different formations that formed. There was about a 3 meter gap between the tripod camera set-up and the ooze tube.

## Camera specifications

The image was taken using a Nikon D80, with an aperture of f/6.3. The focal length was 75 mm and the ISO used was 640. Photoshop was used to crop the image and to bring out the red in the image.

## Further Work

Further work would involve making the gravi-goo and comparing it with the liquid featured in the ooze tube. Densities of both the liquids could be examined and qualitative tests could also be performed to determine if the two liquids react similarly.

## References

1. http://www.nationalautismresources.com/ooze-tube.html

2. http://www.stevespanglerscience.com/content/experiment/gravi-goo

3. www.bubbleology.com

Isenberg, Cyril. "The Physics of Bubbles." *Contemporary Physics* 36.6 (1995): 443-44. Print.

Kundu, Pijush K. *Fluid Mechanics*. San Diego: Academic, 1990. Print.