University of Colorado - Boulder

MCEN 5151 - Flow Visualization

Image 3 Report

Improvised Lava Lamp

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I. Introduction

The purpose of this picture is to explore photography as a means of capturing interesting fluid phenomena. In this case, the fluid phenomena is the classic Coca-Cola and Mentos experiment, but performed underneath a significant layer of canola oil. It should be noted that I forgot the true experiment uses Diet Coke rather than the original, but the reaction is similar regardless. The following report showcases the experimental setup and procedure, discusses the flow phenomena, and outlines the photographic techniques (including post-processing) used to obtain the final image.

II. Experimental Setup and Procedure

The setup for this photograph was actually very simple. A wide-rimmed, clear, glass mason jar was filled with a few ounces of regular Coca-Cola, and then roughly triple to quadruple the amount of canola oil was poured over top (care was taken to leave space for the volatility of the Mentos interaction). The jar was placed in front of an open window to maximize natural lighting (taken near sunset) and the camera was set up directly in front of the jar. A Mentos was then dropped into the jar and pictures were rapidly taken. A diagram of this setup is shown below in figure 1.

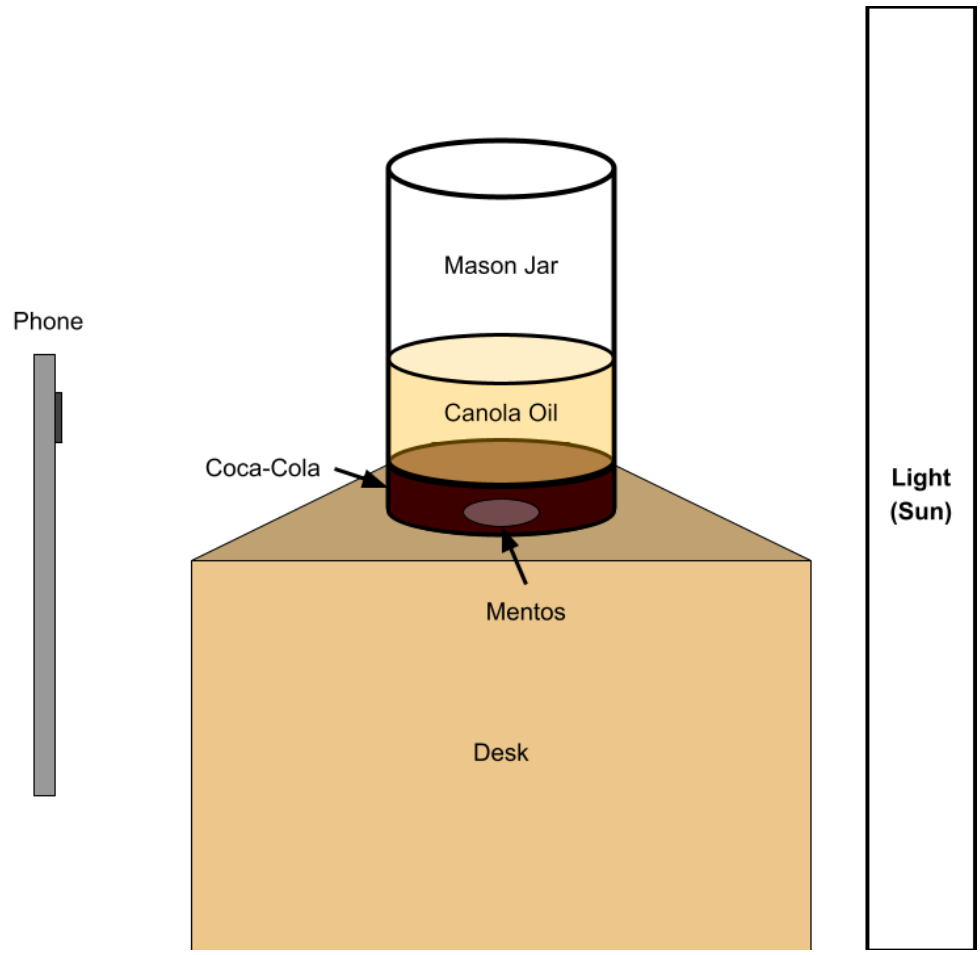

Fig. 1 Diagram of Setup

III. Flow Discussion

While this is a widely recognized experiment (minus the canola oil), the overall reaction occurring is a product of highly complex physical and chemical interactions. Starting with the Coca-Cola and Mentos interaction, the primary driving factors are the surface roughness of the dropped Mentos and its presence as a surfactant [1] in the Coca-Cola, but there are a number of other contributing factors, including, temperature, contact angle, and bubble travel time through the liquid. More specifically, the potassium benzoate (preservative) and aspartame (artificial sweetener) in the Coke cause a reduction in the work required for bubble formation. The other primary factor is surface roughness, which simply increases the surface area available for bubbles to form or attach, called growth sites. An increase in temperature also generally increased the reaction, as does a better contact angle from the drop (better surface area), and a quicker fall time to the bottom (increasing bubble travel time).

The other interaction occurring in the experiment is the canola oil, whose lower density allows it to float on top of the Coca-Cola, and whose differences in surface tension, polarity, viscosity, and other properties allow the interesting bubble interactions seen in the image to take place. As can be seen, because of the difference in polarity between the Coke and the oil, there is a clear separation between the liquids, which also has the effect of maintaining its clear appearance. The viscosity of the oil also decreases the bubble travel time, creating a similar effect to that of a lava lamp.

IV. Photography Technique

Nearly exactly the same as my other photos [2, 3], this image was taken with a simple smartphone camera, although manual adjustments were taken to change ISO, shutter speed, and get a sharper focus. The specific camera settings are listed below:

- Camera: 16 MP Sony IMX 298 sensor (in a OnePlus 3 smartphone)
- Aperture: f/2
- Focal Length: 4.26mm
- ISO: 640
- Shutter Speed: 1/8000s
- Original Size: 2610 x 4640p

Darktable was the program used for post-processing of the image (the appendix includes the original image for reference). To start, some cropping was done in order to center the action in the middle of the frame. I purposefully chose to leave some of the surroundings (namely, the walls of the mason jar and a bit of the foreground) in order to add some context for the viewer (specifically in regards to where the lighting is coming from). Secondly, the color profile of the image was slightly adjusted to accentuate the golden color of the canola oil. Lastly, the sharpness was increased slightly in order to make the bubbles easier to see within all the reflections.

V. Conclusion

While the final photo is not perfect (I wish I shot it more head-on to get rid of the angles between the edge of the mason jar and the edge of the photo), it definitely exceeded by expectations. The experiment was very enjoyable to perform, and the effects seen real time were a sight to behold.

Personally, I especially liked the lighting on the surface between the Coca-Cola and Mentos, as it had a very reflective, metallic quality, similar to liquid mercury.

References

[1] Coffey, T. S., "Diet Coke and Mentos: What is really behind this physical reaction?" *American journal of physics*, Vol. 76, No. 6, 2008, pp. 551–557. URL https://doi-org.colorado.idm.oclc.org/10.1119/1.2888546.

[2] Stone, S., "Leaf Droplet Surface Tension," *University of Colorado Boulder*, 2021. URL https://www.flowvis.org/wp-content/uploads/2021/09/ShawnStoneImage1Report.pdf.

[3] Stone, S., "Marangoni Effect Patterns," *University of Colorado Boulder*, 2021. URL https://www.flowvis.org/wp-content/uploads/2021/10/Shawn_Stone_Image_2_Report.pdf.

VI. Appendix

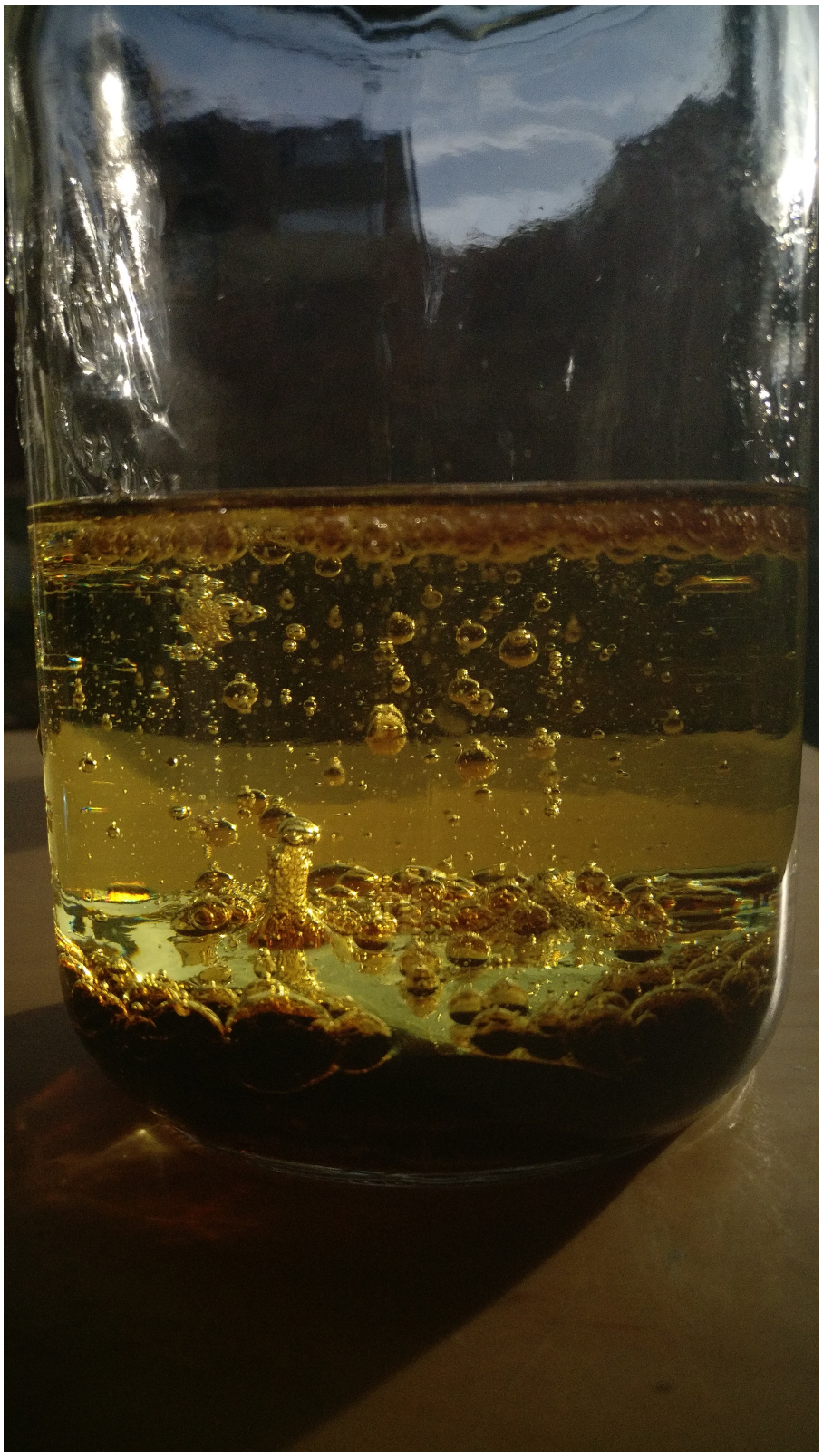

Fig. 2 Original Unedited Image