Team First Report

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MCEN 5151 Flow Visualization

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Introduction

This assignment was the first team assignment of MCEN 5151. My team consisted of myself, Sierra Greeley, Ari Matrajt Frit, and Patrick Watson, as well as Professor Hertzberg for loaning us the fish tank. The setup of the experiment consisted of dropping a bath bomb into room-temperature water within a fish tank. The goal of this experiment was to show the mechanics of a bath bomb dissolving in water. The interaction of the dissolving ingredients and the water is captured in the photo.

Flow Apparatus

The flow apparatus for this experiment was simple, consisting of only a fish tank. The fish tank was filled with tap water. Then it was brought outside, and the bath bomb was placed into the water. We then allowed the bath bomb to fully dissolve, taking pictures for the full duration of the dissolving. A sketch of the apparatus is shown below.

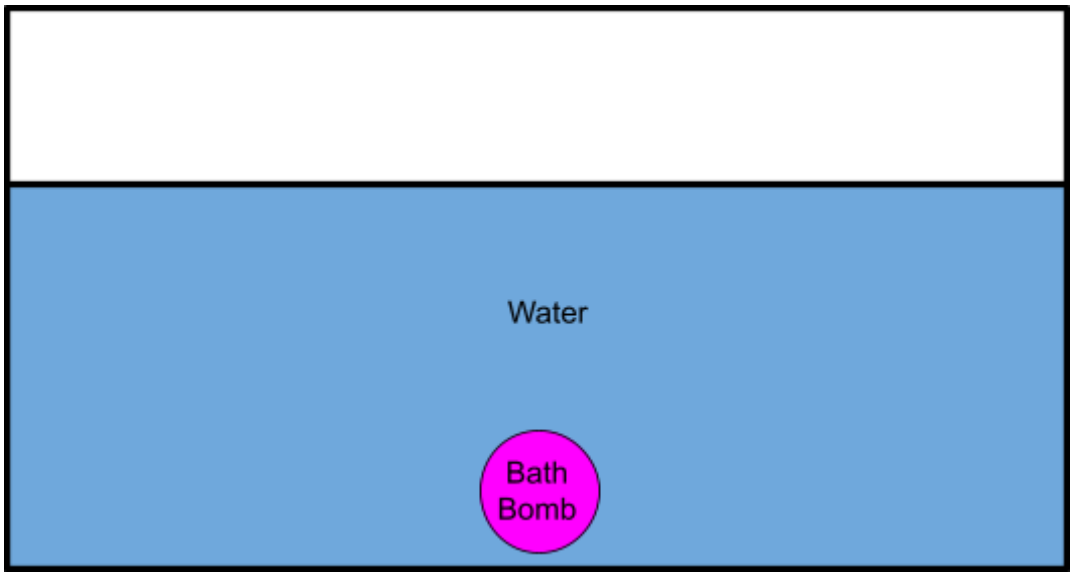


Figure 1: Diagram of experimental set up

Fluid Dynamics

Bath bombs are compacted mixtures of dry ingredients that are used to help create pleasant smells and experiences during a bath. One of the ways this is accomplished is through the bath bomb effervescing when placed into the bath. Bath bombs are composed of many ingredients, and while most are included to create nice aromas or to hydrate skin, the ones needed for the effervescence are citric acid and Sodium Bicarbonate.[2]
Sodium Bicarbonate, more commonly known as baking soda, reacts with the citric acid in a common acid-base reaction.[1] These ingredients are inert in their dry form, and only begin reacting when dissolved in water.[3] This reaction is shown below.

$$NaHCO_3(baking\ soda) + C_6H_8O_7(citric\ acid) \rightarrow NaC_6H_5O_7 + CO_2 + H_2O \quad [1]$$

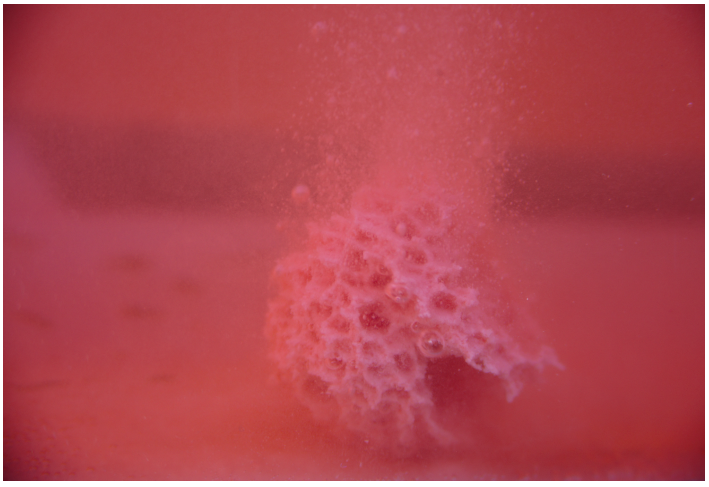
When the reaction happens, it produces sodium citrate, carbon dioxide, and water. The carbon dioxide is released and bubbles to the surface, which causes the effervescence we photographed.

Visualization Technique

The visualization technique for this experiment was relatively simple. A fish tank was borrowed from Dr. Hertzberg. It was then filled about three quarters full with tap water. The tank was brought outside of the ITLL into the sunlight. We placed white paper on the side opposite the camera to help provide better contrast and clarity. The purchased bath bomb was pink and about three inches wide. We placed the bath bomb in the water and took pictures as it dissolved. The whole process took approximately 10 minutes. We then disposed of the water and cleaned the fish tank.

Photographic Technique

The image was captured on a Canon EOS 5D camera with a 28-200 mm lens. This lens has an aperture range of f/3.5-5.6 and a filter thread diameter of 72 mm. The distance from the camera to the object was about 6 inches with a field of view of about 12 degrees. The exposure was 1/200 sec., the ISO was 640, and the focal length was 200 mm. The camera was set to aperture priority. I chose these settings to capture the motion of the image without compromising the vibrancy of the color. The original image was 5616 x 3744 px. My edited image was 3051 x 3051 px. The original and edited pictures are shown below.



Figures 2 and 3: Original and edited images.

I used darktable to edit my image. I really wanted to focus on the bubbles and the cavities of the image. I mainly sharpened the image and increased the contrast. I also adjusted the RGB curve and slightly decreased the red. I noticed that this gave a greater view of the bath bomb itself. I also cropped the image to eliminate unnecessary background noise.

Conclusion

This image shows the simple act of using a bath bomb in great detail, capturing the scientific mechanisms behind the fizz. It was a simple experiment to perform and is highly reproducible. I enjoy how clear I was able to get the bubbles. I also really liked the raw image and felt like it was something creepy and otherworldly, very different than the original bath bomb. I tried to channel that through my editing and I think I succeeded in that aspect. I think that my image could be improved through better post processing. I played around with using masks in darktable, but was unsuccessful. I hope to implement that in my next image. To develop this idea further, I think a pump system could be implemented to remove the dyed water and introduce fresh water. This would help focus on the bubbles and prevent the water from becoming the same color as the bath bomb.

References

[1] *Reaction exposed: The big chill! - activity*. TeachEngineering.org. (2023, July 31). https://www.teachengineering.org/activities/view/wsu_big_chill_activity1#:~:text=In%20the%20presence%20of%20water%2C%20citric%20acid%20%5BC6H,pressure%20so%20no%20explosions%20occur.

[2] Medina, J. (n.d.). *Anatomy of a bath bomb*. Anatomy of a Bath Bomb | Fleet Science Center. https://www.fleetscience.org/blog/2019/08/anatomy-bath-bomb#:~:text=When%20the%20released%20hydrogen%20ion,surface%20with%20a%20delightful%20fizz.

[3] Solomon, M. (2022, November 2). *The Science of Bath Bombs*. Soaposh. https://soaposh.com/bath-bomb-science/