Group Project 2: Adventures With Dry Ice

Shweta Maurya

Supporting Team Members: N/A

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Purpose

Many scientific endeavors end in failure; this project was no exception. The second group project began as a mission to achieve schlieren photography. With days and countless hours contributed to this endeavor, our group realized that, due to the time constraints, another project needed to be realized. As such, I continued on with the group project as a solo member while we all split up to conduct our own projects. Interestingly enough, the pressure of time and the art of improvisation can produce compelling results. The purpose of this experiment is to visualize the interaction of dry ice and water. The intent behind this experiment is to capture the fast-paced reaction created by mixing dry ice into water.

Visualization Technique

This experiment required a simple list of materials in order to be executed:

- 1/4lb of dry ice (King Soopers)
- 1 glass of water (household)
- 1 white table top (household)
- Standard ceiling light (household)
- 1 camera

With the use of the aforementioned items, the experiment can be conducted. One important note is that dry ice typically sublimates at a rate of 5 to 10 pounds every 24 hours. As such, it must be purchased as close to the experimentation time as possible. Another important detail is that the temperature of the water affects the amount of fog produced by dry ice. Warmer water produces more fog. Depending on the intention of the experiment, the appropriate temperature of water is required. For this experiment, a clear glass of water is filled with lukewarm water from a tap. Then, a chunk of dry ice, close to 1/6lb in weight, is placed in the glass of water. Immediately, the reaction will produce fog. Over time, as the water cools, the amount of fog produced will decrease. In order to light this experiment, a bedroom light was turned on, as well as the flash setting on the camera. The clear glass of dry ice was placed on a white table top, and the image was shot from above the glass in order to capture a clean background. A schematic of the experimental set-up is shown directly below.

Figure 1. Set-Up

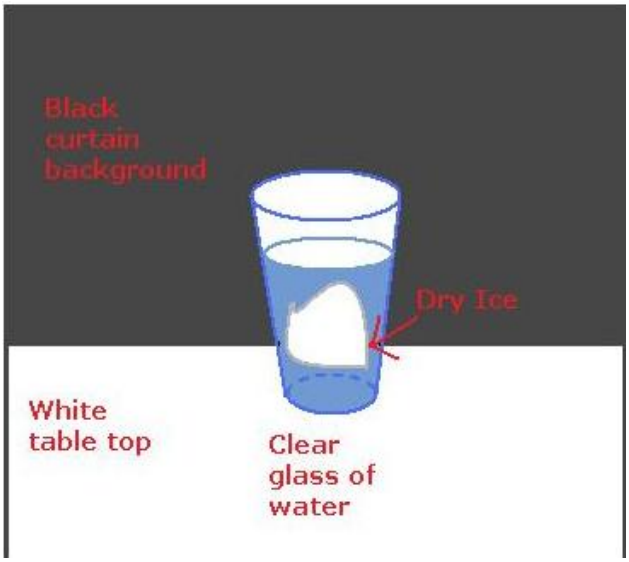

Figure 2. Schematic

Approach

Dry ice is simply the solid phase of CO_2. It exists at a temperature of about -109˚F; when handling dry ice during this experiment, insulated gloves were used at all times. The most fascinating aspect of dry ice is that it is a substance that naturally sublimates; instead of phasing from a solid to a liquid, the ice turns from a solid into a gas. Depending on the ambient medium with which dry ice interacts, the sublimation rate can differ. Typically, dry ice sublimates faster in water than in air, and even faster in hot water. This experiment used lukewarm water to react with dry ice in order to shorten the time of the experiment and observe different phases of the sublimation process.

When the water is warmer, the dry ice not only sublimates, but the interaction of the cold ice and the warm water also creates a foggy cloud of water vapor. An additional by-product of the reaction of dry ice and water is vigorous splashing and, in this case, spilling of water. This splashing is a result of the large and quickly produced bubbles of CO_2 gas sublimated in the process. The emergence of these bubbles pushes the water up too quickly to fall down into the glass and creates overflow. As the interaction progresses, the water begins to cool without an outside source of heat to maintain its temperature. This cooling process brings the temperature of the water closer to the temperature of the ice, and the fog ceases to continue. At this phase of the sublimation, clear bubbles, unobstructed by the fog, can be viewed.

Many pictures were captured during the course of the experiment, from the fog phase to the bubble phase. Ultimately, the latter phase proved to be appealing due to its clarity and vigorous display of speed. In new iterations of the experiment, it may be fascinating to test the sublimation of dry ice in different mediums, and to observe the different phases of its sublimation over a greater range of time and more extreme conditions.

Photographic Technique

The digital camera used in this experiment is a Nikon S9050. The size of the field of view is about 8in wide and 6in tall, while the distance from the camera to the glass is about 8in. The focal length is 4.5mm with a digital zoom ratio of 1. The autofocus mode is turned on. The aperture is f/3.5, while the shutter speed is 1/30sec, and the ISO setting is 200 (considering that the room is lit). In terms of editing, the first step was to crop the image; the original pixel dimensions are 4000 x 3000, while the cropped image is 1538 x 1562 pixels. The original color scheme and lighting of the experimental set-up allow for a simple image; with the use of a while light and white flash from the camera, as well as the white table top background underneath the glass, the color spread of the original image is minimal. As such, the editing of this image involved increasing the sharpness in order to give a crisp texture to the bubbles. The contrast was also increased, creating a dichotomy of shadows and light in the image and outlining the bubbles and the dry ice with more clarity. The minimalistic set-up of the experiment allowed for simple editing that in essence added clarity to the image and some contrast. The following histograms show the how color spread changed before and after editing.

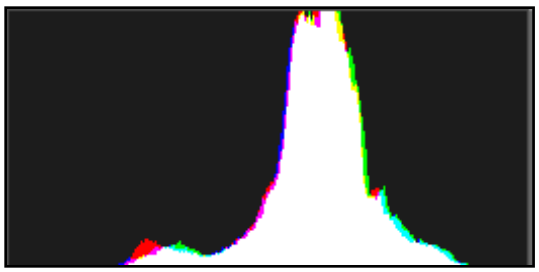

Figure 3. Original Histogram

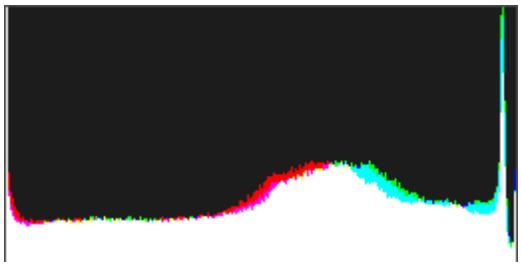

Figure 4. Final Histogram

The image chosen from this experiment successfully demonstrates the phenomenon of the lack of fog from the dry ice and displays the reaction of dry ice and water. The images below demonstrate this comparison between the original and edited images.

Figure 5. Original Image

Figure 6. Final Image

Conclusion

Some of the major points of feedback given by peers were that the image was crisp and the color scheme of black and white was useful in accentuating the phenomenon. One of my favorite points of feedback, and something I had not considered before, was the continuity of the image. The circular glass held a round-like piece of dry ice and produced circular bubbles. This resulted in the image emulating a sense of serenity.

In terms of lessons learned from this experiment, an improvement would be to perform the experiment with comparing different temperatures of water and their respective reaction to dry ice. It may also be fascinating to perform a time lapse of the sublimation of dry ice in water. In the future, a revised experimental method would be required to clean the lens of the camera; due to its position over the glass of water, the lens collected precipitation from the experiment and began to produce blurry images.

Ultimately, this image is the result of a surprising succession of events, from improvising an experiment to witnessing an unexpected phenomenon. The most accomplished aspect of the experiment is its utter simplicity, from materials to the set-up to the process and reaction. The product is striking and peaceful all at once.

Works Referenced

[1] http://dryicenetwork.com/dry-ice-info/dry-ice-fog/

[2] http://www.dryiceinfo.com/

[3] http://www.dryiceinfo.com/fog.htm