

Chris Svedman

Flow Visualization

Get Wet Report

The goal of this image was to capture the sublimation of dry ice as it turns from a solid state to a gaseous state. Gaseous flows are a very beautiful thing. They can be very unpredictable when trying to capture them in a single image. When making a video recording of a gaseous flow you can capture the entire life of the gas. You can really see the motion of the gas as it moves. When taking only a single image, it is much harder to portray that motion. I wanted to create an image that would allow the viewer to visualize in their head the motion of the gas even though they are looking at a still image.

To set up my image I had to first decide on what kind of container I would use to hold the dry ice. What I decided would be most beneficial for viewing what is going on would be a clear glass jar. The jar that I used was a 32 ounce glass juice jar. The jar that I chose also had a unique, raised diamond pattern. I thought that this would create a nice effect when a light was cast on the jar. I soaked the jar in soapy water first to loosen the glue on the label. After the bottle was cleaned, I set up a metal stand for the jar to sit on (See Figure 1). Underneath the jar I placed a small LED flashlight. The flashlight was used as the light source for this image. When turned on, the light shined up through the bottom of the jar towards the camera, which was above the jar. In the jar I placed one half pound of dry ice. The dry ice was broken into golf ball sized chunks to allow for maximum surface area exposure. The more area I exposed to the water the more smoke would be created. To the dry ice I added two cups of warm tap water. Introducing water to the dry ice speeds up the sublimation process, creating a large amount of smoke. The smoke has only one place to go, and that is out of the jar through the 2 inch diameter hole at the top. So what you see in the image is the flow of the CO<sub>2</sub> over the outside of the jar as it is coming out of the opening, viewed from above looking straight down.

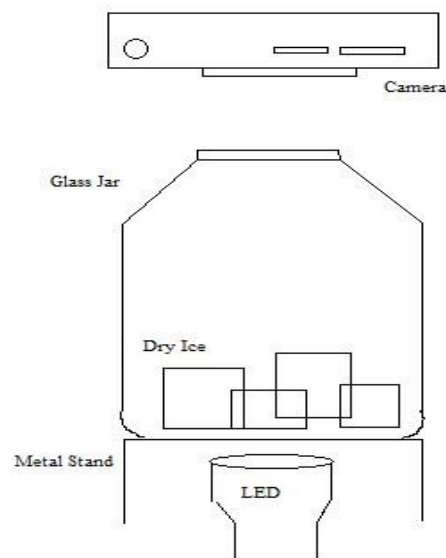


Figure 1: Image Setup

This was all a relatively quick process. Once the water was added to the dry ice, the smoke started flowing right away. This was the best time to capture an image because it is when the most smoke was coming out. After 45 seconds or so the volume of smoke really decreased.

When trying to understand what is going on in the picture, you have to think about the physics that are involved. The flowing smoke creates a very beautiful and unique image. The flowing motion of the smoke is caused by pressure changes. Inside the jar where the dry ice is being converted from a solid to a gas very rapidly, the pressure is increasing. The smoke has to move somewhere, and the only place for it to go is to a region of lower pressure. This means it will flow out of the jar into the open air. Another force acting on the smoke is a temperature gradient. Inside the jar the temperature is increasing due to the phase change that is occurring. I noticed that the outside of the jar was also warming up due to the heat transfer from the water to the jar. Outside of the jar the room temperature was much lower than inside the jar. Once the smoke had exited the jar, another force that acted on it was air movement in the room. Any little gust of air would change the direction that the smoke was moving. It would also change the look and shape of the moving smoke.

The main visualization technique used in this image was smoke. Again, the smoke was created by the sublimation of solid dry ice to its gaseous CO<sub>2</sub> form. This can be harmful if breathed in heavily, since it is carbon-dioxide. When I created this image I was in my kitchen, which is well ventilated to the rest of my house. This provided a sufficient amount of space for the CO<sub>2</sub> to dissipate. The dry ice that I used came from the local grocery store, and was relatively cheap to buy. What I liked about using the dry ice is there were no real environmental hazards to worry about when using it. Once the dry ice had completely sublimated there was nothing left in the jar but water. The jar that I used I got out of our recycling bin, and put in right back in when I was finished to be recycled the following week. To be able to view the smoke, I needed a light source. But to create the eerie effect that I was going for it needed to be dark. To make sure that the only light that was visible in the image was the LED, I turned off all the lights in the kitchen, as well as the flash on my camera. To add to the eerie effect of the image, I changed the "colors" setting on my camera from normal to tungsten. This gave the light coming from the LED flashlight a blue tint. I really like how this turned out in the final image.

When creating this image, I had to decide how to take the shot, and what settings my camera should have to create the best image possible. The field of the view is approximately 8 inches across and 6 inches wide. The camera was held about six inches above the jar when I took this picture. When I zoomed in to take the shot, I created a focal length of 5.8mm. I used a shutter speed of 1/50 second in order to get a crisp clean image. Both the f-stop and aperture values were f/2.8. I also used an ISO setting of 200. All of these settings were used to create a digital image that was 2112 x 2816 pixels in width. The camera that I used was a 6 Mega pixel, Canon Power Shot SD 630 Digital Elph camera with 3x zoom lenses. My camera also has a digital zoom feature that allows you to zoom in up to 12x.

The image that I created reveals the beauty and art that is fluid flow. The motion of the smoke as it flows out of the bottle is a beautiful representation of flows that we may see in our everyday lives

and may not understand how it can move the way that it does. What I like about this image is the way that the smoke is flowing out in every direction. I also like how the bright light creates a layered effect. The smoke seems to be coming up out of the light. One thing that I don't like is the date stamp on the bottle. I didn't realize that this would be such a distraction from the overall image when I took the picture. If I could do this again, I would use Adobe Photoshop to edit out the date stamp. I think that doing that would really complete the picture. If I could develop this image further, I would repeat the process and try to get crisp lines on the smoke boundaries. Overall I am very pleased with the way that this image turned out.

## References

- 1) [http://en.wikipedia.org/wiki/Temperature\\_gradient](http://en.wikipedia.org/wiki/Temperature_gradient)
- 2) [http://en.wikipedia.org/wiki/Pressure\\_gradient](http://en.wikipedia.org/wiki/Pressure_gradient)