Gabriel Paez

MCEN 4151, Flow Visualization

5/1/2013

Team Third Image: Dry Ice Bubble

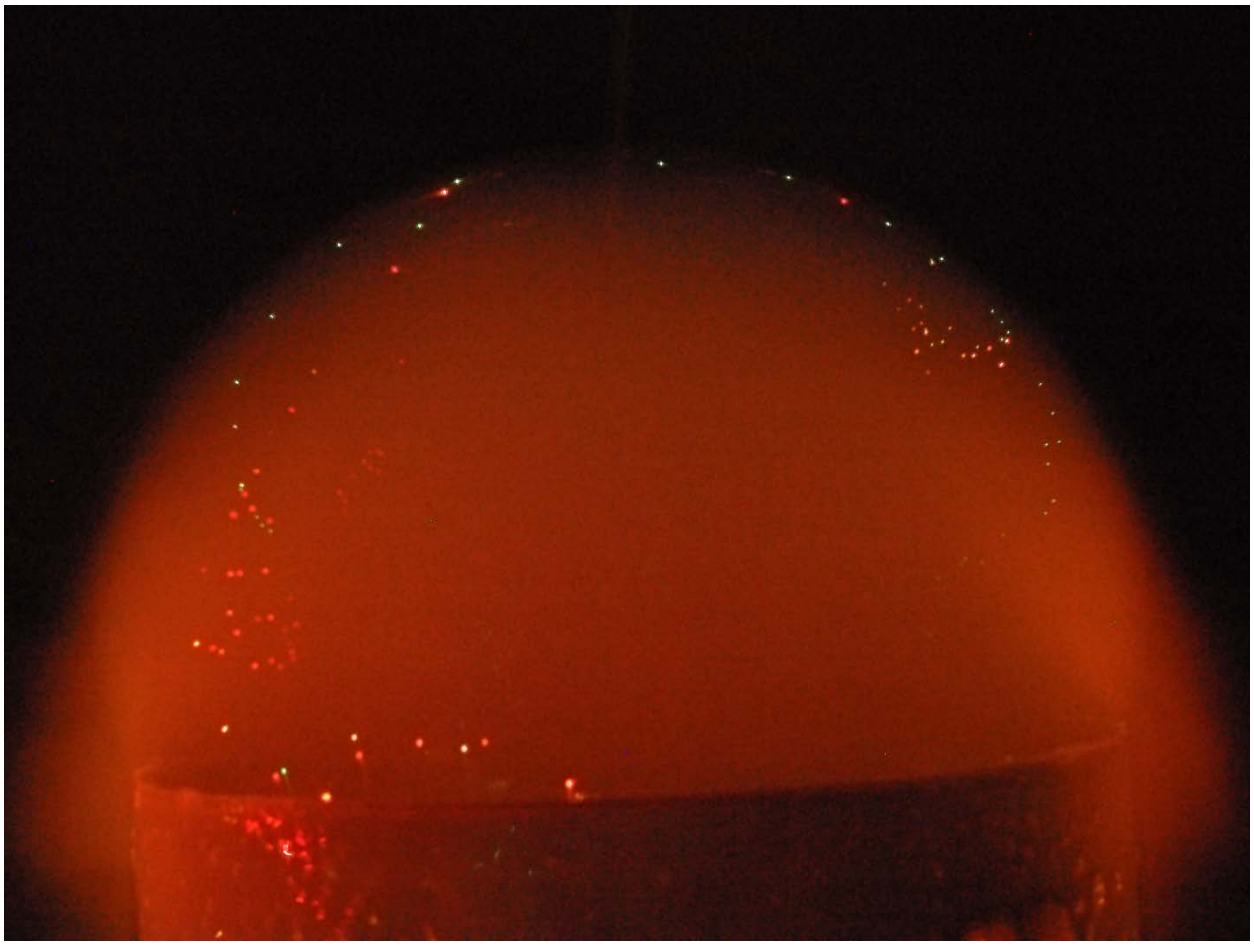

Figure 1: Dry Ice Bubble

Introduction:

The purpose of this image is to finalize what the student has learned from the course by providing a third team image of a fluid flow setup. This specific image focused around the experiment of using the sublimation of dry ice to create bubbles. The image takes place in a dark garage, with decorative Christmas lights of different colors as the only lighting source, which gives the reflection on the soap layer a nice outline. It was captured with a long enough exposure time that it shows the light reflections in the bubbles as well as the fog evacuating the bubble after it pops.

Flow Description:

The properties that play a role in this picture are mainly the sublimation of the dry ice (the solid version of carbon dioxide) and the surface tension of the soap. Sublimation is defined as the transition of a substance from its solid state to its gaseous state. At atmospheric pressure, dry ice has a sublimation temperature of -78.5° C (-109.3° F), shown in the pressure-temperature diagram of CO_2 below. Since the image was shot in Boulder, where the pressure is lower than sea level, the sublimation temperature will be slightly lower. The other notable thing about CO_2 is that the volume of dry ice is about 1600 kg/m^3; while the density of CO_2 in its gaseous state is 1.98kg/ m^3 (this means that during sublimation, dry ice expands about 1000 times in volume).

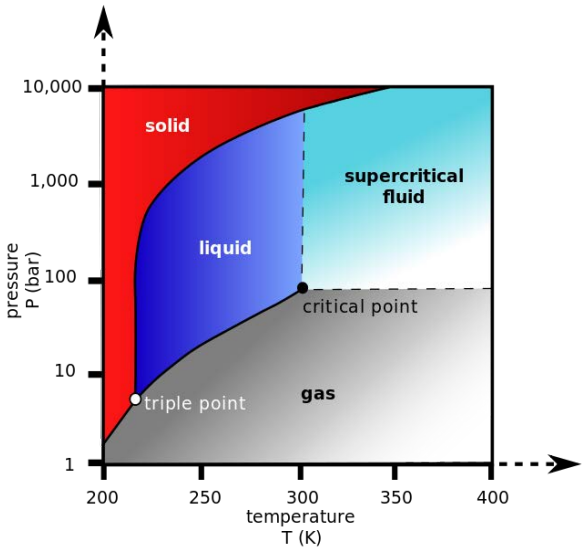

Figure 2: Pressure-Temperature diagram of CO_2

The cylindrical container was filled with a small amount of water and a block of dry ice (about 5m*5cm*3cm in volume). The soap mixture consisted of $1/3^{rd}$ water, $2/3^{rds}$ dish detergent; a cloth was dipped in the soap mixture and then rubbed on the top layer of the container to make the film. Figure 3 attempts to explain the fluid setup that occurs next. It is shown that as the dry ice sublimates and its volume expands significantly; the pressure builds up in the cylindrical container, enough strain the soap film and turn it into a round bubble. The soap

film has enough surface tension in this case to stick to itself while it is stretches and holds pressure. When the bubble pops due to critical pressure, the gas succumbs to gravity and leaves the container in a symmetrical way.

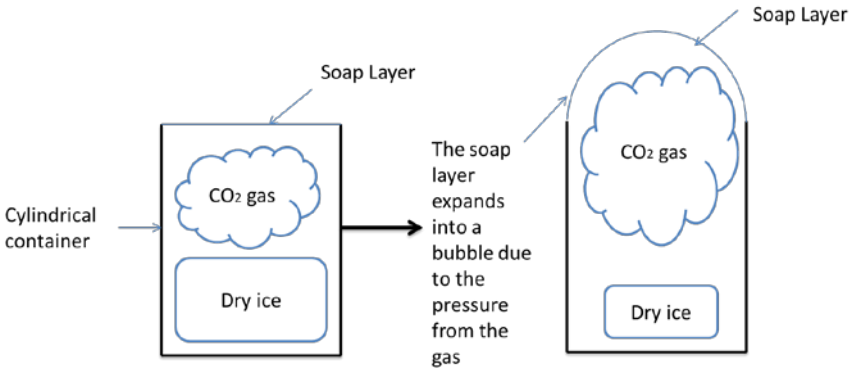

Figure 3: Experiment Setup

Flow Visualization Technique:

The image was captured in the blacked-out garage of the photographer. Red, green and white Christmas lights were chosen as the main source of lighting in order to provide an interesting reflection off of the soap film. An additional source of light was a bright lamp underneath the table where the container stood, to provide just enough lightning and definition to the bubble. A dark blue sheet was used as a backdrop so as to eliminate any distracting elements. Finally, in order to provide a good image, a controlled bubble pop was implemented by using a sharp knife at the top of the bubble. This way, the photographer could easily time the picture in order realize his intent. The container used was approximately 15cm in diameter, so the width of the picture is approximately 19cm, with a depth of field of approximately 30cm.

Photographic Technique:

The image was taken with an Olympus camera, series E-500. Manual mode was used with settings F8.0, shutter speed 1/4s, ISO 320, and zoom @41mm. Manual focus was also used due to the fact that the light reflections on the bubble were difficult to focus on. Because of the dark setting, the image required many editing steps in order to become a final image. The contrast curve was adjusted in order to enhance the presence of the gas inside the bubble; the sharpness was increased to better show the light reflections on the soap film. In addition, the red and green colors were enhanced, and noise reduction was used to its maximum extent so as to reduce any grainy effects on the image. Finally, the image was cropped to cut out unnecessary black space. All these changes were done using the Olympus Viewer software, and then saved as a .TIFF file to avoid any further loss of information.

Conclusions:

This image is very aesthetically pleasing and shows the transition from a pretty bubble to the beautiful white fog leaving its holding space. The exposure time was large enough to capture these two events, and that was the intent of the photographer. One lesson learned was that the editing of the picture really brought the image to fruition, bringing colors out and making the objects more vibrant. The image is still a little grainy, so a lower ISO setting could have probably been used for a better resolution, but the photographer is very satisfied overall. A lot was learned in the setup of this experiment, and the dry ice was handled with care at all times, using gloves to transport it from the cooler to the cylindrical container. All team members were aware of the danger of frostbite that the dry ice represents.