Carbon Dioxide Bomb

Flow Visualization

MCEN 4151

Team First

03/07/2018

Youngwoong Kim

I produced a video which is named as 'Carbon Dioxide Bomb'. The reason I chose 'Carbon Dioxide Bomb' as the title of my video is that carbon dioxide vapor is produced and pops up the soap bubble on the top of container. The phenomenon I was trying to see in my video is that the white vapor spread out around the container as the soap bubble pops up. The container contains half cup of water and half cup of dry ice. The soap bubble is made on the top of the container by smooth cloth which is wetted by soap water. Then, the vapor of carbon dioxide produced by dry ice pops up the soap bubble on the top of container, and the white vapor comes out of the container.

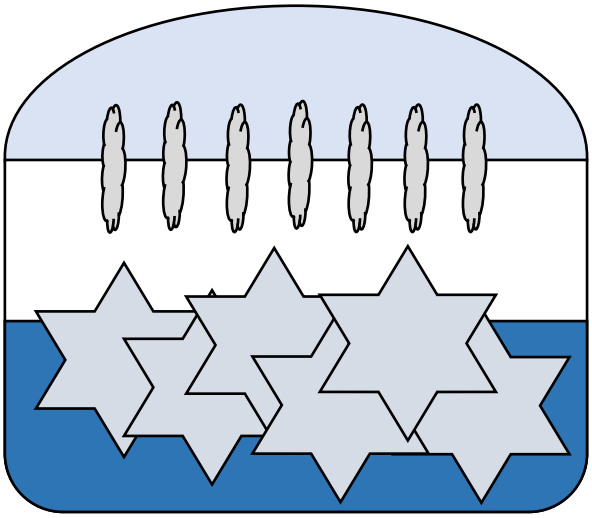

Figure 1: The figure of Set-up including Water, dry ice, and soap bubble

The figure 1 is showing the flow apparatus with whole set-up. The main flow in this set-up is the motion of vapors. The carbon dioxide vapor emerges from dry ice due to the relatively higher temperature of water. The soap bubble inflates due to incensement of volume of carbon dioxide vapor until the surface tension of soap bubble exceeds the

maximum value of surface tension. If the surface tension of soap bubble collapse, the soap bubble pops up and the white vapor come out of container. Actually, the white vapor is water vapor, not carbon dioxide vapor. The carbon dioxide vapor is invisible, so the white vapor must not the carbon dioxide vapor. The water vapor in the container crystalizes due to the cold temperature of dry ice, so the water vapor looks like a white vapor.

$$\mathrm{Re} = \frac{\rho \mathrm{VD}}{\mu} = \frac{VD}{\nu} = \frac{\left(1\frac{\mathrm{m}}{\mathrm{s}}\right)(.012\ m)}{(.101*10^{-6}\frac{m^2}{s})} = 118811.9 \qquad \text{----------} \qquad \text{Eqn. 1}$$

The Reynolds number is the behavior of carbon dioxide vapor. I have figured the velocity of carbon dioxide vapor by inspecting video with slow motion and a diameter is measured with a ruler. I assume that the temperature in container is 10 Celsius, so the kinematic viscosity of carbon dioxide is found as .101*10^-6 m^2/s. With all assumptions and values, I could find that the flow of carbon dioxide vapor is turbulent because the Reynolds number is 118811.9 which is higher than 4000.

I have used water, dry ice, and soap as the visualization techniques. The water is just tap water, the dry ice is from Safeway, and the soap is from Dove. The number of lightening source that I have used is just one. The lightening source is come from ceiling which is placed above the object. The music that is used in the video is no copyright background music provided by Youtube.

I have tried variety sizes of containers, and I figured out that the size of container used in video is just appropriate for the amount of the vapor that is able to pop up the soap bubble. I wanted to show whole wine glass and the frame of video is symmetric, so I have decided the distance from object to lens as about 30 cm. I have used Iphone as my shooting method, and Iphone has two different lenses which are wide-angle lens and

telephoto lens. The wide-angle lens measures 28 mm, and the telephoto lens measures 56 mm. From the EXIF data, we know that the focal length is 3.9 mm. The camera specifications are 1080p at 60 fps, 7 MP, f/2.2 and 32 mm. I reduced video quality to 720p from 1080p due to the size of video by using iMovie.

In my opinion, the video came out well. It captured the behavior of vapor and soap bubble. I could find that the behavior of bubble obeyed the laws of physics which is surface tension. My question is why vapor goes down when it releases from the soap bubble. I think that I fulfilled my intent by showing beautiful flow movement. I think that it would be a significant improvement if I put pure black background to see the movement of flow.