Stella Newman Image-video 3 Report Flow Visualization Fall 2020 Professor Hertzberg 11/23/20

Propulsion Effect; Dry Ice on Water Surface



Link to video: <u>https://vimeo.com/477887574</u>

In my experiment for the Image-Video 3 assignment I demonstrated vortex propulsion by placing a small amount of dry ice on the surface of water. Propulsion is the action of an object being pushed or pulled forward ("Propulsion".2020). It took me multiple attempts to get the vortex effect seen here, which is what I was trying to capture. The surface area of the dry ice touching the surface of the water had to be small enough to propulse itself in a circular motion across the water. Some of the challenges I faced in this experiment were filming without catching a reflection and getting the piece of dry ice small enough to float.

To set up the apparatus used in this experiment I used a 8"x12" non-stick baking dish, 8 cups of water, food coloring, and dry ice. You can visualize the set up based on the illustration in figure 1. The basic physics occurring in this experiment are adhesion, evaporation, propulsion,

and vorticity. Since the dry ice that is in contact with the water's surface is evaporating at a faster rate than the dry ice that is not directly in contact with the water the evaporation creates CO2 gas and water droplets; this is the smoke seen in the video. As seen in the video there are small waves or breaks in the smoke as it moves in a circular motion; these are stick-slip waves. The stick-slip phenomenon occurs when the dry ice slides over the water's surface when the friction is changing ("Stick-Slip Phenomenon",2019). The adhesion, change in friction, and evaporation are also factors that cause the propulsion effect in this case. As the dry ice comes in contact with the water and begins to evaporate the friction pushes the dry ice into a vortex-like movement. The dry ice initially moved in other directions, but after evaporating into a specific shape it began to circulate.



8"x12" stainless steel baking dish



The visualization technique seen here is smoke formed from dry ice and water. I used tap water, blue and purple Wilton brand neon gel food color set from Target, dry ice from King Soopers, and a 8" by 12" baking pan from Target. In order to get small fractions of the larger piece of dry ice I bought from the grocery store I used a spoon to hammer off fragments and then waited for them to evaporate in the water until they could float. Capturing the phenomena without catching a glare was challenging at first, so I moved my apparatus to my living room where natural light at 1:42pm was coming in from two directions and positioned my camera at an angle to minimize reflections. The smoke and dark colored water did eliminate some of the glare as well.

The final field of view in this video was approximately 4 inches tall by 6 inches wide, although, when I took the video my camera was positioned 7 inches from the dry ice. I used my

iPhone Xs to capture this video. My post-processing consisted of running the video through iMovie in order to crop the field of view. I also increased the contrast in the video so the smoke would stand out even more against the dark colored water, I did this so the stick-slip waves would be more visible. I also added a title and a slow motion shot in my final presentation of the phenomena.

This video beautifully portrays stick-slip waves which isn't something I was initially trying to capture but I am more than thrilled with the way they were captured. Although it was hard to position and size the dry ice to see the vortex propulsion effect, I am happy that in the end I finally reproduced the effect. If I were to do this again I would do more research on how to film something on water without catching a reflection because this was a major issue when I was using my camera to film the experiment. Overall, I love this phenomenon and am extremely content with how my final product turned out.

Works Cited

- "Stick-Slip Phenomenon." *Wikipedia*, Wikimedia Foundation, 10 Dec. 2019, en.wikipedia.org/wiki/Stick-slip_phenomenon.
- "Propulsion." *Wikipedia*, Wikimedia Foundation, 16 May 2020, en.wikipedia.org/wiki/Propulsion.