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MCEN 4151
Team Third Report
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Team Third Report

Context

This was for the Team Third project. My team and I wanted to use rheoscopic fluid to visualize different kinds of flows over objects in a recirculating tank. We wanted to capture the flow transitioning from laminar to turbulent flow. Lara and I helped add water to the tank. Michael G. was the plumbing master and got entire setup working properly. Cara helped fix leaks along the way and made sure the lighting was working. Lara did a lot of the camera work and I added the rheoscopic fluid as we took pictures and video. The final image that I chose for this project is in Figure 1.

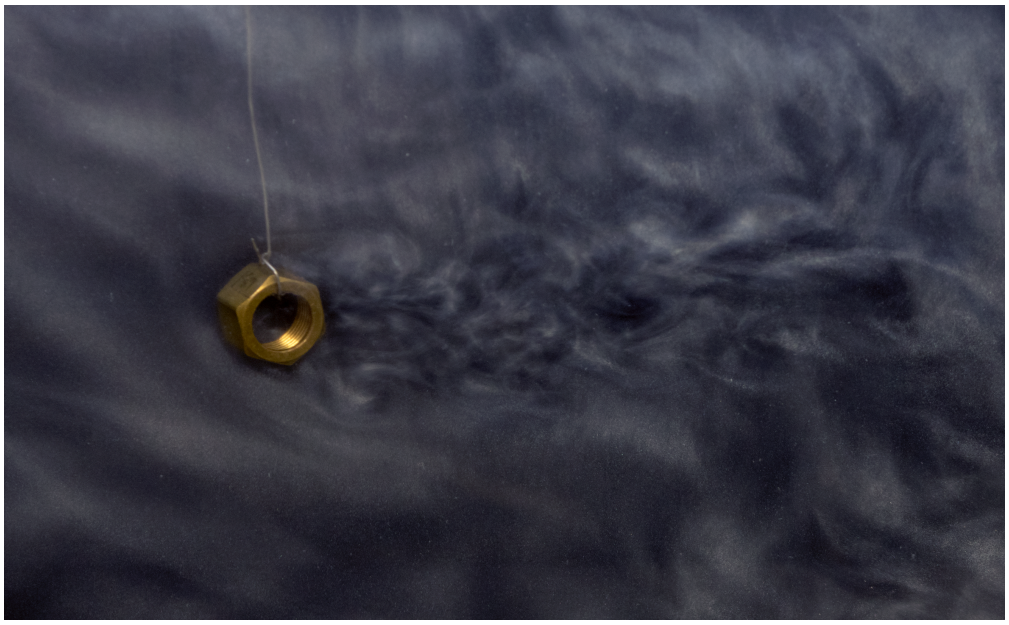

Figure 1: Final image for Team Third project.

Apparatus and Flow

We used an apparatus that was previously made for Flow Visualization students several years ago. This included a huge tank with PVC pipe and a water pump that would recirculate the water through the front of the tank where there were plastic grates to help disperse the rheoscopic fluid within the water more evenly. On top of the tank were LED lights. Figure 2 shows a real image of the entire setup for this image.

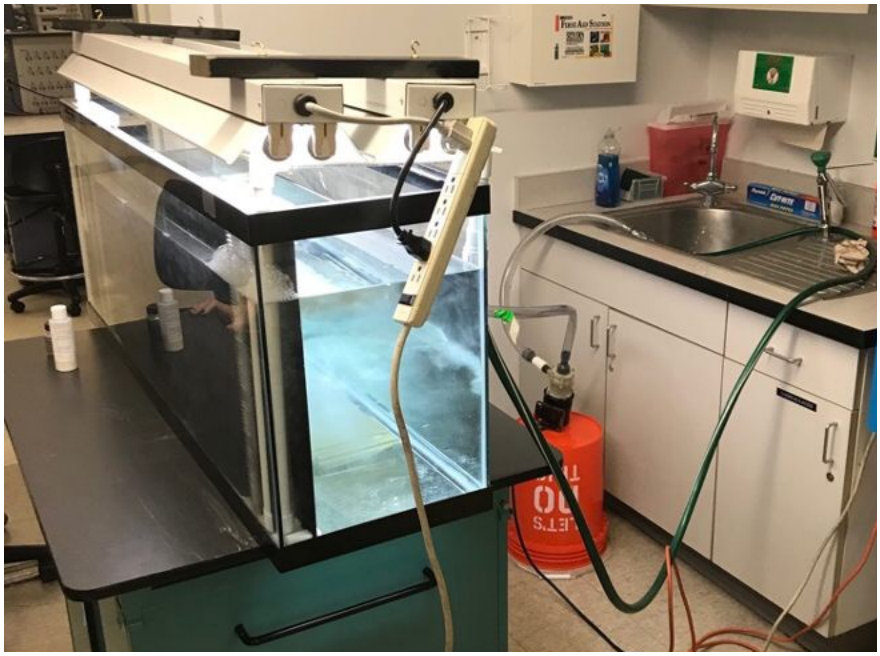

Figure 2: Apparatus for capturing flow image.

We took images from the front side (right side in figure near small bottle) at a slight angle to reduce reflection and glare from surrounding lights. We added rheoscopic fluid on the right of the front side and allowed it to blend into the flow that moved from right to left across the tank face. The fluid was turbulent when we added the rheoscopic fluid and then became laminar when it was finally mixed. The image shows laminar and turbulent flow. The nut was drug through the water slowly causing a wake to form behind it. The fluid in front of the nut was laminar and the fluid behind the nut became turbulent. This can be approximated by the flow over a sphere. The fluid hits the surface of the sphere (nut) and separates. The body of the sphere (nut) causes different vortices to form from drag forces causes by surface of the object[1]. These different vortices expand behind the sphere (nut) forming the turbulent wake that is seen in the final image. The Reynolds number in the laminar region would be around 10^3 and changes to around 10^6 when the flow becomes turbulent.

Visualization Technique

This image was created by adding rheoscopic fluid to water and having the mixture move through a tank at a slow velocity. We then added a nut on a string to image the flow we could have around this object. The light was from the LEDs that rested on top of the setup.

Photographic Technique

The original image was 6000 by 4000 pixels. The original image is shown in Figure 3.

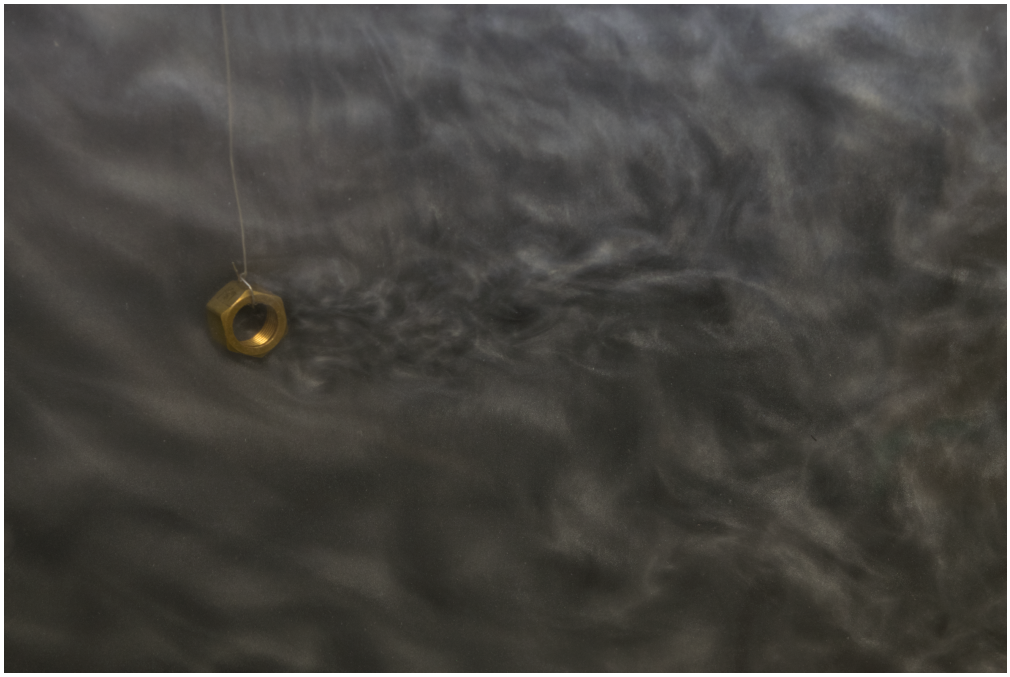

Figure 3: Original image.

The image was taken using a Nikon D3300 that was about a foot away from the tank side. The field of view was around 2 feet wide. The focal length was 55 mm and exposure was 1/15 seconds. The F number was 5.6 and the ISO was 400. The final image was cropped to 4506 by 2767 pixels and I adjusted the curves and contrast slightly to achieve the final image in Figures 1 and 4.

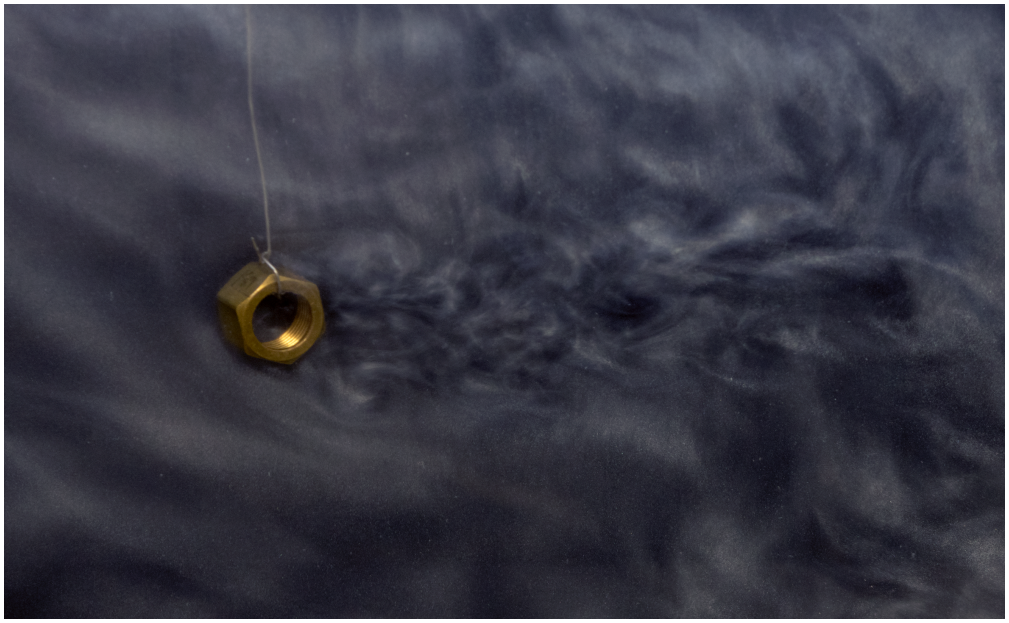

Figure 4: Final image.

What the Image Reveals

I really like how this image shows laminar and turbulent flows at the same time. The color of the water mixture and the gold nut work well together and I am glad I chose not to use gray-scale. I

wish the tank had been a little cleaner so as to avoid the grainy bits of dirt that are somewhat visible. The turbulent flow is demonstrated really well and I am glad the wake showed up so well in the image. I did fulfill my intent with this image to show the flow over an object. To develop this further, I would clean the tank more and adjust the lighting so that we could take video of the moving fluid over the nut.

Citations

1 Drag of a Sphere. (n.d.). Retrieved April 28, 2018, from https://www.grc.nasa.gov/www/k-12/airplane/dragsphere.html