Greg Kornguth Team Second Report

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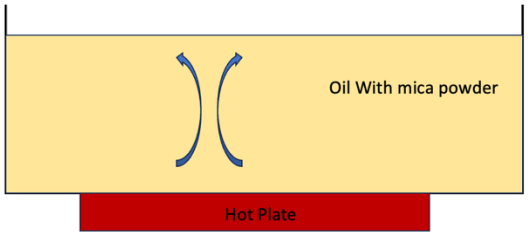
MCEN 4151

Assistance on Photo From: Leo Steinbarth, Austin Sommars, and Stella Meillon

For my team second project, I took a video of Rayleigh-Bénard convection in action. We wanted to see the movement in the fluid due to the temperature difference between the bottom and top of the fluid. The fluid that we used was vegetable oil with mica powder sprinkled in so that any movement would be visible.

To set up our experiment we first poured vegetable oil into a small metal baking tray and added some mica powder. We then placed the baking tray on top of a hot plate and turned the heat on. The effects started to take place very quickly with the hot oil at the bottom rising to the surface and spreading out. In the video, it appears as though the fluid is spreading out from a



point on the surface. This is because once the warm fluid reaches the surface it is pushed outward by the column of fluid under it. The baking tin that we used was about 8 inches wide, 4 inches long, and 4 inches deep. The main force behind the columns of rising warm fluid is buoyancy. Since fluids become less dense as they warm up, a buoyant force is induced which causes the less dense fluid to rise above the colder, denser fluid. If the heat source on the bottom of the tin was more uniform, multiple columns of rising warm fluid would form which would then create cells as the fluid at the surface cools down and begins to sink below the warm fluid. Although we did not see the effect of multiple cells forming, the physics and theory behind our flow are very similar to those of a “true” Rayleigh-Bénard convection interaction.

To visualize the flow, all we did was mix mica powder into the vegetable oil. The tiny reflective particles moved with the flow and made it very easy to see how the fluid was moving. The container that we used was a dark, metal baking tin that we already had, the vegetable oil was just purchased from a local grocery store, and the mica powder was obtained from an arts and crafts store. To light the flow, all we used was a cell phone flashlight shining on the surface of the fluid at an angle so that the light was not visible in the reflection on the surface of the fluid.

For post-editing, I added a filter to the video, added a section of the video that played the original in reverse and removed the sound. I also used a video stabilization setting since my original video was shot without a tripod and was very shaky. The filter that I used was an iMovie filter called “Heatwave”. I felt that the colors of this filter really made the mica powder particles clearer and made it easier to see the flow. I messed around with various other iMovie filters, but I felt that the one that I chose made it the easiest to see the interactions.

Size of Field of View	~4 inches
Distance From Surface of Fluid to Lens	~12 inches
Lens Focal Length	18-55 mm lens
Camera Type	Digital (Canon EOS Rebel T2i)
Exposure Specs	The video was shot in auto exposure mode, so the exposure specs change throughout the video
Frames Per Second	30 FPS
Before: 	After: 

The video that I captured showed the movement of a fluid undergoing Rayleigh-Bénard convection very clearly. It is typically very hard to see how fluids move when being heated up, so it was very interesting to see how the surface of the fluid looked. One thing that I was a little disappointed in was the lack of clearly defined cells in our fluid. In many other videos that we watched to prepare for our project, there were beautiful cells forming and it was very hypnotic. I wonder why our setup did not produce those cells and what we could do to try to create those cells if we do this experiment again.

Sources:
Wikipedia- https://en.wikipedia.org/wiki/Rayleigh%E2%80%93B%C3%A9nard_convection

Research and Didactical Videos – Alessio GUARINO-
https://www.youtube.com/watch?v=nQUH9nGTZTY