MCEN 4151-001

10/12/2020

IV 2 Report

Hannah Newton

https://www.youtube.com/watch?v=wjA1R-CxshA

The video depicts the flow from an essential oil diffuser. Water droplets are seen in a laminar and transitional jet traveling through the air. The intention of the photo was to create a sense of magic with the lighting, and serenity and calmness as well in the fluid movement and dance like nature of the fluid motion. While the aesthetics of the flow are the main purpose, certain physics are intended to be highlighted. The laminar and somewhat transitional flow also depict negative buoyance.

Through video analysis in Tracker, data for the position of the flow was gathered. While difficult to pinpoint particles in the flow, close to the nozzle and along the edge of the vapor, it was possible to do so with some amount of accuracy.

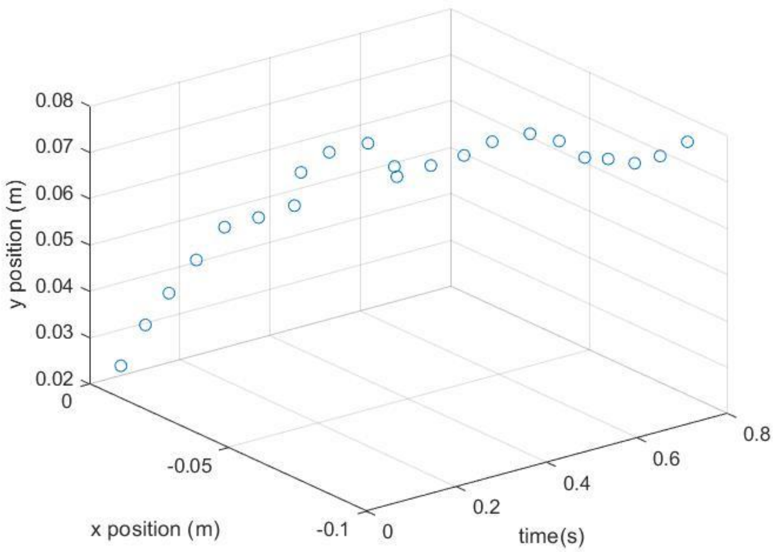

Figure 1, position of water particle from diffuser

Here, one can see the movement of the flow, it is not in a linear path, but also is clearly not turbulent flow. For more characterization of the flow, the Reynold’s number is necessary. To find the velocity of the flow, the x position and time and y position and time were both fit with fourth order polynomials:

$$x_{position} = (1.278*10^{04})t^4 + (2.533*10^{03})t^3 + (1.587*10^{02})t^2 - (4.336)t + 0.014 \quad (1)$$

$$y_{position} = (-2.048*10^{05})t^4 + (4.803*10^{04})t^3 + (-3.756*10^{03})t^2 + (123.234)t - 1.3729 \quad (2)$$

Then, each of those were derived and the velocity was found near the beginning and the end of the data to captured to determine velocities and Reynolds numbers to characterize the flow. The initial X velocity was found to be 4.336 m/s and the final X velocity was found to be 31.28 m/s. The initial Y velocity was found to be 12.32 m/s and the final Y velocity was found to be 33.31 m/s. By combining these velocities, the overall initial velocity is 13.06 m/s and the final velocity 45.7 m/s.

Using the Reynold’s number equation for external flow, $\rho V x/\mu$ (3)
and that the water has a density of 1000kg/m^3 and dynamic viscosity of 1cP given that it was approximately room temperature, the Reynolds numbers were calculated.

The Reynolds number right out of the jet was found as 1.31, the Reynold's number about 10 cm out of the jet was found as 4570. Both values are under the critical Reynold's number for this flow and would lead to the conclusion that this flow is laminar. However, the methods of collecting data for this flow were limited and did not include the flow that was more difficult to pinpoint. The flow that was more difficult to collect data on was the less laminar, moving into to transitional flow.

Negative Buoyance occurs when a denser substance displaces a less dense fluid and sinks. In the video, you can see that there is a force sending the water vapor up and out of the diffuser, but then as it interacts with the air it sinks. This is because water vapor is more dense than air, causing it to sink.

The setup of the video was the oil diffuser with a black sweatshirt hanging behind it. From one side there was a desk lamp with a 60-watt bulb and a Rosco E-Colour 102 light amber gel. From the other side of the setup there was another 60-watt light bulb desk lamp with a Rosco E-Colour 141 bright blue gel. The video was captured on an iPhone 11. The iPhone captures 1080p HD video at 30 fps. The camera has an automatic f/2.4 aperture. The focal length od the camera is 26mm, and the video was shot about ten inches from the diffuser. This allowed the action the be near the focal length.

The video was slowed in iMovie by 20%, and the music and title slides were also added. The music in iMovie is available on a royalty free basis for personal or commercial use. https://images.apple.com/legal/sla/docs/iMovie.pdf

The video reveals a bit of magic and slow dance like movement. Also, the image shows a beautiful gradient with the colors that is shown in the water vapor. The video fulfilled my intent and displayed the physics I wanted to go into. In the future, the video could have been shot on a different camera to add quality and clarity to the video.

Appendix

```
scatter3(diffusedata.t,diffusedata.x,diffusedata.y)
t=diffusedata.t;
x=diffusedata.x;
y=diffusedata.y;
px=polyfit(x,t,4);
py=polyfit(y,t,4);
```