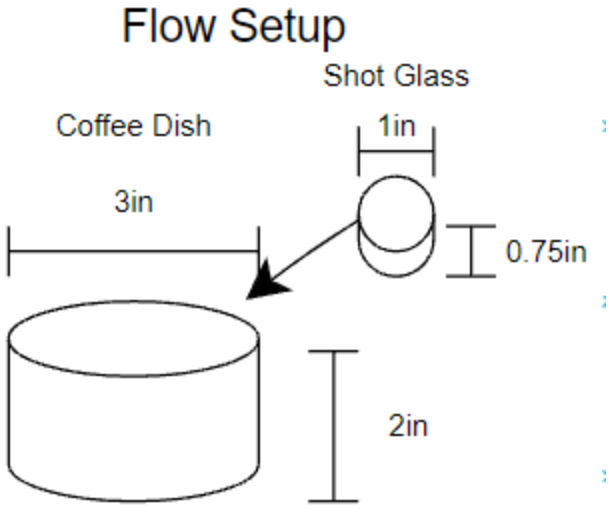
Image Report 1
Flow Visualization | CINE 4200

Trevor Peterson | 9/27/21

Introduction:

In this image, the intent was to observe the different types of flow that occur when pouring milk into different temperature coffee. For this experiment, many different cups of coffee were prepared and left out to cool for differing periods of time. Then after each of the coffee cups had cooled for the allotted time, the milk was poured from a shot glass into the dish of coffee. By backlighting the coffee, the turbulence of the milk is clear in the image as it diffuses into the coffee.



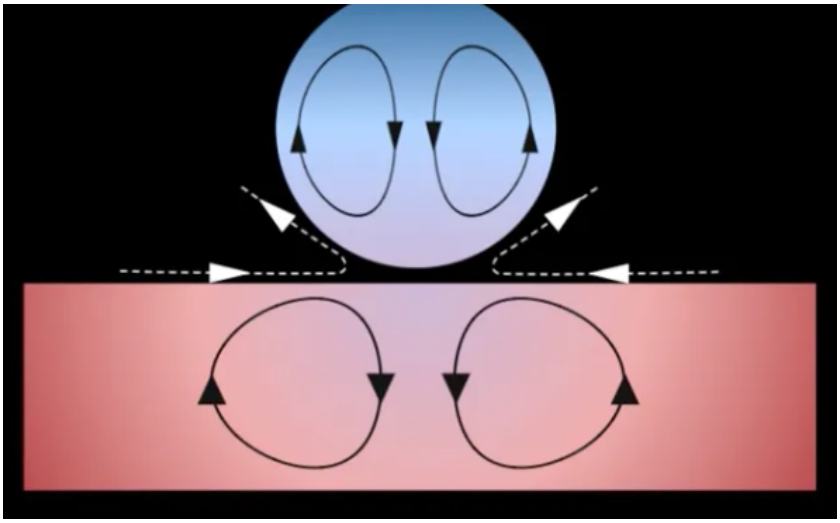
Analysis:

As shown in the diagram above, the coffee dish is larger than the milk being poured into it, and in the final image, the coffee itself is room temperature, while the milk is refrigerated to around 45 deg F. As the milk is being poured into the coffee, the flow is developed by two factors, the differences in temperature, and the gravity pulling the milk down on the surface of the coffee, which is made of water and has a surface tension.

As the milk makes contact with the coffee, the coffee initially has a resistance force on the milk, normal to the surface of the coffee. This pushes the milk up away from the surface, but is mostly negligible in this scenario, as the downward force of gravity from the milk much outweighs that of the surface tension from the coffee. As seen in the raw image below, it can be noted that the milk develops a circular pattern around the point of entry, in the middle.

This turbulent flow, which has inconsistency within the ring, takes some form of consistency in the overall pattern.

This ring develops due to vortices that form when the milk enters the coffee. As the milk flows down into the center of the coffee dish, it has frictional forces that pull down on the surrounding coffee, and these create vortices that form in a ring around the center where the milk is poured in. This image below shows the development of the vortices in detail.[1]



The milk, which is symbolized by the blue circle, is entering the coffee, which is symbolized by the red surface. The two circles with arrows show the developing vortices and direction of flow. As shown, the milk will flow around the vortices and develop the ring shown in the picture. As the milk flows around the vortices, friction between it and the surrounding coffee develops the inconsistencies in the milk 'donut' observed in the image.

Technique:

The flow was using 2% milk Kroger brand, and a medium roast McDonalds coffee. The milk was refrigerated when pouring at approx 45 deg F while the coffee was room temperature at 70 deg F. These conditions allowed for the milk to have a higher density than that of the coffee and sink down into the fluid. For lighting, an iPhone flashlight was placed at the bottom of the glass of coffee. By wrapping a towel around the bottom of the glass, it stopped the light from diffusing to the edges of the photo and over exposing the shot. Next time, it would be best to diffuse the light going into the bottom of the glass by putting a paper in between the dish and the iPhone light. No dilutions were made to either fluid.

For the image, it was taken from above to capture the ring-like flow that developed from the pour. The ISO was set at 200 while the shutter speed was max. The photo was taken at a distance of 5 inches from the surface of the coffee to ensure that the focus was accurate and that the milk could be poured from a proper distance.

To edit the photo, the contrast was slightly increased to highlight the difference between the coffee and milk, and the highlights were brought up to highlight ridges of the milk, while shadows were decreased to increase the visibility to the flow. Finally, the sharpness of the image was slightly increased to highlight the edges between the milk flow and the coffee around it.

Finally, the image was cropped to highlight the flow itself, and the surrounding towels of the coffee dish were blacked out to allow for the image to have menial distractions.

Opinion:

This image reveals how fluids with different densities are affected by the frictional forces between them when they come into contact at velocity with each other. I like how the image relates to my morning routine, and also enjoy how the lighting and capture from above allows for the viewer to easily see the toroid shape that the milk forms in the coffee.

In the future, I would change the bottom lighting to be better diffused along the bottom of the coffee dish by using a piece of paper over the iPhone flashlight. Furthermore, I would like to utilize a better camera that has control over specific shutter speeds and ISO. Finally, dying the coffee so that it contrasts better with the milk would allow the flow to be visualized in a clearer sense.