Team's Third Report

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Flow Visualization MCEN 4151-001

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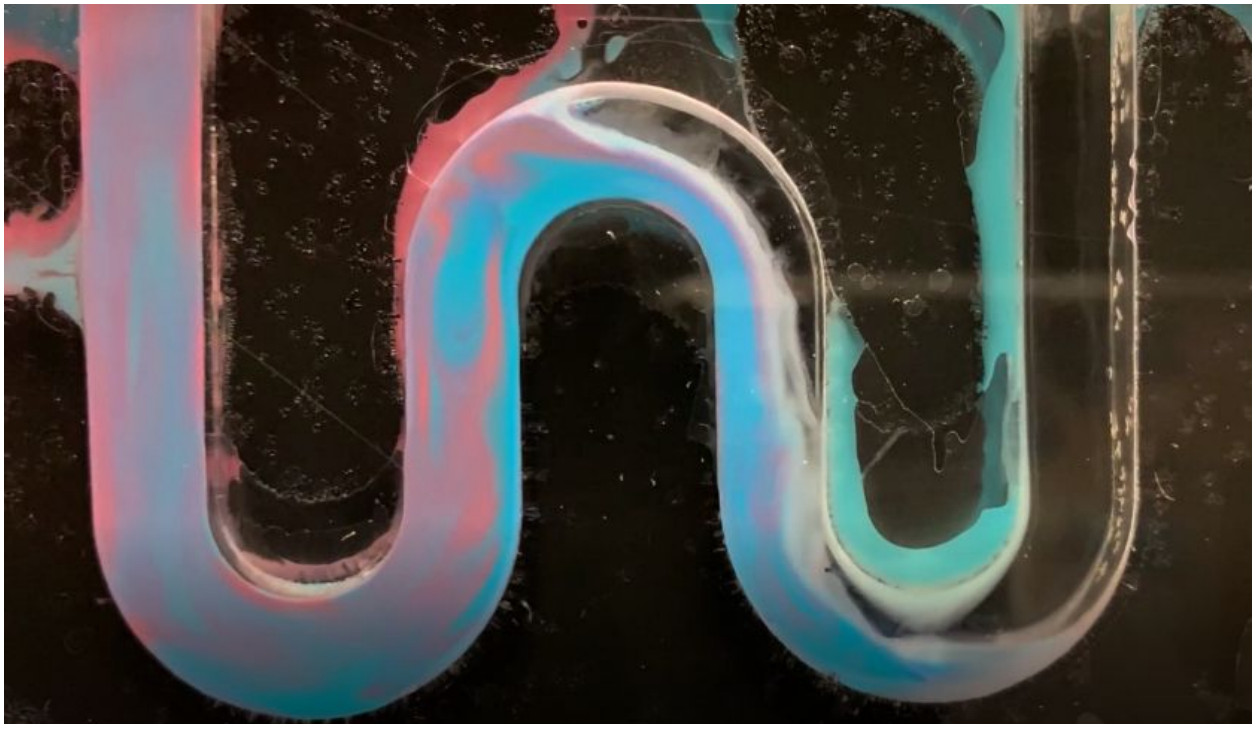
Viscous Fluid in a Channel



Assisted by: Noah Granigan, Peilin Yang, and Winston Douglas

For the third team iteration the goal was to capture a viscous fluid against following a channel that flows against and with gravity. The apparatus used was a setup created by the team in the ITLL at the University of Colorado Boulder. High Surface tension of the fluid overcomes gravity in the experiment and fills the channel's diameter as it as it approaches the outlet. The physics of the viscous fluid through this channel are explained as well as the art and apparatus approach.

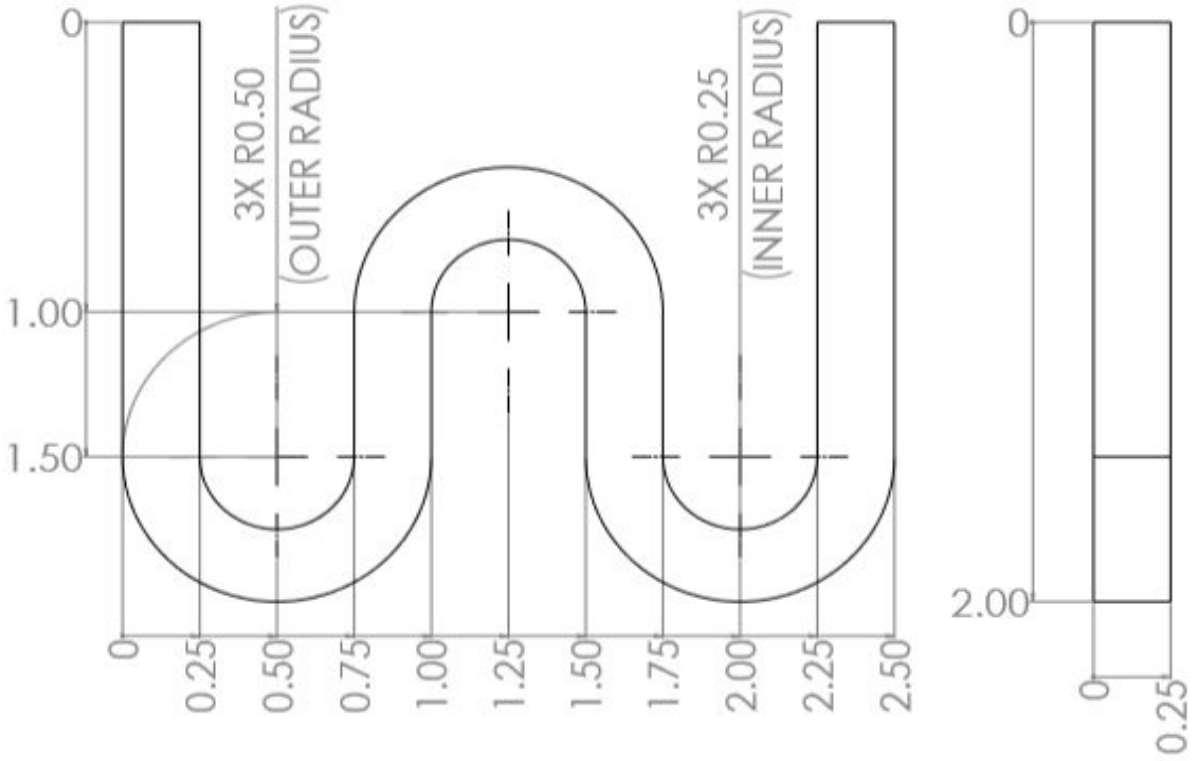


Figure 1. Shows the schematic of the channel used for laser cutting in the ITLL.

The apparatus was constructed out of acrylic which had high transparency. In Figure 1 the schematic is shown of the laser cut material. This design was chosen based on what the team wanted to achieve visually which was observing several direction changes and enough height to go against gravity. Two openings are used as either the inlets or outlets depending on the experimental combination. A black background was glued to the acrylic so transparency behind the fluid would not distract the viewer. One thin film is used to cover the acrylic so the fluid will not overflow out of the channel path at higher pressures.

To create the fluid, six cups were used for mixing. Each had the same amount of water and received a different fraction of glue. The glue was used to make the fluid more viscous. Lastly,

food coloring was adding for separating the fluids. Since the fluid has high inner cohesion there will be a strong outward force against the surface tension on the channel. In the event of channels that oppose or go against gravity the fluid will slightly resist and cause the ¼ inch channel width to completely fill before moving down the channel direction.

For the experimental process it was decided to try four different methods. The first will be entering two fluids at the same time and rate. It is important to note that a small opening for air to escape was placed on the middle of the channel so there can always be a pressure differential. The second process involved adding only an inlet fluid and leaving the outlet exposed. The third involved incremented the fluid output and allowing the fluid's weight to move it over the channels. For the last test, a fluid was mixed in a syringe with small gaps between each fluid. The fluid was then slowly pumped through the channel allowing the viewer to see how the two different viscous fluids flow through the channel together.

Figure 2. A snapshot of the kissing phenomenon from the video of this report. Two colored fluids of different viscosity enter the fluid until it is completely full.

Originally, the video was captured using a new iphone 7. The camera took 60 frames per second and has 12 MP. This camera also has an aperture f/2.8. The field view was roughly 4 inches by 3 inches to capture only the experiment. Additionally, the camera was about 6 inches away from

the setup. The video did not have any editing on color or effects other than transitions and fading. To make the video really stand out all the clips were divided in two fractions. Then they were clustered together in different orders to show only a small section of each clip at a time. The effect gave the view a desire to keep watching as the fluids start entering the channel until the last clip shows the end results. For a suspenseful song, "Two Cellos" by the Piano Guys was chosen as the background music. It should be known that the videos were all sped up 8 times the normal rate due to the slow process of the viscous fluid.

Overall the team was really thrilled with the results of the photos and videos taken. The video really showed the flow clear and the unique mixture of the fluids. The most apparent phenomenon was when the fluid begins to pass the middle channel. As it flows over the surface tension keeps the fluid from separating while the viscous forces does not allow the fluid to travel far from the peak of the channel until all of the fluid has caught up (Lifshitz, E.M. (1987)). If this could be done again it would be spectacular to use a larger channel with a very unique pattern that would reveal itself when the fluid nears completion of all the channel paths.

References

[1] Landau, L.D.; Lifshitz, E.M. (1987), *Fluid Mechanics* (2nd ed.), Pergamon Press, pp. 44–45, ISBN 0-08-033933-6