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Get Wet
Flow Visualization 4151-003
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Volume Contraction

For this video, I attempted to demonstrate the phenomenon of “volume contraction” when 91% isopropyl alcohol mixes with water. This is evident at the end of the video, when 150 millileters of water and 150 milliliters of alcohol does not equal a total of 300 milliliters. This strange occurrence happens because of the packing differences between the pure substances and solvent molecules (Finn Scientific, 2016). At first, I was going to keep the video shorter than its current length, but I ended up including a bit more time in the alcohol pouring portion to show that I finished pouring the full 150 millilters. It also took me several tries to get a consistent water pour. I spilled several times but was finally able to pour at a speed that did not spill any water. In the end, I ended up with a beautiful visual that demonstrated the situation that I wanted very well.

In terms of the apparatus used for this experiment, I poured 150 milliliters of both liquids into measuring cups that I purchased from Target. For pouring the water, I used a drinking glass from my kitchen cabinet. I poured the alcohol out of the plastic bottle which it came in. I usually keep several bottles of isopropyl alcohol on hand for stripping paint off of model trains. After both liquids were in their respective measuring cups, I poured the water into the alcohol cup, as shown in **Figure 1**. I chose to pour the water because I thought that the alcohol could evaporate to a noticeable degree as I was pouring it.

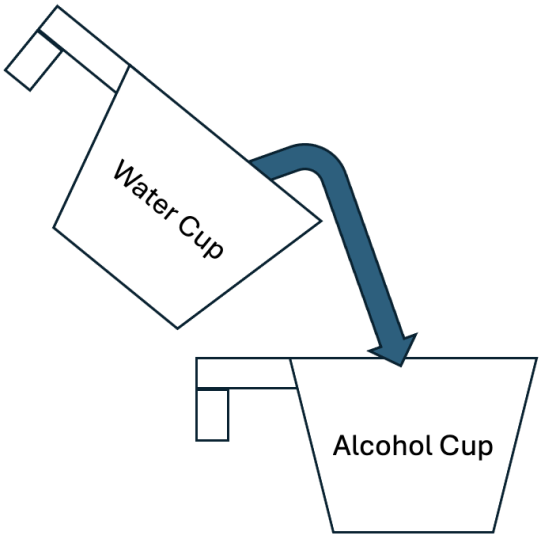

Figure 1 shows the water measuring cup cup being poured into the alcohol measuring cup to form a mixture.

In my experiment, I estimate that the water from the measuring cup was poured from about 8 centimeters above the alcohol cup and that the water was moving at around 1 meter per second. Using these values and the kinematic viscosity of water, we can find the Reynolds number of the flow with **Equation 1** (KSB).

$$Re = \frac{UD}{v}$$

Equation 1: Reynolds number

The Reynolds number for the flow is approximately 79840 which means that it is very turbulent.

The visualization techniques that I used were very simple. I did not dye the water or alcohol, but I may perform the experiment again with dyed water. This would not demonstrate volume contraction any better, but it might look more visually interesting on camera. I chose to use the lighting from my kitchen and nothing else because I thought that the backlighting from the LEDs above my counter gave a calm feel to the video.

Even though I generally try not to use my phone for visual assignments, I decided it would be the best tool for this one since I wanted to record a slow motion

video. I chose the 120 frames per second option because I could record in 1080p high definition, and I thought 240 frames would make the video drag a bit. I set my phone in a cheap tripod from Target, which I do not recommend to others. This tripod was very unstable, and I had to wait for it to stop wobbling every time I touched it. My phone was bout 10 inches away from the subject, which was ideal for the shot I wanted. I did not post-process other than a bit of cropping to make the shots looks similar.

My video reveals the phenomenon of volume contraction very effectively. I like how calming the visuals of the liquid pouring into the containers are, and I like the currents that form in the mixture of the liquids when they come together. That said, there are things that I could have done better. I could have done more takes for both the alcohol and water pours. The water noticeably spills a bit, and the alcohol bottle comes back into frame several times because I did not get the full 150 milliliters on the first try. If I were to do this again, I would also dye the water, so it woud be more visible as it went into the alcohol.

Works Cited

Flinn Scientific, 2016, Volumes Don’t Always Add Up, https://www.flinnsci.com/api/library/Download/bc2d91b9d50f4ead80c9ff320b9a4419#:~:text=When%20500%20mL%20of%20water,volume%20of%20the%20two%20liquids.

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