Fall 2023 Team First

MCEN 4151

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Author: Zach Turner

Co-Author: Ben Clairday, Corey Murphey, Venkata Ramana Murty Durvasula, Zach Turner

The Background

There exists no background purpose for the choice of flow other than an appreciation for its aesthetic. Reference videos and papers had shown many other people had attempted to capture the results of two streams crossing. The effect of the streams crossing created visually appealing laminar flows and or fish bone structures, depending on the fluid viscosity and flow rate. Within our set up we were trying to get the fishbone effect. However, as we will see later the effect requires careful tuning and a very precis set up.

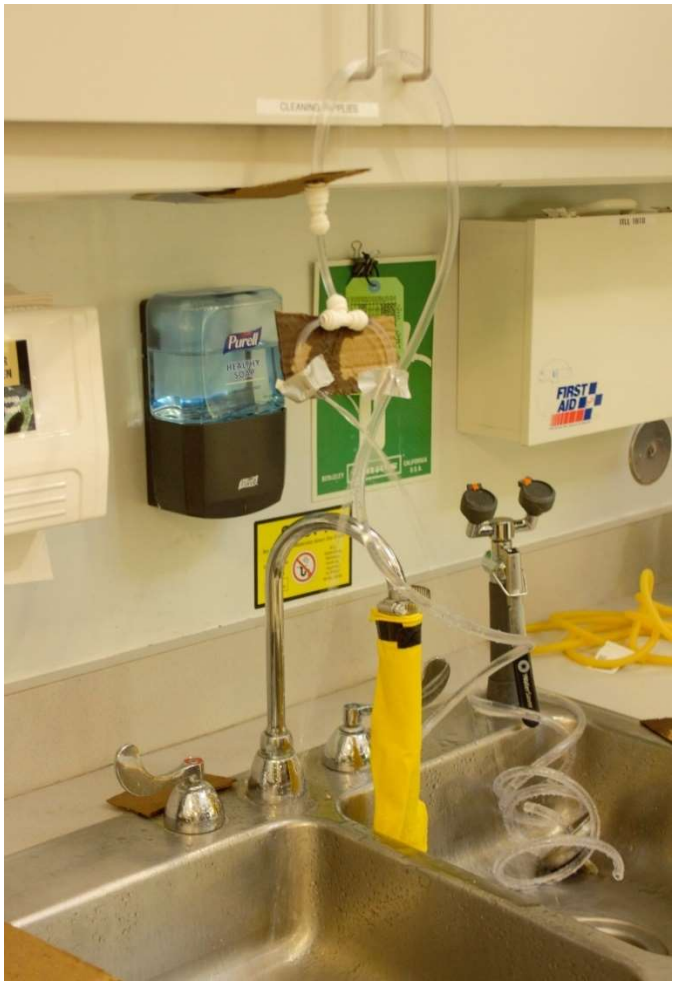

Figure 1 Crossing stream set up.

The setup can be seen above. Water from the faucet was piped upwards and down through a T joint and spit out from two equal length tubes. Corey supplied the tubing and the backdrop for the images. As one person would situate their camera others would hold a halogen light. The light was needed to supplement additional lighting for the faster shutter speed required to capture the flow. This system only utilized water for the working fluid. Alternate sources showed use of sugar syrup and fluid with higher viscosity.

The Math

The best way to characterize this flow is with the flow's Reynolds number. The equation for the flows Reynolds number is as follows.

$$Re = \frac{\rho v D}{\mu}, Re = \frac{\left(997\frac{kg}{m^3}\right) * \left(0.00006309019640343866\frac{m^3}{s}\right) * (0.00635m)}{8.90 * 10^{-4}Pa * s * (\pi 0.00635^2)} = 3543.32$$

The density of water is $997\frac{kg}{m^3}$ with a flow rate of $0.00006309019640343866\frac{m^3}{s}$ (1gal/min) which is a low flow rate from an American faucet running through a $0.00635m$ (0.25in) inner diameter tube. The dynamic viscosity of water is then $8.90 * 10^{-4}Pa * s$. A Reynolds number of 3543.32 indicates we have a transitional flow rending towards a turbulent flow. This matches what we see in the image with the two streams coming in not showing vortices or disruptions.

The Visual

From what can be seen in the image there were no additional effects added to the flow. Originally the addition of glitter was tried but often blurred un the stream. Most of the materials for the set up were 1/4in tubing from Home Depot, a black background, and a halogen light. The halogen light, seen in the photo, provided the majority of the lighting. With such a high shutter speed this hand help light was crucial for a well-defined photo.

Setting / Specification	
Camera	Canon EOS REBEL T3
Lens	28-200mm @200mm
Focal length	28.0mm
Aperture	f/5.6
Exposure	1/1600
ISO	3200

Table 1. Camera Settings

What It Reveals

The image taken reveals the chaotic forces of two colliding fluid streams. We are not given a perfect fishbone effect due to the imperfect set up, but we can see the characteristics of one. The ideal fish bone would look like what can be seen in figure 2. This is a result of a well calibrated system. The two streams of water are colidding almost perfectly normal to each other, cancleing all their adverse momentum leaving only a single plane of motion for them to move in. The viewer can celarly see the seperation of watter droplets as the stream falls, this effect is apparent in the photo taken for class but not nearly as pronounced. Changing the fluid used would also produce differing results. Many other utilized sugar syrup and oils for their heigher viscocities.

Figure 2. Hasha & Bush [1]

References

[1] A. E. Hasha, J. W. M. Bush, “Fluid Fishbones” http://math.mit.edu/~bush/wordpress/wp-content/uploads/2012/08/Gallery-Fluid_fishbones.pdf, September 2002

[2] M. F. G. Johnson, M. J. Miksis, R. A. Schluter, and S. G. Bankoff, ‘‘Fluid Chains produced by obliquely intersecting viscous jets connected by a thin free liquid film,’’ Phys. Fluids 8, S2 ~1996!.