Team 2 Image Report

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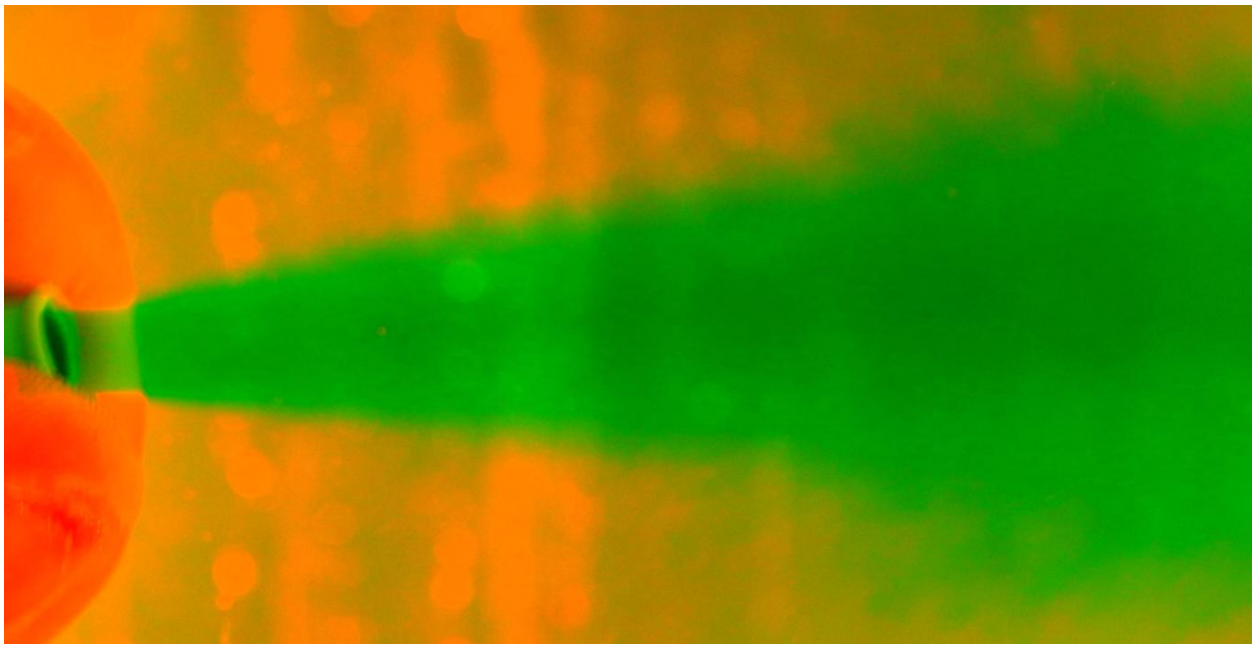

The purpose of this image was to further develop certain flow visualization techniques and perfect the process of image editing. This image is a result of brainstorming done by Team 9 based on previous image experience. The image depicts the axisymmetric jet flow of a balloon expelling dyed water into a calm undyed water environment. To ensure at least one good image, several images were captured during the short burst of the jet. After reviewing the images, this image was selected and edited to bring it to its final form.

The setup of this flow visualization experiment involved a ten gallon glass fish tank filled with water to the rim and a water balloon filled with a concentrated dye solution. The balloon was filled with green food dye in its uninflated state and then filled with water to its maximum size. Once filled, the nozzle of the balloon was left untied and held closed by the finger of the operator. The nozzle of the balloon was then submerged with the nozzle pointed down and releases as the camera caught several images of the jet flow. A diagram of the experimental set up is shown in figure 1.

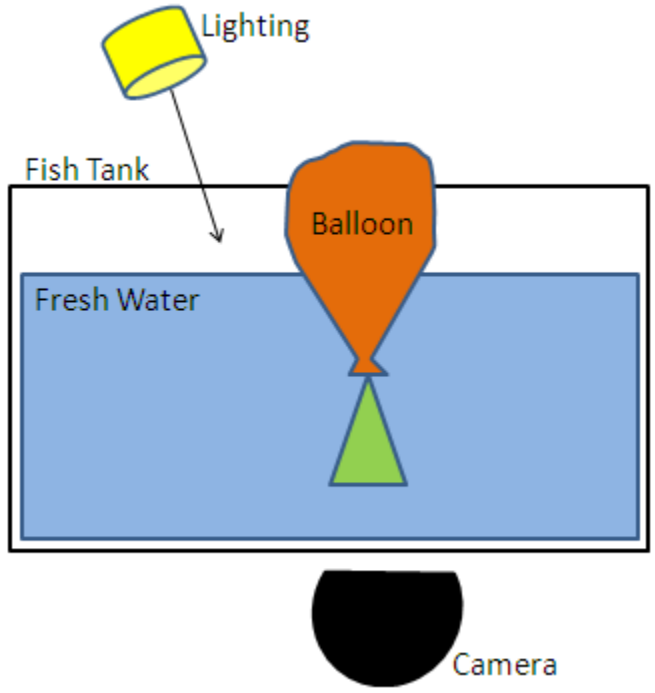

Figure 1: Setup diagram

The flow of this experiment is a form of axisymmetric jet flow. A jet occurs when a flow at an increased velocity from a small opening enters a larger environment at a lower characteristic velocity. The velocity profile increases in width as the mean jet centerline velocity decreases. The jet flow in the image is flowing from left to right and demonstrates an inverse tapering effect as the centerline velocity decays. A schematic representation of the structure of a jet is shown in figure 2.[1] In this experiment it is assumed that the moving airstream U_1=0 since the water in the tank was at rest.

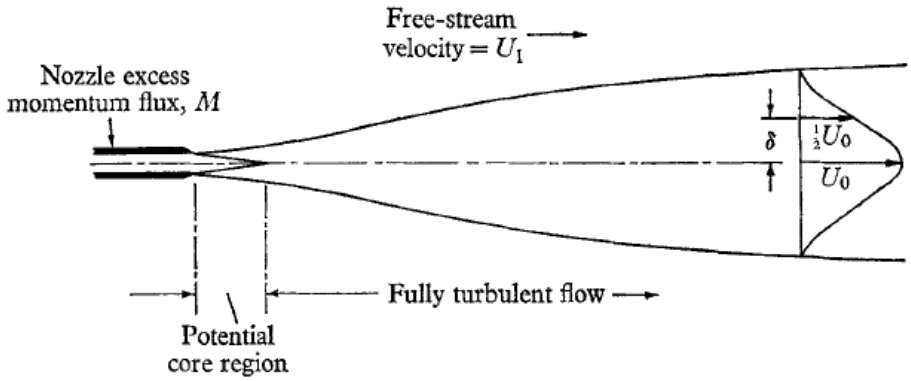

Figure 2: Schematic representation of a jet spreading into a moving airstream[1]

As the dye exits the balloon nozzle it passes through a small potential core region which is generally less than 3 nozzle diameter length long. In this region there is a state of free-mixing layer flow in which the jet will not do much diffusion with its surrounding environment.[2] This is why the green food dye shows a very clear boundary at first, then begins to grow fuzzy downstream as the dye is allowed to mix with the surrounding water. The centerline velocity generally tends to decay at a nearly linear rate[3] showing a direct relation between jet width and horizontal distance from the nozzle exit.

The visualization technique used in this experiment was basic boundary visualization. The dyed water being expelled from the balloon is a different color than the background and therefore stands out. The dye was highly concentrated at approximately a 1:32 dye to water ratio. The standard aquarium lighting was used to illuminate this visualization experiment. This consisted of two 25 watt tubular incandescent light bulbs.

This is a macro shot image with the widest portion of the jet at about 2 inches. The nozzle of the balloon was approximately 9 inches away from the lens of the camera. The focal length of the lens was set at 35 mm with image stabilization on. A Canon Rebel XSi 12.2-megapixel digital camera was used to take the shot creating an original image sized at 4272 by 2848 pixels. The shutter speed was set at 1/10th of a second to capture a small amount of motion blur to make the jet seem like it is moving fast. The ISO was set at 400 to retain image quality and the aperture at F3.5 since it was a small field of view. The original image as shown in figure 3 was edited in picnik.com, an online photo editing website. The image was cropped down to only show the jet zone of interest and rotated counterclockwise 90 degrees to create a neat jet engine effect. The color temperature slider was moved 90% to the hot end to give it a sharp contrast between the jet and the similarly colored background. The final image dimensions are 1375 by 703 pixels.

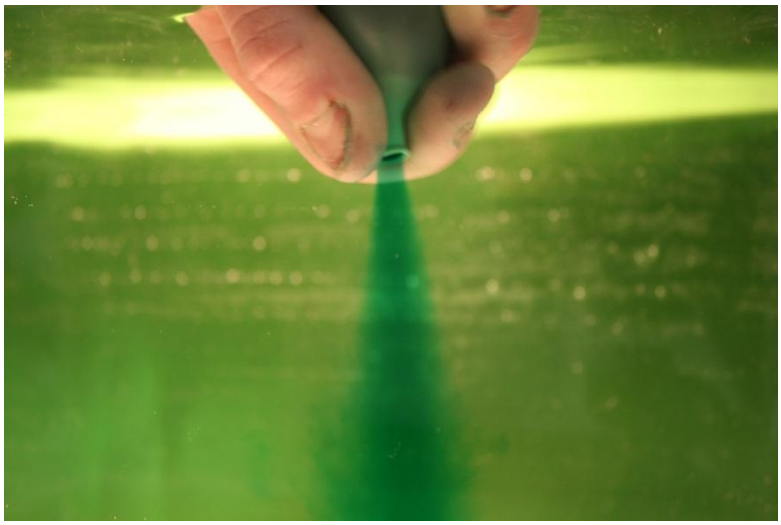

Figure 3: Original Image

The image nicely reveals the flow characteristics that are happening when a balloon is releases and shoots across the room. The simple jet in this image perfectly exemplifies the same patterns that precise axisymmetric jets display. The physics can be seen, however the lack of contrast in the background make it difficult to fully identify the features in the final image. This image could be improved by providing better lighting and backdrop to truly show the nature of the jet. The image should also be zoomed out a little further to show how the jet behaves further downstream. This concept could be expanded by using a larger balloon, or by squeezing the balloon to increase the internal pressure. This image has many areas for improvement and expansion.

REFERENCES:

[1]L. J. S. Bradbury & J. Riley. "The spread of a turbulent plane jet issuing into a parallel moving airstream." Journal of Fluid Mechanics. Vol 27. pp 381-394 (1965)

[2]L. J. S. Bradbury. "The structure of a self-preserving turbulent plane jet," Journal of Fluid Mechanics. Vol 23. pp 31-64 (1965)

[3]D. Olivari, "Analysis of an axisymmetrical turbulent pulsating Jet," Von Karmen Institute for Fluid Mechanics, Technical Note 104, (1974).