

MCEN 4151
Flow Visualization
Team Third Report

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1 Introduction

The purpose of this image was to capture the interesting and beautiful phenomena that occurs when ink is introduced into water. Using a dark ink in clear water against a bright white background created a nice visualization of this phenomena. The random instability shown by the ink dispersing in water is very interesting and dynamic in nature. This project resulted in an artistic capture of a pitch black ink dispersing into water against a very bright white background. The static capture of this quickly dispersing fluid really helps slow down time and observe what is taking place in detail.

2 Flow Apparatus

This experiment was conducted inside in a 10 gallon fish tank filled with water. A small dropper filled with black calligraphy ink was used to administer a small amount of ink into the water. The dropper's tip was just touching the surface of the water so that the ink did not disturb the water when dispersed. A quick squeeze of the dropper created a streamline exit of the ink at a moderate speed that started the dispersion of ink. Once the ink was in the water, it began to exhibit interesting instabilities. Some of these instabilities are known as Rayleigh–Taylor instabilities which occur when two different densities of fluids interact causing the more dense fluid to the bottom of the less dense fluid. The ink used in this experiment was slightly more dense than water causing it to slowly sink into the fish tank. This picture was captured shortly after the ink was dispersed into the water to capture an interesting part of the mixing.

3 Visualization Technique

Creating this phenomena isn't too entirely complex but capturing the flow at the right point of time was a little trickier. With the help of my brother Eric Daniel, we were able to properly time the camera shutter a few seconds after the dropper was squeezed. A nice white background was desired so the glass on the fish tank was carefully cleaned and then an 8.5" x 11" piece of glossy photo paper was taped to the outside of the rear glass. The next step in creating this nice difference in contrast was to ensure proper lighting. Since this experiment was conducted indoors, lots of artificial light was needed

to illuminate all areas of the ink. To accomplish this, two high-powered halogen work lights were used as side fills and two bright LED lights used for photography were positioned directly above the tank. The camera was approximately one foot away from the front of the fish tank and the field of view encompassed the photo paper in the back.

4 Photographic Technique

A Canon Rebel T4i was used with a fixed 50mm lens to capture this flow phenomena. Since the ink only dispersed a few inches wide, close shots were necessary in order to capture the full effect. The ink was fairly slow but still dynamic so an exposure time of 1/320 sec was chosen with an F-stop of f/5.6 and ISO of 400. Capturing the ink during the right moment required a decently fast shutter speed and continuous shots so the best one could be chosen for the final image. A few modifications in Photoshop were made to enhance this image. First, a simple crop was used to center the ink. Then a simple adjustment to the brightness/contrast was made as shown in Figure 1. The last modification was a simple white balance which consisted of three separate curve adjustments (shown in Figures 2, 3, and 4) made using a white, black, and gray point from the original image. The original untouched image is shown in Figure 5.

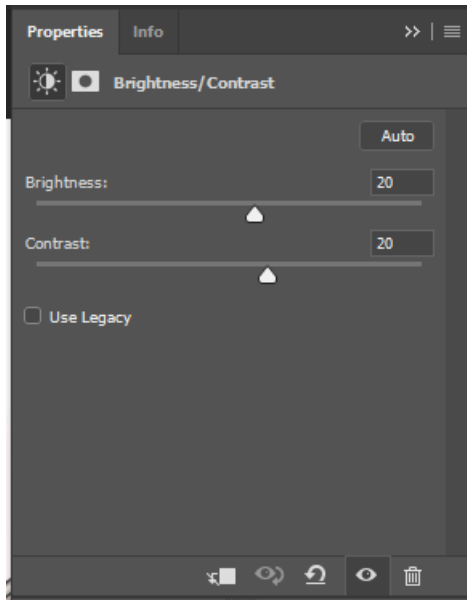


Figure 1: Contrast/Brightness

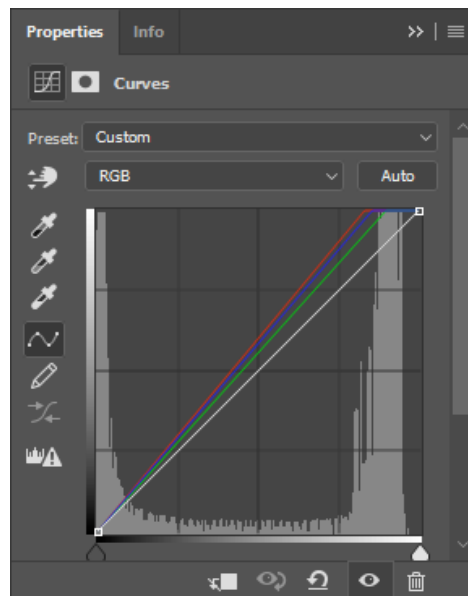


Figure 2: White Curve

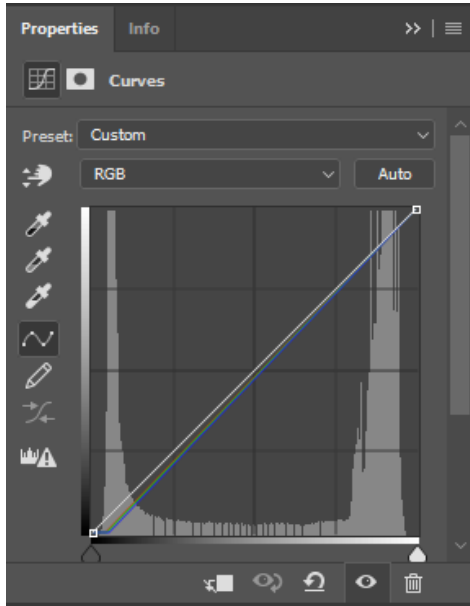


Figure 3: Black Curve

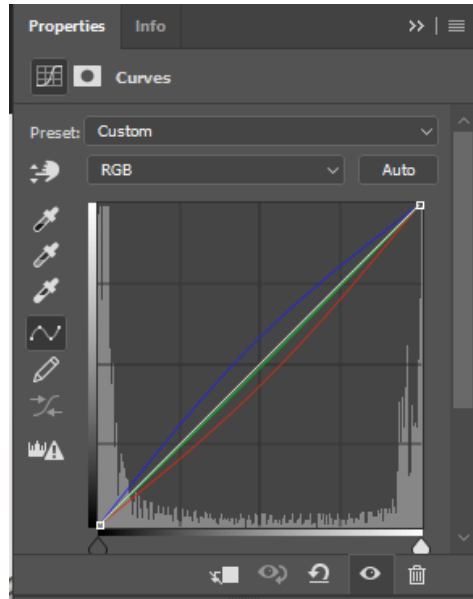


Figure 4: Gray Curve



Figure 5: Original untouched image

5 Conclusion

Capturing the interesting and beautiful phenomena of a greater density fluid interacting in a lower density fluid was achieved by introducing black ink into a tank of water. Using the right amount of ink at the right speed created the amazing Rayleigh–Taylor instabilities. With the proper timing, this flow is clearly illustrated before becoming too mixed. With plenty of light and a nice white background, the contrast displayed is fantastic in this image. This really helps to visualize how the ink is interacting with the water and the results are very rewarding. If the experiment was repeated, I would conduct it outside and use natural sunlight to illuminate the ink even better through the fish tank.