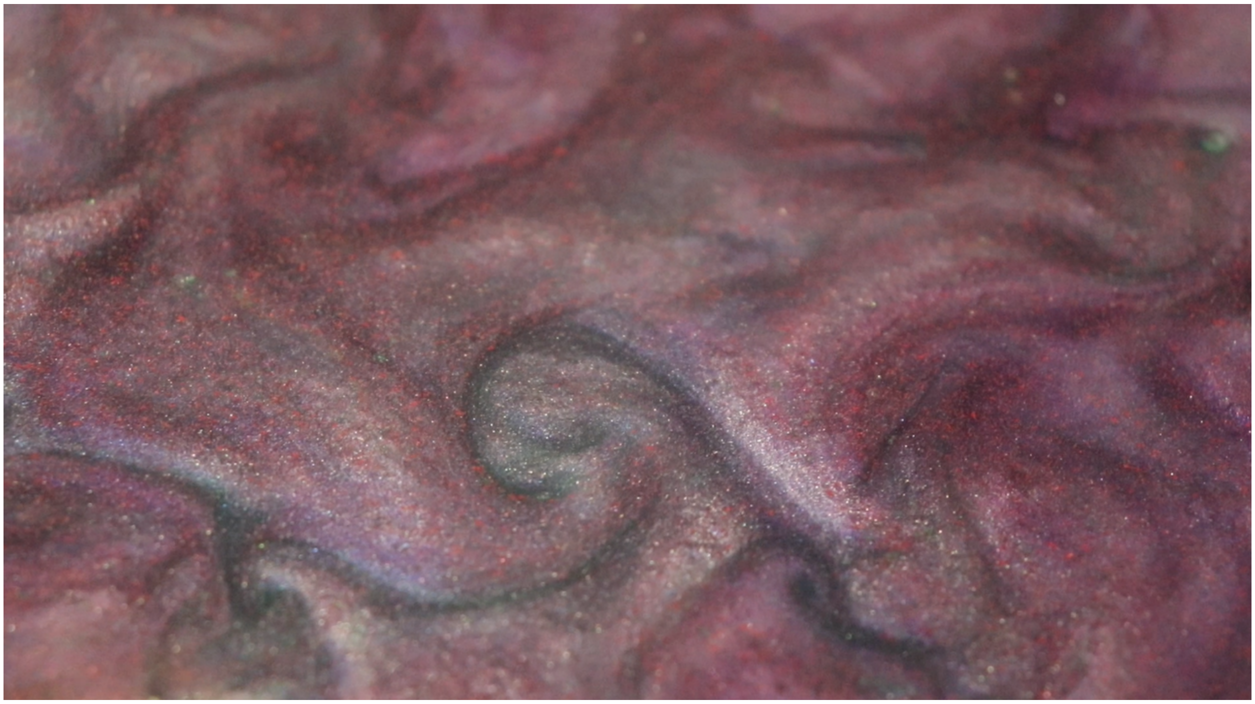

What if we just add more glitter?
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Team Second

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For Team Second it was decided that rheoscopic fluid effects would be interesting to photograph due to the unpredictable outcome from minute agitations. Rheoscopic fluids have microscopic crystalline particles suspended in fluid and, depending on particle size, can increase the internal friction and slow the fluid down significantly. To easily visualize a rheoscopic fluid under different conditions, such as the streamlines, turbulence due to intense agitation, and particle movement, edible glitter was used in an alcohol solution. Alcohol has a lower density than water and the intention was that the glitter would suspend better. At first, a side shot through a drinking glass was thought to be the best way to capture the glitter movement, but there were limitations with the set up that ultimately did not make for a clear photo. Finally, a 13” x 9” baking dish was used and the photo was taken from above. The final shot was taken after pouring in a separate glitter solution into the alcohol solution and letting it “settle” for a few seconds.

It should be worth noting that the fluid movement in both the baking dish and drinking glass slowed down at a surprising rate, and it could only have been attributed to the glitter particles, which were more similar to mica powder. This intriguing effect impacts the base material properties of the Blue Curacao and Rose alcohol solutions so approximations have been made. From running the experiment close to 30 times, there is anecdotal evidence that the viscosity is much higher than water or alcohol –due to the slow down time– and is estimated to be twice as high. However, alcohol has a lower density, so without a concrete number to do calculations there is value in saying that the viscosity is closer to water than alcohol – $1.0x10^{-6}\frac{m^2}{s}$.

To pick a point to specifically analyze (since every point will have different length and time scales) the swirl in the middle is the one the Reynolds number is calculated for, although vorticity would probably have more relevance here. This swirl is about 4” across and moved –swirled– approximately one rotation per three seconds. From the circumference of a 4” circle, this is about 12.57” (0.319m) every three seconds, giving a velocity of 4.19 in/s or 0.106 m/s. This gives the Reynolds number as

$$Re = \frac{(0.319m)(.106\ m/s)}{1.0x10^{-6}\ m^2/s} = 3384,$$

which is in the transitional phase from laminar to turbulence. From the image, it is easy to see that this flow is not quite steady enough to be laminar –the swirls are an indication of this– but there are no “chaotic” flow patterns that are typical of true turbulent flow. As an aside, Stoke’s number –which describes particle motion in a fluid– would be quite low in this case. The particles of glitter follow the trajectory of the fluid, instead of following their initial momentum, indicating that Stoke’s number would be low.

As mentioned before, to create this image a mixture of Blue Curacao (approximately 3oz), Rose (8oz), and edible glitter (5g) was used in a 13” x 9” baking dish. The specific alcohol was chosen to add a background color to build off of for the glitter, and initially red glitter was used in the baking dish. A concentrated slurry of 3g of green glitter and water was poured into the baking dish and is what caused the disturbance on the surface. The image appears quite dark but overhead fluorescent lighting, combined with some natural light from the windows, was used and appeared well lit to the eye. The baking dish was made of clear glass but had no effect on the colors shown.

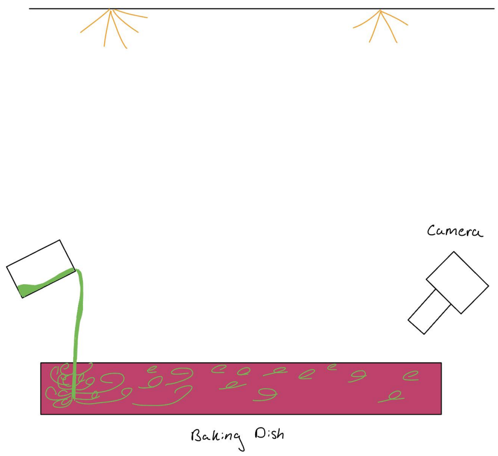

Figure 1: Setup with camera angle acknowledged.

This image (1920 x 1080 pixels) is actually a still from a video of several experiments and was filmed on a Cannon EOS Rebel SL2 (18-55mm lens) with a 59.94 frame rate. The framerate was adjusted from the standard 23.98 to 59.94 because there was too much blur from the individual glitter particles movement. The glitter particles already create a "blurry" look from far away due to the quality of the camera, but at the low frame rate it was near impossible to get a quality image. This image was shot very close to the surface, about 6" away, to not get reflections from lights and the edges of the baking dish in the video/final image. The image was also not edited in any way –even brightening detracted from the image– so no post processing techniques were used.

Rheoscopic fluid is typically used as a way to elevate ordinary drinks and experiments for domestic uses and is studied for its less popular use in industrial settings. There is a hilarious photo from Amazon's website that accurately describes the fascination people have with this pretty fluid phenomenon.

Figure 2: Curious child looks at rheoscopic fluid with a menacing face [1].

The final image fully realizes typical rheoscopic fluid effects and particle motion within it. The glitter color combination also adds a detail of visual interest that perfectly highlights the valleys within a swirl. However, a consistent issue with photographing the glitter is that they made the image look grainy even with a perfectly clear focus. It is more of a human perception issue than anything, but I would wish the frustration that came with running this experiment on anyone. I also wished that post processing methods were effective at lightening the overall image but the highlights from particularly illuminated glitter lost all focus. A different direction to take this in the future would be to change the angle of the camera with the light source. I had better results with the glitter when the camera and light source were perpendicular to each other, but reflections on the glass is a significant challenge in doing this.

<u>References:</u>

[1] “Amazon.Com: Steve Spangler’s Pearl Swirl Rheoscopic Concentrate, 4OZ ...” *Amazon*, www.amazon.com/Steve-Spanglers-Rheoscopic-Concentrate-Gallons/dp/B071J7VSSH. Accessed 12 Nov. 2023.