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MCEN 4228
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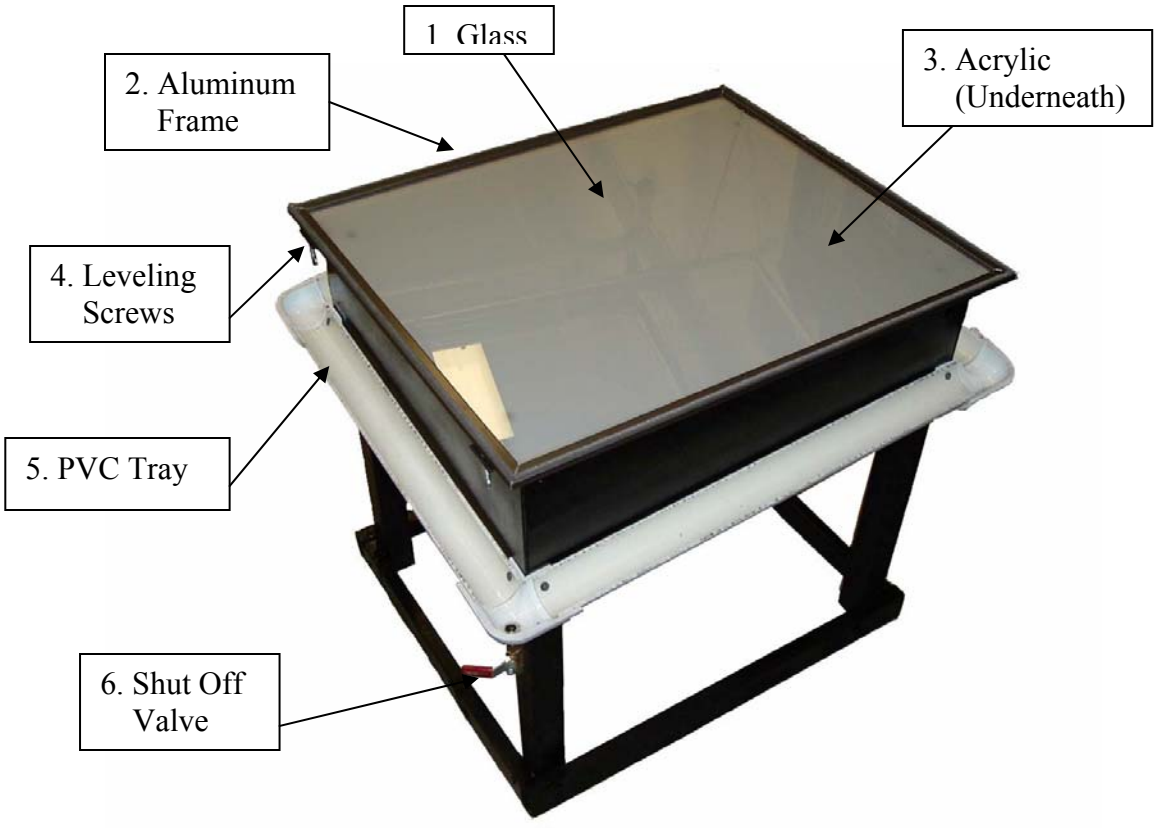
Group Project #1

I submitted two images for this first group project. I wanted to use a black light for these images and decided to do this with the Saffman-Taylor Instability Machine. We tried a few different combinations of fluids and I included two pictures from the two fluid combinations that produced the best looking pictures. The phenomena that we wanted to observe was the viscous fingering that occurred when fluids with different viscosities are injected into a Hele-Shaw cell. This is known as Saffman-Taylor instability and produces some beautiful patterns.

To obtain the images, the Saffman-Taylor Instability Machine was used. A diagram of the machine is included below.



For the first image, Kroger Fabric Softener was placed between the acrylic and glass. Air was then injected into the cell, through a small hole in the acrylic, using a syringe as the pump. In the second image, Karo syrup occupied the cell between the glass and acrylic. Kroger fabric softener was injected into the cell with the same syringe.

Distance of black light from Glass

The first image is 1134 x 964 pixels and the second image is 826 x 872 pixels. The field of view for both pictures is an area of about 1 ft^2. The camera used was a 6.3 mega pixel Canon Digital Rebel with an 18-55 mm lens. The aperture was set at 3.5. The shutter speed was 1/16 sec and the film type was 1600. The camera was digital but it had the option to select film type. We mounted the camera on a tripod at a distance of 3 ft from the glass plate. Both pictures had some Photoshop processing done to them. They were both cropped and the levels were slightly adjusted. When the picture was taken, the fluid particles were approximately moving at 0.5 in/sec. Multiply this by the shutter speed and that says a particle moves 0.0625 inches during the picture. Dividing the field of view (12 in) by this gives the percentage of the picture the particle moves through, which is 0.005%. Since 12 in. corresponds to about 900 pixels in the pictures, the particle will move through about 2 pixels in the images. This is so small that any motion blur will not be visible. Therefore the images have sufficient time and spatially resolution.

Both of the images capture very intricate, beautiful fingering patterns. The fluid physics shown in this experiment are the interaction of fluids with different viscosities. The "fingering" of the less viscous fluid into the more viscous fluid is known as the Saffman-Taylor instability. Injecting the less viscous fluid below the more viscous one causes instability of the system due to pressure gradients. The less viscous fluid is moving at a certain velocity and wants to find the path with the least resistance though the more viscous fluid. I really like the way the colors turned out in these images. The first image has a very nice blue color and the second has an eye catching transparent blue. I don't like how the left side of the images is brighter than the right side. I think it is distracting, especially in the first image. For the most part I fulfilled what I wanted to accomplish. The position of the black light and maybe the amount of black lights could be changed to better illuminate the fabric softener. I also think better fingering effects could be produced with more use of the Saffman-Taylor machine. Experimenting with different combinations of fluids with the fabric softener would be an interesting endeavor. It might lead to some stunning pictures.

References

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