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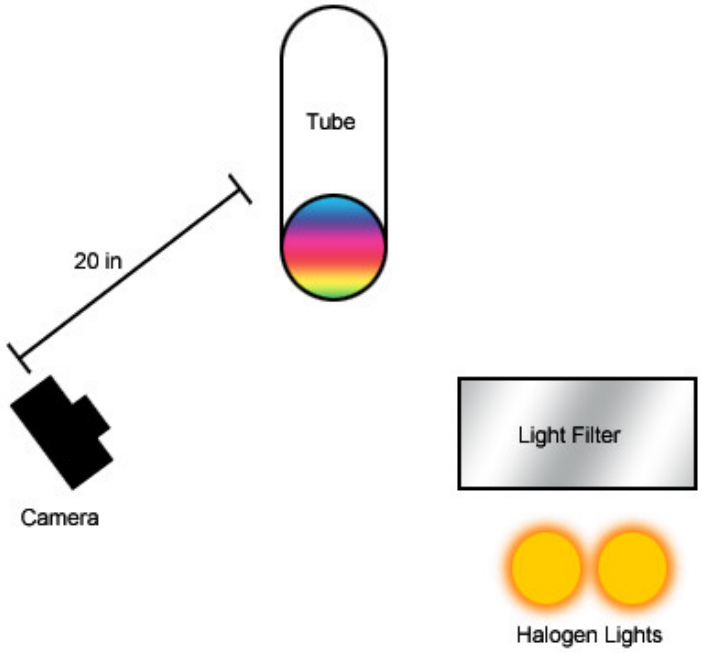
# Team Project 1

The intention of this image was to observe the reflection and interference patterns that form from a soap and water solution stretched into a thin film. We also sought to display the surface tension within a soap-water solution and visualize the thin elastic sheet that this tension can produce. A plastic tube was used to form the soap film on, and a simple solution of Palmolive dish soap and water was used for the film itself. It was difficult to get the positioning of the light source, the camera, and the film so that the reflection and interference patterns were visible in the way that we wanted. The soap film had to be photographed from the side with the light also at an angle to get the most meaningful image.

The image was set up by creating a solution of Palmolive soap mixed with water. A significant amount of Palmolive was used in order to keep the film intact long enough to photograph. A plastic tube with a diameter of 6.5 inches was dipped in this solution and used as the medium that the film could attach itself to. Two halogen lights were placed behind and to the right of the film to get the right angle to visualize the interference. A screen was used to filter out some of the light and prevent direct reflection of the lights on the film. The camera was also positioned at an angle, but it was on the left.

The set up looked similar to this:




The rainbow-like effect is created by interference patterns created within the soap film. "As light impinges on the film, some of it is reflected off the outer surface while some of it enters the film and reemerges after being reflected back and forth between the two surfaces" (1). The cumulative interference created by all of these reflections within the film creates the visual. "Since each traversal of the film incurs a phase shift proportional to the thickness of the film and inversely proportional to the wavelength, the result of the interference depends on these two quantities. Thus, at a given thickness, interference is constructive for some wavelengths and destructive for others, so that white light impinging on the film is reflected with a hue that changes with thickness (1). Because of gravity, the film flows downward so that it is thicker towards the bottom and creates the rainbow visualization effect. "Thicker walls cancel out red (longer) wavelengths, thus causing a blue-green reflection. Later, thinner walls will cancel out

yellow (leaving blue light), then green (leaving magenta), then blue (leaving a golden yellow)" (1).

The film itself is a result of surface tension which is caused by intermolecular forces of the fluid and the attraction of molecules. "At the surface of the liquid, the molecules are pulled inwards by other molecules deeper inside the liquid and are not attracted as intensely by the molecules in the neighboring medium" (2). This creates the elastic film effect seen in the image. However, "soap does not strengthen bubbles, it stabilizes them, via an action known as the Marangoni effect. As the soap film stretches, the surface concentration of soap decreases, which causes the surface tension to increase. Thus, soap selectively strengthens the weakest parts of the bubble and tends to prevent them from stretching further" (1).

To create this image, interference light waves had to be created. This was done through the use of a soap film. The rainbow appearance on the film of the soap-water solution is caused by the varied thickness throughout the film. Two halogen light bulbs were shined on the film through a filter to prevent direct reflection of the bulbs which would obscure the interference patterns. These bulbs had to be placed at an angle with respect to the film in order to create the rainbow pattern.

The field of view is fairly small, about 7 inches tall and 3 inches wide. The diameter of the soap film itself was about 6.5 inches. The tube was held at slightly less than arm's length in my left arm, and the camera was held with my right hand. Therefore, the camera was about 20 inches from the film itself. The focal length of the lens was 16.0 mm. The camera used was a Kodak DX7630 Zoom, a digital camera. The original image width was 2856 pixels and the height was 2142 pixels. The ISO setting

was 100, and the shutter speed was 1/64 seconds to prevent any type of motion blur. The aperture was set to 4.5 to allow enough light in to view the interference and also to prevent too much light from getting through which would create too much contrast to view all the information in the image. Photoshop was used but not significantly. The image was cropped to remove my hand, which was holding the plastic tube, and most of the tube was cropped out as well so as to isolate the film itself. There was a brown strip towards the bottom of the image, presumably something that was accidentally left in the background. I airbrushed this out because it was distracting and did not contribute to the image. Also, the brightness and contrast were adjusted slightly.

The image reveals the rainbow-like visual created by light entering the film and being reflected back and forth throughout this film. The pattern is caused by the interference of all these reflections within the soap film. The effect of surface tension is also observed, as this is the reason the film forms and remains in a thin sheet. I am quite content with the image that was ultimately created. Everything that we sought to create was effectively visualized. We attempted to create images of bubbles as well, but they did not turn out as well as the soap film itself. Bubbles would have been more descriptive with respect to surface tension, but they lacked the rainbow-like interference patterns that the soap films had, because we could not get the lighting angles correct. Overall, I think we effectively visualized the flow that we intended to.

References:


1. Wikipedia. (2007, October 24). *Soap Bubble*. Retrieved October 24, 2007 from http://en.wikipedia.org/wiki/Soap_bubble
2. Wikipedia. (2007, October 24). *Surface Tension*. Retrieved October 24, 2007 from http://en.wikipedia.org/wiki/Surface_tension