Team Second 2016

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Teammates: Michael Waterhouse, Ryan Walker, Hunter Miller

Camera: Professor Truscott

Flow Visualization

Professor Jean Hertzberg

2016

Introduction:

For the second team image, team six decided to try and capture the instance when a balloon filled with water pops and the skin retracts but the surface tension of the water holds the water in its original shape. For this project I worked with and would like to acknowledge my teammates Michal Waterhouse, Ryan Walker, and Hunter Miller. I would also like to acknowledge and thank Professor Truscott for his help and for allowing us to utilize his high-speed camera to capture the footage.

The Apparatus and Visualization Technique:

For this assignment we filled red balloons with water dyed red. For this particular video the balloon was held by me and squeezed to increase the tension in the skin of the water balloon so it would pop with less force applied. The balloon was popped using a small nail put up to the surface of the balloon and then force was applied until the balloon popped. A large fish tank was placed below the balloon to catch the water that exploded out of it. Lighting of the balloon was all from the front or from an ~45 degree offset. The lights at the 45 degree offset were 4 250W halogen work lights, with 2 per side. The front light was provided from 2 LED work lights of similar apparent wattage. A black backdrop was placed behind the balloon to create a clean background for the video.

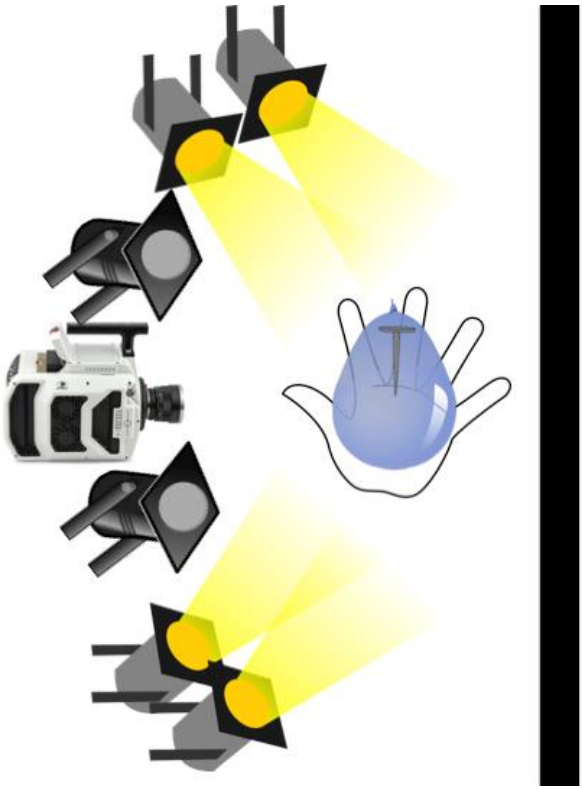

Figure 1: Apparatus Set-Up

During the course of the entire clip 1581 frames transpired for a total of 0.02258 seconds transpiring. In that time the bulk of the flow manages to travel up the length of the nail, approximately one inch. Therefore, during each frame the flow moves 16.1 micrometers for an average speed of 1.13 meters/second. The speed of the water is due to the higher pressure of the water inside of the balloon compared to that outside of the skin. This results in a Reynolds number of approximately 57000, using the properties of water at 20C and a characteristic length of 2 inches, so the flow is turbulent.

Photographic Technique:

The video was obtained using a Phantom v2511 high speed camera shooting at 70000 frames per second. Light was obtained for the video via 6 250 W apparent (2 were LEDs so wattage used was lower) from the front and off to the sides at a 45 degree angle. So much light was needed since the sensor needed to get sufficient light to saturate the pixels every 14.29 microseconds. Focus was obtained manually through movement of the balloon, since it was far easier to move the balloon than adjust the camera.

Camera	Phantom v2511
Captured Frame Rate	70,000 fps
Playback Frame Rate	60 fps
Original Image Size	640 x 480
Final Image Size	640 x 480
Field of View	~4” x ~3”
Time per Frame	14.29 micro seconds
Distance From Camera	12”

Figure 2: Unedited Snapshot

Minor edits were made using the PPC software produced by the company that that make the Phantom high speed cameras. The color levels were modified to deepen the red hues, darken the fingers to bring the focus more to the balloon, and lastly help the droplets sparkle a little brighter.

Image Intentions:

I think this video managed to capture the intent of seeing the effect of water holding its shape through surface tension. And even had the added feature of showing what happens when the balloon is popped over an air bubble. Moving forward I would like to see what happens if the air bubble were larger or if the balloon were under higher pressure.