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Team 4

Group Project 2

Introduction

The second group project consists of a high speed video taken of a balloon that is filled with helium and popped. The purpose of the high speed video is to slow down the sudden tear and sudden gas release from the balloon. An important consideration of the second group project is not only to capture the balloon popping, but to get video that is aesthetically pleasing.

Flow Apparatus

As shown in **Figure 1** the apparatus consists of a high speed digital camera positioned roughly 4 feet away from a floating helium-filled balloon.

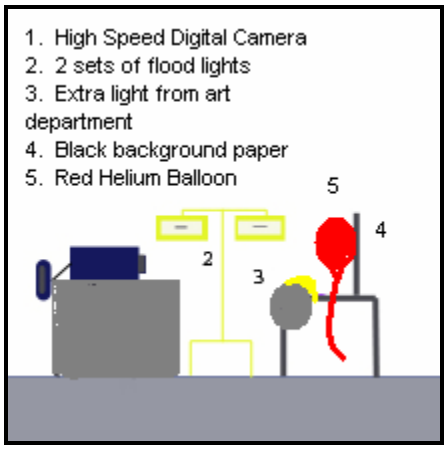

Figure 1

A set of 250 V flood lights is shone on the can at an angle to the viewing plane along with a set of 100 W lights (provided by the art department). The camera settings are then changed to those specified in the "Photographic Technique" section found later in the report.

Fluid Physics

The physics involved with popping a balloon are very straight forward. Some key items to consider are pressure gradient (created by blowing up the balloon), and material failure. It is important to recall that gases such as air and helium will move from areas of high pressure to areas of low pressure. First the balloon is filled with helium creating a pressurized volume on the inside. The pressure that is found within the balloon is greater than atmospheric pressure so the contents of the balloon are trying to escape but the force of the balloon wall keeps them in. At this point the balloon material is stretched and more susceptible to failure. So when a large pressure is applied by the tip of a metal pin on the balloon surface a small puncture forms. At this instant the balloon is too weak to continue to hold its shape with such internal pressure so a rapid tear propagates throughout the balloon material and all of the internal gas is rapidly released causing a loud "pop". From the high speed video one can actually see the rapid tear propagation, which serves as evidence of the fluid physics described above.

Visualization Technique

In order to see the almost instantaneous disintegration of the balloon, a high speed digital camera, set at a frame rate of 1000 fps is used. There are four main sources of lighting (See **Figure 1**), which are positioned approximately one to two feet from the balloon in order to clearly see the balloon. A black sheet is set up behind the balloon to add contrast and aesthetic value to the video as a whole.

Photographic Technique

- Size of field of view – 6” by 4”
- Distance from object to lens – 4 ft
- Lens focal length & other lens specs – f/3.5
- Type of camera – high speed digital camera
- Exposure specs –

  Frame rate – 1000 fps

  Aperture – unsure because of digital zoom

  Shutter speed – 1x

  Film type – NA, saved on a 1 GB flash card and transferred for editing
- Processing – the video was edited by Rick using available editing software

Conclusion

The high speed video is clear visual evidence of tear propagation and rapid depressurization of a balloon when it is popped. Something that is good about the video is the fact that is slows down tear propagation enough to actually be visible to the human eye. Also the video achieves a desired aesthetic value. Something that could be improved would be the amount of lighting used as well as maybe adding smoke outside of the balloon when it is popped in order to get a better visualization of the sudden release of the gaseous balloon contents.