CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Edward Ross

Project Number

J1822

Project Title

Balloon Acoustics: Why Do Balloons Make a Loud Noise When They Pop?

Abstract

Objectives/Goals

My objective was to find out why balloons make a loud noise when they pop. I wanted to get enough data to choose between two main conflicting ideas for what creates the noise: gas expanding rapidly after a balloon pop, or latex ripping or snapping faster than the speed of sound. My hypothesis was that gas expanding and forming a pressure wave after a balloon is popped makes the sound.

Methods/Materials

Each balloon type (round, cylindrical, or long-skinny) was filled with either Helium (He), Air or Tetrafluoroethane (TFE), to a certain inflation level, then popped, at a distance of 1 m or 3.2 m. I measured loudness with a sound level meter and waveform with Audacity software, 10 measurements per combination. I showed my final data to NASA acoustician Dr. J. Panda to help interpret. I took high-speed Schlieren videos to see balloon pops in detail.

Results

TFE was loudest for all cases except less-inflated cylindrical balloons, for which all gases were about the same loudness. Air was usually 2nd loudest but relatively close to He. Long-skinny He balloons were quietest. All cylindrical balloons had relatively small loudness differences between gases. All balloons were louder when inflated more. Balloon popping sounds are rapid oscillations that ramp up then down, not simple impulses like a gunshot. All spectra for all balloons had peak frequency at ~3000-3250 Hz, with a pretty straight decreasing slope past the peak. Spectra for TFE balloons above 3000Hz were almost always higher than for the other gases. Below 3000 Hz, He was loudest for 3 of 8 cases. Balloon pressure was low, less than ~8500 Pa for all cases. Schlieren video showed when a balloon pops, at first a hydrodynamic (noiseless) pressure wave emerges, then the latex on the surface and at the ripped edges begins to ripple, and at the peak of each ripple a pressure wave is released. The latex rips at ~100 m/s and the expanding gas moves even slower.

Conclusions/Discussion

My data disproved common explanations for why popped balloons make a loud noise, including my hypothesis, and led to a new theory. The new theory complied best with my results although some aspects need more research. For characterizing room acoustics, fully-inflated round TFE balloons are loudest and contain the most even frequency spectrum.

Summary Statement

The goal of my project was to take acoustical data to see which explanation of why balloons make a loud noise when they pop is correct.

Help Received

Help from NASA: Dr. Jayanta Panda helped interpret my data, Laura Kirschner and JT Heineck took Schlieren video. Lisa Marcacci and Dr. Kent Gee at BYU gave advice. Dad was my lab assistant; he popped balloons while I took data. Mom helped type and edit my abstract and organize/glue my poster.