CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

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Project Number

S1518

Project Title

Thermoacoustics: Creating Sound with Heat

Abstract

Objectives/Goals

The objective is to understand and demonstrate the thermoacoustic phenomenon, which uses heat to initiate the oscillation of gas without moving parts. The second objective is to characterize the properties of a thermoacoustic engine as a function of the stack position inside the test tube, the length of the test tube, and the applied power. My hypothesis is that a smaller resonant cavity will result in a lower pitched sound, lower sound intensity, and longer sound onset time. Also, it is hypothesized that increasing the applied power will shorten the time of sound onset and increase the sound intensity.

Methods/Materials

For the thermoacoustic engine, I used a Pyrex test tube to house the engine. The stack material inside the test tube is a ceramic cube with airflow-channels in the axial direction. Nichrome heater wire is placed at one end of the stack near the closed end of the test tube. DC voltage is applied to the heater wire to create the temperature gradient across the stack. I varied the stack position and applied different power levels to the stack and studied the generated sound. The data collected includes the applied power, time of sound onset, the temperature of the hot end, and the sound intensity and frequency.

Results

The results of my tests are divided into two sections. First, I used a fixed stack position and plotted the temperature at the hot end, the sound intensity, and time of onset as a function of the applied power. The temperature at the hot end and sound onset time decrease as the applied power is increased. The sound intensity increases as the applied power increases. Second, I plotted the time of sound onset, the temperature at the hot end, the energy absorbed by the stack, and the frequency as a function of the stack position. The time of onset, the temperature at the hot end, and absorbed energy are minimized when the stack is positioned near the middle of the test tube. The frequency of the generated noise is not affected by the stack position.

Conclusions/Discussion

The thermoacoustic engine can generate sound using heat only without moving parts. As the applied power to the stack is increased, the intensity of the generated sound is increased. The time of onset and absorbed energy are minimized when the stack is positioned near the middle of the test tube. In my survey, the general public knows about acoustics, but they are less informed about thermoacoustics.

Summary Statement

I studied and tested a simple thermoacoustic engine to demonstrate that it is possible to generate sound by using applied heat.

Help Received

My mother helped format various materials. My father helped build the apparatus and edit the report.