CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

33969

Project Title

Magnetic Air Conditioner: Finding Efficiency

Abstract

Objectives/Goals

The objective is to determine if a maximum efficiency exists in an magnetic air conditioning apparatus that utilizes the magnetocaloric effect to produce a temperature change.

Methods/Materials

I designed and built three different assemblies: An electromagnet with adjustable magnetic flux density (magnet strength), a gaussmeter, used to measure the strength of the electromagnet, and a thermocouple, used to measure the minute temperature changes of the magnetocaloric material. I placed a small sample of gadolinium (an effective magnetocaloric material) onto the electromagnet with only a craft stick to separate them. The electromagnet was powered and the temperature change of the gadolinium measured. This was repeated with various magnet strengths.

Results

The results of my tests showed that temperature change did increase with the increase of magnetic flux density, as expected. However, as my hypothesis predicted, the efficiency (expressed as temperature change per magnetic flux density) formed a negatively parabolic curve with a maximum as the magnetic flux density increased.

Conclusions/Discussion

My results led me to the conclusion that in any magnetic air conditioning apparatus, a maximum efficiency exists that would produce the greatest temperature change while requiring the least magnetic flux density. Knowledge of this maximum efficiency would produce the highest profit for a manufacturer. This discovery may lead to the use of magnetic air conditioners in replace of environmentally unsafe Freon air conditioners as well as in situations where a standard air conditioner is inconvenient. Example include the high pressures of the ocean floor, the soldiers in the desert who need a lightweight product to keep cool, and situations where a quiet apparatus is optimal.

Summary Statement

This project strives to identify the existence of a maximum efficiency in the magnetocaloric effect for use in a magnetic air conditioning apparatus.

Help Received

Dr. Karl Gschneidner, Anson Marston Distinguished Professor, Department of Materials Science and Engineering, Iowa State University, gave advice and gadolinium sample; Father helped suggest apparatus; Mother helped with grammar of report.