CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

Kentaro Tanaka; Yuji Tanaka

Project Number

J1822

Project Title

Maximizing the Effects of Radiative Cooling for Use in a Non-Electric Refrigerator

Abstract

Objectives/Goals

The objective of this project is to examine the feasibility of the production of non-electric refrigerators based on radiative cooling by constructing a prototype non-electric refrigerator. The design criteria is that the aluminum sheet metal placed inside the prototype reaches a 15 degree temperature difference from the outside ambient air temperature.

Methods/Materials

An insulated box with the top open was built, with aluminum sheet metal painted black on the zenith-facing side placed within the box. The box was left outside and measurements of the temperature of the sheet metal and the air were taken. Measurements of the humidity and the temperature of the night sky (by infrared thermometer aimed at the sky) were taken when needed. To improve the efficiency of cooling, first the opening was covered with different window materials: Glad food wrap (polyethylene), Stretch-tite food wrap (PVC), and glass. Then, different numbers of layers (1 layer, 2 layers, and 3 layers) for that window were tested. Finally, a reflector designed to block out incoming radiation was added. Then, overnight tests were performed using a simple Visual Basic code that took measurements from a thermocouple input sensor connected to the computer.

Results

The most efficient material for the window was Glad, while the glass was least efficient, even less than having no window. The most efficient number of layers was 1 layer, and 3 layers was the least. The reflector consistently showed a significant increase in the temperature difference, while effectively blocking radiation from lower skies. The temperature differences during the overnight tests never reached above 15 degrees, but on a previous test there was an instance of a 15.9 degree temperature difference.

Conclusions/Discussion

The efficiencies of the different window materials were directly related to the transmittance of infrared rays. The number of layers did not improve the efficiency because the transmittance was decreased too much. The reflector was definitely an important addition to the prototype, improving the efficiency by a significant amount. The overnight tests did not reach more than a 15 degree temperature difference, but a prior test during winter showed that a 15 degree temperature difference was possible, so this project should be judged as a success.

Summary Statement

This project is about maximizing the effects of radiative cooling to determine the feasibility of using radiative cooling to build non-electric refrigerators.

Help Received

Mother helped paste paper on display board; Father answered some questions and helped design prototype.