CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Shomil Jain

Project Number

S1011

Project Title

Developing an Artificial Turf Field with Thermoelectric Generators for Heat Absorption and Electricity Generation

Abstract

Objectives/Goals

Extreme heat in artificial turf has been well documented. The purpose of this project is to cool the surface of the turf while generating electrical energy. An artificial turf field prototype was developed that utilizes thermoelectric generators to transfer heat from the surface layer of the turf to the base layer and convert the heat to electricity.

Methods/Materials

A wooden container (46 cm x 60 cm x 10 cm) was filled with potting soil, a cardboard frame with 16 evenly spaced thermoelectric generators (TEGs), thermal grease, the artificial turf mat, and black crumb rubber infill. The TEGs were connected in four parallel circuits of four generators in each. Holes were drilled into one side of the box at multiple heights to allow for an accurate measurement of thermal quantities at each layer of the turf structure. A heat lamp was placed 40 cm above the turf box to simulate a daytime environment. Trials consisted of activating the heat lamp and recording measurements of electricity and temperature. Trials were conducted at lengths of 40, 60, 90, and 360 minute intervals. Open-circuit voltage was measured using a multimeter. Temperature gradients at 5 different levels was measured using digital thermometers.

Results

The maximum temperature gradient and electricity generation was 11.1°C and 25.8 mV, respectively. Six rounds of a 150 minute testing period resulted in a consistent direct relationship between the temperature gradient and electricity generated. A statistical test of correlation found a strong correlation between the two data sets with an average R-Value of 0.9623. The correlation between heat and electricity proved that the generators were working as expected.

Conclusions/Discussion

Extrapolation of the data from the prototype to a full scale artificial turf field of 90 m x 120 m resulted in an electrical output of 1.5 MW. This amount of electricity would be enough to power the majority of an artificial turf stadium's power needs, including a scoreboard or LED floodlights, for an extended period of time. In a residential application, an artificial turf lawn would be able to produce enough electricity (60 kW) to power the average American home. In addition, an artificial turf field with thermoelectric generators would also be capable of producing electricity in the night, due to a temperature difference between the surface layer of turf (cold side), and the base layer (warm side).

Summary Statement

I developed a prototype of an artificial turf field that utilized thermoelectric generators to absorb heat from the surface layer of the field and convert the heat to electricity.

Help Received

My science teacher, Cathy Messenger, helped me procure the required materials, and Brian Messenger, an electrical engineer, helped me verify my electrical data and calculations.