Thesis Project Portfolio

Design of a Thermal Conductivity Measurement Device for Cryogenic Applications

(Technical Report)

The Public Opinion of Environmentalism and How it Relates to Governmental Practices

(STS Research Paper)

An Undergraduate Thesis

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Kyle William Holden Jr.

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Department of Mechanical Engineering

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Sociotechnical Synthesis

The goal of my technical project is to design and fabricate a cryogenic thermal conductivity measurement insert for an evaporation fridge capable of achieving a base temperature of 1 degree Kelvin. The overall problem can be broken down into several subcategories. First, the insert must obtain accurate measurements while fitting within the dimension constraints of the fridge. Second, the insert must allow the user to simply mount the test samples. Third, wires need to be run throughout the length of the insert to be able to obtain measurements of the sample throughout the whole duration of testing. Fourth, the sample must be in a vacuum in order to prevent any unwanted heat transfer and leakage of liquid helium that could invalidate data collection. The experimental tool is designed to measure the material properties of a sample material. The main use of this device is for the Department of Physics to observe the behavior of electricity through various sample materials in the ranges between 300 Kelvin to 1 Kelvin. It is known that temperature affects many properties of materials. The property that this device is measuring is the thermal conductivity. A material's thermal resistance determines how difficult it is for heat/energy to flow; higher resistance means it is harder for heat/energy to flow, lower resistance means it is easier for heat/energy to flow. Thermal conductivity and electrical conductivity are inversely proportional in most scenarios. The device is approximately 6 feet long with the bottom 4 inches housing the sample material, integrated circuit, cartridge heater, socket, necessary wiring, and thermal chuck. Starting from the bottom moving down, the sample will sit inside the integrated circuit which has a specific circuit that will allow us to use the 3ω method. This integrated circuit (ICU for short) and sample combination will sit within a socket that will have the necessary wiring soldered to the pins. The combination of the material, ICU, and socket are mounted onto a thermal chuck made out of copper. The purpose of this chuck is to create a pathway for heat to flow from the sample

material to the liquid helium that sits in the bottom of the fridge. This chuck also houses a cartridge heater that is responsible for heating the material above 1 Kelvin to create a more diverse range of data. These all combine to give a device that can measure the thermal conductivity of the sample materials over a range of small temperature increments.

With the increase of global temperature and extreme weather events, the consequences our actions can be seen more now than ever. However it didn't start here. Since before the first Earth Day on April 22, 1970, people have noticed the impact we, as a collective people, have on the environment. These include: global climate, air quality, and water quality to name a few. Out of all of these, impacting the global climate is the most well known issue. There is regulation in many areas of society which have to deal with limiting the impact we have on climate. We, typically, do this by estimating the amount of carbon that anyone and anything produces. Statistical data shows that people all over the United States of America are aware and affected by the solutions or lack thereof when it comes to environmental issues. However, the issues have continued to increase in severity. I conducted research to find what is the cause of this lack of care for the environment, and I argue that while Americans believe that the federal government is responsible for combating environmental issues, the disconnect lies in that throughout time there has never been a consensus that combating environmental issues is the most important thing that the government should be improving, and that there is a preconceived notion that there is a give and take when it comes to the economy and environmentalism, meaning that when you help the environment you hurt the economy and vice versa. I found that lots of people care about the environment and that they believe it's getting worse.