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SELF-SUSTAINED VACCINE STORAGE SOLUTION USING THERMOELECTRIC DEVICES

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Introduction:

In order to keep their potency, vaccines need to be stored under fairly strict conditions: the temperature needs to be kept at around 5 °C (±2-3 °C). For remote villages in under-developed parts of the world, this creates a big obstacle to bring vaccines to those populations who need them the most. During the transportation and before the vaccines are used, cold chains, even electricity is often not available. Standard portable equipment would push the cost inhibitively high for local health system with little resource. Thermoelectric devices can be used for cooling, which is more cost effective and efficient than regular compressor-based systems for this application.

In this research project , I worked on assembling a self-sustained vaccine storage device that used the Peltier modules as the thermoelectric colling agents. This was a strategic and design-based project that involved critical thinking, problem solving skills, and carrying out sound analysis of the given problem to find a feasible and effective solution.

Objectives:

The primary objectives of this research project were as follows:

(i)- To identify the appropriate circuitry to be used in the final model.

(ii)- Based on the needs of the project, identify the correct combination for the electric components used i.e., which circuit components were to be connected in series, which ones to be connected in parallel combination.

(iii)- To run FEA (Finite Element Analysis) on the vaccine storage box in order to determine its structural integrity.

(iv)- Record temperature values over different time intervals to test the functioning and effectiveness of the thermocouple sensors used in the circuit.

Summary:

As this project was design-based and involved critical thinking in order to come up with an effective, cheap, and feasible prototype, I had to brainstorm ideas and assess the components that I was going to use in a certain model. Once the size of the vaccine storage device was identified, I moved forward with listing all of the electric components of the model. Once the components were available for use, I had to identify the circuitry of the model in order to make sure that the prototype consumes less electric power and still gets the job done.

After learning about how Peltier modules work, and in which combination they draw less power from input, I concluded that in the current scenario they should be connected in series combination rather than parallel combination. The main reason to connect these Peltier modules in series was to have the whole circuit run on low current rather than low voltage. After identifying the combination, I assembled the circuit without the box, just to make sure all of the components were working. The next step was to mount this whole circuit to a thermally insulted box made up of industrial-grade Polyethylene foam. The After mounting the circuit, the next step was to attach two metallic Aluminum plates on the Peltier modules' plate facing inside the box. The primary objective to do it was to have cooling uniformly spread inside the box. The plates were to be provided to me by my project mentor.

With the Aluminum plates not being provided to me by my project monitor, I proceeded with using them in my final prototype, and this had a negative impact on the performance of my final model. In the final step of this project, I used the digital thermocouples to set a threshold value for the internal temperature, so the heat sink fans could draw heat out of the Peltier modules and regulated the temperature. I recorder the time it took for the whole circuit to bring the internal temperature to the desired value. Because there were no Aluminum plates used, the cooling process took more time then it should have taken.