Design, Construction and performance test of CPU cooling system using Peltier module

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May 2023

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A thesis report submitted to the department of mechanical engineering for the partial fulfillment of the award of degree of “Bachelor of Science in mechanical Engineering”

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Acknowledgement

We would like to express all appreciation and gratitude to almighty Allah for giving us the chance and Capability to undertake successfully Complete this project for our study.

We are immensely grateful to our honorable supervisor **Md. Ahatashamul Haque Khan Shuvo** whose guidance and expertise have been invaluable throughout this journey. Their insightful feedback, constant encouragement, and patience have truly shaped the direction of this project.

I would also like to extend my thanks to my Classmates who have provided assistance and support along the way. Their constructive discussions, brainstorming sessions, and willingness to share their knowledge have significantly enriched my understanding of the subject matter.

Furthermore, I am indebted to the participants who generously contributed their time and insights to the research conducted in this project. Their valuable input has been crucial in shaping the findings and conclusions.

In conclusion, I am sincerely thankful to all those mentioned above and anyone else who has contributed to this project in any way. Your support has been instrumental in making this endeavor a success.

Abstract

CPU Cooling system is an emerging technology that utilizes the peltier effect to achieve cooling without traditional refrigerants or mechanical compressors. By applying an electric current across dissimilar materials, a temperature difference is created, enabling heat absorption or release. This technology offers advantages such as compact size, silent operation, precise temperature control, and environmental friendliness. Applications range from residential to automotive and aerospace sectors, including cooling electronic components, small enclosures, car seats, and spacecraft. Challenges include lower cooling efficiency compared to conventional systems and higher initial costs. Ongoing research aims to enhance performance and cost-effectiveness, making CPU Cooling system a viable alternative for sustainable cooling solutions. We got a tremendous result through our project Testing, the initial temperature is 29 degree Celsius. After 22 seconds of operation temperature decrease and become 28 Degree. After following the same process temperature decreases consistently. At 4.28 sec we have got the final temperature of 19 degree Celsius. Ultimately it decreases 10 degree Celsius.

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Chapter 1

Introduction

1.1 General

CPU Cooling systems rely on refrigerants and mechanical compressors to achieve cooling. However, concerns about environmental impact and energy efficiency have driven the exploration of alternative cooling technologies. CPU cooling system, based on the thermoelectric effect, is a promising solution that offers potential advantages in terms of efficiency, compactness, and environmental friendliness [1].

The thermoelectric effect, also known as the Peltier effect, is the phenomenon where a temperature difference across a junction of dissimilar materials results in the generation of a voltage and the transfer of heat. In CPU cooling systems, this effect is harnessed to achieve cooling without the need for conventional refrigerants or moving parts.

The core component of a CPU Cooling system is the thermoelectric module, consisting of multiple pairs of p-type and n-type semiconductor materials. When a direct current is applied to the module, heat is either absorbed from the surrounding environment or released depending on the direction of the current flow. This enables the system to create a cooling effect by absorbing heat from a desired space and dissipating it elsewhere [5].

CPU Cooling systems offer several advantages over traditional systems. Firstly, they have a compact and solid-state design, making them suitable for various applications where space is limited. They are also silent in operation since there are no mechanical components involved. Additionally, thermoelectric systems offer precise temperature control, allowing for better comfort and energy management. Moreover, they do not use refrigerants that contribute to ozone depletion or global warming, making them environmentally friendly.

Despite these advantages, there are challenges associated with CPU Cooling System. One significant challenge is the relatively low cooling efficiency compared to conventional refrigeration technologies. The thermoelectric materials currently available have limited efficiency in converting electrical energy into cooling power. This results in higher energy consumption and limits their application in large-scale cooling systems. Furthermore, CPU Cooling systems tend to have higher initial costs, which can be a barrier to their widespread adoption.

To overcome these challenges, ongoing research and development efforts are focused on improving the performance and efficiency of thermoelectric materials, as well as optimizing system designs. Scientists and engineers are exploring advanced materials, such as nanostructured thermoelectric materials, and innovative approaches to enhance cooling efficiency. Additionally, efforts are being made to reduce manufacturing costs to make thermoelectric air conditioning more economically viable.

In conclusion, CPU cooling system represents a promising alternative to traditional cooling systems. Its compactness, silent operation, precise temperature control, and eco-friendly nature make it an attractive option for various applications. Although challenges exist, ongoing advancements in materials and system optimization hold the potential for significant improvements in the efficiency and cost-effectiveness of CPU Cooling system, paving the way for a more sustainable and efficient cooling technology.

1.2 Objectives

The Objective of the Project is given bellow:

a) To study about CPU Cooling system.
b) To study the design and construction of a CPU Cooling System.
c) To analyze the performance test of the project.

Chapter 2

Literature Review

2.1 Background

D. Zhao and G. Tan [1] CPU Cooling is a cooling technology that utilizes the principle of Peltier effect to provide cooling without the use of traditional refrigerants or compressors. It is a solid-state cooling method that has gained interest due to its potential for energy efficiency and environmental friendliness.

The thermoelectric effect is based on the phenomenon known as the Peltier effect, discovered by Jean Charles Athanase Peltier in 1834. The effect occurs when an electric current is passed through a junction of two dissimilar materials, usually semiconductor materials, resulting in a temperature difference across the junction. One side of the junction becomes cooler, while the other side becomes hotter.

In a CPU Cooling system, multiple pairs of these junctions, known as thermoelectric modules or thermoelectric coolers (TECs), are used. The modules consist of two semiconductor materials, an n-type material and a p-type material, connected electrically in series and thermally in parallel. When a direct current is applied to the modules, one side of each module absorbs heat from the surroundings, while the other side dissipates it. By controlling the direction of the electric current, the cooling effect can be achieved on the desired side.

The cooling capacity of thermoelectric air conditioning systems is limited compared to traditional compressor-based systems, which makes them more suitable for smaller-scale cooling applications. However, they offer several advantages, including:

Compactness: Thermoelectric systems are generally more compact and lightweight compared to traditional air conditioning units, making them suitable for portable or space-constrained applications.

Quiet operation: Since there are no moving parts like compressors or fans, thermoelectric air conditioners operate silently, which can be beneficial in noise-sensitive environments.

Energy efficiency: Thermoelectric cooling has the potential for high energy efficiency because it directly converts electrical energy into cooling without the need for intermediate steps such as phase changes of refrigerants

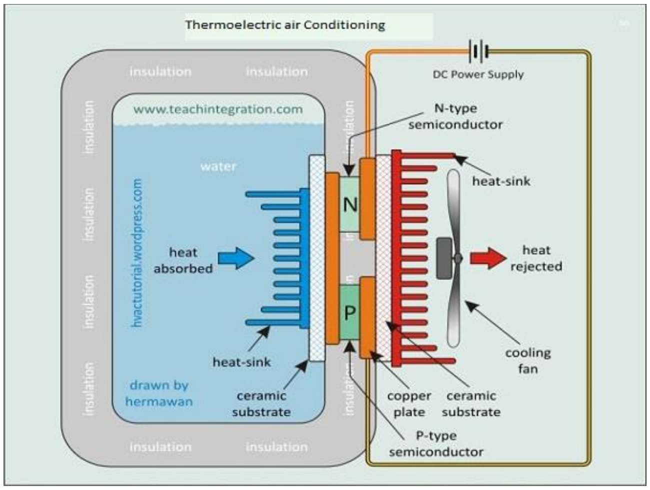


Figure: 2.1CPU cooling system

Environmental friendliness: Thermoelectric systems do not rely on refrigerants that can contribute to ozone depletion or have a high global warming potential, making them more environmentally friendly.

Despite these advantages, CPU Cooling System have some limitations. They have lower coefficients of performance (COP) compared to traditional systems, meaning they require more electrical energy for the same cooling effect. They are also less efficient in removing high amounts of heat, limiting their application in large-scale cooling. However, ongoing research and advancements in thermoelectric materials and system design aim to overcome these limitations and improve the overall performance of thermoelectric air conditioning technology.

2.2 Apparatus Analysis

Peltier module: A Peltier module, also referred to as a thermoelectric module, is a solid-state device that utilizes the Peltier effect to create a temperature gradient across its surface. It consists of multiple pairs of p-type and n-type semiconductor materials that are connected electrically in series and thermally in parallel. When a direct current is applied to the module, electrons in the circuit undergo thermoelectric phenomena, resulting in the transfer of heat from one side to the other. One side of the module becomes cold while the other side becomes hot, allowing it to function as a cooler or a heater depending on the direction of the current.

Figure: 2.2Peltier module

Peltier modules offer several advantages such as compact size, silent operation, no moving parts, precise temperature control, and the ability to cool or heat localized areas. They find applications in various fields including electronics cooling, thermal management, temperature stabilization, portable refrigeration, medical devices, and energy-efficient systems. However, they have lower efficiency compared to traditional refrigeration systems and are typically used for relatively small temperature differentials. **G. Tan and D. Zhao[2]**

A Peltier cooler, heater, or thermoelectric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy, depending on the direction of the current. Figure 3.5: Peltier Cooler . The TEC1-12715 40x40mm Thermoelectric Cooler 15A Peltier Module is the simple application of Peltier Thermoelectric Effect. The module features 127 semiconductor couples in the area of 40mmx40mm. Thermoelectric coolers also are known as TEC or Peltier Module create a temperature differential on each side. One side gets hot and the other side gets cool. Therefore, they can be used to either warm something up or cool 15 something down, depending on which side you use. You can also take advantage of a temperature differential to generate electricity. Figure 3.6: Construction of Peltier Two unique semiconductors, one n-type and one p-type, are used because they need to have different electron densities. The semiconductors are placed thermally in parallel to each other and electrically in series and then joined with a thermally conducting plate on each side. When a voltage is applied to the free ends of the two semiconductors there is a flow of DC current across the junction of the semiconductors causing a temperature 16 difference. The side with the cooling plate absorbs heat which is then moved to the other side of the device where the heat sink is. Thermoelectric Coolers, also abbreviated to TECs are typically connected side by side and sandwiched between two ceramic plates. The cooling ability of the total unit is then proportional to the number of TECs in it. This Peltier works very well as long as you remove the heat from the hot side. After turning on the device, the hot side will heat quickly the cold side will cool quickly. If you do not remove the heat from the hot side(with a heat sink or other device), the Peltier will quickly reach stasis and do nothing. We recommend using an old computer CPU heat sink or another block of metal to pull heat from the hot side. We were able to use a computer power supply and CPU heat sink to make the cold side so uncomfortable we could not hold our finger to it. A thermoelectric cooling (TEC) module is a semiconductor-based electronic component that functions as a small heat pump. By applying the DC power source to a TEC, heat will be transferred from one side of the module to the other. It creates a cold and hot side. They are widely used in industrial areas, for example, computer CPU, CCDs, portable refrigerators, medical instruments, and so on. Also known as thermoelectric cooling modules, Peltier modules, thermoelectric cooling module. Features: 1. small module. 2. Easy transition between the hot side to the cool side and vice-versa just by reversing the polarity of supply. 3. Quality tested cooling cells. 4. Solid state, vibration free, noise-free. 5. Simple to install and operate. 6. Should use with a heat sink.

2.3 Water cooling block: A Peltier cooling block, also known as a Peltier cooler or thermoelectric cooler, is a device that utilizes the Peltier effect to provide cooling. It consists of a Peltier module sandwiched between two thermally conductive plates. When an electric current is applied to the Peltier module, heat is absorbed from one side of the block and transferred to the other side. This causes one plate to become cold while the other plate becomes hot. The cold plate can be used to cool objects or maintain a lower temperature in an enclosed space. Peltier cooling blocks are commonly used in various applications such as electronic cooling, laser diode cooling, thermal

management in laboratory equipment, and beverage cooling devices. They offer advantages such as compact size, precise temperature control, and no moving parts. However, their cooling capacity is limited compared to traditional refrigeration systems, and their efficiency depends on factors such as ambient temperature and heat dissipation. **Zhao, J.Z [3]**

Figure: 2.3 Water cooling block

2.4 Cooling Fan: A cooling fan is an essential component when using a thermoelectric Peltier device for cooling applications. Thermoelectric Peltier devices operate on the principle of the Peltier effect, which enables the transfer of heat from one side of the device to the other when an electric current is applied. However, this process generates heat on the opposite side, requiring efficient heat dissipation.

A cooling fan serves the purpose of enhancing heat dissipation by facilitating airflow across the hot side of the Peltier device. The fan helps to remove the excess Heat generated by the Peltier module and prevent overheating, ensuring optimal performance and longevity of the device. By directing a stream of air over the hot side, the fan aids in dissipating heat into the surrounding environment. **D. Rodriguez, M.Toledo [4]**

Figure: 2.4 Cooling Fan

Choosing an appropriate cooling fan is crucial to match the cooling requirements of the Peltier device. Factors such as airflow rate, static pressure, and noise level should be considered when selecting a fan. Additionally, the fan should be mounted securely to ensure effective heat transfer and proper airflow.

2.5 Heat Sink: A heat sink is a vital component when utilizing a thermoelectric Peltier device for cooling applications. A Peltier module operates by transferring heat from one side to the other when an electric current is applied. However, this process generates heat on both the hot and cold sides of the module, necessitating efficient heat dissipation. **Zheng, W., Xu [5]**

A heat sink is designed to maximize heat dissipation from the hot side of the Peltier module. It typically consists of a thermally conductive material with a large surface area and fins. The heat sink absorbs the heat generated by the Peltier module and dissipates it into the surrounding environment through conduction, convection, and radiation.

The effectiveness of a heat sink depends on its thermal conductivity, surface area, and airflow. A higher thermal conductivity allows for better heat transfer, while a larger surface area and properly designed fins increase the contact area with the air, enhancing heat dissipation. Additionally, optimizing airflow around the heat sink using fans or natural convection helps to further improve its cooling efficiency.

Figure: 2.5Heat sink

Choosing an appropriate heat sink involves considering factors such as the power dissipation of the Peltier module, size constraints, and thermal resistance. Proper installation and securing of the heat sink onto the hot side of the Peltier module are crucial for optimal heat transfer and overall cooling performance.

2.6 Circulating Pump: A circulating pump plays a crucial role in thermoelectric Peltier cooling systems by facilitating the movement of a cooling fluid through the system. Thermoelectric Peltier devices operate by transferring heat from one side to the other when an electric current is applied. To maximize the cooling efficiency, a circulating pump is used to actively circulate a coolant through the cold side of the Peltier module.

The circulating pump ensures that the coolant flows consistently, carrying away heat absorbed by the cold side of the Peltier module. By continuously circulating the coolant, the pump helps to maintain a stable and low temperature on the cold side, enhancing the overall cooling performance. **Rajmane, M. Satish [6]**

Figure: 2.6 Circulating Pump

When choosing a circulating pump, factors such as flow rate, pressure capabilities, and compatibility with the coolant being used should be considered. The pump should be capable of providing sufficient flow and pressure to meet the cooling requirements of the Peltier system. Additionally, the pump should be reliable, durable, and designed for continuous operation.

Proper installation and integration of the circulating pump within the cooling system are essential. The pump should be connected to the coolant reservoir and the cold side of the Peltier module, ensuring a continuous flow of coolant and efficient heat transfer.

2.7 Ahmad, M [7] Thermal glue: Thermal glue, also known as thermal adhesive or thermal epoxy, is a type of adhesive specifically designed for thermoelectric Peltier modules. It is used to create a strong and thermally conductive bond between the Peltier module and a heat sink or other surfaces.

Thermal glue helps to improve heat transfer between the Peltier module and the heat sink by eliminating air gaps and enhancing thermal conductivity. It fills in microscopic imperfections and irregularities, ensuring efficient heat flow and reducing thermal resistance.

When choosing a thermal glue for Peltier modules, it is important to consider factors such as thermal conductivity, curing time, and adhesive strength. A high thermal conductivity value ensures effective heat transfer, while the curing time determines the duration required for the adhesive to fully set and develop its bonding properties. Adhesive strength is crucial for maintaining a secure bond between the Peltier module and the heat sink, ensuring long-term reliability.

Figure: 2.7Thermal glue

Proper application of thermal glue involves cleaning and preparing the surfaces, applying an appropriate amount of adhesive, and allowing it to cure according to the manufacturer's instructions. It is essential to follow the recommended guidelines to achieve optimal thermal performance and secure attachment of the Peltier module.

2.8 Radiator: A radiator is a device commonly used to release heat from water in various applications. In the context of water heating or cooling systems, a radiator is designed to efficiently transfer heat from the water to the surrounding environment through a process known as convection.

A typical radiator consists of a series of interconnected tubes or channels, often made of metal, which provide a large surface area for heat exchange. As the heated water flows through these tubes or channels, the excess heat is transferred to the radiator's fins or fins attached to the tubes. The fins increase the surface area and enhance heat dissipation.

Figure: 2.8Radiator

To optimize heat transfer, radiators are often designed with a combination of factors such as tube or channel geometry, fin density, and airflow. By maximizing the contact area between the water and the radiator, and ensuring adequate airflow across the fins, the radiator efficiently releases heat into the surrounding environment.

Radiators are commonly used in central heating systems, automotive cooling systems, and other industrial applications where heat needs to be removed from water or coolant. They are essential for maintaining optimal operating temperatures and preventing overheating. **L.S. Sundar, M.K. Singh [8]**

2.9 Connecting Pipe and Cable Tie: Rubber pipes, also known as rubber hoses, are flexible tubes made from rubber materials that are used for various applications. Rubber pipes offer flexibility, durability, and resistance to abrasion, chemicals, and weathering. Here are some common types of rubber pipes and their applications It is used to withstand the pressure and flow of water while maintaining flexibility. **PTI New Delhi [9]**

Figure: 2.9 Connecting Pipe and Cable Tie

Cable ties, also known as zip ties, are versatile fastening tools used to secure and organize cables, wires, and other objects. They are commonly made of nylon and consist of a flexible strap with a ratchet mechanism.

2.10 Power Supply:

Huang Xufeng [10] A switched-mode power supply (switching-mode power supply, switch-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics. Figure 3.1: SMPS Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. A hypothetical ideal switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time (also known as duty cycles). In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight. Switching 10 regulators are used as replacements for linear regulators when higher efficiency, smaller size or lighter Weight is required. They are, however, more complicated; their switching currents can cause electrical noise problems if not carefully suppressed, and simple designs may have a poor power factor. Switched-mode power supplies are classified according to the type of input and output voltages. The four major categories are: • AC to DC • DC to DC • DC to AC • AC to AC A basic isolated AC to DC switched-mode power supply consists of: • Input rectifier and filter • Inverter consisting of switching devices such as MOSFETs • Transformer • Output rectifier and filter • Feedback and control circuit The input DC supply from a rectifier or battery is fed to the inverter where it is turned on and off at high frequencies of between 20 KHz and 200 KHz by the switching MOSFET or power transistors. The high-frequency voltage pulses from the inverter are fed to the transformer primary winding, and the secondary AC output is rectified and smoothed to produce the required DC voltages. A feedback circuit monitors the output voltage and instructs the control circuit to adjust the duty cycle to maintain the output at the desired level. 11 Figure 3.2: Basic working concept of an SMPS A switching regulator does the regulation in the SMPS.A series switching element turns the current supply to a smoothing capacitor on and off. The voltage on the capacitor controls the time the series element is turned. The Continuous switching of the capacitor maintains the voltage at the required level.

Figure: 2.10 Power Supply

Overall, selecting the right power supply is vital for the proper functioning, efficiency, and safety of thermoelectric air conditioning systems. Careful consideration of voltage and current requirements, power capacity, efficiency, and safety features will ensure optimal performance and reliability.

2.11 Insulating Material (Cork Sheet): Cork sheet is not typically used in thermoelectric refrigeration systems due to its insulating properties. Thermoelectric refrigeration relies on the Peltier effect, where an electric current is passed through a junction of two different materials, causing heat to be absorbed or released. To maximize the efficiency of this process, the junction needs to have good thermal conductivity to transfer heat effectively.

Cork, on the other hand, is a natural insulator with low thermal conductivity. It is commonly used for its insulation properties in applications such as soundproofing and heat insulation. While it may have some benefits in terms of reducing heat transfer between different components or as an insulating layer in certain parts of the system, it is not ideal for the critical junction areas where efficient heat transfer is crucial for thermoelectric cooling.

Figure: 2.11 Cork Sheet

Instead, materials with high thermal conductivity and good electrical properties, such as metals or certain semiconductors, are typically used in thermoelectric refrigeration systems to optimize the Peltier effect and enhance the cooling efficiency. **Al-Homoud, D. M. S [11]**

2.12 Ge R., Xu C.J. [12] Reservoir Tank: In a thermoelectric air conditioning system, a reservoir tank and a pump are commonly used for circulating the coolant and facilitating the heat transfer process. Here's how they are typically incorporated:

The reservoir tank serves as a storage and expansion vessel for the coolant. It is usually located in a convenient position within the system, such as near the thermoelectric modules or the heat exchange components. The reservoir tank helps in maintaining the coolant level, allowing for expansion and contraction due to temperature variations.

The main functions of the reservoir tank include:

Coolant Storage: The reservoir tank holds an adequate amount of coolant, ensuring a continuous supply for the thermoelectric modules and other components. It helps to maintain the system's coolant level and prevents any interruptions due to insufficient coolant.

Thermal Stability: The reservoir tank assists in stabilizing the temperature of the coolant. As the coolant circulates through the system, it absorbs heat from the hot side of the thermoelectric

Figure: 2.12 Reservoir Tank

Modules and releases heat at the cold side. The reservoir tank helps to balance the temperature fluctuations and maintain a consistent operating temperature.

Air Separation: The reservoir tank allows any entrapped air or gas bubbles within the coolant to rise to the top, facilitating their removal. This prevents air pockets from forming, which can reduce the efficiency of heat transfer in the system.

The pump in a thermoelectric air conditioning system is responsible for circulating the coolant between the thermoelectric modules and the heat exchange components. It provides the necessary flow rate to ensure efficient heat transfer and uniform cooling or heating across the system. The pump is typically placed in-line with the coolant flow path, either on the supply or return side.

The primary functions of the pump include

Coolant Circulation: The pump creates a continuous flow of the coolant through the system, allowing it to absorb heat at the hot side and release heat at the cold side. This circulation helps in maintaining the desired cooling or heating effect.

Flow Control: The pump regulates the flow rate of the coolant, ensuring proper heat transfer and maintaining consistent performance. The flow rate is adjusted based on factors such as the system's cooling capacity, desired temperature differentials, and specific application requirements.

Pressure Enhancement: The pump helps to increase the pressure of the coolant, ensuring that it flows efficiently through the thermoelectric modules, heat exchangers, and other components. Adequate pressure is crucial for achieving optimal heat transfer and system performance.

It's important to select a reservoir tank and pump that are compatible with the coolant used in the system and capable of meeting the flow rate and pressure requirements. Proper sizing and installation of the reservoir tank and pump contribute to the overall effectiveness and efficiency of the thermoelectric air conditioning system.

A temperature meter, also known as a thermometer, is a device used to measure the temperature of an object or the environment. It typically consists of a temperature sensor and a display unit to provide a numerical or graphical representation of the temperature reading.

There are various types of temperature meters available, each with its own principles of operation and applications. Here are a few common types:

Mercury-in-glass thermometer: This traditional thermometer consists of a glass tube filled with mercury. As the temperature changes, the mercury expands or contracts, causing it to rise or fall within the graduated scale on the tube. However, mercury thermometers are being phased out due to environmental concerns.

Thermometer: These thermometers use electronic sensors, such as thermocouples or resistance temperature detectors (RTDs), to measure temperature. The readings are then displayed digitally on an LCD or LED screen. Digital thermometers are commonly used in medical settings for measuring body temperature.

Infrared thermometer: Also known as non-contact thermometers, these devices measure temperature without direct contact. They use infrared radiation emitted by the object being measured and convert it into temperature readings. Infrared thermometers are useful for measuring the temperature of objects that are difficult or unsafe to touch, such as hot surfaces or moving machinery.

Thermocouple thermometer: Thermocouples consist of two different metal wires joined together at one end. When the junction is exposed to a temperature gradient, it generates a small voltage that is proportional to the temperature difference. Thermocouple thermometers use this principle to measure temperature across a wide range.

Resistance temperature detector (RTD): RTDs are temperature sensors made from pure metals, such as platinum, whose electrical resistance changes with temperature. RTDs offer high accuracy and stability and are commonly used in industrial applications where precise temperature measurements are required.

These are just a few examples of temperature meters available on the market. The choice of a temperature meter depends on the specific application, temperature range, accuracy requirements, and environmental conditions in which it will be used.

2.13 Digital thermometer: A digital thermometer is a type of temperature meter that utilizes electronic sensors and displays the temperature reading digitally on a screen. It has become increasingly popular due to its ease of use, accuracy, and quick response time. Digital thermometers are commonly used in various settings, including medical, culinary, industrial, and household applications.

Here are some key features and advantages of digital thermometers:

Accuracy: Digital thermometers can provide highly accurate temperature measurements. They are designed to display temperature readings with decimal points, allowing for precise monitoring and control.

Fast response time: Digital thermometers typically provide quick temperature readings, making them convenient for situations where immediate results are required. This is especially useful in medical applications, where rapid temperature assessment is crucial.

Easy-to-read display: Digital thermometers feature an LCD or LED display that shows the temperature reading in numerical form. The digital display makes it easy to read and interpret the temperature, eliminating the need for manual interpretation of a scale like in traditional thermometers.
A thermometer is a device that measures temperature or a temperature gradient (the degree of hotness or coldness of an object). A thermometer has two important elements: a temperature sensor (e.g. the bulb of a mercury-in-glass thermometer or the pyrometric sensor in an infrared thermometer) in which some change occurs with a change in temperature. **Abayomi-Alli A [13]**

Figure: 2.13Digital thermometer

Memory and data storage: Some digital thermometers come with built-in memory or data storage capabilities. This allows users to record and review previous temperature readings, making it useful for tracking temperature trends over time.

Various probe options: Digital thermometers often come with interchangeable probes suitable for different applications. For instance, a digital thermometer for medical use may have a flexible probe for oral or rectal measurements, while a culinary thermometer may have a stainless-steel probe for food temperature measurements.

Non-contact options: Some digital thermometers incorporate infrared technology, enabling non-contact temperature measurements. These thermometers can measure the temperature of an object or a person's forehead without physical contact, making them hygienic and convenient for certain applications.

Alarm and alert features: Many digital thermometers have programmable alarm features that can be set to sound an alert when the temperature exceeds a certain threshold. This is particularly useful in medical settings or when monitoring temperature-sensitive processes.
It's important to follow the manufacturer's instructions for proper usage and calibration of digital thermometers to ensure accurate and reliable temperature measurements. **M. Nardin et al [14]**

2.14 Glue Gun: A glue gun is a handheld device that uses hot melt adhesive (glue) sticks as its heat source. It consists of a heating element inside the gun that melts the glue stick, which is then dispensed through a nozzle at the front of the gun. The melted glue quickly solidifies upon cooling, forming a strong bond between surfaces.
Power source: Glue guns are available in both corded and cordless models. Corded glue guns need to be plugged into a power outlet, while cordless glue guns are powered by rechargeable batteries.

Figure: 2.14 Glue Gun

Temperature control: Some glue guns have adjustable temperature settings, allowing you to choose between high and low heat. This feature is useful when working with different types of glue sticks or materials.

Trigger mechanism: Most glue guns have a trigger mechanism that controls the flow of the melted glue. Squeezing the trigger dispenses the glue, and releasing it stops the flow

Chapter 3

Methodology

3.1 Working Process CPU cooling system, also known as solid-state cooling, is a method of cooling that utilizes the thermoelectric effect to transfer heat from one side of a device to the other. Here's a general overview of the working process of thermoelectric air conditioning:

Thermoelectric Modules: The heart of a thermoelectric CPU cooling system is the thermoelectric module, also called a Peltier device. A thermoelectric module consists of two different types of semiconductors, typically made of bismuth telluride, that are connected in series and sandwiched between two ceramic plates.

Peltier Effect: When an electric current is passed through the thermoelectric module, the Peltier effect comes into play. One side of the module, called the hot side or heat-absorbing side, absorbs heat from the surrounding environment. The other side, called the cold side or heat-rejecting side, releases heat into the surrounding environment.

Heat Transfer: As the electric current flows through the module, heat is absorbed from the hot side, causing the electrons in the semiconductor material to gain energy and move to the cold side. This movement of electrons transfers heat energy from one side to the other, creating a temperature difference between the two sides.

Cooling Mode: In the cooling mode, the hot side of the module is attached to the area that needs to be cooled, such as an enclosure or room, while the cold side is exposed to the outside environment. The heat absorbed from the cooled space is transferred to the cold side and then released into the outside environment.

Control System: A control system, typically comprising temperature sensors and a feedback mechanism, monitors the temperature of the cooled space and adjusts the current flowing through the thermoelectric module accordingly. This allows the system to maintain the desired temperature by regulating the cooling effect.

It's worth noting that thermoelectric CPU Cooling systems have certain limitations compared to traditional compressor-based cooling systems. They typically have lower cooling capacities, higher energy consumption, and are less efficient for large-scale cooling applications. However, they offer advantages in terms of compact size, absence of refrigerants, precise temperature control, and suitability for specific niche applications where portability and reliability are key factors

3.2 Electrical Cycle

In this cycle lots of components are used, these are given bellow

1. Peltier Module
2. Electrical Pump Motor
3. Cooling Fan
4. Power Supply

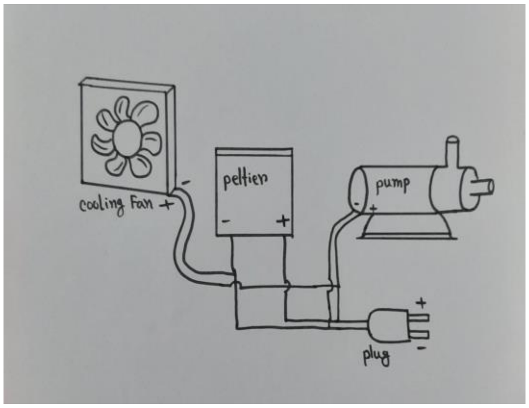


Figure: 3.2 Electrical cycle

Process: When we connect with the power supply, the pump, Peltier module and cooling fan are activated. The pump continues to circulate the projectile liquid coolant. On the other hand, due to the effect of PN junction in Peltier, one side becomes cold and the other side becomes hot. The cooling fan also starts its operation.

3.3 Mechanical Cycle

Mechanical Components name is given bellow.

1. Radiator
2. Cooling Block
3. Pump
4. Reserve Tank
5. Hose Pipe

Process: After the pump starts, it takes liquid from the coolant reserve tank and sends it through the pipe to the radiator. The radiator sends the hot coolant to the cooling block to cool it by the rejection of heat. On the other hand, the hot liquid in the cooling block takes the coolant and sends it back to the radiator. Similarly this cycle continues again and again. That’s how it reduce the temperature form CPU.

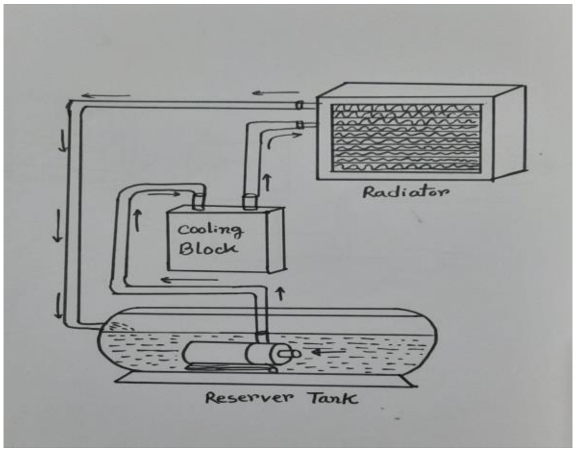


Figure: 3.3 Mechanical cycle

3.4 Final View of Our Project

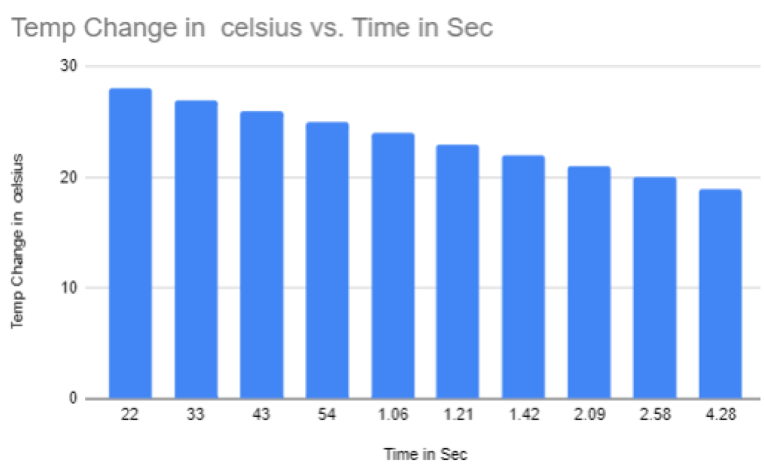
Chapter 4

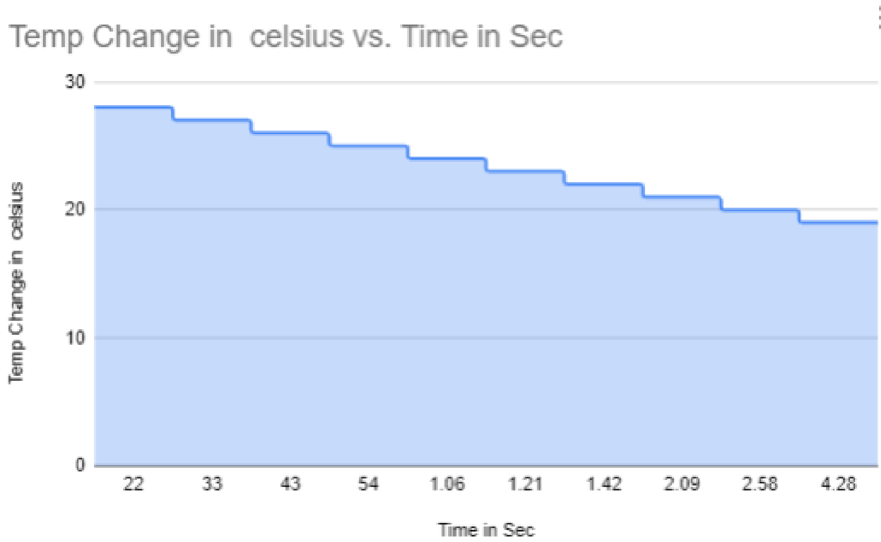
Result and Discussion

4.1 Table

SL. No	Initial Temperatue in Celsius	Final Temperatre in Celsius	Time Difference (in sec)	Total Time (in Sec)
1	29	28	22	22
2	28	27	11	33
3	27	26	10	43
4	26	25	11	54
5	25	24	12	1.06
6	24	23	15	1.21
7	23	22	21	1.42
8	22	21	27	2.09
9	21	20	44	2.58
10	20	19	1.30	4.28

4.2 Temperature graph





In horizontal line we took the time changing data, and in vertical line temperature data. When temperature decreases 1 degree Celsius its takes 22 sec. in accordance to that process rest of data are collected from the table and graph is filling up by the data.

4.3 Result

The initial temperature is 29 degree Celsius. After 22 seconds of operation temperature decrease and become 28 Degree. After following the same process temperature decreases consistently. At 4.28 min we have got the final temperature of 19 degree Celsius. Ultimately it decreases 10 degree Celsius.

Chapter 5

5.1 Conclusion:

In conclusion, the CPU cooling system project aims to explore and implement a cooling or heating system based on the thermoelectric effect. The project involves the use of thermoelectric modules, a power supply, control system, heat dissipation components, and a coolant circulation system.

CPU cooling systems offer advantages such as compact size, quiet operation, and environmental friendliness due to the absence of refrigerants. However, they generally have lower efficiency compared to traditional vapor compression systems. The project's success relies on thorough research and understanding of thermoelectric materials, system design, and optimization techniques.

The key components of the CPU cooling system, such as the thermoelectric modules, power supply, control system, reservoir tank, and pump, play vital roles in achieving effective cooling or heating. The control system monitors and regulates the temperature and current flow to optimize the system's performance.

The project's success also depends on proper sizing and integration of components, selection of appropriate materials, and implementation of efficient heat dissipation techniques. Additionally, considerations such as system safety, reliability, and cost-effectiveness should be addressed during the project's development.

By successfully implementing the CPU cooling system and addressing its limitations, the project can contribute to advancements in energy-efficient and environmentally friendly cooling or heating solutions.

Overall, the CPU cooling project presents an opportunity to explore an alternative approach to cooling, showcasing the potential of thermoelectric technology in specific applications where compactness, noise reduction, or sustainability is essential.

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