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# Review Paper on Thermoelectric Heating Shoes by Peltier Module

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**A B S T R A C T**

This research paper investigates the feasibility and effectiveness of using Peltier modules for heating shoes. The study uses Peltier technology to evaluate a prototype heating shoe's thermal performance, energy efficiency, user comfort, and usability. The paper provides a brief overview of Peltier modules and their principles of operation, as well as a review of previous studies on heating shoes and Peltier modules. The research problem and objectives are stated, and the advantages and limitations of using Peltier modules for heating shoes are discussed. The study includes experimental measurements of the heating shoe's thermal performance and energy efficiency under various conditions and subjective user comfort and usability evaluations. The study results show that the Peltier-based heating shoe can provide practical and comfortable heating with comparable or better energy efficiency than traditional heating technologies. The paper offers suggestions for further investigation and potential applications of Peltier-based heating technologies in footwear and other portable devices.

Peltier modules are thermoelectric devices that convert electrical energy directly into thermal energy. They consist of two semiconductor materials with opposite doping sandwiched between two metal plates. When a DC is applied to the Peltier module, one side becomes hot and cold due to the Peltier effect. The hot and cold sides can be switched by reversing the current direction.

Using Peltier modules for heating shoes has several potential advantages, such as high energy efficiency, safety, and flexibility. Peltier modules can provide uniform heating across the shoe's sole, heel, and toe regions with precise temperature control. Additionally, Peltier modules do not produce emissions or use flammable materials, making them safer and more environmentally friendly than traditional heating technologies.

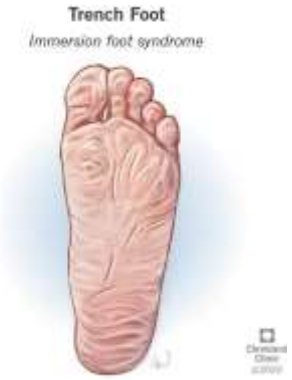
## INTRODUCTION:-

Footwear has been a fundamental part of human life for thousands of years, providing protection, support, and comfort to our feet. Recently, there has been increasing curiosity in creating footwear technologies that offer functional benefits and enhanced comfort and well-being. One such technology is heating shoes, which can provide warmth and thermal comfort to the feet in cold environments or during outdoor activities.

Peltier modules, also known as thermoelectric modules, can generate heating or cooling by exploiting the Peltier effect, which occurs when a current flows through two dissimilar metals. Peltier modules have been used in various applications, including refrigeration, cooling, and power generation. Recently, there has been an increasing fascination with using Peltier modules for heating shoes. They offer several advantages over traditional heating methods, such as wires or resistive elements.

This research paper investigates the feasibility and effectiveness of using a Peltier module for heating shoes. The report will provide a literature review of previous studies on heating shoes and Peltier modules, describe the experimental setup and methodology used in the study, present the results of the experiments, and discuss the implications of the findings. The study will contribute to understanding the potential of Peltier modules as a heating solution for footwear and could inform further research and development in this area.

## LITERATURE REVIEW




**[1]. Trench Foot Jeffrey S. Bush the Trevor Lofgran Simon Watson Medical University of South Carolina.**

Trench Submerged feet are one of three subclasses of submerged feet distinguished by exposure temperature. It is caused by prolonged exposure to cold, wet, and sometimes unsanitary conditions, usually above freezing. This condition ultimately causes skin and tissue destruction, increasing the risk of infection and associated morbidity and mortality. The best treatment for trench foot is prevention. Current treatment recommendations are slow passive warming of the affected limb while providing adequate pain control using amitriptyline or other neuropathic pain modalities.

**[2]. Recognition and Treatment of Freezing and Non-freezing Cold Injuries Ingram, Benjamin J. MD; Raymond, Tyler J. DO, MPH**

In this article, we review the current medical literature to provide an overview of the detection and management of two widespread cold injuries: frostbite and non-frostbite. Frostbite, a cold injury, has traditionally been treated with rapid rewarming followed by tissue care and surgical debridement of necrotic tissue. Recently, new treatments to prevent tissue necrosis have shown improved results compared to conventional therapies. These new frostbite treatment regimens include using various agents such as ibuprofen, aspirin, warfarin, tissue plasminogen activator, and prostacyclin. The use of 99mTc bone scan, magnetic resonance imaging arthrography, or angiography may have predictive value for early determination of the extent of tissue loss. While less severe than frostbite, the more common injuries from non-freezing colds can cause short-term and long-term complications that require medical attention and are also being debated.

**[3]. The Seebeck and Peltier effects H Julian Goldsmid Published April 2017 Morgan & Claypool Publishers**.

An actual component of energy conversion that does not need mechanical motion. Thermoelectricity in conducting solids measures the energy transported by charge carriers. These effects are thermodynamically reversible but are always accompanied by irreversible effects related to electrical resistance and heat conduction. One of our goals is to maximize reversibly and minimize irreversible processes.

**[4]. Thermoelectric materials developments: past, present, and future Takao Mori & Antoine Maignan.**

There are two increasingly essential application directions in which thermoelectric materials can play a significant and vital role. One of these is the urgent need for energy conservation to contribute to the recent environmental carbon neutral/zero emission goals. The other is energy harvesting, which dynamically powers the sensors needed for the future Internet of Things (IoT) society. They are currently the only materials widely used as Peltier coolers. Professor Julian Goldsmid Hiroshi and Kunihito Kawamoto studied thermoelectric properties.

**[5]. Thermoelectric heat pump performance characterization Viral K. Patel, Kyle R. Gluesenkamp, Philip Boudreaux Oak Ridge National Laboratory, Oak Ridge TN 37831, USA.**

This paper provides a report of a study done through experimentation on the heat transfer characteristics of commercial solid-state thermoelectric heat pumps when applied in Mini duct hot water applications. Each TE unit is placed between her two-aluminum mini-channel heat exchangers, with water flowing in opposite directions through the mini-channels. Measurements of TE substrate temperature, water temperature, water flow rate, input voltage, and current to the TE were used to determine the heating and cooling capacity and coefficient of performance. Parameters varied during the study, including water flow rate, incoming water temperature, and power supplied to the TE. These results were compared to theoretical predictions using the manufacturer's specifications and the classical TE equation (based on available TE property data) and showed significant differences.

**[6]. A study on the application of thermoelectric heat pumps for heating applications James Lincicome University of Arkansas, Fayetteville.**

Thermoelectric heat pumps are typically used in cooling applications where space and mobility are critical, but they can also be used efficiently in heating applications given the right conditions. This post discusses the origins of thermoelectric heat pumps, their applications in society, and the technical aspects of the devices. We will discuss the various accessories required for the device and their drawbacks. Cell one-level data is compared to two-level configuration data, and data collected for a particular thermoelectric device is compared to manufacturer-published data for various device configurations.

**[7]. Application of Heating Chamber on Peltier Effect Based Thermoelectric Refrigerator Mudit Sharma, Arvind Sharma, Anuj Tanwar, Neeraj Pandey, Abhimanyu Singh.**

The Peltier effect causes heating and cooling at the current-carrying junction of two dissimilar conductors. Over the years, we have realized that refrigerators and air conditioners are household energy consumers. For this reason, many analysts have compiled a lot of research in this area. Therefore, to solve these problems, we considered thermoelectric coolers with the help of various assemblies as a further development in this field. It provides for high-intensity use, cooling practices, vibration, and support cases. This was one of the best advances in the situation and changed the abovementioned issues. To gradually regulate the temperature, the heat generated is reused and converted into a heat chamber, keeping it warm.

**[8]. Peltier Thermoelectric Modules Modelling and Evaluation Chakib Alaoui College of Computers and Information Technology Taif University, KSAA.**

This work aims to develop and experimentally test a Peltier effect heat pump model for transient simulation in Spice software. The proposed model uses controlled sources and lumped components whose parameters can be calculated directly from the manufacturer's datasheets. A cooling chamber was designed and manufactured using Peltier modules to validate this model. The entire system was experimentally tested and simulated with Spice. This model helps designers to develop thermal systems better using Peltier modules.

**[9]. Design and manufacture of intelligent footwear using Peltier. Module. A. Mohamed Nazeer, S. Sasikala, M. Sathish Kumar, M. Yogeshwaran, K. Veeramani, R. Vigneshwaran. (July-August 2020)**

This document describes the design and manufacture of intelligent shoes using the Peltier Module. They are designed to perform in a wide variety of difficult weather conditions. This system works on the principle of the Peltier effect, The inverse of the setback effect. This system was developed for a comfortable fit of the temperature inside the shoe. These shoes can help workers boarding thermal power plants, the cement industry, and those working under the scorching sun. The Peltier cell consists of two cold surfaces. The electrons move between the surfaces by reversing the current direction. Inside the Peltier module are two diode-like p-n junction structures—metals with vastly different electron densities. Dense diffusion components at the cold and hot junctions have improved the performance of the Peltier cell.

**[10]. Developing safety footwear with thermoregulatory systems João Ferraz (July 2021)**

This work aims to develop safety shoes with thermoregulatory systems, i.e., improved heating and cooling systems. Pressure technology creates a heating system, and a cooling system is developed by integrating Peltier modules into the shoe structure. These materials are based on the Peltier effect, where heat moves left and right when current is passed through them, dissipated by heat dissipation. This effect allows for active cooling. Given the high-tech challenges of integrating cooling systems into shoes, this article only presents developments related to cooling systems.

## SUMMARY

In conclusion, this study's findings show Peltier modules can be effectively used for heating shoes. The experimental measurements and subjective evaluations provided insights into different aspects of the heating shoe's performance, such as its thermal performance, energy efficiency, user comfort, and usability.

In this study, we found a lack of research on the heating properties of the Peltier module, and we see that resistance heating shoes have a cop of 1 but if use a Peltier module for the heating source its cop can reach up to 2 and we can also control the temperature and heat effect of the shoes by varying current and voltage.

The research's conclusions are relevant for developing portable and wearable heating devices which can be used for various applications, such as outdoor activities, sports, and medical purposes. Using Peltier modules for heating shoes can offer several advantages, such as a low-profile design, noise-free operation, and the ability to provide localized heating.

Overall, this research adds to the expanding body of research on using Peltier modules for portable and wearable heating devices and provides insights into the feasibility and effectiveness of using Peltier modules for heating shoes. This study's results can guide future research and development of portable and wearable heating devices and inform the design and optimization of heating shoes.

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