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Development of Solar Based Heating and Cooling System Using Thermo-Electric Module

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Abstract – *The current work is emphasized to design and analyzed Heating & Cooling system which can be utilized as a non-conventional energy source. In this proposed work a portable system has been developed on the principle of 'Thermoelectric Module'. The module is implemented for hot side and cold side, The cold side of the thermoelectric module was utilized for cooling purposes whereas the rejected heat from the hot side of the module was eliminated using heat sinks and fans.*

Keywords- Thermoelectric heating, thermoelectric cooling, solar panels, renewable energy

I- INTRODUCTION

The current tendency of the first world is to look at renewable energy resources as a source of energy. This is done for the following two reasons; firstly, the lower quality of life due to air pollution; and, secondly, due to the pressure of the ever increasing world population puts on our natural energy resources. From these two facts comes the realization that the natural energy resources available will not last indefinitely. Therefore, the ideal solution would be to use some type of renewable energy resource to provide these houses with energy without an expensive electrical grid connection [1]. One solution is a RAPS (Remote Area Power Supply) using an alternative form of energy. A study done by the University of Cape Town's Energy Development Research Centre came up with interesting facts that can be used to support the application of PV systems to Third World housing. The thermometric cooler it will utilize the power from the PV panels when the battery is fully charged, and at night, will use a small amount of power to maintain the temperature in the cooler box. In. other words, if the battery of the system is fully charged, and there is no appliance to absorb the power generated from the PV panel, it would be wasted, resulting in a 'poor efficiency factor for the whole PV system [2]. The cooler box integrated in a RAPS would allow for a very efficient system utilizing all the excess generated power from the sun.

II-INTRODUCTION OF EMBEDDED SYSTEM

An Embedded System is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a specific function. A good example is the microwave oven. Almost every household has one, and tens of millions of them are used every day, but very few people realize that a processor and software are involved in the preparation of their lunch or dinner. This is in direct contrast to the personal computer in the family room. It too is comprised of computer hardware and software and mechanical components (disk drives, for example). However, a personal computer is not designed to perform a specific function rather; it is able to do many different things. Many people use the term general-purpose computer to make this distinction clear. As shipped, a general-purpose computer is a blank slate; the manufacturer does not know what the customer will do wish it. One customer may use it for a network file server another may use it exclusively for playing games, and a third may use it to write the next great American novel. If an embedded system is designed well, the existence of the processor and software could be completely unnoticed by the user of the device. Such is the case for a microwave oven, VCR, or alarm clock. In some cases, it would even be possible to build an equivalent device that does not contain the processor and software. This could be done by replacing the combination with a custom integrated circuit that performs the same functions in hardware. However, a lot of flexibility is lost when a design is hard-cooled in this way. It is much easier, and cheaper, to change a few lines of software than to redesign a piece of custom hardware. Renewable & alternative non-conventional green energy technologies used for heat-pumping applications have shown real merits and received renewed interest in recent years especially in small-scale portable heating applications. Solar-driven thermoelectric heat pumping is one of these innovative technologies [1]. Solar energy is the most low cost, competition free, universal source of energy as sunshine's throughout. This energy can be converted into useful electrical energy using photovoltaic technology. Thermoelectric heating (or cooling) technology has received renewed interest recently due to its distinct features compared to conventional technologies, such as vapor- compression and electric heating (or cooling) systems. Thermoelectric (TE) modules are solid-state heat pumps or refrigerators in case of cooling) that utilize the Peltier effect between the junctions of two semiconductors. The TE modules require a DC power supply so that the current flows through the TE module in order to cause heat to be transferred from one side of the TE module to other, thus creating a hot and cold side [2] [3].

III- PROPOSED SYSTEM

In the recent years, we all are facing electricity crisis. It's time to harness the renewable energy resources of the nature. Our project utilizes the solar energy to run a heating and cooling system. In this project we have fabricated a thermoelectric system using solar energy. It is an eco-friendly project, made by using thermoelectric module. The project supports both heating and cooling. The project has various applications like, military or aerospace, medical and pharmaceutical equipment etc. Thus it proves to be very helpful.

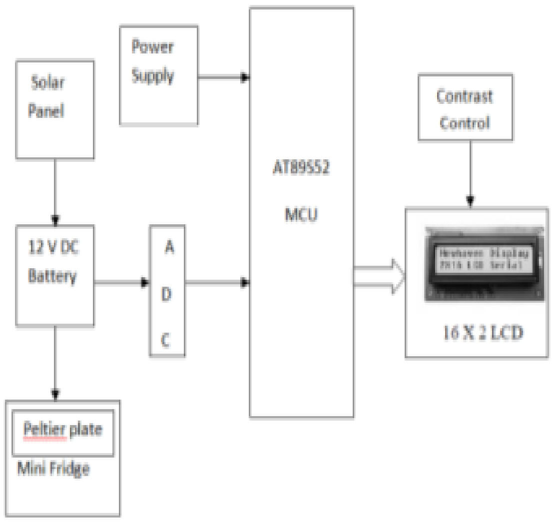

Fig. 1. Blog Diagram

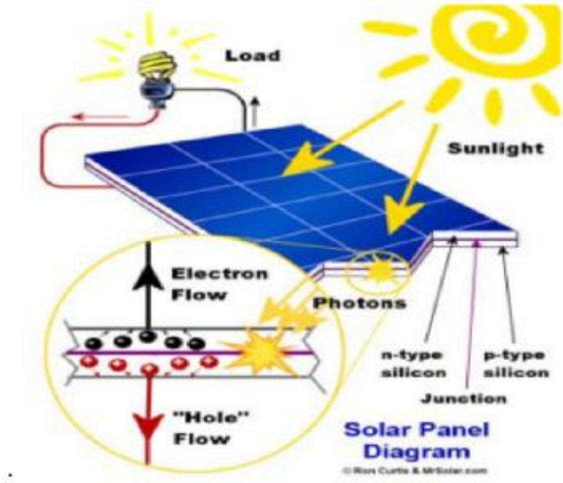

Fig. 2 - Solar Panel Diagram

A typical thermoelectric module is composed of two ceramic substrates that serve as a foundation and electrical insulation for P-type and N-type Bismuth Telluride dice that are connected electrically in series and thermally in parallel between the ceramics. The ceramics also serve as insulation between the modules internal electrical elements and a heat sink that must be in contact with the hot side as well as an object against the cold side surface. Electrically conductive materials, usually copper pads attached to the ceramics, maintain the electrical connections inside the module. Solder is most commonly used at the connection joints to enhance the electrical connections and hold the module together [6]. Most modules have and even number of P-type and

Ntype dice and one of each sharing an electrical interconnection is known as, "a couple." [6]. While both P-type and N-type materials are alloys of Bismuth and Tellurium, both have different free electron densities at the same temperature. P-type dice are composed of material having a deficiency of electrons while N-type has an excess of electrons. As current (Amperage) flows up and down through the module it attempts to establish a new equilibrium within the materials. The current treats the P-type material as a hot junction needing to be cooled and the N-type as a cold junction needing to be heated. Since the material is actually at the same temperature, the result is that the hot side becomes hotter while the cold side becomes colder. The direction of the current will determine if a particular die will cool down or heat up. In short, reversing the polarity will switch the hot and cold sides [7].

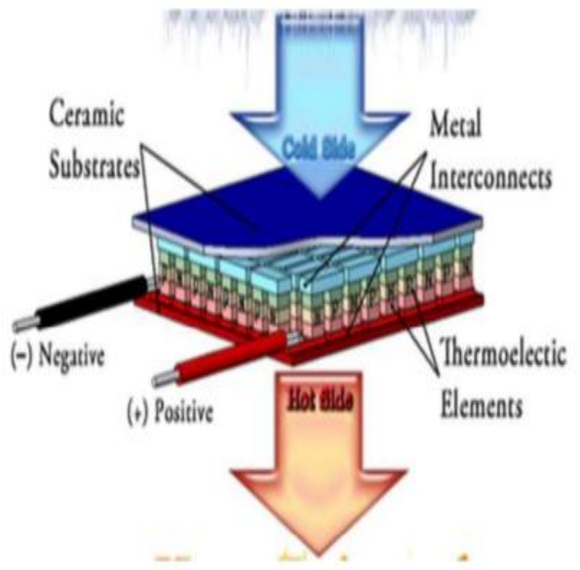

Fig.3 - Operating principle of thermo-electric module

Thermoelectric modules are solid-state heat pumps that operate on the Peltier effect (see definitions). A thermoelectric module consists of an array of pand n-type semiconductor elements that are heavily doped with electrical carriers. The elements are arranged into array that is electrically connected in series but thermally connected in parallel. This array is then affixed to two ceramic substrates, one on each side of the elements (see figure below). Let's examine how the heat transfer occurs as electrons flow through one pair of p- and n-type elements (often referred to as a "couple") within the thermoelectric module.

IV- TECHNICAL SPECIFICATIONS

Thermoelectric modules withstand potentially detrimental environmental conditions operating without failure under the low temperature point being equal to 285K (12°C) and the high temperature point being equal to 328 K (+55°C). Thermoelectric modules successfully meet the below specified conditions without failure: sinusoidal vibration, 10-50 Hertz, with vibro-acceleration amplitude up to 20 m/s2 (2g). Unsealed thermoelectric modules withstand high humidity conditions with the RH level up to 88 % and 298 ° K (25°C) without any failure in operation. Thermoelectric modules withstand single mechanical shock with the peak shock acceleration being equal to 20G (200m/s2) and 2-4 msec- Collision Momentum without any failure [9]

V- RELIABILITY

Reliability is one of the major criterions of thermoelectric module (TEM) selection. TEMs are considered to be highly reliable components due to their solid-state construction. However premature TEM failure roots in soldered joints degradation which is primarily caused by the following factors: Improper operation and faulty mounting of TEM's leads to catastrophic electrical or mechanical failure; Continuous exposure to an elevated temperature results in TEM's is overheating. It is important that the modules are installed in full accordance with these general instructions to minimize the possibility of premature TEM failure. If you choose the right TEM or calculate/ design thermoelectric cooling assembly, please takes into account TEM's operating temperature, which is TEM's hot side temperature [10]. This is highly important since if the TEM is exposed to the higher temperature range, this will result in degradation changes in semiconductor material parameters and subsequent TEM's failure. We manufacture TEMs with the operating temperature of 80° C or 150°C. The latter are marked with HT symbol. According to the tests' results, the Mean Time between Failures (MTBFs) for TEMs is in excess of 200,000 hours at ambient room temperature. It is recommended, however, to design thermoelectric cooling assemblies in such a way as to provide the maximum heat dissipation from the TEM hot side to minimize the possibility of premature TEM failure [11].

VI- CONCLUSION

Thus our article concludes that solar energy systems must be implemented to overcome increasing electricity crisis. In this work, a portable solar operated system unit was fabricated and tested for the cooling and heating purpose. The system was designed based on the principle of a thermoelectric module to create a hot side and cold side. The cold side of the thermoelectric module was utilized for cooling purposes whereas the rejected heat from the hot side of the module was eliminated using heat sinks and fans. And hot side of the thermo electrical module was utilized for heating purpose. In order to utilize renewable energy, solar energy was integrated to power the thermoelectric module in order to drive the system. Furthermore, the solar thermoelectric cooling and heating system avoids any unnecessary electrical hazards and proves to be environment friendly. The article is useful for the instant chilling/hot applications. Experimental work has been carried out carefully. The result shows that higher efficiency is indeed achieved using the embedded system according to requirement of the user.

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