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Fabrication of solar refrigeration using peltier effect

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Abstract – In order to meet with the increasing population there is a need for increased energy production. Solar energy which is one of the renewable sources of energy helps in satisfying this need for power. Our main objective is to construct a refrigeration system which runs with the help of solar energy. This system consists of a thermoelectric module consisting of two dissimilar semiconductor materials which works based on the principle of peltier effect utilizing power from the solar panel. In our project, we have replaced conventional energy using renewable energy for providing refrigeration to rural and undeveloped areas where there is lack of power supply. Solar refrigeration using peltier module also helps in reducing the amount of carbon-di-oxide in the environment.

Index words – Solar refrigeration, semiconductor material, thermoelectric module, refrigeration, peltier effect.

I. INTRODUCTION

The seeback effect, Peltier effect and Thomson effect are encompassed as "Thermoelectric effect". Seeback and Peltier are often referred to as Peltier-Seeback effect as they are the manifestation of the same physical process. The conversion of heat into electricity by applying it to the junction of two dissimilar metals is called Seeback effect. The seeback effect was discovered in 1787 by Italian scientist Alessandro Volta. The peltier effect which can be defined as the inverse process of the seeback effect was discovered by Jean Charles Athanase Peltier in the year 1834. According to peltier heat can be absorbed or removed by altering the polarity of the electric current applied between the junction of the two conducting material. Chlorofluorocarbon also known as Freon halogenated paraffin which contains carbon, chlorine and fluorine produced as volatile derivative of methane, ethane and propane is widely used as a refrigerants in most of the conventional refrigerators is responsible for the depletion of the ozone layer in the upper atmosphere. Despite the consideration of ozone layer, the use and need for refrigerator has increased now-a-days. As refrigerators has become a part of our daily life and there is demand for electricity. We intend to reduce

the emission of Chlorofluorocarbon but using an refrigerator which doesn't use refrigerants and utilizes alternate energy for the refrigeration process. In our project the thermoelectric module acts as a heat exchanger and Transfers the heat from one side to the other side keeping one side of the system cool and the other side the refrigerator hot.

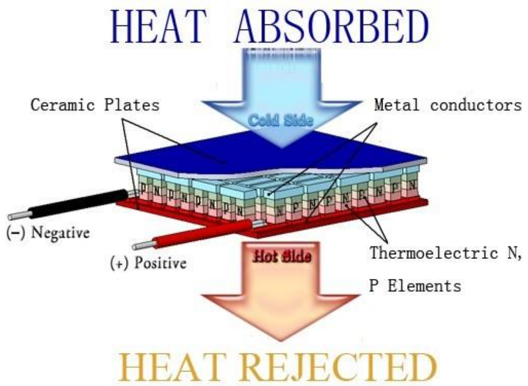

Fig. 1 Peltier effect

The eminent benefit of this system is being environmental friendly saving energy and controlling humidity temperature separately. The solar refrigerator is portable and it reduces total residential electricity by 25% or more in humid regions.

II. LITERATURE SURVEY

[1] Sanchit Kumar Gupta (2015) "*Enhancing the performance of solar refrigeration system*". Sanchit kumar gupta in his experiments tried to improve or

enhance the power of solar refrigeration and thus achieved an improved output by using fans as an enhancer.

[2] Onoroh Franchis (Feb 2016) *"Performance Evaluation of a thermoelectric refrigerator".* The performance of the thermoelectric refrigerator was simulated using mat lab under various operating conditions by Onoroh Francis.

[3] Jonathan Winkler (2016) *"Potential benefits of thermoelectric element used with Air-cooled heat Exchanger",* Jonathan Winkler made a study on the possible or potential benefits than can be obtained by using thermoelectric element in air cooled heat exchanger.

[4] Wei He, Gan Zhang (2015) *"Recent development application of thermoelectric generator and cooler",* Wei He made a study on the recent developments and application of thermoelectric generators and coolers.

[5] S.B.Riffat (2016) *"Thermoelectric: a review of present and potential application",* S.B. Raffit made a study a search of the existing thermoelectric applications as well as the thermoelectric applications that can be developed in the future.

III. SOLAR PANEL

Solar panel utilizes sunlight (photons) as a source of energy to generate electricity. Silicon is mounted beneath non reflective glass to produce Photovoltaic panels that collect photon from the sun and convert them into DC electric power. The DC power then flows into an inverter, which transform it into basic AC electrical power Number of solar cell, are combined to form a solar module. A solar module is made up of 6×10 photovoltaic solar cells. A number of solar modules are combined to form a solar panel. The cells are connected in series with each other. They are connected in series to achieve desired output voltage. The photovoltaic modules use MC4 connectors (MC stands for manufacturer Multi Connect .

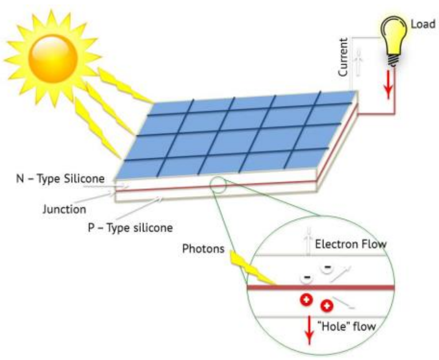

Fig. 2 Solar panel working diagram

IV. THERMOELECTRIC MATERIAL

There are several commercially available thermoelectric materials. The most commonly used materials are skutterudites, a cobalt arsenide mineral with variable amount of nickel and iron, bismuth telluride desiccant wheels are silica gel and lithium chlorides. The material used in this thermoelectric module is bismuth telluride which is a compound of bismuth and telluride which when alloyed with antimony or selenium, is an efficient thermoelectric material for refrigeration. Bismuth telluride has a high electrical conductivity of 1.1×10^5 S. m/m^2. Bismuth telluride is a narrow gap layered semiconductor with a trigonal unit cell. The valence and conduction bond structure can be described as many ellipsoidal models with six constant energy ellipsoids that are centered on the reflection planes. Bismuth telluride bonds with neighboring tellurium atoms due to Vander Waals force .Hence polycrystalline bismuth telluride based materials should be used for refrigeration system.

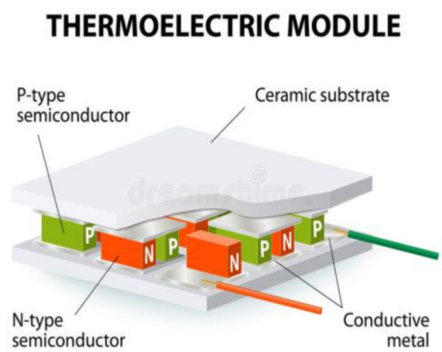

Fig. 3 Thermo electric material

V. REFRIGERATION

The removal of unwanted heat from a selected object, substance, or space and transferring it to another object, substance or space is called refrigeration. Removal of heat lower the temperature, this may be accomplished by using ice, water and mechanical refrigeration.

The methods of refrigeration are:

1. Non cyclic refrigeration
2. Thermoelectric refrigeration
3. Magnetic refrigeration
4. Cyclic refrigeration
   - Vapor compression cycle
   - Vapor absorption cycle
   - Gas cycle

Thermoelectric cooling is used to transfer heat energy from one space to another. This can be done by applying a voltage of constant polarity to a junction between dissimilar electric conductors or semiconductors. In thermoelectric refrigeration Peltier effect is used to create a heat flux between the junctions of two types of material. This effect is commonly used in portable refrigerators for cooling purposes. When voltage is applied to the thermoelectric module heat is produced which is carried from one side of the module to the other side. Thus one side of the device gets cooler while the other side gets hotter.

VI. EXPERIMENTAL SETUP

An experimental set up is established as shown in figure. The experimental set up consists of main components like solar panel, polarity switch, thermoelectric module, battery, and container. The system can be used for 2 purposes one is for refrigeration or cooling purpose and the other is for heating purpose. The setup has a cooling volume of 4 cubic meters (2m × 1m × 2m). The peltier module is made using a semiconductor material which is bismuth telluride which has high electrical the peltier module is placed inside a polystyrene container covered using a insulating container to prevent the leakage of the heat and to prevent to setup from external heat. The energy from the sunlight (photon) is captured and transferred to the battery by the solar panel through conducting wires. A 12V or 4 to 5 amps battery is used to store the energy from the solar panel and then transfer to the peltier module. A polarity switch is provided to inverse the polarity of the current supplied and there by inverting the heating and cooling regions. The overall setup is placed over a stand.

VII. WORKING PRINCIPLE

The direct conversion of voltage difference into temperature difference and vice versa using a thermocouple is called thermoelectric effect. The thermoelectric device produces voltage when there is temperature difference on each side of the thermocouple, when there is a temperature difference it generates electricity According to seeback when two dissimilar semiconductor materials are placed at two different temperatures there is an voltage is generated. Our project is based on peltier effect which is an inverse of seeback effect that is when current is applied to two dissimilar semiconductor materials a voltage difference is produced at the junction by which a heat difference is produced thus to the heat is transferred to one side of the thermoelectric module.

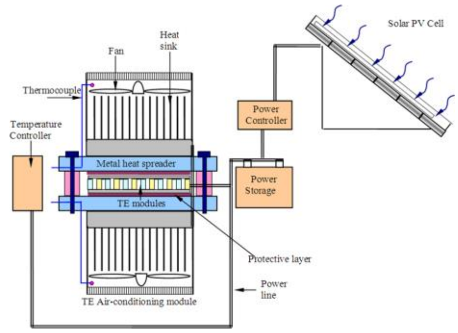

Fig. 4 Solar refrigeration with dissimilar metal

VIII. CONCLUSION

Solar refrigeration system is typically a method which consumes less electric energy. There by alleviating the peak electrical demand caused by the traditional refrigeration systems. Due to usage of solar panel for refrigeration there is reduction of usage of harmful refrigerants which causes ozone layer depletion. We achieved improved indoor quality by implementing this system. It has huge application in food processing industry, Dairy, schools, and Meteorological laboratories and in many other domestic applications. In conclusion, further improvement in energy utilization rate, reduction in cost and size, standardization in design and production are the key issues faced by the solar refrigeration system for achieving more extensive application.

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