Review of Use of Thermoelectricity as Renewable Energy Source

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***Abstract*- The objective of this paper is to investigate the usefulness of the thermoelectricity and find out the ways to make it renewable energy source, And also to compare it with other renewable and non-renewable sources. This analysis has been done by studying the basic fundamental of energy generation, energy conversion of the energy and the development and need of the renewable energy sources. the relative advantages and disadvantages of thermoelectricity with other renewable and non renewable sources have also been done in this analysis. we have also make one conceptual thermoelectric solar generator model to study its capacity to generate energy. Finally, it is concluded that thermoelectricity is the new and very advantageous energy sources, but now a days this is in development phase but in future it may be proved as a non comparable renewable source.**

***Index terms*: thermoelectric generator, thermoelectric solar generator, thermocouple, thermoelectric module, advantages and limitations of TEG, solar concentrator.**

I. INTRODUCATION

The thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice versa. A thermoelectric device creates voltage when there is a different temperature on each side. Conversely, when a voltage is applied to it, it creates a temperature difference. At the atomic scale, an applied temperature gradient causes charge carriers in the material to diffuse from the hot side to the cold side. This effect can be used to generate electricity, measure temperature or change the temperature of objects. Because the direction of heating and cooling is determined by the polarity of the applied voltage, thermoelectric devices can be used as temperature controllers. The term "thermoelectric effect" encompasses three separately identified effects: the Seebeck effect, Peltier effect, and effect. The Seebeck effect is the conversion of temperature differences directly into electricity. The Peltier effect is the presence of heating or cooling at an electrified junction of two different conductors. Thomson effect describes the heating or cooling of a current-carrying conductor with a temperature gradient. But our area of interest is seebeck effect. The Seebeck effect is used in thermoelectric generators, which function like heat engines, but are less bulky, have no moving parts, and are typically more expensive and less efficient. They have a use in power plants for converting waste heat into additional electrical power (a form of energy recycling) and in automobiles as automotive thermoelectric generators (ATGs) for increasing fuel efficiency. now days new trend is to use this science to convert solar heat into electricity directly. But because of less efficiency this science is used as only to measure a temperature because its use as energy source is in development phase. Thermocouples and thermopiles are devices that use the Seebeck effect to measure the temperature difference between two objects, one connected to a voltmeter and the other to the probe. The temperature of the voltmeter, and hence that of the material being measured by the probe, can be measured separately using cold junction compensation techniques. Thermocouple is nothing but the pair of two different metals wire by joining their ends and by making it junction by fusing it. and when more then one thermocouple are joined in series to multiply the output then it is called as thermopiles. But now days new semiconductor type thermopiles are used as energy generator because of its higher efficiency then conventional thermocouples or thermopiles, and they are known as thermoelectric modules as shown in figure.

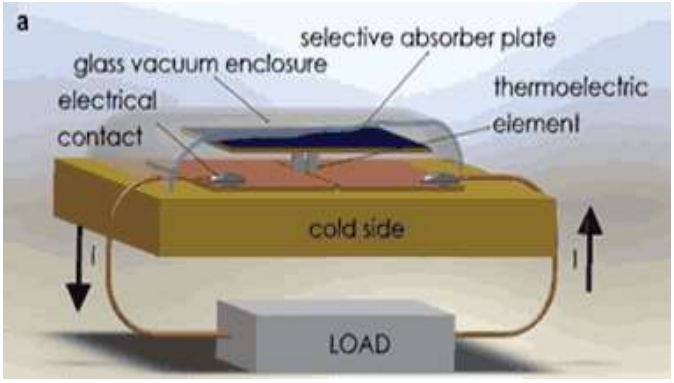


Fig.1.principle of thermoelectric generator

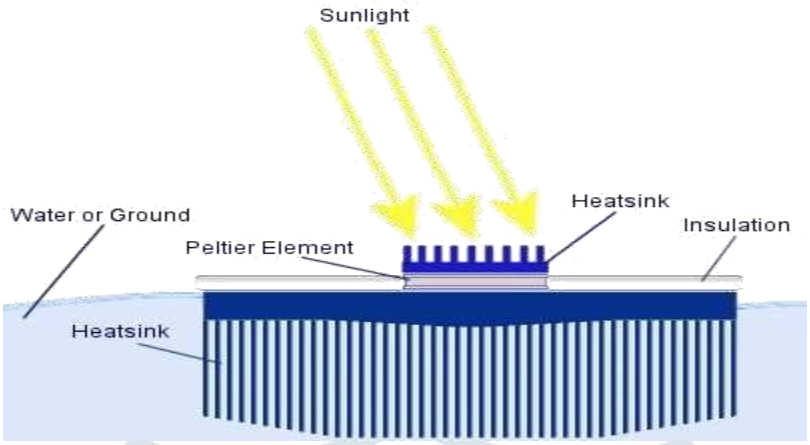


Fig.2.principle of solar thermoelectric generator

II. TYPES OF THERMOELECTRIC GENERATOR

In these both figure the basic principle of thermoelectricity is shown.1st picture is based on automotive thermoelectric generator, in which we can use the exhaust of th any mechanical machines or automobile engine as a heat sources of hot junction of thermoelectric module (pettier or seebeck thermoelectric thermopile).and in 2nd picture use of solar energy as heat source is shown. So according to our application thermoelectric generator can be classified into..

1. Conventional thermoelectric generator (based on exhaust heat)

2. Non conventional thermoelectric generator (based on solar heat)

We have chosen the second option for study of thermoelectricity as new renewable energy source.

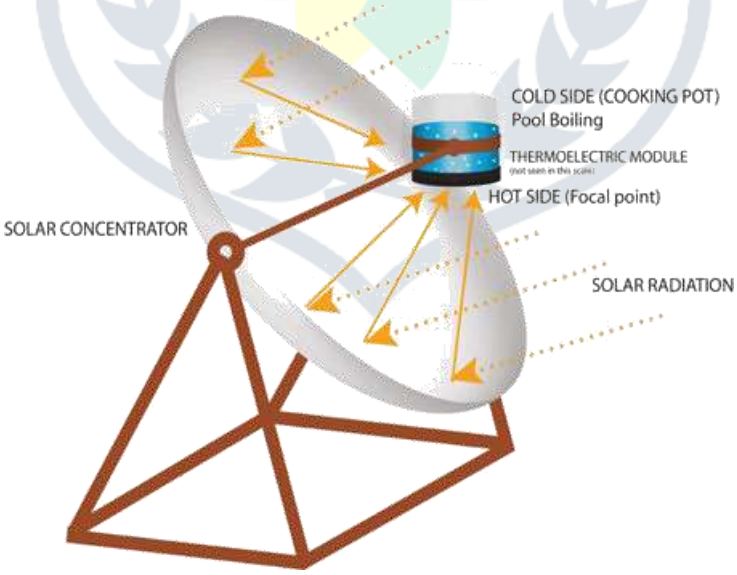


Fig 3.non conventional thermoelectric generator

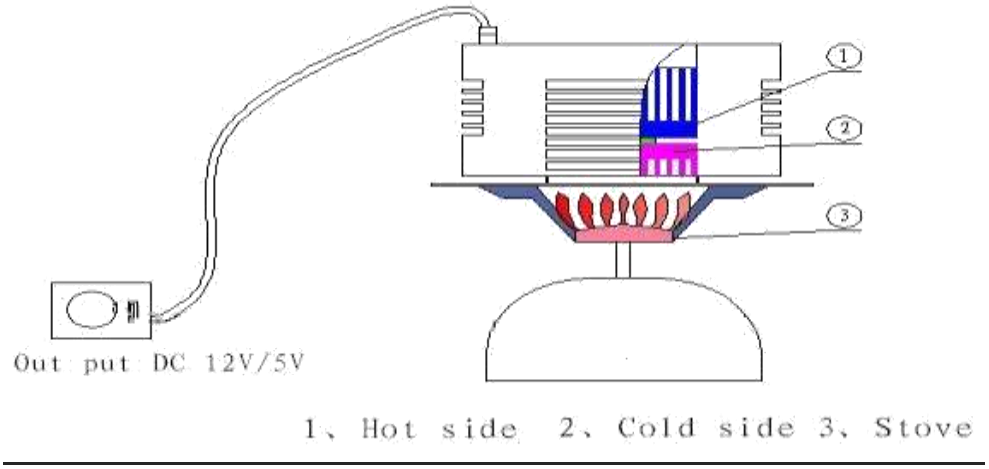


Fig.4 conventional thermoelectric geneartor

III. STUDY OF THERMOELECTRIC SOLAR GENERATOR(NON CONVENTIONAL THERMOELECTRIC GENERATOR.

Constructional detail:

1. Solar concentrator:

The selection of solar concentrator is based on concentration ration and ease of construction.
Optimum solution: parabolic dish type concentrator
Reason: concentration ration-2000 to 3000

2. Reflecting material:

The selection of this item is based on its reflectivity, availability and cost.
Optimum solution: aluminium foil (Reynolds aluminium wrap)
Reason: reflectivity is around 0.9, economical, easily available

3. Cooling system for cold junction:

Two type of cooling is available, 1st is natural circulation of water or 2nd is force circulation of water.
Optimum solution: natural circulation of water
Reason: force circulation needs power consuming pump

4. Thermoelectric module:

Selection is based on efficiency and cost and availability.
Optimum solution: semiconductor TEG module
Reason: higher efficiency (can generate 1V emf per 80 degree temp.diff.)

Experimental analysis:

This result is taken on conceptual model of thermoelectric solar generator. The output can be multiplied by bigger actual practical model.

Fig.5.Experimental setup

Specification of conceptual model:

Diameter of opening of the parabola =**1.47 m**

Surface collecting of the parabola = **1.78 m^2**

Depth of the parabola= **0.22 m**

Focal distance f =**0.61 m**

Hot junction temperature (Celsius)	Cold junction temperature (Celsius)	Temperature gradient	Output voltage
50	30	20	0.35
70	30	40	0.5
90	30	60	1.0
110	30	80	1.5

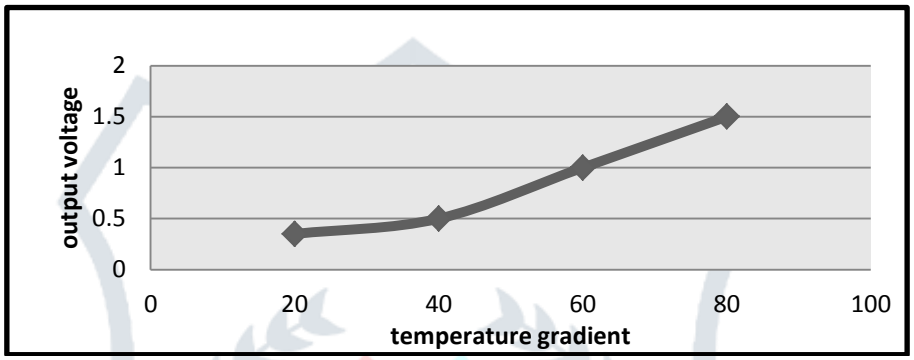
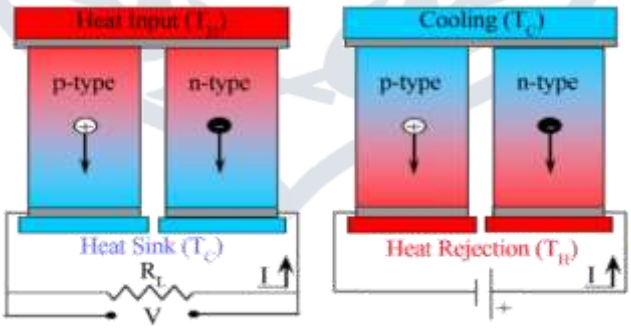


Fig.6. graph of experimental results

IV. LITRATURE REVIEW

1.) Essam E. Khalil : It can be seen that although much effort has been made to develop direct solar thermal power generation technology(thermoelectric generator), the conversion potential and practical applications are still not widely used. In order to make full use of its advantages and develop practical civil devices, more effort should be devoted to material research, structure optimization, and practical application development.



2.) J.SAARVESH : Two avenues for improving the efficiency of these devices are improving the selective surface and improving the material properties of the thermoelectric material thus a larger temperature gradient can produce a larger voltage. This shows that improvement in the power generation of STEG(solar thermoelectric generator) which in turn results in an increase in the fuel efficiency which serves as a great advantage in the scenario of rising petroleum costs. So reducing carbon emissions would serve as a security concern for environment and also for reducing environmental hazards. In order to reduce carbon emissions and increase fuel efficiency we have simulated different materials for solar thermoelectric generators like chalcogenides and selenium-platinum thermocouples and we came to know that chalcogenides thermocouples generates larger voltage than selenium platinum thermocouples due their higher temperature gradient. As solar energy is renewable form of energy and abundant it can be utilized to the maximum .In the future, improvement of solar thermoelectric generators can occur if further advancement and discovery of new materials with higher temperature gradients can take place.

3.) Taleb M. Maslamani : the potential of thermo electric cells combined with concentrator solar energy as a power generation system has been tested. An experimental prototype of concentrator thermo electric generator using parabolic dish concentrator of

0.3 m2 projected area (CTEG), heat sink cooling system and Petier thermo electric generator is being fabricated at the centre. the perspective applications for such power system is strongly depend on the development of the thermoelectric material, therefore, research about testing the latest TE material under the current CTEG system is recommended so that for this particular area, the concentrator thermo electric generation(CTEG) can be considered as a perspective candidate of the renewable energy based power source.

4.) R K Aggarwal, Sangeet Markanda: It is recommended that the thermoelectric generation modules be implemented in the design of a micro electric energy generator utilizing thermal energy from sun. To maintain a high value of the hot junction of thermocouple, greenhouse effect applied to it that is considered the main part of the research. For maintaining the long run high temperature, greenhouse gas can be filled in the green house built up as a heat source.

5.) M.Eswaramoorthy : The power generation from the combined system of solar parabolic dish collector and commercial thermoelectric modules was developed. The results of absorber plate temperature, power output and overall conversion efficiency are derived from the experimental investigation are reported for the different solar beam radiations. The performances of the systems are greatly affected by the heat sink temperature. Correlations for determining the plate temperature, electrical power output and overall conversion efficiency have been developed in terms of solar beam radiation. The experimental investigation shows that the generation of electricity from the low cost solar parabolic dish collector and commercial thermoelectric modules is a feasible option and also it is highly suitable for isolated energy demand where the conventional grid is not feasible or available.

V. CONCLUDING REMARKS:

1. Some literature shows that thermoelectric technology is feasible option as non conventional energy source in future.
2. some literatures shows that, there are various parameter which will decide the efficiency of this system like temperature difference, TE materials, reflecting surface and heat sink etc.
3. Some literature say that solar thermoelectric technology has several outstanding advantages like non polluting energy, no emission of carbon, direct heat to electricity conversion lower cost than PV cells etc, hot junction heating system.
4. From the study, we can conclude that thermoelectric power generation system is still in development phase, many steps are there to improve it. we can also say that though this system have lesser efficiency, but has some outstanding advantages.

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