Conceptual Design of Solar and Sea Based Renewable Energy Production with Thermoelectric Generator

Ali Ekber Özdemir[1*], Yavuz Köysal[2], Tahsin Atalay[2] , Engin Özbaş[2]

[1]Fatsa Deniz Bilimleri Fakültesi,52400, Ordu
[2]Yeşilyurt demir çelik vocational school, Ondokuz Mayıs Iniversity, 55330, Samsun
eozdemir@omu.edu.tr, yavuzk@omu.edu.tr, atalayt@omu.edu.tr, engin.ozbas@omu.edu.tr

Abstract

Main purposes of this paper are to show and discuss an alternative renewable energy producing system via thermoelectric generator (TEG). A TEG module produces electricity from temperature differences. This temperature differences is applied to two sides of TEG module that they are called hot and cold sides. In many applications TEG modules are used for energy producing from waste heat. But our paper is based on renewable energy producing. For this reason, needed temperature difference is ensured from solar energy that uses for heating process and sea that uses for cooling process. Solar collector tubes are used for concentrating solar radiation. Presented system is a conceptual design and a suitable system for any improvement.

1. Introduction

The most important kind of energy is electric energy for human civilization. All of technology is based on electricity. For example taken satellite images during the night can show us some parameters as population density and distribution, power consumption, and economic activities [1] based on electricity usage. All human population activities are related to the energy. But energy usage by human population causes some economic and environmental problems. Emission of green houses gas and fuel oil consuming increases together dramatically. Therefore the major factor of mitigating global climate change and greenhouse gas emissions is energy sector [2]. For this reason renewable energy is one of the most popular studies. There are some well-known renewable energy sources such as solar, wave, wind, dry and wet biomasses, bio gases, and geothermal resources [3]. In fact, main renewable energy source is solar energy. Other sources affected from sun directly or indirectly.

Our proposed conceptual design is based on solar energy conversion. For energy producing a simple thermoelectric generator (TEG) is used. TEG is a special semi-conductor structure that converts thermal energy to electrical energy. Fig.1 shows a TEG structure.

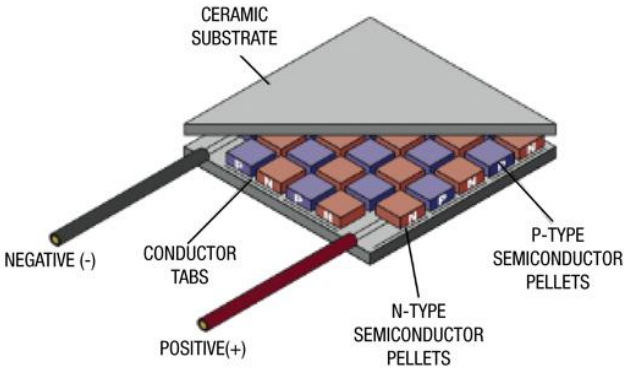

Fig.1. TEG structure

TEG structures produce electric energy with a temperature differences from two sides that is referred as hot and cold sides. Produced electric power have related to this temperature differences (Δt). Fig.2 shows temperature differences in a typical TEG structure and TEG output open circuit voltage [4] characteristic. In Fig.2, cold side temperature of TEG module is fixed on some absolute temperature (30 °C, 50 °C and 80°C). But hot side temperatures change between 0 – 300 °C. The output voltage depends on the temperature differences. Namely, for high output current or voltage, high temperature difference is ensured. We think that for high hot side temperature a heat pipe with solar collector tube can be used and sea water is a good choice for cooling process.

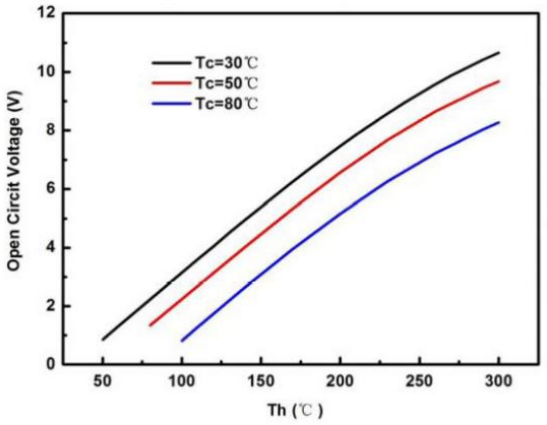

Fig.2. Δt – V characteristic of a typical TEG

In literature there are many applications that use TEG structures. Many of them are related to waste heat recovery. For example car waste heat recovery systems [5], domestic waste heat recovery systems [6] and industrial waste heat recovery systems [7]. Some applications are related to renewable energy producing [8]. And also this study is related to renewable energy.

In our conceptual design the required heating energy is provided from sun. And for cooling process sea water is used. Therefore our proposed conceptual design is based on solar heating and sea water cooling. Main purpose of this study is to show the proposed design and getting improvement to the system via other scientists' advices. This conceptual design that will be defined and discussed in next sections can be an alternative renewable energy producing method.

2. System description

Fig.3 shows main components of proposed generator structure.

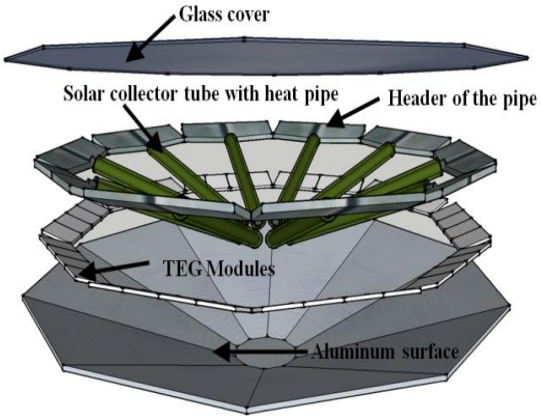

Fig.3. Proposed conceptual design

In Fig.3, aluminum surface and glass cover keeps away the TEG modules, solar collector tubes and heat pipes from sea water. At the same time aluminum surface ensures cooling and sun light reaches the solar collector tube via glass cover. Concentrated solar radiation is used as heat source. Little of water in the vacuumed heat pipe is carried up to the head of heat pipe by heat. And this heat comes from solar radiation. Head of heat pipe is contacted with hot sides of TEG modules. And also cold sides of TEG modules are contacted with aluminum surface in sea water. Fig.4 shows the proposed conceptual design in sea water.

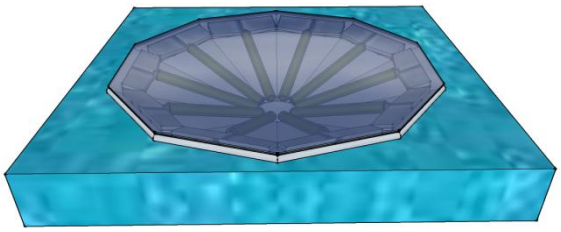

Fig. 4. Placement of System in water

3. Key studies

System parameters have to be defined well for the usable energy producing. For example heat pipe location angle, size of aluminum surface, number of heat pipe, size of head of heat pipe and number of TEG modules, etc. For this parameter definition a series of experimental study is needed. After this experimental studies optimum system design can be built. But there are some problems that must be faced. We think that salty sea water will cause corrosion. This problem can be the major problem that must be solved. Second problem is saving the system from destructive effect of sea wave. And next, glass cover can deform and this can cause more little solar energy for solar collector. Other problem can be humidity for TEG modules. The last problem that we think is algae or other sea creatures covered aluminum surface. This can cause performance decrease of cooling process. It seen that many of problems are related to material selection. After the optimum system design, cost and efficiency analysis should be done for proposed system.

4. Conclusions

Energy is vital for human civilization. But producing of energy can cause some economical or environmental problems. To solve these problems renewable energy application can be useful tool. Our main aim in this study is seeking for an alternative renewable energy producing method. Proposed system has some advantages including no moving part, no short maintenance period. And also it does not require big area. System is modular. Required energy producing can ensure more added modules. But for this advantage some problems must be solved before system construction process. We aim to solve some of these problems with a scientific project that supported from Ordu University. After the all process we aim to produce energy about 500 KW for each generator.

Acknowledgements

This work is partly supported by Ordu University Research Foundation Grant (2015-BAP-AR-1418).

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