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A Novel Co-Generation of Electricity Using Boost Converter Based Thermoelectric Generator in Boilers

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Abstract: Generating electricity is present there is a shortage of fossil fuel, oil, gas etc. Burning of these fuels causes environmental problem like radio activity pollution, global warming etc. So that these (coal, oil, gas) are the limiting resources hence resulting new technology is needed for electricity generation, by using thermoelectric generators to generate power as a most promising technology and environmental free and several advantage in production. Thermoelectric generator can convert directly thermal (heat) energy into electrical energy. In this TEG there are no moving parts and it cannot be produced any waste during power production hence it is consider as green technology. Thermoelectric power generator convert direct waste heat in to generate electricity by this it eliminated emission so we can believe this green technology. Thermoelectric power generation offer a potential application in the direct exchange of waste-heat energy directly into electric power can too improve the overall efficiencies of energy conversion system. Heat source which is need for this conversion is less when contrast to conventional method.

***Keywords* - Thermoelectric generators, Heat sink, Thermal grease, Inverter, Boost Converter, etc.**

I. Introduction

Nowadays, one of the major economic problems is the increasing energy consumption. This results in a rapid depletion of fossil fuel resources. To reduce the consumption level of these resources, a lot of investment in renewable energy and development investment in these sources. However, there is also the possibility of improving the efficiency of energy production from non-renewable sources. Energy production often involves the formation of by-product which is waste heat. However the waste heat is a certain volume of energy carrier which can still be utilized. One of the equipment processing heat into electricity is a thermoelectric generator. Its operation is based on the principle of thermoelectric phenomenon, which is known as a Seebeck phenomenon. The simplicity of thermoelectric phenomena allows its use in various industries, in which the main waste product is in the form of heat with the temperature of several hundred degrees. The most beneficial seemingly waste heat with the highest temperature. Thermoelectricity was discovered in the nineteenth century. The phenomenon of heat conversion into electricity and vice versa are called thermoelectric effects. Distinguishes the 3 main types of these phenomena: Seebeck, Peltier, and Thomson. Thermoelectric effect in the 20th century was used in various fields, eg. power the spacecraft, drawing heat for the heating of a single connector on the nuclear reactions. Thermoelectric materials were also used to power the pacemaker. Thermoelectric generator can also be used in the exhaust systems of cars. According to estimates, in modern engines with spark ignition and compression ignition heat contained in the exhaust gases is approx. 30% of the total heat from burning fuel. This heat instead of giving ineffectively to the environment, can be though to some extent re-use. This will increase the efficiency of the drive system. The use of thermoelectric generators to convert about 6% derived waste heat will reduce fuel consumption by up to 10%.

II. LITERATURE REVIEW

[1] Rasit Ahiska and Hayati Mamur (2013) "Design and implementation of a new portable thermoelectric generator for low geothermal temperature".

In this study, the design and implementation of a new portable thermoelectric generator of 100 W for low geothermal temperatures has been carried out. For this system, a new SCADA-based testing and measuring system equipped with special software has been developed and employed for the first time. Thus, effects of the hot cold water flow rates, the temperature differences between the surfaces and the load resistance affecting output power and efficiency of the thermoelectric generator have been investigated by a single testing and measuring system device. In the established SCADA-based testing and measuring system, the hot–cold water flows passed throughout the surfaces of the thermoelectric generator were increased by up to 3.7 and 12.8 l/min, respectively. Then, the temperature difference between the surfaces of the thermoelectric generator was measured as 67°C. When the load resistance of the thermoelectric generator was about 15 Ω, the maximum power of the thermoelectric generator was obtained as 41.6 W and the conversion efficiency was calculated as 3.9%. Also, the SCADA based testing and measuring system will open up a new stage in examination of various thermoelectric generators.

[2] Robert Haugeto and Michael Kajor (2002) "Small Thermoelectric Generator".

Thermoelectric generators with combustion heat sources are being developed for the U S Army, -ARDEC, by Hi-Z Technology, Inc., for battery replacement in the field and for powering lightweight portable battery chargers. These small generators range in output TACOM power from 0.3 watts to 20 watts. The main thrust of the development work is to demonstrate utilization of diesel or other military logistics fuel as the heat source. The thermoelectric generating modules being used operate at relatively low hot side temperatures and with modest power conversion efficiencies. Nevertheless, the concept shows potential advantage over batteries in watts per pound and watthours per pound, thus addressing the "battery problem" and the need for lightening the soldier's battery burden, and doing so at reasonable costs. The thermoelectric material used in this application is current state-of-the-art. However, Hi-Z is also developing advanced of the thermoelectric materials and devices that promise significantly improved performance in the near future.

[3] Pedro Carvalhae ,Flavio Jose and Andreu Cabot (2005) "Autonomous Multisensor System Powered by a Solar Thermoelectric Energy Harvester with Ultralow- Power Management Circuit"

An autonomous multisensor system powered by an energy harvester fabricated with flat-panel solar thermoelectric generator with an ultralow-power management circuit is presented. The multisensor system was tested in an agricultural application, where every 15 min the values of the temperature, air humidity, and solar radiation have to be measured and stored in a mass memory device (a Secure Digital card), with their respective time stamp. The energy-harvesting switching dc–dc converter is based on a low-input-voltage commercial integrated circuit (LTC3108), which charges a 1.65-F supercapacitor up to 5.0 V. A novel ultralow-power management circuit was developed to replace the internal power management circuitry of the LTC3108, and using this circuit, the operation of the system when no energy can be harvested from the environment is extended from 136 h to more than 266 h. The solar thermoelectric generator used for the energy harvesting is composed of a bismuth telluride thermoelectric generator with a 110-mV/°C Seebeck coefficient sandwiched between a 40 cm × 40 cm anodized aluminium flat panel and an aluminium heatsink. On a sunny winter day in the southern hemisphere (12 August 2014, at Campinas, SP—Brazil, Latitude: 22° 54'), the energy supplied by the harvesting system to the supercapacitor was 7 J.

[4] Jiabin Yan and Xiaoping Liao (2018) "MEMS-Based Thermoelectric – Photoelectric Integrated Power Generator".

This letter presents a novel MEMS-based thermoelectric– photoelectric power generator, which integrates a micro-scale thermoelectric generator (μ-TEG) and a solar cell on a single silicon chip by MEMS technology for the first time. To optimize the heat flux path of μ-TEG, one side of the thermocouple square array is on the interdigitated electrode of the solar cell and the other side is on the thick oxide passivation layer to realize thermal isolation. Moreover, the hot side and the cold side are insulated by a thick polyimide thermal insulating layer above the thermopile, and a series of square holes is created to enhance the thermal coupling between the thermopile and surrounding environment. Several common measures, like the back surface field and oxide passivation layer with limited contact openings, are adopted for the design of the solar cell. All the measuring electrodes the same side of the device for the convenience of bonding wire and package. When a sputtered Al membrane covers the front side of the device, the maximum output voltage factor and the power factor of the μ-TEG are 0.149 V·cm−2 K−1 and 3.03 × 10−3μW·cm−2 ·K−2, respectively. When the front and back sides of device receive light, the measured photoelectric conversion efficiencies are 4.45% and 0.682%, respectively.

[5] Lie Zuo, Brian Vick, Michael Heibel [2015] "Thermoelectric energy harvesting system for powering sensing nodes in nuclear power plant".

A thermoelectric energy harvester system aimed at harvesting energy for locally powering sensor nodes in nuclear power plant coolant loops has been designed, fabricated and tested. A complete modelling method that considered the impact of the heat sinks, a heat pipe and the insulating material on system performance has been proposed, and yields good accuracy in power anticipation. The effect of gamma radiation on thermoelectric harvester has been determined experimentally. The system could generate a match load voltage of 4.15V and a maximum output power of 2.25W at a temperature difference of 128.3ºC in lab-based experiments with 2 TEM of 1.1" by 1.1", which was sufficient to power all the electronics designed for this application. An optimization towards the current system was carried out based on the proposed modelling method, the maximum power is then anticipated to reach at 3.78W by integrating 6 TEMs; the maximum efficiency is anticipated to reach to 2.4% by integrating 4 TEMs.

III. MATERIAL AND METHOD

Thermoelectric generators are built of thermoelectric modules. A single module is made with a thermocouple. A single thermocouple generates a small thermoelectric force, and therefore to the formation of one module is used even hundreds of thermocouples. The module is encased ceramic layer which also acts as a housing and the insulator. Under the housing elements are arranged. The thermal energy is supplied to the heat exchanger. Then, the heat is directed to the thermoelectric modules in which a partial conversion of thermal energy into electricity. The rest of the heat is discharged to the cooler. The process of Thermoelectric begins at the start of one side of the generator heating. Absorption of a certain amount of heat causes diffusion of the mobile charge carriers along the temperature gradient. Negative particles flow to the "cold" side by an semiconductor n- type, and the particles of the positive p-type semiconductor. As a result, between the two parties to the generator potential difference is formed. Seebeck module is attached to the boiler through heat sink .when the boiler waste heat come then seeback module work is started and it can directly convert heat into electricity by seeback effect but for proper output we can use boost converter it can boost the voltage and the current stored in the battery .

IV. BLOCK DIAGRAM

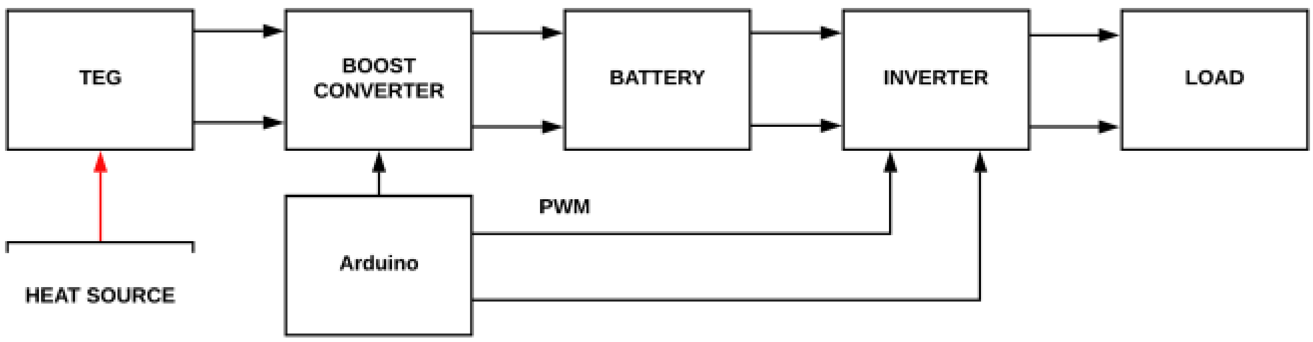

Figure 1. Block Diagram

V. EXPERIMENTAL SETUP

Figure 2. EXPERIMENTAL SETUP

VI. CONCLUSION

The limited availability of primary energy resources, increasing concern of environmental issues of emissions and the growing global demand for conserving energy continue to accelerate the search for technologies of generating electrical power. Thermoelectric power generators have now emerged as a promising alternative green technology owing to their potential to directly convert waste-heat energy into electrical power. The application of this alternative green technology in converting waste-heat energy into electrical power can improve the overall efficiencies of energy conversion systems. Currently, a large amount of waste heat is discharged from industry including power utilities and manufacturing plants. Hence most of the research activities have been directed towards the utilization of industrial waste heat. Research on thermoelectric generators might be needed to focus on finding suitable thermoelectric materials that can withstand higher temperatures of various industrial heat sources at a feasible cost with good performance.

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