Impact Factor (SJIF): 5.301

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 6, Issue 4, April-2019

Review on To utilise vehicle heat and exhaust energy

Rut Parikh[1*], Meet Patel[1*], Jaimin Prajapati[1*], Bhavik Vasava[1*], Maitreya Pandya[2#]

1* Students of Mechanical Engineering, Shroff S R Rotary Institute of Chemical Technology, Vataria (GTU, Ahmedabad, Gujarat)

2# Assistant Professor, Shroff S.R. Rotary Institute of Chemical Technology, Ankleshwar, Gujarat.

ABSTRACT: In the conventional method of generating electricity is converting thermal energy into mechanical energy then to electrical energy. In recent year, due to environmental issues like emissions, global warming, etc., are the limiting factor for the energy resources which resulting in extensive research and novel technologies were required to generate electric power. Thermoelectric power generators have emerged as a promising another green technology due to their advantages. Thermoelectric Power Generator directly converts this Thermal energy into Electrical energy. So number of moving and rotating part has been eliminated. Thermoelectric power generation offer a potential application in the direct exchange of waste-heat energy into electrical power where it is unnecessary to believe the cost of the thermal energy input. The application of that option green technology in converting waste-heat energy directly into electrical power can improve the overall efficiencies of energy conversion systems.

***Keywords*:** Thermoelectric Generator, Turbine, Heat Energy, Kinetic Energy, Generator

1. INTRODUCTION

The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors produces a voltage difference between the two substances. A Thermoelectric generator or TEG (also called a Seebeck generator) was a solid state device that converts heat (temperature differences) directly into electrical energy through a phenomenon called the Seebeck effect. Thermoelectric generators could be used to convert waste heat of automobile into additional electrical power and in automobiles as automotive thermoelectric generators (ATGs) to increase fuel efficiency. Thermoelectric power generators consist of three major components: thermoelectric materials, thermoelectric modules and thermoelectric systems that interface with the heat source. Substantial thermal energy is available from the exhaust gas in modern automotive engines.

2. NEED OF THIS SYSTEM

This system is needed to utilize the energy which leaves as exhaust energy through automobile vehicle. The studies conducted in the past reported the effect of leg length and ceramic plate materials on the performance of thermoelectric modules. The overall goal of this to develop an optimal design of automotive exhaust thermoelectric generator system

(AETEG). To utilize the kinetic energy by attaching small dynamo/generator which will convert KE to electrical energy. So we can charge the additional battery by that electric energy and will use it for charging our modems like laptop or mobile. This charged battery is also used in indicator light and horn.

3. REVIEW OF PAST EXPERIMENTS

Use of exhaust heat energy of two wheelers to generate power

In internal combustion engines the thermal efficiency is around 30 %, roughly 30% of the fuel energy was wasted as exhaust gases, and 30% in cooling water and 10% are unaccountable losses. Efforts were made for catching this 30 % energy of exhaust gases. If that waste heat energy was trapped and converted into usable energy, the overall efficiency of an engine can be improved. Thermoelectric modules which were solid state devices that are used to convert thermal energy to electrical energy from a temperature gradient and it work on principle of Seebeck effect. The process plan includes using a Thermo-Electric Generator (TEG) to produce electricity using the temperature difference between the exhaust gas temperature and air flowing over the system.

Thermoelectric Conversion of Waste Heat to Electricity in an IC Engine

Yang has discussed that the thermoelectric technology has the ability to produce tens of kilowatts by converting the exhaust heat of vehicles. Morelli studied thermoelectric technology for the automotive application needed for developing a new material with a higher figure merit. Furthermore, the design of an exhaust gas generator such as heat transfer, size, location, backpressure, and cost were investigated. His recommendation was to do more research on skutterudite compounds and a new intermetallic semiconductors. It was also expected that the thermoelectric for a power generator would become popular and competitive for next century. Rogl. G conducted a study that focused on increasing the energy cost and environmental regulation, which expresses the importance of using waste heat in automotive.

Generation of Electricity by Using Exhaust from Bike

The exhaust system was comprised mainly pipes of several different shapes, each designed to connect to one another and shaped to conform to a specific part of the underside of the car. The pipes however are usually bent to wrap around nearby components under the car. Each pipes are responsible to move the exhaust gas towards the back, but many of the sections are specialized in function such as the resonator and muffler. I.P. Kandylas and A. M. Stamelos (2009) has published their findings on the design of engine exhaust system based on heat transfer computation in which the main challenges in accurately estimating the parameters are due to complex geometry of the exhaust pipeline as well as the special flow condition. In the published paper as well they have tabulated exhaust pipe transient heat transfer model in which the model characterize the heat transfer mode in the form of rate expression and equation according to particular cases. A methodical concept development of Thermoelectric generator in which they focused on finding the best TEG architecture for vehicle application.

Engine Battery Supercharging from Exhaust Gas

S.Pratheebha has done work on usage of exhaust from any automobile engine to generate power using Thermoelectric generators [4]. She placed a turbine with generator rotor in the path of exhaust in the silencer.

The turbine is connected to a dynamo, which is used to generate power. Depending upon the airflow the turbine will rotates, and then the dynamo will also start to rotate. A dynamo

is a device which were used to convert the kinetic energy into electrical energy. The generated power was stored to the battery.

Waste heat recovery of a diesel engine using a thermoelectric generator equipped with customized thermoelectric modules

Experimentally investigated the waste heat recovery performance of a thermoelectric generator (TEG). Customized thermoelectric modules (TEMs) were installed on the upper and lower sides of a rectangular exhaust gas channel. Air at an ambient temperature of 293 K was supplied from a atmosphere and was used to create a temperature difference across each TEM [4].The diesel engine was operated under various conditions for maximizing the TEG power output observed that the power output of the TEG increases with the engine speed. The maximum power output was approximately 117W at 2000 rpm with a BMEP of 0.7 MPa; the maximum energy conversion efficiency is approximately 2.7%. The pressure drop across the TEG was experimentally found to be 0.45– 1.45 kPa under all engine operation conditions.

Multi-objective optimization of heat exchanger in an automotive exhaust thermoelectric generator

Designed a heat exchanger for an automotive exhaust thermoelectric generator. They also evaluated the thermal properties and pressure losses of a HE. The horizontal temperature difference after optimization was reduced; the average temperature was improved from 220.45 degree Celsius to 226.4 degree Celsius, whereas the longitudinal temperature difference was decreased from 29.36 degree Celsius to 27.9 degree Celsius. Moreover, the pressure drop was decreased by approximately 21%, which may be significant for them improvement of a thermoelectric generator system.

Design optimization of a thermoelectric generator

Performed investigation and design optimization of the thermoelectric generator (TEG) which wass applied for automobile exhaust waste heat recovery. Their work develops a Multiphysics thermoelectric generator model for automobile exhaust waste heat recovery, in which the exhaust heat source and water-cooling heat sink are actually modelled.

Use of exhaust heat energy of two wheelers to generate power by seebeck effect

Kranthi Kumar and Yakoob Kol ipak demonstrated a concept of generating power in a stationary single cylinder diesel engine by the usage of turbines. The turbine was connected to a dynamo, which is used to generate power, similar to the work done by Pratheebha.

Sr No.	Author	Content	Conclusion
1	John W. Fairbanks	U.S. Department of Energy commented that as low as 22% of the energy was used to actually move a car. With the introduction of thermoelectric generator, those energy lost in the form of exhaust heat can be recovered	Even modern internal combustion engines have no more than 40% of efficiency. The remaining 60% of the energy gained from the burning fuel is considered as waste energy. Half of the waste energy was transferred to the environment by the exhaust system. As exhaust gas has higher temperature than the environment the heat energy of the gas could be utilized
2	Yang and Morelli	Discussed that the thermoelectric technology have the ability of producing tens of kilowatts by converting the exhaust heat of vehicles. Morelli studied thermoelectric technology for the automotive application needed for developing a new material with a higher figure of merit. Furthermore, the design of an exhaust gas generator such as heat transfer, location, backpressure, and cost were investigated.	His recommendation was to do more research on **skutterudite** compounds and a new inermetallic semiconductors. It was also expected that the thermoelectric for a power generator would become viable and competitive for next century.
3	S.Pratheebha	Has worked on usage of automobile exhaust from any engine to generate power using thermoelectric generators. She placed a turbine in the path of exhaust in the silencer. The turbine is connected to a dynamo, which is used to generate power. Depending upon the airflow the turbine will start rotating, and then the dynamo will also start to rotate. A dynamo is a device which is used to convert the kinetic energy into electrical energy. The generated power was stored to the battery.	Using Lithium-Polymer (Li-Po) battery due to its advantages such as light in weight and requires less time to charge as compared to traditionally used Lead Acid batteries. Also a greater range of current rating can be obtained using the Li-Po battery. The battery further causes the ease in operating the vehicle as an electric bike for desirable distances

Sr No.	Author	Content	Conclusion
4	Young Kim, Assmelash A. Negash, Gyubaek Cho	Has investigated the waste heat recovery performance of a thermoelectric generator (TEG). Customized thermoelectric modules (TEMs) were installed on the upper and lower sides of a rectangular exhaust gas channel. Air at an ambient temperature of 293 K was supplied from atmosphere and was used to create a temperature difference across each TEM. The diesel engine was operated under various conditions for maximizing the TEG power output observed that the power output of the TEG increases with the engine load or speed. The maximum energy conversion efficiency was approximately 2.7%. The pressure drop across the TEG was experimentally found to be 0.45– 1.45 kPa under all engine operation conditions.	The temperature of the exhaust gases of a petrol engine is higher as compared to the diesel engines. 40 TE modules will be connected in series to form a TEG as a whole. The thermoelectric modules will be selected according to the temperature of exhaust and specifications as mentioned above. The TE modules will be mounted on the heat exchanger such as the hot plate was in contact with the hot exhaust gases and the cold plate is in contact with air.
5	C. Liu, Y.D. Deng, X.Y. Wang, X. Liu, Y.P. Wang, and C.Q. Su	Has designed a heat exchanger for an automotive exhaust thermoelectric generator. They also evaluated the thermal properties and pressure losses of a heat exchanger. The horizontal temperature difference after optimization is reduced; the average temperature is improved from 220.46 degree Celsius to 224.4 degree Celsius.	The heat exchanger will have an inlet and an exit manifold. The inlet was directly attached to the exhaust pipeline in order to prevent losses in temperature. Further the temperature difference created will develop a voltage difference between the two terminals of the TEG generating power which will be used to charge a battery.
6	Jing-Hui Meng, Xiao-Dong Wang, and Wei-Hsin Chen	Performed investigation and design optimization of the thermoelectric generator (TEG) which was applied in automobile exhaust waste heat recovery. Their work develops a multiphysics thermoelectric generator model for automobile exhaust waste heat recovery, in which the exhaust heat source and water-cooling heat sink are actually modelled.	The reduction in emissions was an important aspect with respect to environmental damage. As a whole, this project was a blend of energy conservation and security.

4. CHALLENGES

The major challenges that face the use of Thermoelectric Generator are listed below.

- To find the place to fix TEG.
- To find out the distance to place turbine for better effectiveness.

- To find out different velocity of exhaust at different speed.

5. TECHNICAL DIFFICULTIES

- To ensure that no back pressure is generated.
- To ensure that the exhaust through automobile vehicle is sufficient to run turbine.
- To select the proper material for turbine to resist corrosion of turbine blade.

6. CONCLUSION

- We predicting that utilisation of vehicle exhaust is more effective in the reduction of heat loss from the engine using TEG.
- Thermoelectric power generators have emerged as a promising another green technology due to their diverse advantages. Thermoelectric Power Generator directly converts this Thermal energy into Electrical energy.
- The efficiency of turbine is less but in optimum design best results can be achieved.

REFERENCES

1. Nicolas Bailly, Jean-Marie Dilhac, Christophe Escriba, Claude Vanhecke, Nicolas Mauran1,Marise Bafleur, Author manuscript, published in "8th International Workshop on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMS 2008), SENDAI : Japan (2008)"

2. Ganni Gowtham, Ksitij Kumar, S.S Charan, K Manivannan, International journal of mechanical engineeringand technology (ijmet) ISSN 0976 – 6340 (Print) ISSN 0976 – 6359 (Online) Volume 3, Issue 3, September - December (2012), pp. 471-482

3. Young Kim, Assmelash A. Negash, Gyubaek Cho, Waste heat recovery of a diesel engine using a thermoelectric generator equipped with customized thermoelectric modules, Engine Research Laboratory, Korea Institute of Machinery & Materials, Daejeon 34103, Republic of Korea.

4. Jing-Hui Meng, Xiao-Dong Wang, and Wei-Hsin Chen, Performance investigation and design optimization of a thermoelectric generator applied in automobile exhaust waste heat recovery, State Key Laboratory of Alternate Electrical Power System with Renewable Energy Sources, North China Electric Power University, Beijing 102206, China.

5. Natkrita Prasoetsopha, Supree Pinitsoontorn, Vittaya Amornkitbamrung, Department of Physics, Faculty of Science, Khon Kaen University, Khon Kaen 40002, Thailand
6. International Research Journal of Engineering and Technology (IRJET)

7. C. Liu, Y.D. Deng, X.Y. Wang, X. Liu, Y.P. Wang, and C.Q. Su, Multi-objective optimization of heat exchanger in an automotive exhaust thermoelectric generator, Applied Thermal Engineering 108 (2016) 916–926

8. S.Pratheebha, Engine Battery Supercharging from Exhaust Gas, International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 23492763 Issue 04, Volume 3 (April 2016)