

# Waste Heat Recovery from Chimney Using Advance Design of Chimney Structure via Thermoelectric Generator Module

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**Abstract**—The worldwide requirement of electricity is increasing day by day with increasing population. There are several methods for developing electricity. But this paper focuses on waste heat recovery. This project involves the electricity generator (Seebeck effect). Heat can be a good source to produce power. These modules are connected in series and parallel manner, which are attached at the hot junction created by the hot waste coming out of the chimney. The cold side is maintained cold with the help of water jacket around modules and fins are provided on the surface of water. To keep the water jacket, cool for long time, fins are used for proper heat transfer. Advanced design of chimney increases the waste heat temperature, which helps for more power generation. Heat is converted into electricity, which is useful for driving any electronic setup. This is the effective manner of heat generation from waste flue gasses.

**Index Terms**—waste heat recovery, design of chimney structure, thermoelectric generator

## I. INTRODUCTION

Some part of the energy generated by a conventional power station is actually lost in the form of waste heat that escapes out from the chimney. But if we could swab up the wasted heat and could convert it into usable electricity, it would make the power generation much more efficient. And this in turn, would be best for the environment. We would need to burn less fuel for specific work and less pollutant gases emission takes place. This will happen by the use of advanced Thermo electric generator modules associated with proper chimney design. As most of the heat released by chimney is utilised for heat generation, less heat is escaped to the atmosphere. Thereby, reducing global warming and avoiding release of harmful gases.

This paper deals with the study of electricity generation from thermoelectric generator module working on Seebeck effect with efficient design of chimney structure.

## II. LITERATURE REVIEW

This paper deals with the study of thermoelectric generator module working on Seebeck effect which produces electricity. It shows that the advantages over the conventional systems.

Moreover, their versatility in application of cooling and power generation also makes them considerable over electrically

powered devices. The modules discussed in the above invention are used in this research paper [1].

This research paper deals with the electricity generation from flue gases via thermoelectric generator. In our research paper we are going to generate high amount of electricity by using more efficient and method and advanced Industrial chimney design [2].

This paper deals with heat generation from exhaust gas of IC engine using thermoelectric generator module working on Seebeck effect [3].

This research paper deals with the study of waste heat recovery by using the different thermodynamics assumptions and processes [4].

The electricity generation in this paper is somehow same as our project. But the advancement in this project is the use of water jacket which increases temperature difference and hence increases power generation [5].

This paper deals the electricity generation by same module by creating turbulence also. In our paper, black coating is also provided to increase the inside temperature of waste which ultimately increases temperature difference. Hence efficiency increases [6].

This paper deals with the structure of solar chimney tower for production of electricity. Hence via this system will get heat only in summer and hence this system needs to replace to improve efficiency [7].

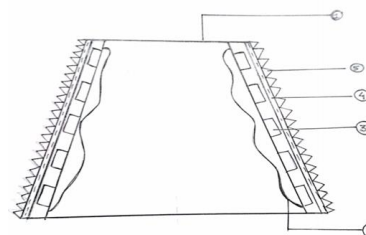


Fig. 1. Section view of chimney

**A. Part Description**

*Part 1- Chimney:* It is a device which is used to release waste heat to the surroundings. The internal valleys are provided to increase flue gas temperature.

*Part 2- Internal turbulent valleys:* It creates turbulent in flue gases and increases its temperature and pressure.

*Part 3- Thermoelectric generator module working on Seebeck effect:* It is a solid state device which converts heat flux (temperature differences) directly into electrical energy through a phenomenon called the Seebeck effect (a form of thermoelectric effect).

*Part 4- Water jacket:* It cools one side of the thermoelectric generator module (part 3) via heat transfer.

*Part 5- Fins:* It increases outer surface area of water jacket and keeps water cool. It avoids overheating of water and thereby, increasing the efficiency.

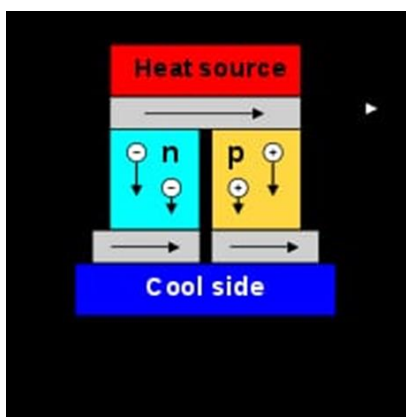


Fig. 2. Thermoelectric generator (Seebeck effect) [10]

**III. METHODOLOGY**

In Industries, where flue gases are released through chimneys, a lot of heat energy is wasted and this decreases the overall efficiency. Hence, this waste heat should be recovered in order to improve overall efficiency of the plant.

The flue gases coming out of the chimney carries large amount of heat in it. This heat can be utilized to generate electricity using thermoelectric generator module. This module works on the principle of Seebeck effect.

The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances [9].

Thus, for working of module temperature difference is must. The module works by keeping one side as a hot junction and other as cold junction. One side of modules gets heated by waste flue gases coming out of the chimney and the other side is kept cool by water jacket.

According to the surface area of the chimney, a number of modules are installed. These modules are surrounded by water jacket. Hence, constant temperature difference is maintained between the two sides of the module.

The water jacket is cooled by the phenomenon of natural convection. Radiator fins are mounted on the outer surface of the water jacket. This increases the surface area of water jacket and thereby, increases heat transfer rate. And so, the other side is kept cooled and overheating of water is avoided.

Internal valleys are provided on the inside surface of chimney. The irregular valley structure creates turbulence in the flue gases. The turbulence increases the temperature of flue gases.

Black coating is provided to the inner surface of chimney. This coating absorbs more heat from the flue gases. And hence, net heat absorption increases.

That's why the temperature difference increases from previous design of chimneys. The efficiency of module increases with increasing temperature difference. And hence, efficiency of plant increases.

The electricity generated by the modules is supplied to the voltage stabilizer. The voltage stabilizer regulates the overall voltage and supplies voltage to the charging module as shown in flow chart. Further, this voltage is supplied to the battery, as it is the store house of the energy.

The exhaust escapes through air filter to the surrounding to decrease pollution.

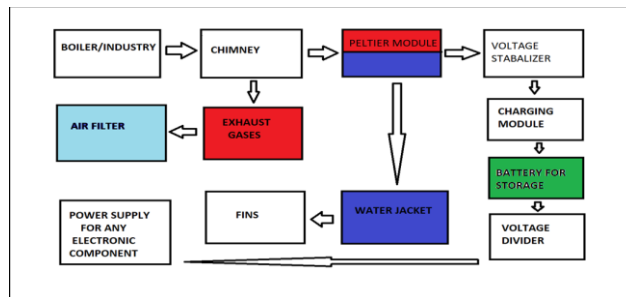


Fig. 3. Flow chart

**IV. MODULE SELECTION**

Peltier Thermoelectric Module SP1848-27145.  
 Thermoelectric Power Generator / High Temperature / SP1848-27145 Peltier Module.  
 High Temperature 150°C Peltier Thermoelectric Module SP1848-27145 40x40x3.4mm.

**V. SPECIFICATIONS**

- Color : White
- Lead Length : about 30cm
- Size : 40mm x 40mm x 3.4mm
- 80°C temperature difference : the open circuit voltage 3.6V, generated current: 558mA
- 100 °C temperature difference : open circuit voltage 4.8V, generated current: 669mA
- The above values are for reference only, the wiring in actual use, and the step-up board, there will be loss of current [8]

The temperature of flue gases coming out of chimney is 150 °C to 200 °C. The temperature of water jacket is around 50 °C. Hence we will consider net temperature difference around 100 °C to 120 °C.

#### VI. FUTURE SCOPE

Industrial thermoelectric generator – Heat fumes coming out from chimney can be converted into electricity. By using thermoelectric generator, connecting in series or parallel, we can generate the power for maximum level. Even household appliances generate the heat that can be utilized by using TEG to generate the power for charging the portable equipment like laptop, mobile etc. Automotive thermoelectric generator- Heat from car exhaust fumes can be convert into electricity. By installing TEG in the vehicle, above the radiator, the vehicle battery is charged by itself. This system requires less space. Waste heat can be recovered using of thermoelectric power generation system in a biomass gasifier.

#### VII. CONCLUSION

From the above research, waste heat is used to regain energy in form of heat and is used in electricity generation. Thus, waste heat has become the source of energy. The system is eco-friendly, as it reduces greenhouse effect, which is the main source of global warming. It is also used to reduce emission of hot air into the environment. As the waste flue gases emitted are used for power generation, the overall efficiency of system increases and hence forth this advance technology based system

is highly efficient and eco-friendly. Establishment of this system is one time investment. This system will be useful in urban and rural areas where power availability is less or totally absent. This is a promising technology for solving power crisis to an affordable extent. This nonconventional system is clean, noiseless and easy to maintain.

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