Thermoelectric Power Generation by Using Waste Heat Energy

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Abstract— Generating electricity in present is due to there is shortage of fossil fuel like oil, gas, etc. Burning of these fuels causes environmental problem like radioactive pollution, global warming, etc. There are shortage of fossil fuels hence resulting new technology is needed for electricity generation. So thermoelectric power generator is used to generate power as a most promising technology which is pollution free and having several advantages in production. Thermoelectric generator can convert directly heat energy into electrical energy. In this no moving parts are used and it eliminates pollution during power generation hence it consider as a green technology. Thermoelectric power generation offer a potential application of this green technology in converting waste heat energy directly into electric power and it improves the overall efficiencies of the energy conversion systems.

Key words: Waste Heat, Thermoelectric Power Generation, ATEG Model, Fishbone and Scattered Type Heat Exchanger

I. INTRODUCTION

Every year society spends very large amount of its energy resources and significant amount of this energy resources consist of fossil fuels which were created several years ago and are non-renewable. It has been seen that 70% of energy is get wasted to atmosphere at the time of electricity generation and transportation, this is due to the system inefficiencies. This wastage of heat can be minimised by improved system efficiencies and efficient utilization of energy resources.

Large amount of energy resources are being converted into thermal energy and after utilization remaining is rejected as a waste heat to atmosphere. Even a highly efficient combustion engine converts only one third of the energy in the fuel and remaining heat discharged as waste heat. So converting waste heat into electric power is effective for a number of primary and secondary applications. current research is focusing on a technology which is able to convert the thermal energy contained in a exhaust gas directly into electrical energy. For this exhaust of twin cylinder diesel engine is used.

II. LITERATURE REVIEW

E.F Thacher et al[1] [2007]employed a rectangular, 1018 carbon steel compact heat exchanger with offset strip fins for a 5.3 L V8 gasoline engine. With the same requirements for exhaust heat exchanger in vehicle waste heat recovery by Rankine cycle, a shell and tube counter flow heat exchanger was used with exhaust gases in tubes and working fluids in shell.

Y.Y. Hsiao, W.C. Chang et al[2] [2010] presented a mathematic model of thermoelectric module with applications on waste heat recovery from automobile engine. The commonly utilized components in a vehicle for implementing the TEGs are the radiators and the exhaust system. They attached the TEGs to the waste recovery system than to the radiators which obtains a better performance based on the simulation models and experiments.

Base I Ismail et al[3] [2014] in their work "thermoelectric power generation using waste heat energy as an alternative green technology" explained that thermoelectric power generation and applications of waste heat energy.

D.T.Kashid et al[4] [2015] in their work "Design and performance analysis of heat exchanger for thermoelectric power generation using exhaust heat energy" explained that design and performance analysis of heat exchanger and also which thermoelectric material is considered.

D.T.kashid et al [5] [2016] in their work "thermoelectric power generation using waste heat energy from internal combustion engine" explained that thermoelectric modules are used to convert thermal energy into electrical energy and it works on principle of 'seeback effect'

Pandraju Aditya sai charan et al[6] [2016] in their work "design of thermoelectric generator" explained that direct conversion of waste heat recovery into electric power as well as use of double stacked type heat sink

III. LITERATURE SUMMARY

This research works are focused on waste heat recovery into electrical power generation using thermoelectric module which works on the seeback effect. Some research works among them are focused on to increasing power generation by using different type of heat exchanger and heat sink in sandwitched structure with thermoelectric module by increasing area of contact on hot and cold side.

IV. CONSTRUCTION AND WORKING

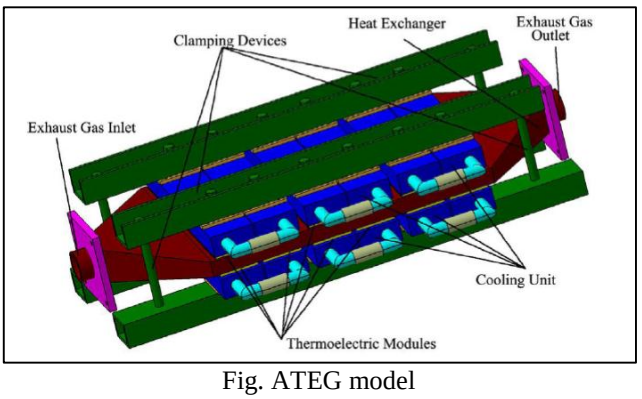

Fig. ATEG model

ATEG is consist of a thermoelectric module, a heat sink and a heat exchanger. Thermoelectric module is sandwitched between a heat exchanger and heat sink and this structure is kept by clamping device.

Heat exchanger is connected to the exhaust pipe through which hot exhaust gas is passed and heat sink is suggested to be provided for circulation of cooling water.

One surface of the thermoelectric module is in contact with the hot side heat exchanger and other is in contact with the cold side heat sink and thus potential difference is created and power is generated due to the seeback effect.

V. CASE STUDY

The objective of this paper is to reduce the waste heat from engine, to implement eco-friendly power generation method for domestic and commercial use and to improve the overall efficiency of the engine. This can be done by connecting thermoelectric generator at the exhaust of the twin cylinder engine. The efficiency of the twin cylinder engine is approximately 45% and this can be increased by connecting TEG at the exhaust of twin cylinder engine.

A. DATA AVAILABLE:

Items: Engine (gasoline)
Engine type: four stroke, two cylinder
Bore dia: 87.5 mm
Orifice dia: 26 mm
Compression ratio: 17.5:1
Fuel system: diesel
Cooling: water cooled
Engine speed: 1500 RPM

VI. DESIGN CALCULATIONS

A. Hot side heat exchanger

Module size: 30x30x3 mm
Lmod zone = wmod x Nmod,ser
= 60 mm
wmod,zone = wmod x Nmod,par
= 30 mm
Amod,zone = Lmod,zone x wmod,zone
= 1800 sq.mm
Blw = *Lmod,zone / wmod,zone*
= 2
Azone = γ x *Amod,zone*
= 7200 sq.mm
Ains = Azone - Amod,zone
= 5400 sq.mm
Lz = √ Blw x *Azone = 120* mm
Wz = √ (1/ Blw) x *Azone = 60* mm
Therefore final dimension of Hot side heat sink = 120 x 60 mm.

B. Design of fins for fishbone type heat exchanger:

Number of fins = 14
Length of fins = 25mm,
Thickness of fins = 2mm,
Height of fins = 11mm.

C. Design of Fins for Scattered Type Plate Heat Exchanger:

Number of fins = 39
Length of fins = 10mm,
Thickness of fins = 2mm,
Height of fins = 11 mm,

D. Cold side heat sink:

Number of fins (*Nf*) =11
Number of channels (*Nch*) =Nf-1 =10
Thickness of an individual fin (tf) =2mm
The length of heat sink = K × (length of hot side heat exchanger)
=1.5 × 120 = 180mm
The width of heat sink = 62mm
The length of an individual fin protrudes from its base (*Lf*)=14mm
Thickness of the base (*tb*) =5mm

E. Area Not Covered by TEG Modules = Area of insulation

= Azone - Amod,zone
= 6400 – 3200
= 3200 sq.mm

VII. ADVANTAGES

1) Clean, Noise less, Cost is less, this is a Non-conventional system, No fuel is require, easy maintenance, portable Charging time is less (maximum temp)
2) Promising technology for solving power crisis to an affordable extent. Simple in construction.
3) Pollution free, reduces transmission losses.
4) It required less space
5) It can be used at any time when it necessary.

VIII. SUMMARY

The paper introduce ATEG model for application of waste heat recovery in this fishbone and scattered type heat exchanger is used. This ATEG system is simple in construction and easy to manufacture and increases efficiency of system.

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