Design And Experimental Analysis On Gas Turbine Model (Waste Heat Recovery System)

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Abstract - The main objective of this project work i.e., design and test the WHR model is to reduce global warming, to convert waste heat to useful work or electricity with low cost. Industrial processes, such as oil refining, steel making, glass making, HCL producing plants and cement factories, big diesel generator sets are major sources of waste heat. Waste heat is recovered and converted in to steam and the steam so produced is allowed to expand in steam turbines to turn turbine and generator rotor which produces electrical energy in larger size of plants. But in smaller industries and plants this waste heat is left in to atmosphere since even if this heat is recovered, cannot produce work / electrical energy due to lack low temperature equipments available in market. This leads to increased global temperatures and demand / scares of fuels.

Turbine is a rotary mechanical device that extracts energy from a fluid flow and converting it into useful work. It is a turbo machine with at least one moving part called a rotor assembly, which is a shaft with blades attached. Moving fluid acting on the blades so that they move and impart rotational energy to the rotor. Gas, steam, and water turbines have a casing around the blades that contains and controls the working fluid. Most of the Gas and steam turbines used to produce power operates at very high temperatures, corrosive environment and built to handle very high volumes of gas or steam hence needs special materials and coating to protect the turbine rotor as well as casing, leading very high manufacturing cost ranging from millions to billions of dollars.

Low temperature waste heat produced in several processes and industries can be recovered and used for producing mechanical work (either to drive some machine or producing electricity) if we can develop turbines which can be operated in low temperature gases / air and easy to manufacture designs / low cost.

Key Words: **Waste Heat Recovery System, Gas Turbine Model, coal.**

1. INTRODUCTION

1.1 Classification of turbines

Turbines are basically classified based on two criteria. They are
i) Working fluid ii)Working action of fluid

working: Steam turbine convert a part of the energy of the steam evidenced by high temperature and pressure into mechanical power-in turn electrical power. The steam from the boiler is expanded in a nozzle, resulting in the release of a high velocity jet. This jet of steam impinges on the moving vanes or blades, placed on a rotor. The steam is condensed in a condenser.

Due to the striking of the steam with the blades they will be in motion and due to this the rotor disc which is keyed to a shaft and finally the shaft rotates. This rotary power of shaft is used in many applications.
The efficiency of a rankine cycle can be increased by employing regenerating method or reheating method

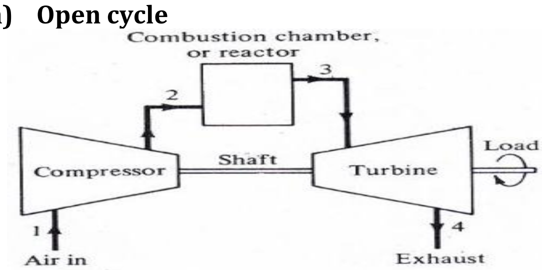
1.2 Gas Turbine

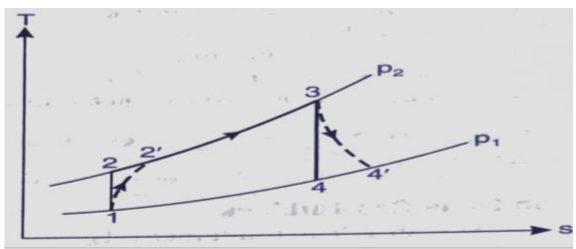
A gas turbine is a turbine that uses gas (e.g. air, nitrogen, helium, argon, etc.) as working fluid. It works on the principle of Brayton cycle.
Basically gas turbines are of two types

1) Constant pressure combustion gas turbine
   a) Open cycle
   b) Closed cycle
2) Constant volume combustion gas turbine

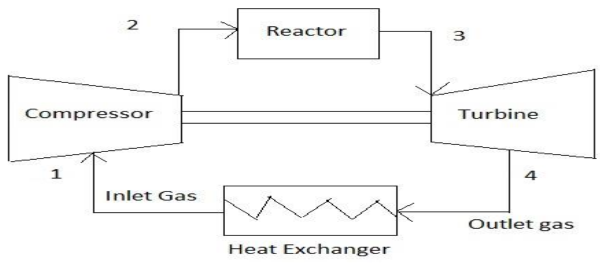
1) Constant pressure combustion gas turbine

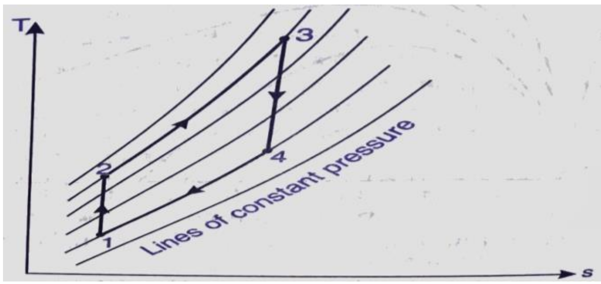
   a) Open cycle



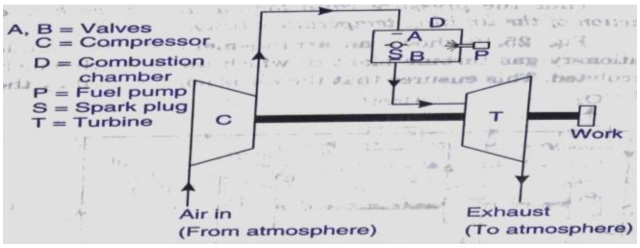


b)Closed cycle





2)Constant volume combustion gas turbine cycle

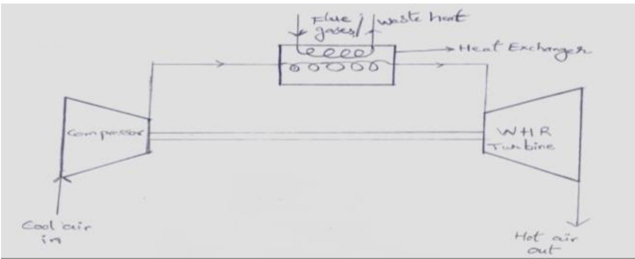


1.3 About Waste Heat Recovery Turbine

It is an impulse type hot air turbine which utilizes waste heat from industries to produce useful work or energy.

The main components of a waste heat recovery turbine are

i) Turbine
ii) Heat exchanger
iii) Compressor



Working: Initially the fresh air is drawn and compressed by means of a compressed and the compressed air is heated in the heat exchanger by means of the flue gases or the hot gases released in the industries.

Now the compressed hot air is sent to the turbine where the hot and compressed gases strike the blades and get expanded and due to the impact of the jet of compressed air the blades move and rotor rotates.

If a generator is coupled with the shaft then power can be produced.

2. Design of the turbine model

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Fig1

fig2

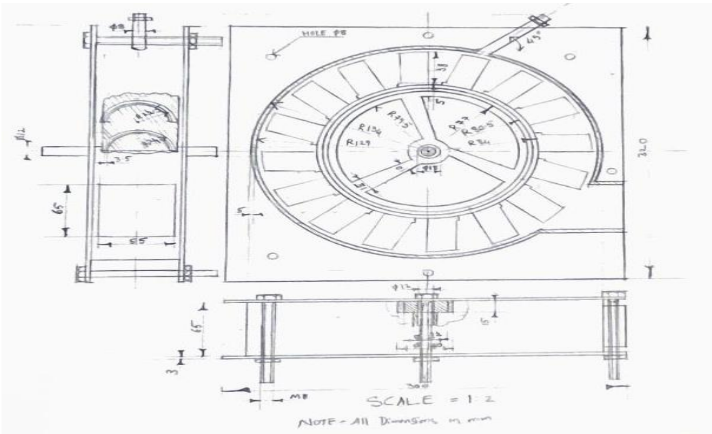


Fig .3

Fig. 1 Turbine
Fig .2 Heat exchanger
Fig .3 Compressor

3. Testing of the turbine model

The compressor is connected to the heat exchanger and the heat exchanger is connected to the nozzle of the turbine

testing setup for the turbine. For demonstration purpose the compressed air is heated using the coal but for practical application the compressed air is heated using the flue/ waste gases.

The turbine is tested for its performance at a pressure of 6 bar pressure.

Input to the turbine

The input given to the turbine is pneumatic energy and heat energy.

Total input of the turbine = pneumatic energy +heat energy=776.7W

Output From The Turbine

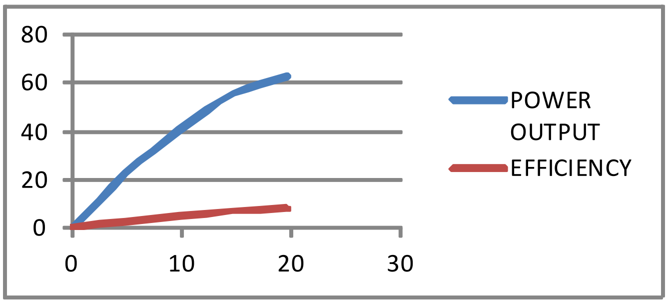
The output from the turbine is the rotary motion of the shaft. The output from the shaft can be obtained by applying loads on the pulley. The results obtained are tabulated as shown in table 1

S No .	Mass (m) kg	Load (N)	Speed (N) rpm	Torque (T) N-m	Power (P) Watts	Efficien cy (%) ɳ
1.	0	0	1600	0	0	0
2.	0.5	4.903	1468	0.147	22.59	2.908
3.	1	9.806	1316	0.294	40.51	5.215
4.	1.5	14.709	1206	0.441	55.69	7.170
5	2	19.613	1016	0.588	62.55	8.053

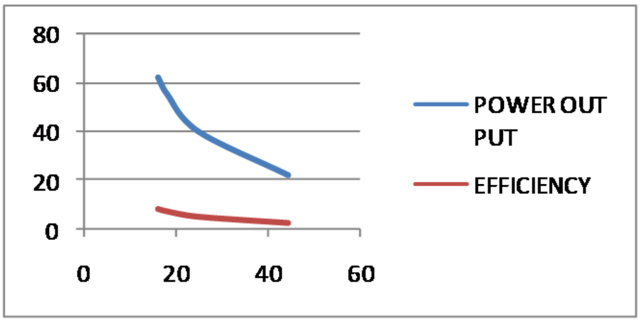
Table 1

3.1. Result Analysis

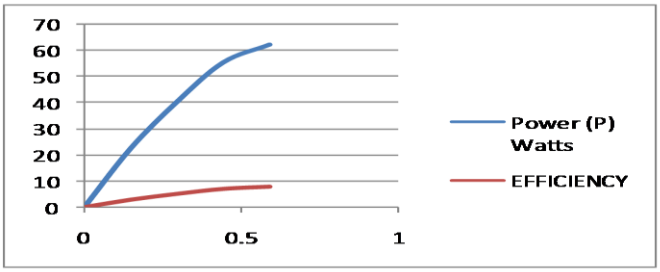
Load Vs Power Output Vs Efficiency



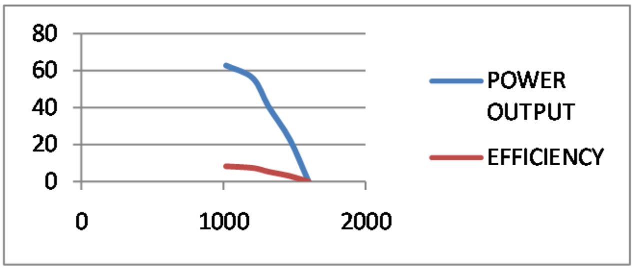
Specific Fuel Consumption Vs Power Out Put Vs Efficiency



Torque Vs Power Output Vs Efficiency



Speed Vs Power Output Vs Efficiency0



4. CONCLUSIONS

After the completion of project, I came to know how difficult is to design a real life turbine. Now-a-days, we can observe that there is a large shortage of power and in future still the power shortage increases which results in the exploitation of the non renewable resources and finally they deplete in a short span of time. So if we use WHR turbine, we can utilize the waste heat and produce power to compensate the peak loads, so that the load on the power plants using non renewable resources gets reduced up to some extent thereby causing less exploitation of the non renewable sources.

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