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Power Generation from Exhaust Flue Gas in Thermal Power Plant

S.Saranraj[1], R.Naveenvignesh[2], S.Bruntha[3], P.Praveenkumar[4], S.E.Murthy[5]

U.G. Student, Department of EEE, Knowledge Institute of Technology, Kakapalayam, Tamil Nadu, India [1, 2, 3, 4]

Assistant Professor, Department of EEE, Knowledge Institute of Technology, Kakapalayam, Tamil Nadu, India [5]

ABSTRACT: Electricity is one of the greatest demands for all countries nowadays. Many new methods are growing since the available resources are exhausting at a faster rate. The main objective of this project is to generate electricity from industrial exhaust gas using a turbocharger. Flue gases are emitted at larger quantities to the atmosphere hence these gases are used to generate electricity. In this project a turbine is placed in the path of flue gas which comes from chimney and this turbine is coupled with an alternator to generate power.

KEYWORDS: Power Generation, Flue Gas, Turbo Charger, Exhaust Gases

I. INTRODUCTION

Electricity has become one of the most important and inevitable need of mankind. So in order to meet out the demand various methods of generation of power has been under research. The main theme of this project is to generate electricity from exhaust gas by using turbocharger. Flue gas is the major component emitted from most of the power plants in large quantities this is used to generate electricity. A gas turbine is placed in the path of flue gas. The turbine is connected to an alternator, to generate power. Based on the rate of flow of flue gas the turbine rotates and consequently power gets generated in alternator. Since all the power plants are aiming at the 100% utilization of raw materials this method enables them to meet out their aim. As per today's scenario, we have so many industries in the world which emit most harmful gases into the atmosphere. C.Nagarajan et al [3,6] proposed a solution to reuse these gases. The gases emitted from industries are unstable and these gases no more can be converted into stable. But these can be converted into their respective ions. These ions most likely are negative ones. Due to huge amount of heat evolved in this process these negative ions have more affinity towards electrons. If we are able to satisfy the need of these ions then there will be an avalanche of electrons and the electricity gets generated.

II. SURVEY

In India, we have 267 thermal power plants out of this 167 power plants use coal as their raw material. The total generation out of these 267 power plants is about 222906.58 MW. 71% of India's total power generation comes only from these thermal power plants. Many of India's coal-based power plants are way below global standards in terms of efficiency and several among them violate air pollution norms and are struggling to dispose fly ash generated by them, a study by a leading NGO working in the environment sector has claimed. Centre for Science and Environment (CSE), in its two-year long study 'Heat in Power', analysed and rated 47 coal-based thermal power plants on nearly 60 environmental and energy parameters and found that the sectors .The study claimed the average efficiency of the plants, it assessed, was 32.8 per cent, one of the lowest among major coal -based power producing countries.

In these power plants the flue gases are emitted to atmosphere via chimneys. These chimneys have height of about 250 feet. The temperature of flue gas in the chimney is around 140ºC-150ºC. This temperature should be maintained in order to avoid the adverse effects of formation of acids and bases inside the chimneys which causes cracks on the surface of chimneys. The flow rate of flue gas in chimney is about 400-470m³/sec. The flue gas consists of 77% Nitrogen, 14% Carbon dioxide, 6% Water and rest compounds of Sulphur.

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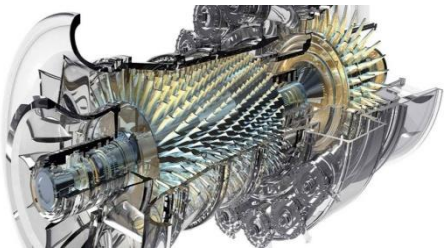
III. MAIN COMPONENTS

A)Turbo Charger:

Turbocharger is a turbine-driven forced induction device. It is used to increase the internal combustion engine's the volumetric efficiency and power output by forcing extra compressed air into the combustion chamber. Turbocharger generally boosts up the velocity of the gases. The turbocharger consists of two sections mainly turbine and compressor. It is more efficient whereas the response is very low.

B)Gas Turbine:



A gas turbine is a Brayton cycle which uses air as its working fuel.Gas turbine uses burning fuel in the combustion chamber. A gas turbine is a combustion engine that is used to extract mechanical energy from natural or available gas, this energy is allowed to flow through a generator which will produce electrical energy. The atmospheric air with high pressure enters the turbine this expands the exhaust gases.

C)PIC Microcontroller 16F877A:

16f877a is one of the picmicro family microcontrollers. It uses a flash memory technology so it can be write and erase easily.It has large programming memory. It has 368 bytes of RAM. It has 256 bytes of EEPROM data memory and also it is self-programming. Its operating voltage is 4.0-5.5v, operating speed is 20MHZ.

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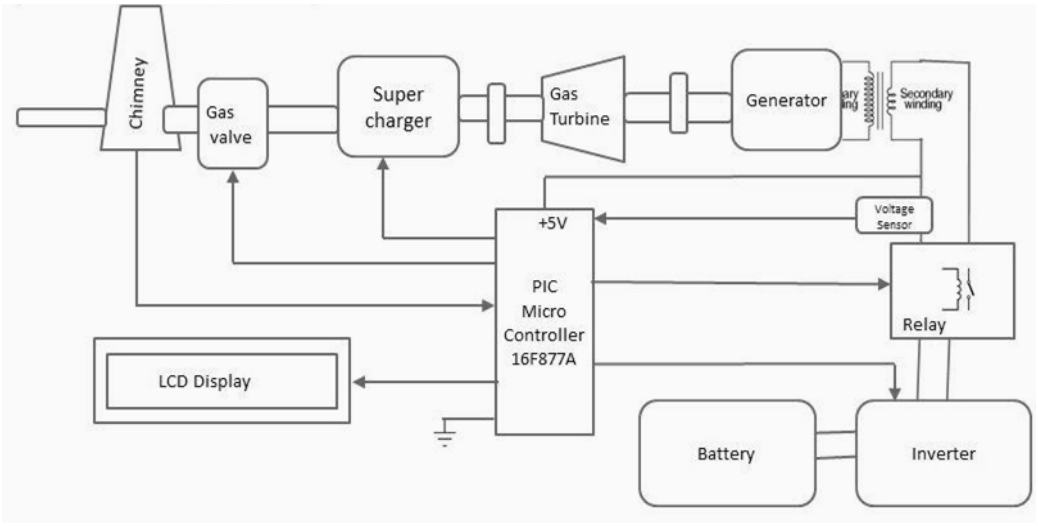
D) Alternator:

An alternator is generally used to convert mechanical energy to electrical energy.An alternator uses the permanent magnet for its magnetic field which is called as magneto. This uses the principle of faradays law. The magnetic field produces the electromotive force(EMF). This reverses the polarity of the conductors.

E) Battery:

A battery is an electrochemical cell that can be charged electrically. The battery generally consists of anode, cathode and an electrolyte.Here we use lithium-iron battery for the storage purpose. It is of huge size fitted to a room. There are large number of rooms allocated for the battery, which is protected individually from over voltages.

IV. BLOCK DIAGRAM



The exhaust gas from the chimney is allowed to pass through the super charger or turbocharger in order to increase the velocity of the flue gas. After increasing the velocity it is allowed to flow through the gas turbine to maintain the velocity in the required rate. Then the gas passes through the generator which will generate electric energy which is stored in the battery which can be used when it is needed. The LCD display is used for the monitoring purposes. The microcontroller is used for controlling the storage of energy in the battery with the help of the relay.

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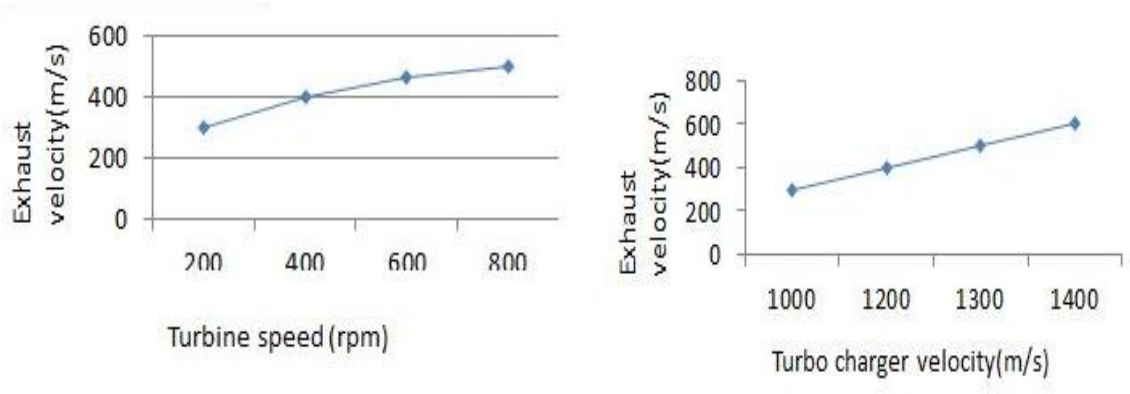
V. WORKING

The gas is released in the atmosphere through the chimney is first treated with some filters to reduce the harmful substance in the gas. The treatment involved is that ESP which is abbreviated "Electrostatic Precipitator". This is a non-invasive kind of treatment. Other such treatments are WESP, baghouse and many other filters are also available. The heat of the gas must be maintained at a temperature of 156°c and higher, otherwise the gas would be converted into liquid form which will react with the sulphur present in it and a harmful substance will be formed such as sulphur oxide.so the temperature must be maintained at the specified rate. If it is reduced then the gas valve is used to stop the flow of gas through the turbine. The flow rate must be in the specified range that is around 460(m^3)/sec to 600(m^3)/sec. If it exceeds this limit then the gas will be cut off to flow through the turbine with the help of the microcontroller. The microcontroller used in this system is 16F87A.This is a 40 pin PIC microcontroller. It can operate up-to 20MHZ frequency. The operating voltage is between 4.2v to 5.5v more than this voltage is given then it will get damaged.

The turbocharger is mainly used to increase the velocity of the gas coming from the chimney, also the temperature gets increased. The turbocharger controls the speed of the air flowing from the chimney. The temperature will be sensed by using a temperature sensor and if it is not in the specified rate then the controller controls the gas without allowing it to flow through the turbocharger. The gas after passing through the turbocharger then it is allowed to pass through the gas turbine. The controller will control the gas passage if it is less than 160°C. The same microcontroller is used to control the passage of the gases. Then the generator produces the electric energy which is stepped down with the help of a step down transformer. After that the voltage sensor sense the voltage from the generator and the information is send to the relay which is used to protect the battery without getting damaged by cutting off the supply. An inverter is used to convert AC to DC for the storage purposes. This is stored in the battery. The LCD display is used to display the temperature level, flow rate, voltage level, energy stored in the battery. These LCD display is used for monitoring purposes.

VI. RESULT AND DISCUSSION



The first graph is drawn between exhaust velocity (m/s) and turbine speed (rpm). The gas which is exhausted from the chimney is of low velocity (200m/s). This velocity is not sufficient to run then turbine. Here we need to increase the flue gas velocity.The exhaust flue gas is directly sent to the turbo charger. According to this investigation area of flue gas passage duct is 160*130cm which is taken as exit area of nozzle which is 10*6cm. Thus the convergent nozzle of the turbo charger is analysed by using ANSYS 15.1 software, the result of this analysis is shown above. The second graph is drawn between Exhaust velocity (m/s) and turbo charger velocity (m/s).After passing through the turbocharger the velocity of the flue gas is doubled from its normal velocity.

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VII. CONCLUSION

In this project we are reutilizing the waste flue gas with presence of thermal energy(heat) into direct generation of electric energy by placing turbocharger in before the flue gas heat energy are exhaust to the atmosphere. The proposed design of a power plant layout has design and analysed for generation of about 12.5MW of electric power from recovery of waste exhaust gas. There is also provision made to meet cement factory need of 15MW i.e., for extra 2.5MW.

VIII. FUTURE SCOPE

The future scope of this project is connecting turbocharger with chimney of the industry. Thus the 100% coal energy is converted as electric energy.

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