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Hardware Implementation of Steam Power Plant

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Abstract: There is a silent revolution throughout the world in energy sector. There is a trend towards decentralized and distributed generation of renewable energy. The steam power plants are highly capital intensive and suitable for generation of electricity. The work of establishing the steam power plant is really revolutionary and it will create history of total change of transforming highly centralized capitalist tool beneficial to the entire world. Steam power plant consists of Boiler, Turbine and generator which can be used for electrification of village and community. Steam power can be used directly exhaust steam of the steam turbine can be used for heating in the process. So steam power plants give double benefits. The steam power plant is using steam as working fluid. Steam is produced in a boiler using LPG as fuel and is used to drive the prime motor, namely, the steam turbine. In the steam turbine, heat energy is converted into mechanical energy which is used for generating electric power. Generator is an electro-magnetic device which makes the power available in the form of electrical energy. The temperature, pressure and output voltage are monitored by using lab view software programming, and the controlling can be done by DAQ cord. The parameters interface with the Data acquisition card MCC DAQ for monitoring purpose by means of graphical programming. The resulting models allow the implementation of various system of plant configuration.

Keywords: Generation, Boiler, Turbine, DC motor.

I. INTRODUCTION

Electricity is modern society's most convenient and useful form of energy. Without it, the present social infrastructure would not be feasible. The Energy in the form of electricity is most desirable as it is easy to transport, and can be easily converted to heat or work as per requirement Power is generated in various methods from various resources. Out of all Thermal, Hydro and Nuclear Power generation have gained importance for their availability in abundance &easy existence of their resources. 65% of the total installed capacity is steam Plants.

The main objective is to design a steam power plant. The temperature, pressure and output voltage are monitored by using Lab View Software Programming. The parameters interface with the Data Acquisition Card MCC DAQ for monitoring purpose by means of graphical programming.

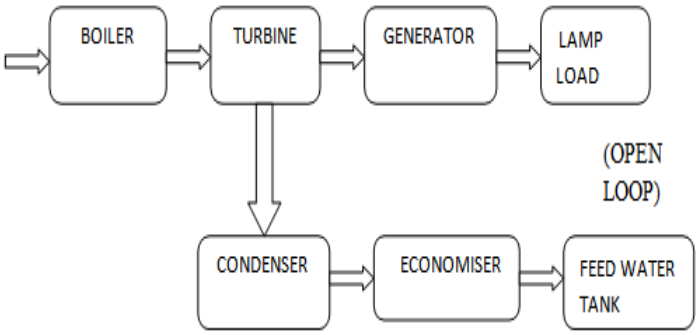

Fig 1: Block diagram of the Steam Power Plant

Fig 1 shows the Block diagram of the Steam Power Plant. The input given to the system is fuel. LPG is used as fuel. The fuel is given to the vessel so that the chemical energy is converted into heat energy. This heat energy is converted into mechanical energy with the help of rotating blades of the turbine. Generator converts mechanical energy into electrical energy and it is given to the load. The remaining heat is dissipated through the condenser and is given to the economizer. The heat is further cooled by using Feed Water Tank. Through the analysis of real time monitoring and control, we obtained the useful information concerning plant management from both technical and economical point of view. This is really practicable and achievable further the plant parameters can also be controlled by Aurdino Servo Motor.

II.THEORY OF OPERATION

Generation:

The process of power generation in a steam power plant consists of two main systems. They are:

- Steam Generation and Utilization
- Condensate System

The main fuel used in the steam power plant is LPG. The available chemical energy that is in the form of gas is converted into thermal energy by combustion and heat energy is used to converted water into steam. This action takes place in boiler also called as steam generator. The steam energy is converted into mechanical energy in the turbine, which drives the rotor of the alternator, where the mechanical energy is converted into electrical energy.

The steam energy generator or boiler is a two pass tower type, reheat natural circulation single drum, balance draft designed for the chemical energy of LPG is transferred into thermal energy by burning it. The resulting heat produced is used to boil water and steam thus generated is used to rotate turbines, thus converting it to mechanical energy. The shaft connected to turbine is coupled with rotor shaft of generator and it is rotated with a constant speed of 3200 rpm. Thus electrical power is generated which is distributed via transmission lines.

Energy Conversion

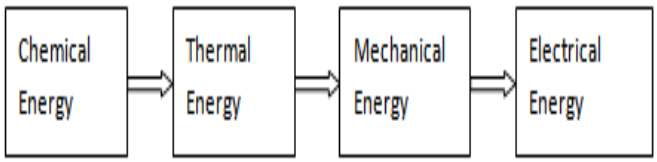

Fig 2: Block diagram of the energy conversion

Power generation procedure:

The steam energy generator or boiler is a two pass tower type, reheat natural circulation single drum, balance draft designed for burning of LPG as principle fuel. The complete furnace section is of welded membrane wall type arranged as gas and pressure tight envelope. The walls of the furnace are made up of water tubes. These are connected to headers and feed water is circulated through them. While water passes the tubes, heat is absorbed from the furnace by radiation. The water in tubes gets converted into steam.The steam and water mixer flows into the drum and steam is separated in the drum. This steam is called saturated steam. The saturated steam to increase the heat energy supplied to the steam turbine.

II. DESIGN OF THE PLANT

Steam turbine:

The steam energy is converted mechanical work by expansion through the turbine. The expansion takes place through a series of fixed blades (nozzles) and moving blades each row of fixed blades and moving blades is called a stage. The moving blades rotate on the central turbine rotor and the fixed blades are concentrically arranged within the circular turbine casing which is substantially designed to withstand the steam pressure.On large output turbines the duty too large for one turbine and a number of turbine casing/rotor units are combined to achieve the duty. These are generally arranged on a common centre line (tandem mounted) but parallel systems can be used called cross compound systems **.**

Fig 3: Impulse turbine

Design calculation:
Radius of the central core: 20mm
Length of the Blades: 20mm
Width of the Blades: 8mm
Spacing between the two blades: S = 2* pi * r / n
r – Radius of the central core = 20mm
n – Number of the blades = 12
s = 10mm
Circumference of the turbine casing: 360mm

Shaft:
Length of the Shaft: 200mm
Diameter of the Shaft: 8mm

Furnace:
Burners are set at each corner and are directed to strike an imaginary circle at the centre of the furnace. This is called tangential firing.

Condenser:
Steam boiler has main function to convert water to high quality steam. The steam is then supplied into turbine generator. Before supplied into turbine generator, steam should apply the requirement for both pressure and temperature. Condenser is used in power plant to make back pressure and temperature of steam from turbine generator is lower and then converts steam into condensate.

Economizer:
Economizer is the part of the boiler. It consists of a number of pipes through which water from the HPH'S are circulated. This water gains temperature from the flue gases escaping out of the boiler .Therefore, medium of heating here is flue gas.

Feed water system:
The energy streams entering and leaving the Feed Water System are as follows,
The mass of the water flow and the steam flow must be regulated so mass water flow equals the mass steam flow to maintain drum level. The feed water control regulates the mass water flow to the boiler. The effects of the input control actions interact, since firing rate also affects steam temperature and feed water flow affects the steam pressure, which is the final arbiter of firing rate demand. The overall system must be applied and coordinated in a manner to minimize the effects of these interactions. The inter actions can be greatly affected by the control system design. If the boiler operates under varying steam pressure, the calibration of the liquid level will also vary with steam density.

DC motor:
The DC motor can be used as generator; the turbine shaft is coupled to the DC motor shaft. As the turbine rotates to its specified speed, Stationary permanent magnets form the stator field, produces torque, that any current-carrying conductor placed within an external magnetic field experiences a mechanical force. In a motor, the magnitude of this force, thus the output torque, is a function for rotor angle. When current moves through a conductor a circular magnetic field is induced around the conductor. The Motor (armature) rotation is caused by the simultaneous attraction and repulsion between the electromagnetic field in armature and a fixed magnetic field. The magnetic field surrounding a current carrying conductor interacts with an existing magnetic field which determines the direction of DC current carrying conductor in a fixed magnetic field. Thus the motor gives an output of around 10V DC and output current capacity of 2-3 Amps. This output is connected to load.

Coupler:
A coupler is a device used to connect two shafts together at their ends for the purpose of transmitting power. Couplings do not normally allow disconnection of shafts during operation. However, there are torques's limiting couplings which can slip or disconnect when some torque limit is exceeded. The primary purpose of couplings is to join two pieces of rotating equipment while permitting some degree of misalignment or end movement or both. To provide for the connection of shafts of units that is manufactured separately such as motor and generator and to provide for disconnection of repairs.

Power plant boiler:

A boiler or steam generator is a closed vessel which generates steam by heating water. The boiler or steam generating unit is defined "As a combination of apparatus for producing, furnishing or recovering heat together with the apparatus for transferring the heat so made available to the field being heated and vaporized". Boiler is the most important and crucial component in a power plant.

Water tube boiler:

In water tube boilers, water circulates through the tubes and hot products of combustion flow over these tubes Water tube boilers require less weight of metal for a given size, are less liable to explosion, produce higher pressure, are accessible and can respond quickly to change in steam demand. Tubes and drums of water tube boilers are smaller than that of fire tube boilers and due to smaller size of drum higher pressure can be used easily. Water tube boilers require lesser floor space. The efficiency of water tube boilers is more.
For that reason we prefer low pressure boiler, the steam is up to 15kg/cm2, exactly water tube boiler is choose for our steam power plant operation.

Fig 4: Water Tube Boiler

Measurements:

The various parameters, which are measured in the steam plant as per our requirement and safety purpose, are as follows:

Measurement of Temperature: 0 – 110 deg C.
Measurement of Pressure: 4 – 6 psi
Measurement of RPM: 3000 rpm
Measurement of output voltage: 0 – 12 V DC

IV. IMPLEMENTATION AND RESULT OF THE PLANT:

Design of the Steam Power Plant is completed. The output voltage is obtained using steam as input. The parameters such as Pressure, temperature and Output voltage of the plant are monitored using lab view software programming. The output is represented graphically and numerically in the front panel of the software. The results obtained are as shown below.

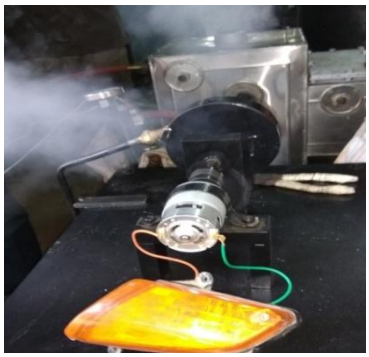

Fig 5: Load connected to the plant

Table1: Test Results

Sl. No	Temperature (deg C)	Pressure (psi)	Output Voltage (V)
1	98	0	0
2	100	1	4
3	104	4	7
4	108	6	9
5	112	9	11

V. CONCLUSION

In power plant monitoring of temperature , pressure and output voltage was tested, this monitoring are done through MCC DAQ 1208FS Multifunction card, with single ended mode and differential ended mode connection. This gives an excellent results ranging from low to high temperature and pressure through VI software. Designing of steam power plant using close loop, improves the efficiency and reduces the loses. Speed monitoring can also be done by using lab view software. It is also helpful in the field of MEMS (Micro Electronic Mechanical Systems) applications.

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