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Performance Analysis and Efficiency Improvement in 210 MW LMW Turbines at METTUR Thermal Power Station

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Abstract: The performance of the turbine running to generate power desired to give an output of work done by the turbine to the heat supplied to the turbine. The efficiency of the turbine was decreased due to the drawbacks in the process cycle. The performance of the turbine and the component of thermal power plant is going to be studied and analyzed. The main parameters of the turbine are going to be calculated and the losses impact in the turbine was found. The Designed values are compared with the actual values and the initial conditions were suggested to increase the efficiency of the turbine. By calculating the enthalpy of steam flow rate at the inlet and outlet of every component, the solutions for increasing the efficiency such as increasing the steam flow temperature and pressure, by increasing the vacuum in the condenser is considered. This project discusses how to overcome these difficulties and to improve the efficiency of the turbine by determining some suggestions to generate more power and also to implement the resultant factors.
Keywords: Turbine, condenser, thermal power plant, efficiency improvement

I. INTRODUCTION

At present 54.09% or 93918.38 MW of total electricity production in India is from Coal Based Thermal Power Station. A coal based thermal power plant converts the chemical energy of the coal into electrical energy. This is achieved by raising the steam in the boilers, expanding it through the turbine and coupling the turbines to the generators which converts mechanical energy into electrical energy. In this project, the minimal losses are found which affects the performance of the turbine and in turn decrease the power production in 210 MW LMW Turbine at Mettur Thermal Power station. This project discusses about, how to overcome this difficulty and to improve the efficiency of the turbine and also to implement the resultant factors. The working parameters of the components in thermal cycle are collected and the actual efficiency of the turbine was calculated. By these calculations, the characteristics of improving the efficiency of the turbine were discussed.

II. PROCESS CYCLE

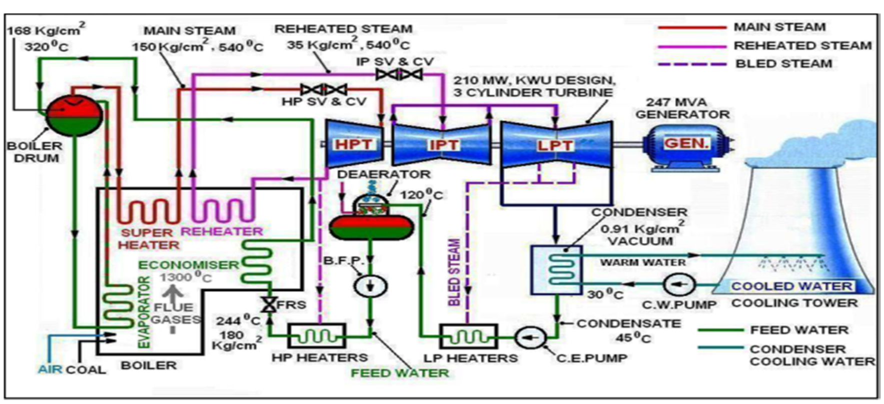

Fig 1.1 flow cycle

III. WORKING PRINCIPLE

Coal based thermal power plant works on the principle of Modified Rankine Cycle. A Rankine cycle describes a model of the operation of steam heat engines most commonly found in power generation plants. Common heat sources for power plants using the Rankin cycle are coal, natural gas, oil, and nuclear. The Rankine cycle is sometimes referred to as a practical Carnot cycle as, when an efficient turbine is used, the TS diagram will begin to resemble the Carnot cycle. The main difference is that a pump is used to pressurize liquid instead of gas. This requires about 1/100th (1%) as much energy [*citation needed*] than that compressing a gas in a compressor (as in the Carnot cycle).The efficiency of a Rankine cycle is usually limited by the working fluid.

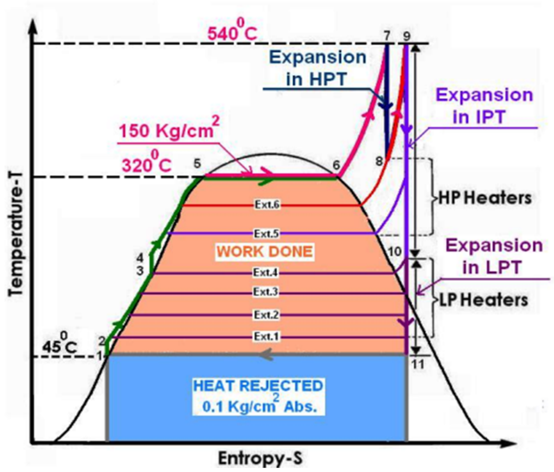

Fig 1.2 T-S diagram

Without the pressure going super critical the temperature range the cycle can operate over is quite small, turbine entry temperatures are typically 565°C (the creep limit of stainless steel) and condenser temperatures are around 30°C. This gives a theoretical Carnot efficiency of around 63% compared with an actual efficiency of 42% for a modern coal-fired power station.

IV. COMPONENTS

A. *Fuel preparation system*

In coal-fired power stations, the raw feed coal from the coal storage area is first crushed into small pieces and then conveyed to the coal feed hoppers at the boilers. The coal is next pulverized into a very fine powder, so that coal will undergo complete combustion during combustion process. **Pulverizer** is a mechanical device for the grinding of many different types of materials. For example, they are used to pulverize coal for combustion in the steam-generating furnaces of fossil fuel power plants.

B. *Boiler and auxiliaries*

A Boiler or steam generator essentially is a container into which water can be fed and steam can be taken out at desired pressure, temperature and flow. This calls for application of heat on the container. For that the boiler should have a facility to burn a fuel and release the heat. **Economizer** It is located below the LPSH in the boiler and above pre heater. It is there to improve the efficiency of boiler by extracting heat from flue gases to heat water and send it to boiler drum.

C. *Air Preheater*

The heat carried out with the flue gases coming out of economizer are further utilized for preheating the air before supplying to the combustion chamber. It is a necessary equipment for supply of hot air for drying the coal in pulverized fuel systems to facilitate grinding and satisfactory combustion of fuel in the furnace.

D. Reheater

Power plant furnaces may have a reheater section containing tubes heated by hot flue gases outside the tubes. Exhaust steam from the high pressure turbine is rerouted to go inside the reheater tubes to pick up more energy to go drive intermediate or lower pressure turbine.

E. Steam turbines

Steam turbines have been used predominantly as prime mover in all thermal power stations. The turbine generator consists of a series of steam turbines interconnected to each other and a generator on a common shaft.

F. Condenser

The condenser condenses the steam from the exhaust of the turbine into liquid to allow it to be pumped. If the condenser can be made cooler, the pressure of the exhaust steam is reduced and efficiency of the cycle increases.

G. Boiler feed pump

Boiler feed pump is a multi-stage pump provided for pumping feed water to economizer. BFP is the biggest auxiliary equipment after Boiler and Turbine. It consumes about 4 to 5 % of total electricity generation.

H. Cooling tower

The cooling tower is a semi-enclosed device for evaporative cooling of water by contact with air. The hot water coming out from the condenser is fed to the tower on the top and allowed to tickle in form of thin sheets or drops. The air flows from bottom of the tower or perpendicular to the direction of water flow and then exhausts to the atmosphere after effective cooling.

I. Fan or draught system

In a boiler it is essential to supply a controlled amount of air to the furnace for effective combustion of fuel and to evacuate hot gases formed in the furnace through the various heat transfer area of the boiler. This can be done by using a chimney or mechanical device such as fans which acts as pump.

J. Ash handling system

The disposal of ash from a large capacity power station is of same importance as ash is produced in large quantities. Ash handling is a major problem.

K. Generator

Generator or Alternator is the electrical end of a turbo-generator set. It is generally known as the piece of equipment that converts the mechanical energy of turbine into electricity. The generation of electricity is based on the principle of electromagnetic induction.

V. DESIGN OF TURBINE

LMW – LENINGRAD MACHINE WORKS is the design of the turbine used in Mettur Thermal Power Station.LMW was a RUSSIAN DESIGN.RANKINE CYCLE describes the operation of steam heat engines in Thermal Power Plants.

VI. OPERATION

The principle of operation of steam turbine is entirely different from the steam engine. In reciprocating steam engine, the pressure energy of steam is used to overcome external resistance and the dynamic action of steam is negligibly small. But the steam turbine depends completely upon the dynamic action of the steam. According to Newton's Second Law of Motion, the force is proportional to the rate of change of momentum (mass × velocity). If the rate of change of momentum is caused in the steam by allowing a high velocity jet of steam to pass over curved blade, the steam will impart a force to the blade. If the blade is free, it will move off (rotate) in the direction of force. In other words, the motive power in a steam turbine is obtained by the rate of change in moment of momentum of a high velocity jet of steam impinging on a curved blade which is free to rotate. The steam from the boiler is expanded in a passage or nozzle where due to fall in pressure of steam, thermal energy of steam is converted into kinetic energy of steam. Attached on a rotor which is mounted on a shaft supported on bearings, and here steam undergoes a change in direction of motion due to curvature of blades which gives rise to a change in momentum and therefore a force. This constitutes the driving force of the turbine. It should be realized that the blade obtains no motive force from the static pressure of the steam or from any impact of the jet, because the blade in designed such that the steam jet will glide on and off the blade without any tendency to strike it.

VII. CALCULATION

Cycle efficiency = work done/ Heat input **Turbine cycle efficiency =** Work done by turbine/ Heat input to turbine.

= 761878.4558 / 1838225.303 *100

= 41.44 **%**

VIII. RESULT AND ANALYSIS

By using our project the maximum power should be produced and then the efficiency of the turbine should be increased. The above calculation should be obtained by our project in the thermal power station, mettur. So, this power production and the efficiency of the turbine should be obtained and produced by using our project in an efficient manner.

IX. CONCLUSION

This project should be having high efficiency and then this should be also increased the condenser, boilers, turbines efficiency in a great manner.so, our project should be mostly used for reproducing the power and obtaining the power from the same source of thermal power plant. Let's we concluded that our project should having the efficiency to produce the large potential of energy from the output of the turbine.