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Study and Analysis of Efficiency of 510 MW Thermal Power Plant

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Abstract: ***The shortage of coal resources is becoming increasingly serious. A thermal power plant has been widely used for the production of electricity in India. To make electricity production cost-effectively, an efficient method used in thermal power plants has been analyzed in this study. The simulation work for the system performance using the internal energy is analyzed. Results show that the performance of the system where the majority of energy is internal gives an efficient performance and an optimal intermediate temperature (343°c) of preheated steam before reaching the boiler has been achieved which results in minimum coal consumption. Multiple re-heaters are used between turbine and economizer to reheat the used steam and the extraction of steam used for reheating is done from the steam used in the turbine and no external source is used in this reheating process. And for the operation of the pump energy is produced using the extracted steam from turbines and no external electricity Is used there which is also a bigger reason for the greater efficiency in this thermal power plant.***
Index Terms: Rankine cycle, Turbines, Efficiency, Thermal power plant.

I. INTRODUCTION

With continuous industrial progress, NON-RENEWABLE RESOURCES LIKE COAL is gradually becoming scarce. To prevent these resources from getting extinct we can at least reduce their use. In this study,
We have analyzed the production cycle of a thermal power plant so we can know what measures are being taken to reduce coal use and make production more efficient.

II. PLANT INTRODUCTION

The power plant has a total installed power capacity of 510 MW. The powerhouse consists of three steam turbine units. The schematic diagram of one 525MW unit is shown in Fig.1 This unit employs reheating and regenerative feed water heating system. Feed water heating is carried out in two stages of high-pressure heaters (HPH-6, HPH-5) and three stages of low-pressure heaters (LPH-3, LPH-2, LPH-1) along with one deareating heat exchanger. Steam is superheated to 180 bar and 543 degrees Celsius in the steam generator and fed to the high-pressure turbine. The high-pressure turbine exhaust then goes to the re-heater where steam is reheated to 543 degrees Celsius and enters to intermediate pressure turbine. Low-pressure turbine exhaust is sent to the condenser. Condensate collected in the hot well is extracted and pumped by condensate extraction pumps (CEP) to the low-pressure heaters. Feed water after LPH-3 goes to the dearator and is then pumped by boiler feed pumps to the high-pressure heaters. And thus, the whole cycle repeats again. Single-pass, Surface type shell, and tube condenser manufactured.

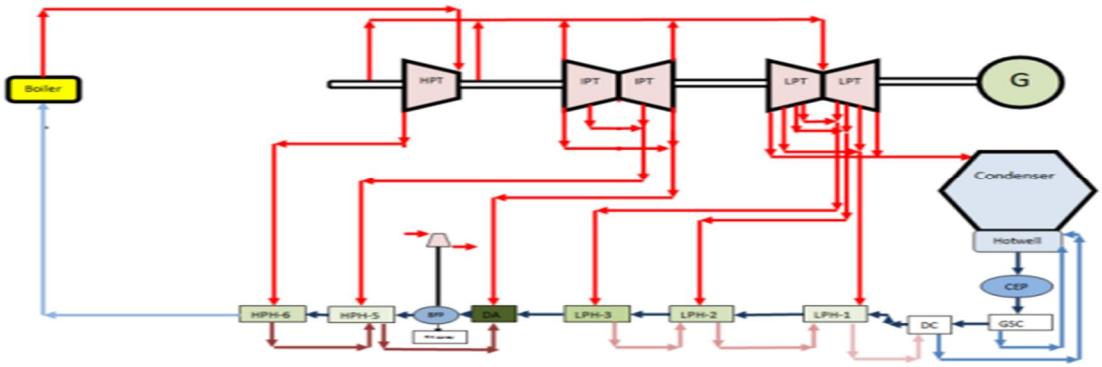

Fig: Schematic drawing of thermal power plant.

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III. WORKING

The thermal power plant works on the principle of Rankine cycle as shown in fig.2 where four components play their part individually and they are boiler turbine condenser and pump.

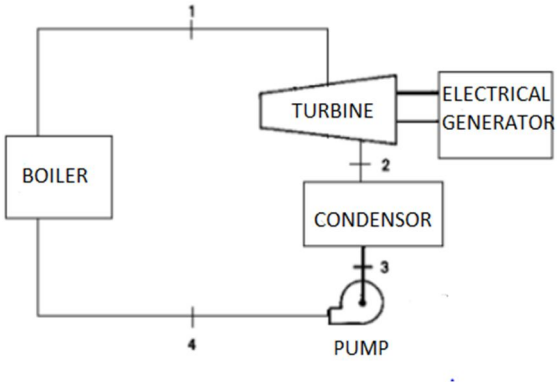

Fig 2. Rankine Cycle

IV. TURBINE CYCLE AND EXTRACTION FLOW DIAGRAM

The components that are used between boiler and condensers with the specific temperature and pressure of the steam passing through.

V. HOW THE EFFICIENCY OF THE PLANT IS INCREASED?

As the process goes by the superheated steam at **543**°C and 180 kg/cm², enters HPT, and expansion of steam takes place which results in pressure loss and temperature loss.

To maintain the required temperature for the LPT, the used steam is resent to the boiler to reheat the steam and obtain the steam of 543°C which is then sent to IPT and then to LPT.

The condenser is placed just below the IPT where a vacuum of 0.8 absolute is maintained. Inside the condenser, many tubes are placed through which water at atmospheric temperature is flown continuously to condense the used steam, which brings down the temperature of the steam to 45°C.

A CEP is placed just after the condenser which increases the pressure of the condensed steam and sends it to LPH.

Now, from LPT a small percentage of heated steam is extracted and sent to LPH which is mixed with the condensed steam and starts the process of reheating, and takes the temperature of the condensed steam to 120°C approximate.

Now, this fluid at 120°C flows to the deaerator which is a large tank-like structure where extracted steam from IPT is used and mixed with the fluid and takes the temperature to 180°C approximately.

To increase the pressure of the steam BFP is used which requires electricity to perform its operation. Which is produced using a turbine attached to it which is run by using the extracted steam from IPT and HPT. No external means is used to run the BFP. Hence is one of the bigger reasons for the increased efficiency.

After BFP an HPH is placed where extracted steam from HPT is used which gets mixed with the heated steam and takes the temperature of the steam to around 260°C to 280°C.

Then after HPH, the steam is then heated in ECONOMIZER using the hot fluid gases from the boiler which increases the temperature of the steam to 343°C approximately known as PREHEATED STEAM.

This preheated steam is then sent to the boiler and the cycle continues.

VI. CONCLUSION

In this study, we have studied the measures taken to increase the efficiency of the thermal power plant. We have studied that the extraction process is used in the whole cycle multiple times for reheating process in low pressure heaters and high- pressure heaters and the extraction is done from the steam used in the turbine process which reduces the requirement of burning coal in the boiler as the steam is already at 343°C which is almost the half temperature required at the start of the cycle in turbine so it directly reduces the burning of coal to produce required heat in the boiler.

Also, the energy used for the operations of BFP (boiler feed pump) is produced internally using the turbine attached to BFP which is run by the steam extracted from the turbines.
Hence the increase in efficiency of the 510 MW thermal power plant has been studied.

VII. ACKNOWLEDGMENT

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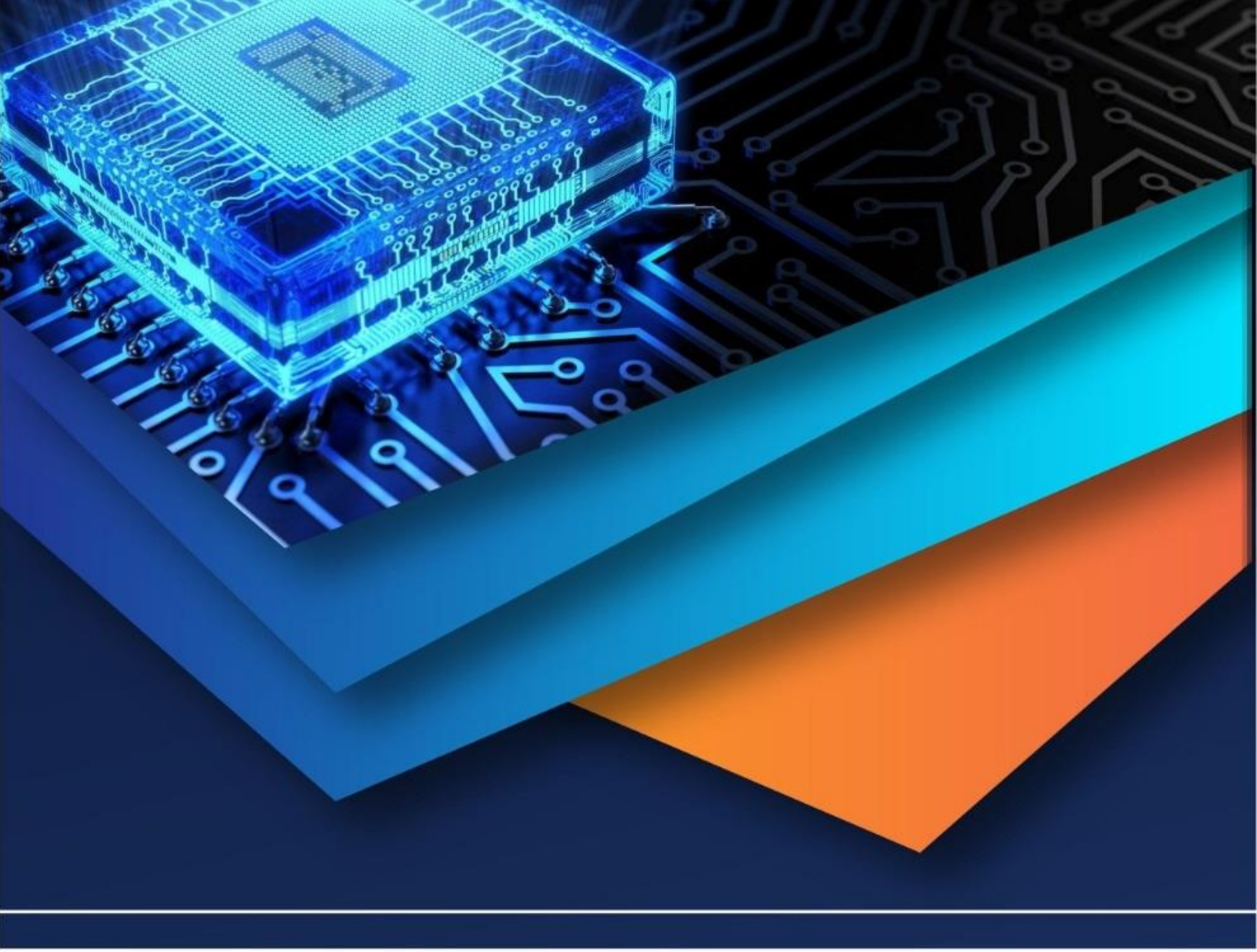

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