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Implication of Regenerative Heaters In Coal-Fired 600 MW Thermal Power Plant

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***Abstract*-- Regenerative heaters play a significant role in the overall efficiency of the power plant. The average temperature of the plant cycle is increased by having a series of feed water heaters. The effective use of the feedwater heaters in cascading process shows a prominent reduction in fuel consumption, significant improvement of plant heat rate and reduces the overload of condenser performance The gradual increase in the raise of temperature of the feed water avoids the thermal stress produced inn the boiler water tubes.**

***Keywords*-- Regenerative Heaters, Overall efficiency, Fuel consumption, Low pressure Heater, High Pressure heater.**

I. Introduction

In a Rankine cycle, the condensate enters the boiler at a relatively lower temperature of around 35 degree C. Inside the boiler, the sensible and latent heat has to be provided to heat the cold water to boiling point and then to evaporate the liquid water to steam. A low pressure heater integrated with Rankine cycle of a thermal power plant improves the thermal efficiency [1].

Feed water heating reduces the thermal shock to all components of boiler and system reliability is enhanced and the wet corrosion is reduces increasing the lifetime of the equipment [2]. If a feed water is present as a series between condenser to economiser, the feed water gets heated gradually and the heated water enters the economiser which reduces the heat addition to boiler significantly.

II. Description Of The Regenerative System

The schematic of the regenerative cycle is shown in Figure No.1. Superheated steam enters into the High Pressure turbine at a temperature of about 540 degree C and at a pressure of around 137 Ata. The work is done by the High Pressure turbine at 14 stages to generate a power of 143 MW.

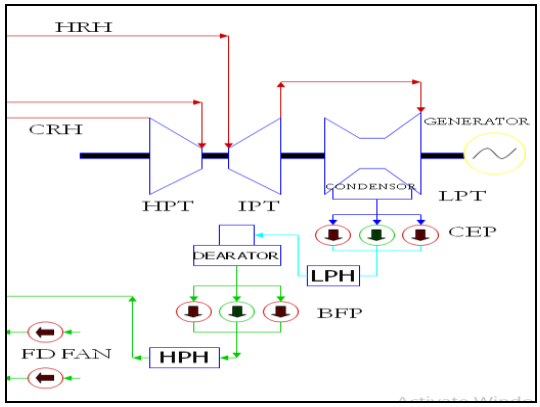


Figure No.1 Schematic of the regenerative cycle of 600 MW

The expanded steam at the outlet of the High Pressure turbine is around 333 degrees C and 43 Ata. It is then heated in a re-heater to a temperature of around 560 degree C and pressure drops slightly to 41 Ata. This reheated steam expands in the Intermediate pressure turbine by entering axially and expands both sides to a pressure of around 7.7 Ata and temperature of 328 degree C. There are 10 stages and the power generated is around 198.1 MW. The expanded steam from the exhaust of intermediated turbine is allowed to expand in the Low pressure turbine to a pressure of 0.1033 Ata and temperature of 46.1 degrees C. The expansion of steam happens in 2 x 8 stages generating 236.8MW.

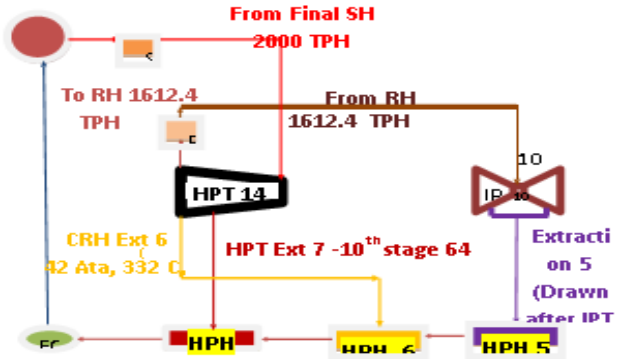


Figure No. 3 Extraction cycle in High pressure heaters

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A deaerator is installed to exhaust the dissolved gases which improves the quality of the feed water [3]. By this the low pressure steam is sent to deaerator to strip the gas out and another portion of steam is taken from main steam line and used in the gland steam condenser [4]. Figure No.3 shows the schematic of the cascading effect of HP heaters where the steam from boiler Br is superheated in a superheater SH and expands in the High Pressure Turbine HPT .

The Superheated steam from superheater at a mass flow rate of around 2000TPH flows at a pressure of 540 degree C and at a temperature of 537 Degrees C and a temperature of 170 Ata expands in 14 stages. The entry parameters to the intermediate turbine are 1612.4 TPH, 41 Ata, 565 Degrees C. The various extractions from high pressure turbine are after 14th Stage, 10th Stage with extraction points as 6 and 7 respectively.

Extraction at point 6 has the temperature of 332 degrees C and 42 Ata and transfer heat to 7th High pressure heater HPT 7 and point 7 with a temperature of 390 degrees C and 64 Ata to heat the feed water in 6th High pressure heater HPH 6. The Extraction 5 is bled from intermediate pressure turbine IPT, after 6th Stage of expansion at a pressure of 49 Ata and temperature of 445.1 degrees C to provide its heat to 5th High pressure heater 5.

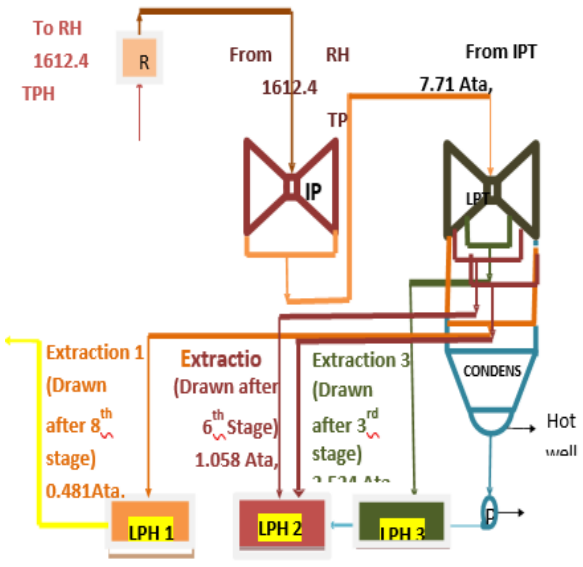


Figure No.4 Extraction cycle in Low Pressure Heaters

The Low pressure turbine has three extraction points: Extraction 1 drawn after 8th Stage at a pressure of 0.481 Ata and temperature of 80.38 Degrees C and provides exchange of heat in low pressure heater 1, the Second extraction point is drawn after 6th with a pressure of 1.058 Ata and a temperature of 122.2 degrees C transfer its heat to lower pressure heater 2, the third extraction point is extracted after 3rd stage with a pressure of 2.524 Ata and temperature of 206.5 degrees C exchanging heat to Low pressure heater 3.

III. Conclusion

The cascading heating effect of the feed water heaters causes the heat to add in stages and temperature of feed water increases in a thermodynamic staircase style and the overall heat addition in the boiler is reduced proportionally. The heat transfer is made to regenerate since the bled steam temperature has a higher temperature than the feed water entering at various points. The process of above said heating reduce fuel consumption increasing the cycle efficiency [5].

The sensible heat to heat the water without feed water heaters is reduced by using feed water heaters since the feed water gets heated as a condensate via Low pressure heaters 3,2,1 and high pressure heaters 5,6,7. 10 to 20% of the steam is made to condense by transferring its heat to the feed water heaters. This reduces the amount of heat rejection in the condenser thus increasing the efficiency. The gradual increase in the temperature of the feed water prevents the boiler water tube from thermal stress considerably.

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