Abstract: The Regenerative system of a Thermal power station consists of low pressure heaters, deaerator and high pressure heaters. All the components of the regenerative system as whole, and heaters in particular, play a vital role in increasing the thermal efficiency of the power plant.

In this work, an attempt has been made to evaluate the performance of the various components of the regenerative system in our project titled “PERFORMANCE ANALYSIS OF REGENERATIVE FEED WATER HEATERS IN 210MW THERMAL POWER PLANT”. The working principle, construction and operation which may frequently occur in the system are also narrated.[1-5]

The features like Terminal Temperature Difference, Drain Cooler Approach, Temperature Rise and steam flow rate used in the components are clearly explained and the evaluation is made by comparing the calculated values with that of design values.

Neyveli Lignite Corporation Limited, a “Navratna” Government of India Enterprise, under the administrative control of MOC has a chequered history of achievements in the last 56 years since its inception in 1956. A pioneer among the public sector undertakings in energy sector, NLC operates Three Thermal Power Stations with a total installed capacity of 2490 Mega Watt at Neyveli.

All the Mines of NLC are ISO Certified for Quality Management System, Environmental management System and Occupational Health & Safety Management System. All the Power stations of NLC are also ISO Certified for Quality Management System and Environmental Management System. NLC’s growth is sustained and its contribution to India’s social and economic development is significant. The Regenerative system of a Thermal power station consists of low pressure heaters, deaerator and high pressure heaters. All the components of the regenerative system as whole, and heaters in particular, play a vital role in increasing the thermal efficiency of the power plant.

In this work, an attempt has been made to evaluate the performance of the various components of the regenerative system in our project titled “PERFORMANCE ANALYSIS OF REGENERATIVE FEED WATER HEATERS IN 210MW THERMAL POWER PLANT”. The working principle, construction and operation which may frequently occur in the system are also narrated.[10-14]

The features like Terminal Temperature Difference, Drain Cooler Approach,[10] Temperature Rise and steam flow rate used in the components are clearly explained and the evaluation is made by comparing the calculated values with that of design values.

In unit-I performance test for heaters are conducted. The observations made are according to plant’s current condition and is tabulated. Calculation regarding TTD(Terminal Temperature Difference), DCA(Drain Cooler Approach), TR(Temperature Raise), Qe(Extracted Steam Quantity) are made. [11]

The tabulation (TABLE-A) mentioned below is the average of five readings of all low pressure and high pressure heaters and deaerator.
Feed heaters are said to be self-regulating as there are no control valves in the extraction steam piping and yet the steam now adjusts itself in response to varying operating conditions. Here is how it happens.

a) At any thermal equilibrium, the steam now rate equals the rate at which the steam condenses in the feed heater. Steam leaks (e.g., through the feed heater vents, extraction steam piping drainage equipment, etc.) and condensation in the piping are ignored here because they are usually very small in comparison with the rate at which the steam condenses in the feed heater.

b) If we neglect the heat losses through the feed heater shell, the rate of steam condensation depends on the rate at which

c) heat (h) is transferred from the

d) steam, as expressed by the familiar equations:

$$Q = UA\Delta T_m$$

1. Various Operating Conditions Affect Factors Of This Equation

The various operating conditions affect factors of this equation. The overall heat transfer coefficient ($U$) depends on the tube cleanliness, concentration of gases in the feed heater shell, and feed water and steam velocities.

2. Significance of Feed Heater Drains Level

If a feed heater drain level is too high, it may result in water induction into the turbine via the extraction steam piping. This may severely damage the machine.
2. Reduces the overall thermal efficiency due to lowered feed water outlet temperature as less heat is transferred to the feed water due to tube flooding.

3. Decreased turbine efficiency due to a deviation from the design distribution of the extraction steam. Flows to individual feed heaters. This causes the steam pressure profile along the turbine and thus, the pressure ratio in groups of turbine stages between individual extraction steam points. Impaired moisture removal from the turbine as the extraction steam flow is decreased.\[8\]

4. Dumping of hot drains to the condenser (this is due to the automatic actions taken in response to a high drains level). Not only does it cause a loss of drains heat from the cycle, but it can also increase condenser pressure slightly.\[11\]

Possible need to valve out the whole bank of feed heaters to prevent water induction to the turbine. If a feed heater drains level is too low, \[12\]

1. Equipment damage may occur due to the following some steam may leak into the drains sub cooling section. When pockets of this steam condense in the drains sub cooling section, water columns collide which produce violent steam hammer. The drains sub cooling section may suffer severe damage. If the level drops so much that steam can blow through the drains sub cooling section and the drains piping, the slugs of water carried by the blowing steam can damage this equipment through water hammer.\[14-21\]

2. The feed heater internals (tubes, baffles, impingement plates) can get damaged due to impingement and high flow induced vibration if Steam flows through the feed heater too fast. This can happen\[2-27\] (particularly in the HP feed heaters) if the drains dump valve failed in the open position, creating a large pressure difference between the feed heater shell and the condenser.

3. The overall thermal efficiency is decreased if the low level is caused by the drains dump valve failed open such that some of the feed heater drains flow directly to the condenser; the design distribution of the extraction steam flows to individual feed heaters is upset. This happens when the drains level is so low\[7\] that some steam blows through the drains piping to the adjacent feed heater operating at a low.\[28-30\]

Performance test was conducted for feed water heaters in unit I. Initially with existing condition using the test setup standards, test was conducted. In this test it was observed that\[10\] TTD, DCA, TR and extraction steam flow of heaters vary with the design values. Reason for this variation was analyzed and found, that is due to improper functioning of Drain condensate level control valves. Then by manual intervention with due care, \[13\] maintaining drain condensate level at design value, drain condensate flow made only through cascading order. This time the values of key elements come closer to design value. Based on the analysis we recommend,

1. HPH-7 to HPFT.
2. HPH-6 to HPFT.
3. LPH-4 to LPFT.

Level control pneumatically operated valves are to be replaced. Remaining all LCVs to be corrected by calibration.

Moreover sluggishness in LCV operation may lead to water entry to turbine also. To avoid this LCV operation logic modification also possible. i.e., HPH-7, 6 to HPFT. LCV opens on DC very high level logic to be modified to LCV opens on DC level high logic.

On the event of Turbine trip, extraction MOV to be closed. This logic may be included. Preventive maintenance required for,

1. All extraction MOVs.
2. All FCNRV

References


