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Effect of Condenser Pressure (Vacuum) On Efficiency And Heat Rate of Steam Turbine

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Abstract: Electricity plays a vital role in our daily life. The power demand is increasing day by day due to increasing the population. The power is required for Industrialization and development of nation. Our country mainly depends on thermal power plant for electrical supply. In thermal power plants turbine is considered to be HEART of the plant. Maintained required condenser parameters to improve the performance and efficiency of turbine and these parameters direct impact the economical growth of power plant. This venture includes the development highlights, start up, and Shut down, crisis operation, safe operation and assurances of the 32 mw steam turbine. The primary point of this venture is investigation the how to impact the condenser weight (vacuum) on effectiveness and warmth rate of regenerative steam turbine by scientific figurings.

1. INTRODUCTION

Steam turbine is prime-mover which converts heat energy of steam to mechanical energy. When steam is allowed to expand through an orifice then heat energy (enthalpy), is converted into kinetic energy. This kinetic energy of steam is changed to mechanical energy through the impact (impulse) or reaction of steam against the blades. The force of steam is used to spin the turbine blades which spin the generator, producing electricity.

2. RANKINE CYCLE

Ranking cycle is a model that is used to predict the performance of steam turbine system. That ranking cycle is an idealized thermodynamic cycle of a heat engine that converts heat energy into mechanical work. The heat is supplied externally to a closed loop, which usually used water as the working fluid.

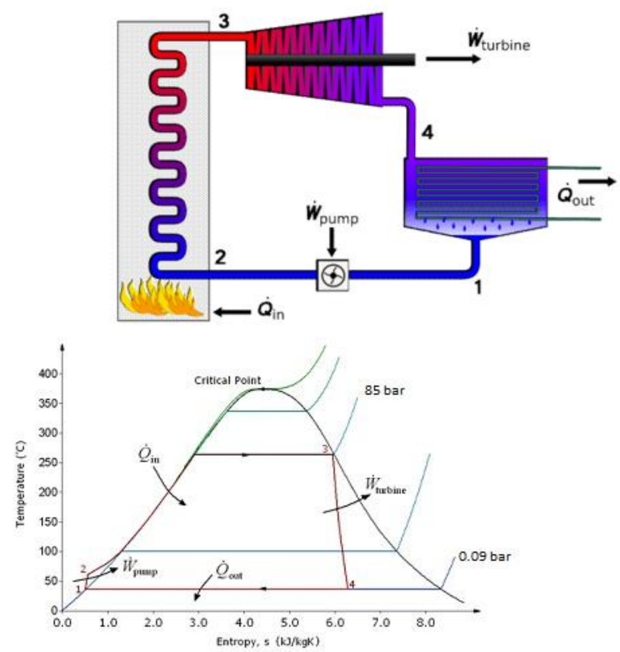

Fig-1 T-S diagram of a typical Ranking cycle

2.1Bearings

The bearings are made in two halves and are all tilting type. The Rotor is supported by two bearings. Bearing Babbitt temperatures are measured by the thermo couples directly under the white metal. The temperature of the thrust pads is measured by the thermo couples in two opposite pads on both turbine side and generator side. Lube oil is admitted in the oil spaces that are milled into the bearing shells at the horizontal joint and are open to the shaft journal.

There are two types of bearings mostly used in turbine are

1. Journal bearings
2. Thrust bearings

Fig. 2.Journal bearing (segmental type)

Fig. 3.thrust bearing (tilting type)

3.GOVERNING OF STEAM TURBINE

Governing of steam turbine is the procedure of monitoring and controlling the flow rate of steam into the turbine with the objective of maintaining its speed of rotation as constant. The flow rate of steam is monitored and controlled by interposing valves between the boiler and the turbine. Depending upon the particular method adopted for control of steam flow rate different types of governing methods are being practiced. The principal methods used for governing are described below

3.1TURBINE PROTECTIONS

Protection system shuts off steam supply to turbine by closing stop valves (independent of control valves) and control valves in the following possible hazardsIt is not necessary to trip the turbine in all above mentioned eventualities. Manufacturers select a group of these for tripping depending on their designs. In case of 'lube oil failure' and 'thrust bearing failure', vacuum is also usually broken in order to bring turbine at standstill in minimum time so that no damage occurs to turbine. Protection system consists of transducers for above mentioned eventualities; their unstable pilots and associated hydraulic amplifiers which act on stop and control valves. Turbine protection systems perform to cover the following functionsThe mechanical trip was operated by reaction force on the tripping device for the draining the trip oil to close the ESV. The most mechanical tripping devices are used for over speed tripping of the turbine, which was operated by centrifugal force

3.2Rotor:

If the turbine is impulse type the rotor is disc type i.e. blades are carried in the discs, which may be integral forged with shaft or shrunk on the shaft. Each rotor is subjected to 20% over speed test and is balanced at 4909rpm. The rotors carry the moving blades. The shaft seals are axial. All the rotors are dynamically balanced to every fine degree of precision; this ensures that there are minimum vibrations and dynamic loading of bearings. Labyrinths with the sealing strips caulked into the shafts. Sealing in turbine casings is provided to check steam leakage from HP side and air leakage into LP side.

Fig.4. 32MW Turbine rotor

4.THERMAL POWER PLANT

In this turbine, the steam is removed from the turbine at three points B1 and B2and B3.It is then fed into low pressure heater (LPH), high pressure heater (HPH) and dearator. The steam enters the turbine at point A. Let some amount of Steam after partial expansion (at pressure 24 kg/cm2) is drained from the turbine at point B1 and enter the high pressure heater. Similarly, let another some amount of steam after further expansion (at pressure 5.3 kg/cm2) is drained from the turbine at point B2 and enter the dearator. Let some amount of Steam after expansion (at pressure 1.5 kg/cm2) is drained from the turbine at point B3 and enter the low pressure heater. The Remaining steam (at pressure -0.85 kg/cm2) is further expanded in turbine, and leaves it at point C and enters into condenser.

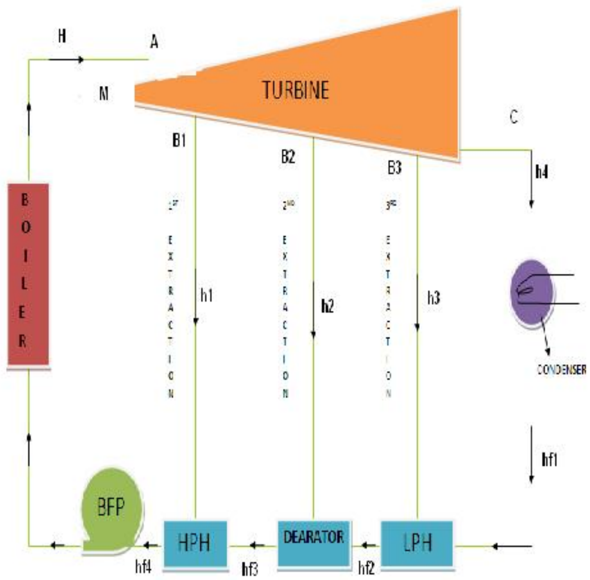

Fig.5. Line Diagram of 32 MW Thermal power Plant

The steam is then condensed in the condenser. The condensate from the condenser is pumped into the low pressure (LP) heater, where it mixes up with the steam extracted from the turbine. Main condensate from low pressure heater passed into dearator, where it mixes up with the steam extracted from the turbine. The feed water from dearator entered into high pressure (HP) heater through the boiler feed pump where its gain the temperature with the steam extracted from turbine. The feed water from HP heater entered into boiler where it is converting into steam then passed into turbine. Cycle is repeated again

4.1Glands:

In the HP the seals consist of a series of sealing strips caulked alternatively in the shaft and into stationary rings. In the case of LP glands sealing strips are fitted in the stationary rings only. Each sealing ring consists of 6 or 8 segments and is carried in grooves in the casing to allow radial movement. Each segment is held in position against a shoulder by two coil springs. Both fixed and moving blades are fitted with a continuous shroud in which steps have been machined to produce a labyrinth. The sealing strips are caulked into the casing and shaft opposite to the blade and are of stainless steel which can be easily replaced.

Turbine shaft glands are sealed with auxiliary steam supplied by an Electro hydraulically controlled seal steam pressure control valve. A pressure of 0.01kg/cm2 is maintained in the seals. Above a load of 80 the turbine becomes self-sealing. The leak off steam from HP glands is used for sealing LP glands. The steam pressure in the header is then maintained constant by means of a leak off control valve which is also controlled by the same Electro hydraulic controller, controlling seal steam pressure control valve. The last stage leak off of all shaft seals is sent to the gland steam condenser for regenerative condensate heating.

Fig. 6.Arrangement of glands to the turbine rotor

CONCLUSION

In this project, I analyzed the how to condenser pressure (vacuum) effect on efficiency of 32MW regenerative steam turbine and. I also studied the safe running operation procedure, start-up, shutdown, safety protections, troubles and their remedies.

1. Thermal calculations are carried out to know the turbine efficiency, turbine heat rate and also overall plant efficiency at 3 different condenser pressers.

    A. at condenser pressure -0.75 kg/cm2 (vacuum)

       Turbine efficiency = 30.30
       Turbine heat rate = 2370.61 Kcal/KWh
       Plant efficiency=25.33

    B. at condenser pressure -0.85 kg/cm2 (vacuum)

Turbine efficiency = 30.81
Turbine heat rate = 2363 Kcal/KWh
Plant efficiency=25.67

C. at condenser pressure -0.95 kg/cm2 (vacuum)
Turbine efficiency = 31.59
Turbine heat rate = 2357.69 Kcal/KWh
Plant efficiency=26.33

From above calculations

2. From A to B decrease condenser pressure -0.10 kg/cm2 then increase the turbine efficiency 0.51,increase plant efficiency 0.34 and decrease turbine heat rate 7.61 kcal/KWh.

3.From B to C decrease condenser pressure -0.10 kg/cm2 then increase the turbine efficiency 0.78,increase plant efficiency 0.66 and decrease turbine heat rate 5.31 kcal/KWh.

From this project I identify to maintain the proper condenser pressure to increase turbine efficiency and plant efficiency and reduce turbine heat rate
Reduce coal consumption due to reduce turbine heat rate for KWh generation
By Reduce coal consumption to saving the fuel (coal) and to control the atmospheric pollution

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