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Experimental analysis of condenser to improve the efficiency in thermal power plant

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Abstract –In a thermal power plant, one of the main parts is considered that is a condenser, which is used to condensate the low-pressure steam into a liquid state. In this, we use surface condenser type water-cooled condenser number of tubes used in circulating water for condensing of outlet turbine low-pressure steam into liquid. The circulating cooling water extracts the heat in the low-pressure heat steam and changes into warm water. The warm water is cooled by using cooling tower and again circulated to a condenser. Condenser outlet is condensate liquid. Then the condensate is again pumped and reuse to boiler this way we increase the whole performance and efficiency of the thermal power plant. The heat transfer between the water and steam is done by depending upon the heat transfer rate and thermal conductivity of the condenser tube. So we analysis the shell and tube type condenser with fluent software and also change the material of the condenser to get more heat transfer between the water and steam. At present cupronickel material is used the material have some drawbacks to fluid flow, so we analyze and use titanium material.

Keywords–Power plant, condenser, condensate mass, inlet and outlet temperature of steam, condensate, cold water, warm water.

I. INTRODUCTION

In thermal power stations, heat energy produced by heat engine (Boiler).Then the heat energy is send to a mechanical device of a turbine in this heat energy is converted to mechanical energy turbine blade rotates with the pressure of the high pressure steam so that mechanical energy is produced. The turbine output shaft is connected to a generator input shaft so that the generator also rotated generator is electronic device so electrical power is produced. This is the main function of the thermal power plant use the thermal power we produce electricity. After the finishing of turbine rotation the outlet low pressure steam is come to the condenser for condensing process this is the our project area.

Now we come our project area of condenser section. A steam condenser is a closed vessel in this low pressure steam is exhausted by turbine, and condensed after doing condensing process.

The low pressure is accompanied by low temperature and thus all condensers maintain a vacuum

Under normal condition. The output of condensed steam is called as condensate. The temperature of Condensate value is higher on leaving the condenser than the circulating water at inlet.

II. LITERATURE SURVEY

[1]. Amir vosough-Using Carnot cycle efficiency, the cycle only give most efficiency compare to another cycle efficiency, so he use the cycle to improve the efficiency in condenser.

[2]. R.K.Kapooria-Most of the electricity being produce by the world today in steam power plant, so he improve the condenser efficiency by using thermal analysis of condenser.

[3]. Deva Leissner-The largest single factor that can affect the turbine cycle efficiency with a generation statin is the heat transfer of the condenser, so increase the heat transfer in condenser.

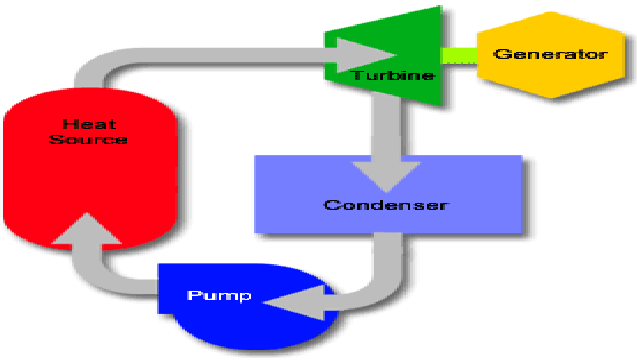

Fig.1.Layout Of Power Plant

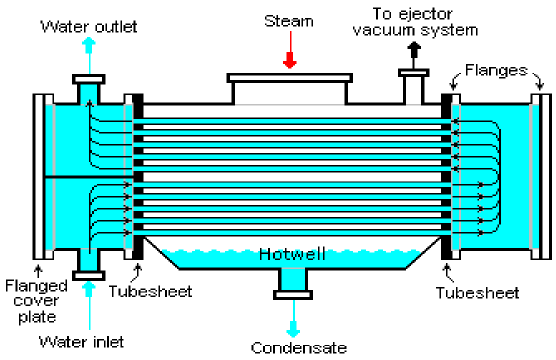

Fig.2.Condenser

III. COMPONENTS OF A SURFACE CONDENSER

The basic main components of surface condenser include hot well, water boxes, flash box, condenser shell, tubes, support plate.

Hot well:

The condensate collected in the bottom of the condenser hot well and is returned to the circuit by the extraction pump. The pump flow rate is controlled by the condensate level in the hot well.

Water boxes:

The inlet/outlet water box is divided into four sections to provide two inlets and two outlets and return water box is divided into two sections. This arrangement is to ensure uniform distribution of the cooling water to the condenser tubes. They are designed for low hydraulic pressure losses. They are fitted with special internals to ensure optimal distribution of the sponge cleaning balls to all tubes.

Flash box:

During start up and load transients the high energy internal turbine drains are rooted via a flash box into the condenser. In the flash box flashing phase separation into steam and condensate take place. Injection water lowers the temperatures of high temperatures inlet before they enter the condenser .This products the condenser and the steam turbine from the hot drains.

Condenser shell:

The shell is mild steel strength the internally by mild steel ribs. The bellow piece is welded to the return end of the shell with return water box bolted to it. The mild steel bellow accommodates the differential expansion between tubes and condenser shell.

Tubes:

The condenser tubes are made of aluminum, brass, and cupronickel. The end of each tube are secured in the tube plates by expanding the end in the parallel fashion and inlet ends are bell mounted to improve the water flow. It is divided into two tubes bundle into which steam can flow from all sides. The tubes are mainly used for circulating of cooling water.

Support plates:

In order to prevent destructive tube vibrations, generated by the velocity of the steam, the tubes are mounted in support plates. The support plates spacing is carefully calculated to withstand extremely operating condition.

IV. TYPES OF CONDENSER

1. Jet condenser
2. Surface condenser

Jet condenser:

These days, the jet condensers are seldom used because there is same loss of condensate during the process of condensation and high power requirement for the pump used. Moreover the condensate cannot be used as feed water to the boiler as it is not free from salt. In jet condenser water will be injected by a jet and high velocity and condensing the steam, the condensing steam is called as condensate.

Surface condenser:

This type of condenser is mainly used for most of the applications, in this power plant also this type of condenser used to condensing of the steam into condensate. Condenser is a type of heat exchanger in which hot fluid becomes cold fluid. Surface condenser is commonly used term for a water-cooled shell and tube heat exchanger installed on the exhaust steam from steam turbine thermal power stations.

These condensers are heat exchangers which convert steam from it gaseous to its liquid state at a pressure below atmospheric pressure where cooling water is in short supply, an air-cooled condenser is often used. An air- cooled condenser is however more expansive and cannot achieve as low as steam turbine exhaust pressure as a water –cooled surface condenser.

Table.1.Condenser Specification

Type	Cross flow surface condenser
Capacity	27000m^3/hr of cooling water
Number of tubes	7810 × 2
Size of tube	Internal diameter=28mm External diameter=30mm

	Thickness=10mm
Length of the tube	10m
Material	Cupronickel
Flow arrangement	Cooling water inside the tube and exhaust steam over the tube
Manufacturer	BHEL

V. PROBLEMS IN CONDENSER

Fouling:

The use of fouling factor to maximize the lifespan, run time and efficiency of the heat exchanger by accounting for the amount of fouling an exchange will sustain over a period of the time. These often results in increasing the surface area of a heat exchanger, so that fouling will not have much often effect.

Fouling factor:

Fouling depends on the type of heat exchanger, and the kind of tubes being transferred. Due to different designs, composition and transfer fluid, each type of heat exchanger will suffer fouling in unique ways. The tube side of a shell and tube heat exchanger is usually easy to clean but the shell side can be more difficult to access.

TYPES OF FOULING

1. Crystallization
2. Sedimentation
3. Corrosion
4. Freezing fouling

Crystallization:

Crystallization is one of the most common type of fouling. Certain salts commonly present in natural water have solubility in warm water then cold. Therefore, when cooling water is heated during the cooling process these dissolved salts will crystallize on the surface in the form of scale.

Sedimentation:

Sedimentation, the depositing of dirt, sand, rust and other small matter is also common when fresh water is used, these can be controlled to a degree by the heat exchanger design.

Corrosion:

Corrosion can destroy area of heat exchanger, creating costly damage. Fouling will slow down heat transfer and damage equipment unless it is dealt with accordingly.

Freezing fouling:

Freezing fouling results from over cooling at the heat transfer surface causing solidification of some of the fluid stream components.

Condenser Performance:

During the performance evaluation, portable monitoring instruments are measure the following parameters:

T_{h1}-Inlet temperature of hot fluid (steam)
T_{h2}-Outlet temperature of hot fluid (condensate)
T_{c1}-Inlet temperature of the cold fluid (water)
T_{c2}-Outlet temperature of the cold fluid (water)
m_c- mass flow rate of cold fluid
m_h- mass flow rate of hot fluid
T_m- Logarithmic mean temperature difference

VI. METHODOLOGY

Total heat transfer- $Q=m_c c_c \Delta T_m$

Q=Heat gained by cold liquid=Heat lost by hot liquid

$$Q = m_c c_c \Delta T_m = m_h c_h \Delta T_m$$

$$\eta_{condenser} = T_0-T_i/T_v-T_i$$

T_v-Vacuume temperature by condenser pressure

Table.2.Material Comparison of Grade2Titanium&Cupronickel

	Grade2Titanium	Cupronickel
Density	4.51g/cc	8.94g/cc
Melting Point	1665^0C	1171^0C
Tensile strength	344Mpa	360Mpa
Shear modulus	48.0Gpa	57.0Gpa
Poisson’s ratio	0.37	0.34
Young’s modulus	105Gpa	152Gpa
Thermal conductivity	16.4	29

VII. ANALYSIS OF CONDENSER TUBE

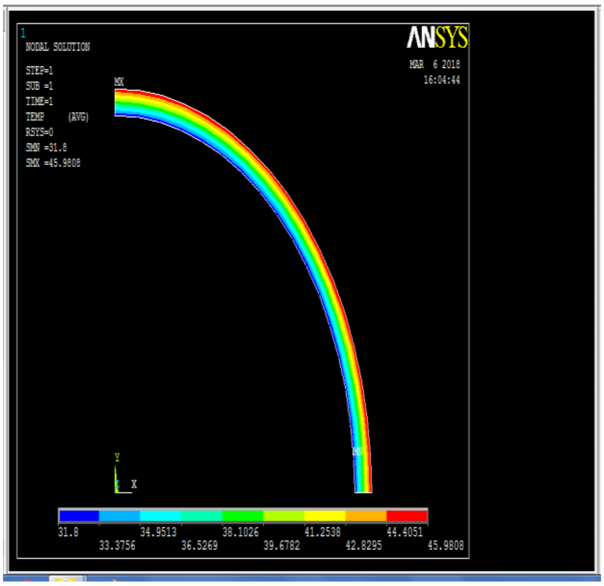

Fig3: Heat transfer between water and steam

VIII. RESULT AND DISCUSSION

In first cupronickel material will be used but some drawbacks are there, drawbacks are in this condenser tube many solid contents, dirt, salts, sand, rust are forming inside the tube so heat transfer between the steam and water will be reduced so condenser efficiency also been reduced.

After using of titanium material the formation of solid contents, dirt, sand, rust are will be low to compare the cupronickel material, so the heat transfer rate will be increased and condenser efficiency also will be increased.

Thus the condenser efficiency is increased in analyze and after using of titanium material up to 5%. The condenser efficiency is get nearly 60%.

Table.3.At Present in Cupronickel Material

	Inlet temperature	Outlet temperature
Water	31.8^0C	37.6^0C
Steam	48.69^0C	46.7^0C

Table.4.After Analysis by using Titanium

	Inlet temperature	Outlet temperature
Water	31.8^0C	39.4^0C
Steam	48.69^0C	44.8^0C

IX. CONCLUSION

If the value of fouling factor increases than heat transfer rate decreased. So, more surface area required to transfer the heat. So, when we select the titanium material which has less effect of fouling then we reduce the surface area. Also select the cooling medium which has low of fouling factor at that time reduced the surface area for heat transfer.

Considering the inherent limitation of this parameter as well as turbine limitation, the minimum allowable condenser pressure should be chosen to produce maximum efficiency and output power. This pressure should be always controlled during the power plant operation. The maximum energy loss was found in the condenser where nearly 60% of the input was lost to the environment.

At present material of the condenser in cupronickel material the condenser efficiency is 55.52%. After analyze and using of the titanium material in condenser the fluid flow and corrosion will be low so the heat transfer between steam and water will be increased so condenser efficiency also increased nearly to 60%.The condenser efficiency increased up to 5% in titanium material.

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