Experimental Investigation on Improving the Performance of Surface Condenser in a 120 MW KTPS Thermal Power Plant

KANAKAPUDI PRADEEPKUMAR[1] PROF.ER.P.SANJEEVA[2]
PG SCHOLAR[1] pradeepkanakapudi@gmail.com, Gandhiji Institute of science and Technology
PROFESSOR[2], Sanjeev.phd@gmail.com, Gandhiji Institute of science and Technology

Abstract

In power system network thermal power plants having greater importance. The thermal power plants are designed based on several parameters such a steam output, operating range of pressure and operating temperature of steam etc, but actually inlet conditions are not based the base designed conditions. For the successful installation there must require lots of constraints. Its mandatory reduce or increase output power and heat rate of thermal power plants. Due to these parameters, the designed power and heat rate are never achieved. Steady state Variations in the power outputs from plant are always a matter in the disputes. So the parameters for power and heat rate are generated for different conditions of condenser pressure, flow rate of water through the condenser, Temperature difference. On the basis of measurement and designs data collections only such that performance of the Surface Condenser unit can be evaluated. These evaluations indicate that if operating parameters vary, then power output and heat rate also vary. This paper deals with Improving the Performance of Surface Condenser in a 120 MW KTPS Thermal Power Plant

Index Terms—Ship Data Network, Opnet ,QOS

I. INTRODUCTION

About Thermal power plant

The basic principle based on which the thermal power plant as shown in fig works as law of conservation of energy which states the energy neither can be created nor destroyed bur can be transformed from one form to another. Here in thermal power plants chemical energy is converted to heat energy are converted to mechanical energy is converted to electrical energy.

1.1 About TS GENCO:

TS power Generation corporation Limited is the power generation company of Telangana. Its installed capacity is 6550.9MW.It is the third largest power utility in India.

1.1.1 Vision: To be best power utility in the country and one of the best in the world.

Mission:

1. To generate adequate and reliable power most economically effectively and eco friendly.
2. To spear head accelerated power development by planning and implementing new projects.
3. To implement renovation and modernization of all existing units and enhance their performance.

1.1.2 About KTPS:

Kothagudem Thermal power station, K.T.P.S a place of pride in the thermal map of India. It was the first major Thermal power station to set up in AP State Electricity Board.

KTPS is basically the coal fired thermal power generating station. It consists of two plants old plant (o&m) and new plant with total installed capacity of 1720 MW.

Old plant consists of 3 stations named KTPS-A, B& C stations.KTPS-A was constructed in two stages, Stage-I consists units 1&2 and stage-II consists of units 3&4 each of 60MW capacity.KTPS-B Station consists of two units 5&6 each of 120MW,KTPS-C Station of two units 7&8 each of 120MW.Finally old plant generates 720MW poring 2003.

It consists of two stages, stage-v consists of 9&10 units each of 250MW, stage-VI consists of 11^{th} unit of 500MW capacity. New plant generates 1000MW.So the total installed capacity of entire KTPS plant is 1720MW.

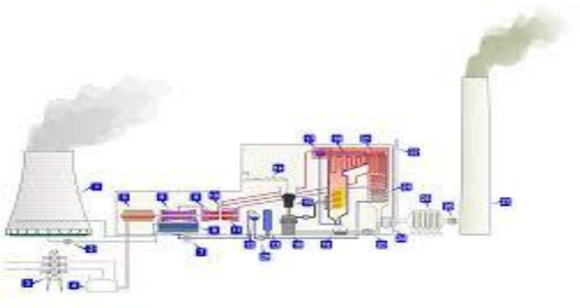
1.2 Over view of the plant:

In the case of coal fired boiler. The coal is supplied from the coal storage to the boiler through coal handling plant. The atmospheric air is fed to the boiler through an air preheater.Where air is heated by the flue gases coming out as a waste heat. The heated air enters the boiler and increases its efficiency. As a result of combustion water gets converted into steam and ash and flue gases are formed. The ash is removed by the ash handling and disposal system where as flue gases passes through the air preheated, dust collector and finally chimney to the atmosphere. The steam so generated passes through the super heater tubes and gets converted in to superheated steam. This superheated steam enters to the turbine through the steam stop valve(S.V) and governing valve(G.V).The stop valve is used for starting and stopping the turbine where as the governing valve maintains the speed of the turbine sensibly constant irrespective of the load. Expansion of steam takes place in turbine because steam does not work in the turbine. Alternator converts mechanical energy produced by turbine in to electrical energy which is fed to the transformer, circuit breaker and finally to the bus bar.

The exhaust steam from the turbine is condensed in the condenser due to exchange of heat with cooling water. Condenser is equipped with a vacuum pump to extract any air which may be present due to leakage through joints.

The condensate is extracted by a condensate extraction pump and led to L.P.Feed Heater (Direct contact type) where feed water is heated with steam blade from the turbine. The heated feed water is pumped back to the boiler through H.P feed heater (surface type).

The cooling water is supplied to the condenser by circulating water pump through
a closed circuit. The heated water is cooled in a cooling tower. Some quantity of cooling water in the form of



water vapor is carried away by the air hence make up cooling water to the condenser is supplied from the river or lake or ocean through a filter. If the source of cooling water is an ocean, then there is need of desalination plant. If the source of cooling water (river or lake) is very vast, the cooling tower can be dispensed with and the hot water is led to the river or lake in the case may be.

Due to leakage of steam from the turbine, some quantity of steam gets lost. Hence make-up water, well treated through a water treatment plant is generally added up in the well of condenser.

1.2.1 MAJOR ELEMENTS IN THERMAL POWER PLANT:

1. BOILER
2. STEAM TURBINE
3. CONDENSER
4. FEED PUMP
5. CIRCULATED WATER SYSTEM

BOILER:
In the boiler plant, the working fluid, water receives heat due to combustion of fuel and is converted in to steam. Its efficiency is 90%.

STEAM TURBINE:
In the steam turbine, the steam from the boiler expands (i.e., steam does work by reducing its pressure, temperature and heat constant) and thus perform mechanical work. It is a rotative dynamic machine. Its internal efficiency is about 80%.

CONDENSER:
In the steam condenser, the exhaust steam from the turbine gives up heat on condensation to the cooling water which cannot be converted to work and must be rejected to restore the initial condition of the working fluid. The condenser enables the exhaust steam to be used as the working fluid of the boiler again and again. It also increases the output of the turbine due to vacuum created inside the condenser. About 50% of the heat energy input is rejected in the condenser.

FEED PUMP:
It pumps the feed water coming out from the condenser to the boiler. It is either motor or turbine driven. It consumes about 2 to 2.5% of the power output.

CIRCULATED WATER SYSTEM:
Its supplies cooling water to the turbine condenser and thus act as a medium through which heat is rejected from the steam cycle to the environment. Cooling water can flow through the condenser in two methods.

1. Once-through system
2. Closed loop system Once-through system is used when there is a large source of water available. Water is taken from a natural body of water like a lake, river or ocean and pumped through the condenser, where it is heated, and then discharged back to the sources.

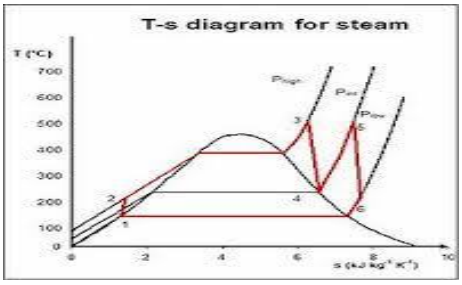
In closed loop systems, warm water from the condenser is passed through a cooling device like a cooling tower or a spray pond and the cooled water is then pumped back for condenser circulation.

However a natural body of water is still necessary nearby to supply the makeup water to replace the loss due to evaporation. Blow down and so on. The once-through system though more efficient, cause thermal pollution. In addition, availability of gauge quantity of water is shriking. Closed loop system are now almost universally preferred.

Overview of the plant:
Power cycle continuously converts heat in to work in which a working fluid repeatedly performs a succession of progress. In the vapor power cycle, the working fluid is a water or binary fluid which under goes a change of phase.

The Rankine cycle:
The rankine cycle as shown in fig is standard for steam power plants that are built around the world. The basic steam power plant consists of four main components:

- Steam generator
- Turbine
- Steam condenser
- Pump



Process 1-2-> Pump Work (Boiler Feed Pump)
Process 3-4-> Latent Heat (vaporization)
Process 2-5-> Heat supplied in the boiler
Process 5-6-> Expansion process (Turbine)
Process 6-1-> condensation (condenser)

The actual rankine cycle used in modern power plants has many more components, but the above components are common to all power plants. In this cycle, water is heated in the steam generator to produce electricity from a generator that is connected to the turbine. The steam from the turbine is then condensed back in to the water in the condenser. The pump then returns the water to the steam generator.

- Thus, the main purpose of the condenser are to condense the exhaust steam from the turbine for reuse in the cycle and to maximize turbine efficiency maintaining a proper vaccum.As the operating pressure of the condenser is lowered(Vacuum is increased),the enthalpy drop of the expanding steam in the turbine will also increase the amount of available work from the
- Turbine (electrical output). By lowering the operating condenser pressure, the following will occur:

➢ Increased Turbine Output
➢ Increased Plant Efficiency
➢ Reduced Steam Flow (For a Given plant output)

About Steam Turbine:

Steam turbine as shown in figure is a rotating machine which converts heat energy of steam to mechanical energy

Basic Principles:

The thermal power plant with steam turbine uses Rankine cycle. Rankine cycle is a vapor cycle having two basic characteristics:

i. The working fluid is a condensable vapor which is in liquid phase during parts of the cycle and
ii. The cycle consists of succession of steady flow processes, with each process carried out in a separated component specially designed for the purpose. Each constitutes an open system, an all the components are connected in series so that as the fluid circulates through the power plant each fluid element passes through a cycle of mechanical and thermodynamic stages.

Working principle:

When steam is allowed to expand through a narrow orifice, it assumes kinetic energy at the expense of enthalpy (heat energy).It is kinetic energy of steam is changes into mechanical (rotational) energy through the impact (impulse) ore reaction of steam against the blades.
It should be realized that the blade of the turbine obtains no motive force from the static pressure exerted as the result is normal to the blade surface at all points. The total motive force acting on the blade is thus the resultant of all the centrifugal forces plus the change of momentum. This causes the rotational motion of the blade.

Condensate system:

A typical condensate system consist of the following

i. Condenser(including hot well)
ii. Condensate pump\
iii. Air extraction system Gland coolers and L.P.heaters
iv. Deaeration

Condenser:

Condenser is basically a heat exchanger
The function of condenser is

i. To provide lowest economic heat rejection temperature for the steam. Thus saving on steam required per unit of electricity.
ii. To convert exhaust steam to water for reuse thus saving on feed water requirement.
iii. Deaeration of makeup water introduced in the condenser
iv. To form convenient points for introducing makeup water.

Types of condensers:

i. Direct contact
ii. Surface contact

Direct contact type (jet condenser)

In this type as shown in fig, condensation of steam takes place by directly mixing exhaust steam and cooling water. Requirement of cooling water is much less here compared to surface type. But cooling water quality should be equal to condensate quality.

Surface condenser:

This type is generally used for modern steam turbine installation. Condensation of exhaust steam takes place on the outer surface of the tubes which are cooled by water flowing inside them as shown in fig.

The condenser essentially consists of a shell which encloses the steam space. Tubes carrying cooling water pass through the steam space. The tubes are supplied cooling water from inlet water box on one side and discharged, after taking a way heat from the steam, to the outlet water box on the other side.

Instead of one inlet and one outlet boxes, there may be two or more pair or separate inlet-outlet water boxes, each supplying cooling water to a separate bundle of tubes. This enables cleaning and maintenance of part of the tubes while turbine can be running on a reduced load.

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Circulating water system:

As mentioned earlier, the circulating water system is one of the most important systems of steam power plants. Its supplies cooling water to the turbine condensers and thus acts as vehicle by which heat is rejected from the steam cycle to the environment.

Circulating water system is broadly classified as a (a) once-through (b) closed loop (c) combination system.

Once-through cooling system:

In this case, water is taken from a natural body of water such as like, river or ocean and pumped through the condenser where it is heated and then discharged back to the source. There are mainly three method of discharge namely (i) surface discharge (ii) submerged discharge and (iii) diffuser discharge.

Once through cooling system is thermodynamically, the most efficient means of heat rejection due to scarcity of water or other environmental regulation, closed loop system is universally used.

Closed loop system:

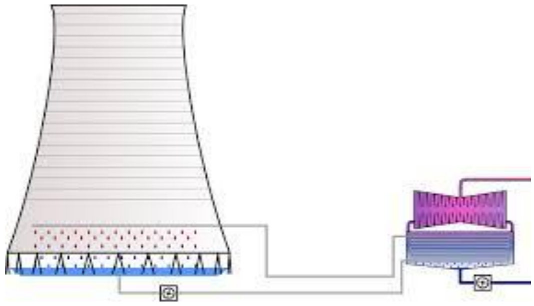
In this case hot water coming out from the condenser is passed through a cooling device (such as cooling towers, spray ponds, spray canals and cooling lakes) and is returned to the condenser with the help of pump. A nearby natural body of water is still necessary to supply makeup water to replace the lost by evaporation during the cooling process (in cooling tower) and to receive blow down from it.

Combination cooling system:

In combination cooling system is such in which wet cooling tower is used and as per requirement either the cooling water coming out from cooling tower is led to the open mode or closed mode as per availability of water or scarcity of water .

Cooling Towers:

The purpose of cooling tower as shown in figure is to cool the warmed water discharged from the condenser and feed the cool water back to the condenser. By this way, the cooling water requirement gets reduced to make-up water only. The cooling tower may be wet or dry type.



Introduction of Surface Condenser:

A steam condenser is a closed vessel in to which the steam is exhausted, and condensed after doing work in an engine cylinder or turbine. A steam condenser has the following two objects:

1. The primary object is to maintain a low pressure (below atmospheric pressure) so as to obtain the maximum possible energy from steam and thus to secure a high efficiency.

2. The secondary object is to supply pure feed water to the hot well, from where it is pumped back to the boiler.

3. The low pressure is accompanied by low temperature and thus all condensers maintain vacuum under normal conditions. The condensed steam is called condensate.

4. The temperature of condensate is higher on leaving the condenser than that of circulating water at inlet. It is thus obvious, that the condensate will have a considerable liquid heat.

1. Improved work done and efficiency:

The work done and efficiency of the plant increases due to increase in available enthalpy drop (h_1-h_2).

2. Recovery of condensate:

Recovery of condensate, due to condensation of steam is possible. This condensate is collected in a hot well from where it is pumped back to boiler as feed water. Recovery of condensate reduce the quantity of makeup water that should be added to boiler from 100% to 1.5%.recovery of condensate is essential where good quantity of feed water is not available.

3. Reduced steam consumption:

There is about 6% of reduction in steam consumption for kw/hermit the vacuum increases from 71-73.5cms of mercury.

4. Reduced thermal stresses:

Supplying of water to boiler reduces thermal stresses affects economy.

5. Economy in water softening plant:

If the feed water is not available in pure form, it has to be treated in a water softening plant recovery of condensate reduces the capacity of water softening plant and in therefore economical.

The efficiency of power plant depends to a greater exhaust on the pressure at the exhaust than the high pressure condition of steam at inlet. The rate of increase of steam consumption for one cm of vacuum from designed turbine condition is 1.5-2% for normal units operation at an absolute pressure of about 72cms of mercury. This one fact is sufficient to explain the importance of condensing plans in a thermal power station.

The quantity of water available and its temperature decides the vacuum which can be maintained in the condenser. The effect of water temperature and water quantity and the vacuum, in the condensers as shown in the fig.

3.1.4. STEAM SURFACE CONDENSER AIR REMOVAL

The two main devices that are used to vent the no condensable gases are Steam Jet Air Ejectors and Liquid Ring Vacuum Pumps. Steam Jet Air Ejectors (SJAE) use high-pressure motive steam to evacuate the noncondensables from the condenser (Jet Pump). Liquid Ring Vacuum Pumps use a liquid compressing to compress the evacuated noncondensables and then discharges them to the atmosphere. (See the HEI Primer on Vacuum on the HEI Website, www.heatexchange.org, for further information about Steam Jet Ejectors and Liquid Ring Vacuum Pumps.)

To aid in the removal of the no condensable gases, condensers are equipped with an Air-Cooler section. The Air-Cooler section of the condenser consists of a quantity of tubes that are baffled to collect the noncondensables. Cooling of the noncondensables reduces their volume and the required size of the air removal equipment.

Air removal equipment must operate in two modes: hogging and holding. Prior to admitting exhaust steam to a condenser, all the noncondensables must be vented from the condenser. In hogging mode, large volumes of air are quickly removed from the condenser in order to reduce the condenser pressure from atmospheric to a predetermined level. Once the desired pressure is achieved, the air removal system can be operated in holding mode to remove all no condensable gases.

3.1.5 SURFACE CONDENSER OPERATION:

In surface condensers, there is no direct contact between steam to be condensed and the cooling water, there is a wall interposed between than through, which heat in transferred by conduction and convection. The temperature of condensate may be higher than cooling water at outlet, because the circulating water and cooling water does not mix, as the cooling water and steam does not mix, the condensate is directly available as an ideal boiler feed. The surface condensers are more efficient in creating higher vacuum than jet condensers and hence are popular for thermal power plants. Further advantage which is very important is that any kind of cooling water can be used in surface condenser, where as in jet condenser the cooling water has to be pure. The only disadvantage is that the initial capital cost is higher and comparatively much volume space in needed or surface condenser.

The tubes of the surface condenser are usually made of red brass (or) muntz metal for pure water and with admiralty brass for salt and impure water.

Fig:- 2.7 Surface condenser

The surface condensers are further classified as according to:

a) No of presses single pass and multiples
b) Direction of condensate flow on tube arrangement down flow
c) Central flow or regenerative condenser

1) Single pass and multi pass condensers:

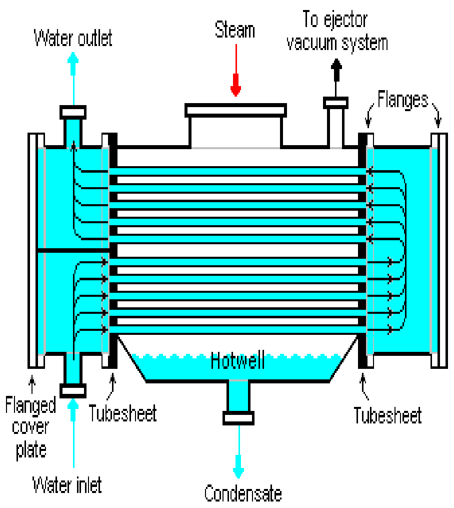
It comprises a cast iron cylindrical shell having the two ends covered by cover plates. Other shapes of shell, such as, oral or U may also be used in bigger size plant, rectangular shape may be used due to difficulty in manufacturing. A nest of brass tubes is fixed to the two tube plates at the ends. They are fixed by brass ferrules so that they can be easily replaced, when necessary. The space between the tube plates and cover plates is known as water boxes. The tube plates are sand witched between the water boxes and condenser shell which receives the steam. For a two pass or multi pass condenser a partition is made in the water box which receives cooling water. These partitions enables, the circulating water to make too passes of the tubes before being discharged.

The cold water is sent through the lower half section of tubes and comes out through the upper half section. The lower half section tubes contain water at lower temperature than upper half section. Exhaust steam enters the shell at the top and courses down surrounding the cold water tubes. Steam first comes in contact with tubes containing comparatively hotter water which has been progressively heated by the condensing steam and then passes down and is effectively condensed by the cold water by the tubes, before being extracted by the extraction pump.

Fig:- 2.8 Single pass and multi pass condensers

The surface condensers may operate on the wet vacuum or dry vacuum systems. For wet vacuum systems two pumps are required, one or circulating cooling water and the other or extracting both air and condensate together.

In dry vacuum type condenser three pumps are required, one for circulating cooling water, after for removing condensate and the third, the dry air pump, for removing air. a battle in arranged at the air exit to prevent the steam going along with air; since air removed contains very little steam, the temperature of air is reduced. This reduces the capacity of dry air pump



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3.3.1. CONDENSER TUBE CLEANING METHODS:

Regardless of the tube material, the most effective way to ensure that tubes achieve their full life expectancy is to keep them clean. Each time the tube deposits, sedimentation, biofouling and obstructions are removed, the tube surfaces are returned almost to bare metal, providing the tube itself with a new life cycle, the protective oxide coatings quickly rebuilding themselves to repassivate the cleaned tube.

The majority of cleaning procedures are performed off-line, the most frequently chosen and fastest method being chemical method.

1. OLTC(online tube cleaning)
2. Hydro jet cleaning method
3. Bullet shot method
4. Chemical cleaning method.

1). OLTC (online tube cleaning):

Very few on-line methods are available to clean condenser tubes but the best known is the Taprogge system, which uses recirculated sponge rubber balls as the cleaning vehicle. These system is often operate for only a part of each day and, rather than maintaining absolutely clean tube surfaces, tend to merely limit the degree of tube fouling.Unfortunately, although the tubes may become cleaner if abrasive balls are used, tube wear can now become a problem.

Mussalli et al(8) showed some uncertainty concerning sponge ball distribution and therefore, how many of the tubes actually become cleaned online. It is also not uncommon to find that numerous sponge balls have become stuck in the condenser tubes and these appear among the material removed during chemical cleaning operations. For these reasons, the tubes of condensers equipped with these on-line systems still have to be cleaned periodically off-line, especially if loss of generation capacity is of serious concern.

In the on-line process, the cleaning body moves through the tubes with the conveying medium and cleans them by means of its oversize compared to the tube diameter. In the range of diameters of up to 50 mm these cleaning bodies consist of sponge rubber, in larger diameters up to the size of oil pipelines it is a matter of scrapers or so-called pigs. Sponge rubber balls are applied mainly for cooling water, like sea, river, or cooling water. For the chemical or pharmaceutical industry, specially adapted cleaning bodies are imaginable but the conveying media flows are so weak that off-line processes are employed in most cases. Given the fact that the cleaning bodies are not allowed to remain in the conveying medium they have to be collected after passing through the tubes.

In the case of sponge rubber balls this is done through specials trainer sections; for scrapers or pigs an outward transfer station is provided. According to the Taprogge process, the sponge rubber balls are re-injected upstream of the system to be cleaned by a corresponding ball recalculating unit whereas the scraper or pig is mostly taken out by hand and re-injected into another collector. Sponge rubber balls therefore safeguard a continuous cleaning while the scraper or pig system is discontinuous.

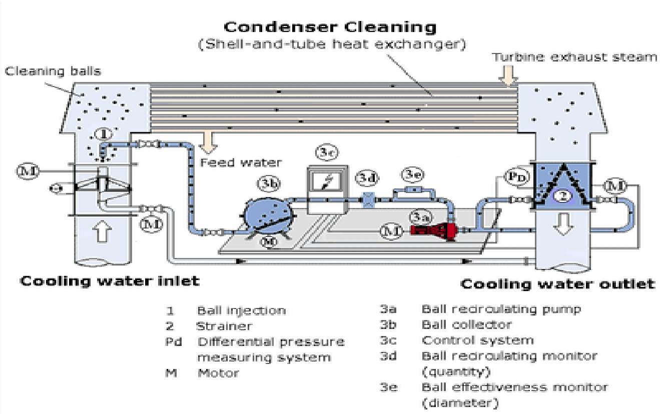

Fig:- 3.1 Schematic representation of the cleaning process and of the filtration technology

2. Hydro jet cleaning method:

Among other off-line methods is the use of very high-pressure water but, since the jet can only be moved along the tube slowly, the time taken to clean a condenser can be become extended. Great care must be taken to avoid damaging any tube sheet or tube coatings which may be present; otherwise the successful removal of fouling deposits may become associated with new tube leaks or increased tube corrosion, only observable after the unit has been brought back on-line.

Hydro-jet cleaning is a method of cleaning with high pressure streams of water to remove build up and debris in tanks and lines. This process is best described as a more powerful form of power washing, which has also gained popularity as a means to clean driveways, homes, streets, commercial vehicles and more.

3).Bullet shot method:

Cooling Water causes different tube fouling problem that affects the heat transfer and life expectancy of Condenser Tubing.Bio fouling is organic debris that adheres to the inside diameter of the tube surface or blocks the intake flow at the tube sheet. All tube fouling will increase flow velocity, reduce heat transfer, increase back pressure and decrease efficiency of the condenser.Bio fouling will substantially increase fuel costs. Slime/Algae is bacteria that adhere to the condenser tube surface. This bio fouling will

reduce the usable tube surface area, will have a negative effect on heat transfer, will constrict cooling water flow and will significantly decrease plant performance.

These biological organisms will aggravate and accelerate corrosion, erosion and cause pitting of the condenser tubes. Foreign Material lodged downstream in the tubes causing flow deflection, will result in localized pitting, eventually leading to premature

Fig:- 3.3 Bullet shot method

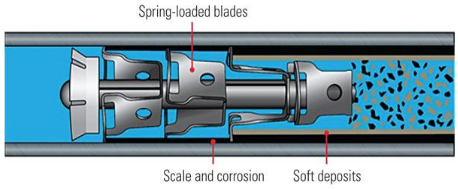

Fig: - 3.4 Chemical cleaning method

PERFORMANCE ANALYSIS OF CONDENSER:

Normally, the following affect s the performance of condenser

1. High condenser deferential pressure caused by the tube side fouling.
2. High condenser block pressure due to inadequate cooling water flow.
3. High condenser pressure because of a large number of lagged tubes.

Efficiency of condenser:

$$\eta_{Cond} = \frac{Actual\ cooling\ water\ te}{Max.possible\ temp\ r}$$

$$\eta_{Cond} == [T_{out} - T_{in} / T_{sat} - T_{in}]$$

Vacuum Efficiency:

$$\eta_{Vac} = \frac{Actualv}{Idealva}$$

Actual vacuum: P_b-P_t

Ideal vacuum= P_b-P_s

$$\eta_{Vac} = (Pb - Pt / P_b - P)$$

P_s=Saturation pressure of steam in bar corresponding to the steam temperature entering into the condenser.

P_t = Actual pressure (or) total pressure of air and steam in condenser (P_b+P_s)

Performance of condenser:

Evans has suggested the following performance factor for condenser.

Performance factor K

= $(T$

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Tabular form values before cleaning of condenser:

S. NO	USED METHOD	T_{cw} inlet	T_{cw} outlet	T_{inlet} steam	Vacuum	η_{th}	η_{cond}	η_{vac} cum	K
1	OLTC	10	25	48^0	91.0	28%	50.3%	100%	3.125
2	BULLET SHOT	29	39	32^0	71.1	23%	52.6%	98.16%	7.142
3	HYDROJET	32	41	35^0	71.0	25%	52.9%	98.2%	8.653
4	CHEMICAL CLEANING	34	44	38^0	69.0	30%	58.82%	96.13%	9.89

Before Cleaning Of Condenser:

OLTC (Online Tube Cleaning method):

η_{Cond} = = 0.503= 50.3%

$\eta_{Vacuum} = \frac{(}{(1.0132}$ = =1.0093=100%

Performance (K) = $\frac{1800}{(39.83-25)\times(39.83-}$=3.125

BULLETSHOT METHOD:

η_{Cond}= =0.529=52.9%

η_{Vacuum}= =0.982=98.2%

Performance (K) = $\frac{18}{(49-41)\times(}$=8.653

HYDROJET METHOD:

η_{Cond}= **=0.526=52.6%**

η_{Vacuum}= =0.9816=98.16%

Performance (K) = $\frac{18}{(48-39)\times(}$=7.142

CHEMICAL CLEANING:

η_{Cond}= **=0.5882=58.82%**

η_{Vacuum}= =0.96.13=96.13%

Performance (K) = $\frac{18}{(51-44)\times(}$=9.89

Tabular form values after cleaning of condenser:

S. NO	USED METHOD	T_{cw} inlet	T_{cw} outlet	T_{inlet} steam	Vacuum	η_{th}	η_{cond}	V_{ac}uum	K
1	OLTC	12	28	48 0	0.91	31 %	55.33 %	100 %	4.054
2	HYDROJET	31	42	32 0	711	26 %	55 %	98.16 %	8.035
3	BULLETSHOT	37	45	35 0	710	28 %	57.14 %	98.2 %	10.714
4	CHEMICAL CLEANING	35	45	38 0	69	34 %	62.5 %	96.13 %	13.84

AFTER CLEANING OF CONDENSER:

OLTC (Online Tube Cleaning method):

η_{Cond} = = 0.533= 53.33%

$\eta_{Vacuum} = \frac{(}{(1.0132}$ = =1.0093=100%

Performance (K) = $\frac{18}{(40-28)\times(}$=4.054

BULLETSHOT METHOD:

η_{Cond}= =0.5714=57.14%

η_{Vacuum}= =0.982=98.2%

Performance (K) = $\frac{18}{(52-45)\times(}$=10.714

HYDROJET METHOD:

η_{Con}= =0.55=55%

η_{Vacuum}= =0.9816=98.16%

Performance (K) = $\frac{18}{(50-42)\times(}$=8.035

CHEMICAL CLEANING:

η_{Cond} = =0.625=62.5%

η_{Vacuum}= =0.96.13=96.13%

Performance (K) = $\frac{18}{(51-46)\times(}$=14.

RESULT AND DISCUSSION

Cooling water parameters influence on the condenser performance:

Condenser heat transfer rate strongly depends on condensing pressure, cooling water flow rate and temperature. In an ideal situation, when the venting system properly removes air from the steam condenser, the achievable condensing pressure is determined by temperature of cooling water .For the steam power plant with closed cycle cooling system,cooling water temperature is determined by natural water source or ground temperature. This means that cooling water temperature is changing with weather conditions in particular region, and cannot be changed in order to achieve better condenser performances i.e., higher vacuum in the condenser).Still, cooling water temperature directly affects condenser performances. Suitable parameters for on-line control is cooling water flow rate, and it can be varied in a wide range, with appropriate circulation pumps. During plant operation the objective is to operate at the optimum cooling water flow rate, which depends on cooling water temperature and power demand. In that manner, cooling water temperature and flow rate are considered variable parameters in the simulation of the surface condenser operating conditions.

Condensing pressure and cooling water temperature:

With cooling water temperature rise, the mean temperature difference in the condenser decreases, and condenser heat transfer rate for the same condensing pressure will also decrease.

It means that this particular condenser is designed at its maximum heat transfer and with increased cooling water temperature it cannot achieve required value. In this way, the question of the valid designed parameters is opened. Increasing of cooling water flow rate will increase the condenser heat transfer rate for the given cooling water temperature.

Condensing pressure dependence on cooling water temperature is obtained for the given water flow rate and steam load of the condenser. Steam load is considered constant, in order to obtain a clear illustration of this dependence as it is shown in fig. It is obvious that with cooling water increasing, pressure in the condenser will also increase.

The efficiency of the condenser is reducing of reduced loads.

Even though the vacuum efficiency is 100% and cooling water temperature is also low at 29^0c, at the load of 116Mw. The efficiency of condenser is low; this is due to the loss of heat transfer to the cooling water. These may be, to the fouling and scaling effect of CW tube or it may be due to the unclean condenser surface.

This performance factor is also decreases form 11.11 as full load 120MW to 7.14 at a reduced load of 116MW

Hence it is concluded that for better efficiency and performance of the surface condenser .The unit is to be run as full load i.e. 120MW

CONCLUSION

This paper evaluated all the aspects of condenser which affecting the performance of surface condenser. This paper worked on three causes which affecting the performance of condenser are deviation due to inlet temperature of cold water is 25.4mbar ,deviation due to cold water flow on load 0.8 mbar, deviation due to air ingress/dirty tube, so total deviation of pressure in the condenser is 35.4mbar.Eventually,this paper find that the total efficiency of a surface condenser will reduces. To overcome all of these deviation in the condenser and by overcome these three reasons, the performance of surface condenser can be rises with a good level.

The performance of the condenser is mainly dependent on the following factors.

- Cleanliness of the CW tube
- Cleanliness of the heat transfer or surface
- Inlet CW temperature
- Efficiency of air ejection system
- Heat transfer rate

By using of chemical cleaning method. The chances of fouling and scaling inside the CW tubes are reduced, to the maximum extent.

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