PERFORMANCE AND ANALYSIS OF COOLING TOWER

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Abstract- *In thermal power plant one of the main parts is consider, which cools the refrigerant. When cooling the refrigerant, the cold water becomes the hot water. The hot water temperature is reduced by cooling towers. When hot water enters into the induced draft cooling tower and sprayed by nozzles. So hot water is converted into cold water .The effective cooling of water depends upon the dry bulb temperature and wet bulb temperature, size, height of the cooling tower and velocity of air .The project deals with the performance study and analysis of induced draft cooling tower, which is one of the deciding factors used for increasing the power plant efficiency also modelling and analysis of flow using software .A cooling tower is an enclosed device for the evaporative cooling of water by contact with the air. Cooling tower is a heat rejection device. Common application includes cooling the circulating water used in oil refineries, petrochemical, and other chemical plants, thermal power stations and HVAC system for cooling buildings. The efficiency and effectiveness of cooling tower depends on number of parameter like inlet air angle, inlet and outlet temperature of air and water, fill materials, fan speed etc.*

Keywords*: inlet air angle, inlet and outlet temperature of air and water, fill materials, fan speed etc.*

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LIST OF SYMBOLS

T	Temperature	ºC
P	Pressure	N/mm^2
WBT	Wet bulb temperature	ºC
DBT	Dry bulb temperature	ºC
Q	Convective heat transfer	KJ/hr
V	Velocity	m/s
δ_a	Density of air	kg/m^3
P_{motor}	Motor power	KW
M_w	Mass of water vapour	Kg
K	Overall enthalpy coefficient	J/kg
C_{pw}	Specific heat	J/kgK
ε	Efficiency	%

I.INTRODUCTION

The steam thermal power stations are requiring the steam to be condensate to return to the boiler in a liquid phase; i.e., water. The condensation process involves heat rejection from the working fluid, the steam. The heat rejection process requires cold water to be supplied to the condenser. Usually, this cold water is supplied from continuous water resource. This type of cold water supply to the condenser is cold "Open Cooling System". In cases of shortage of the cold water supply for any reason, the designers intend to compensate by using "Closed Cooling System". In such case, the cooling water is circulating in a close loop consisting tower unit to reject the heat from the cooling water to the open atmosphere. In some cases, some percent of the cooling water is added from the available water resources to the closed system to reduce the size of the cooling tower. The percentage of the added water is called mixing ratio. When the mixing ratio is zero, it is completely closed system. When the mixing ratio is 100%, it is an open system.One of the important cooling tower components is the tower fill or packing. The tower till can be classified into two types: film type or splash type. In either case, the main function is to increase the contact area between the cooling water and air and to maximize the resident time for the cooling water in the tower. In general, the film type packing has a denser configuration than do the splash-type fills. Thus less volume of film-type packing is required to remove a given heat load.

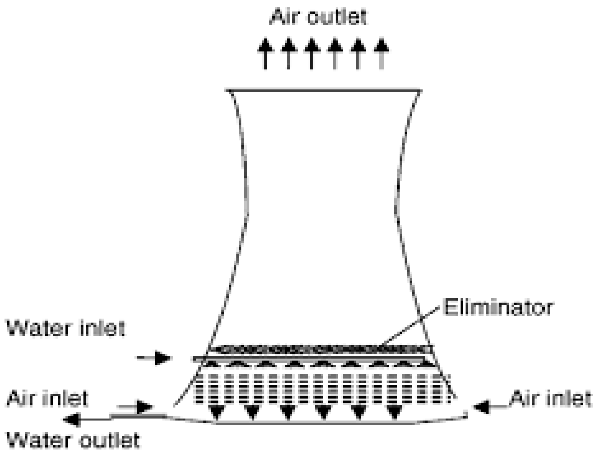
II.TYPES OF COOLING TOWER

This section describes the two main types of cooling towers is

- Natural draft cooling tower
- Mechanical draft cooling tower

Natural draft cooling tower

The natural draft or hyperbolic cooling tower makes use of the difference in temperature between the ambient air and the hotter air inside the tower as hot air moves upwards through the tower (because hot air rises), fresh cool air is drawn into the tower through an air inlet at thebottom.

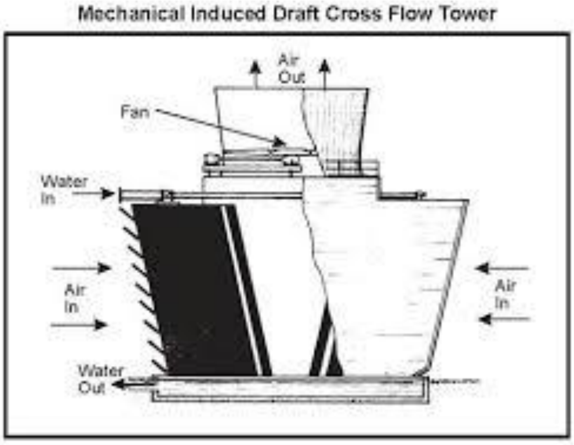


Mechanical draft cooling tower

Mechanical draft towers have large fans to force or draw air through circulated water. The water falls downwards over fill surfaces, which help increase the contact time between the water and the air -thishelps maximize heat transfer between the two. Cooling rates of various parameters such as fan mechanicaldraft towers depend upon diameter and speed of operation, fills for system resistance etc.

Types of Mechanical draft cooing tower

- Induced Draft Counter Flow
- Induced Draft Cross-Flow



III.SELECTION OF COOLING TOWERS

The selection of cooling tower depends on many factors. An improper selected cooling tower will financially cause a loss in production due to increase in circulating water temperature and increase in electrical operating costs. Emphasis must be placed on properly specified and designed cooling towers that require minimum maintenance. To properly select a cooling tower many choices and decisions are required. The required cooling tower size and performance depends on

- Mass flow rate of water
- Hot water temperature
- Cold water temperature
- Cooling range
- Approach to wet bulb temperature
- Tower type
- Materials of construction
- Total heat rejection
- Water quality
- Air flow rate
- Wet bulb temperature
- Fill media (film, splash)

IV.COMPONENTS OF COOLING TOWER

The basic components of a cooling tower include the frame and casing, fill, cold-water basin, drift eliminators, air inlet, louvers, nozzles and fans.

V.COOLING TOWER MATERIALS

Originally, cooling towers were constructed primarily with wood, including the frame, easing, louvers, fill and cold-water basin. Sometimes the cold-water basin Wilk; made of concrete today, manufacturers use a variety of material to construct cooling towers. Materials are chosen to enhance corrosion resistance, reduce maintenance, and promote reliability and long service life. Galvanized steel, various grades of stainless steel, glass fiber, and concrete are widely used in to construction, as well as aluminum and plastics for some components

VI.CFD ANALYSIS OF COOLING TOWER

Here ANSYS workbench is used for CFD analysis of cooling tower. For CFD analysis following steps are performing. In step 1 cooling tower model make in Creo, which is converted into STEP file and this step file are imported in ANSYS. In step 2 the meshing of this cooling tower modelling is done. In meshing CFD mesh type is selected and fine meshing is done by using ten node tetrahedral elements. The reason for selecting these element is that gives the good meshing on curvature parts. Here the ANSYS is automatically select the element. In step 3 various domains is defined. Here there are 3 domains are defining. Domain 1 is for water. The domain 2 is porous domain and domain 3 is air domain. After define the domain interface between each domain to transfer the effect of each other. In boundary condition the inlet water temperature 38^{0}c, inlet air temperature 20^{0}c, volume of circulating water circulated in cooling tower 30 m3/hr.

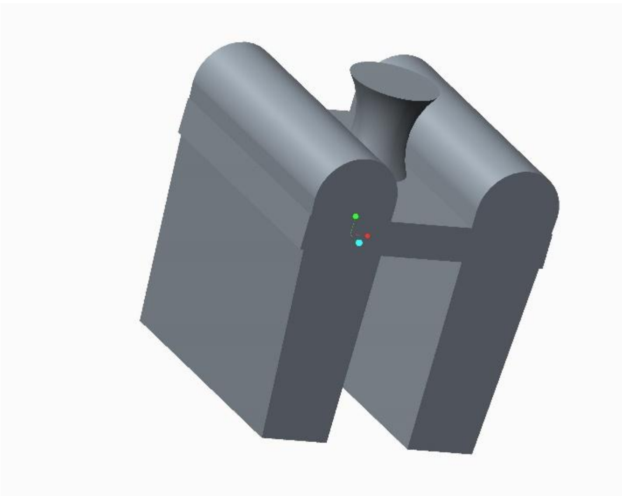


Fig :1 Modeling of Cooling Tower

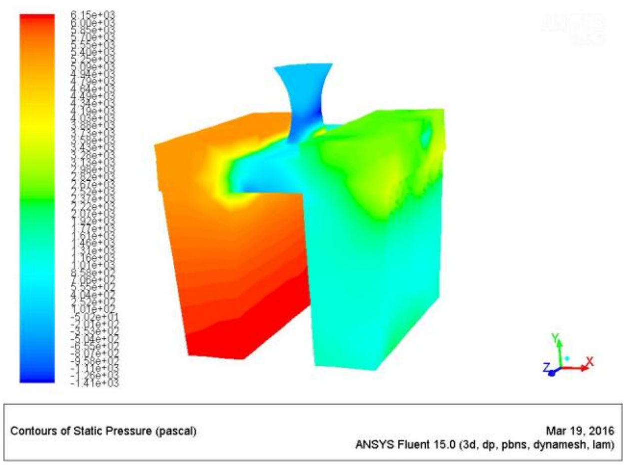


Fig :2 Contours of Static Pressure

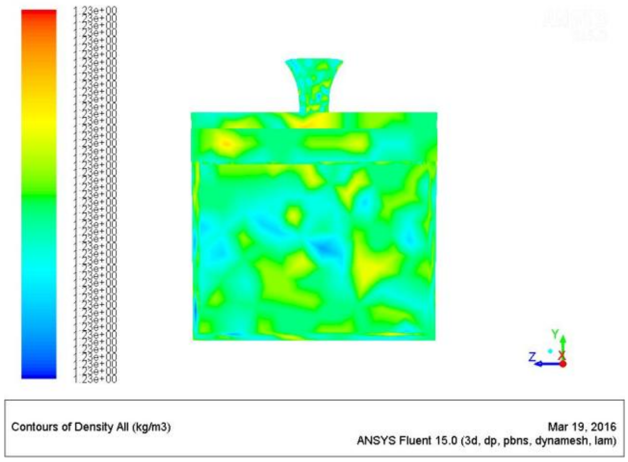


Fig :3 Contour of Density

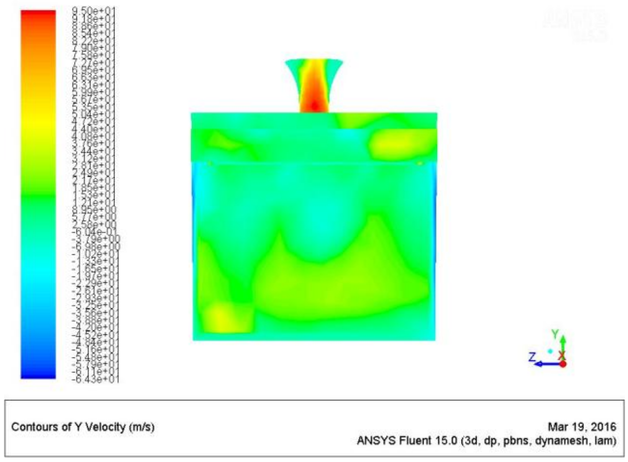


Fig:4 Contour of Velocity

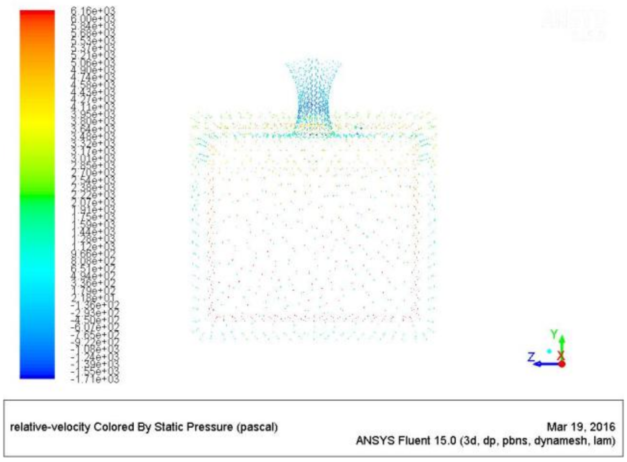
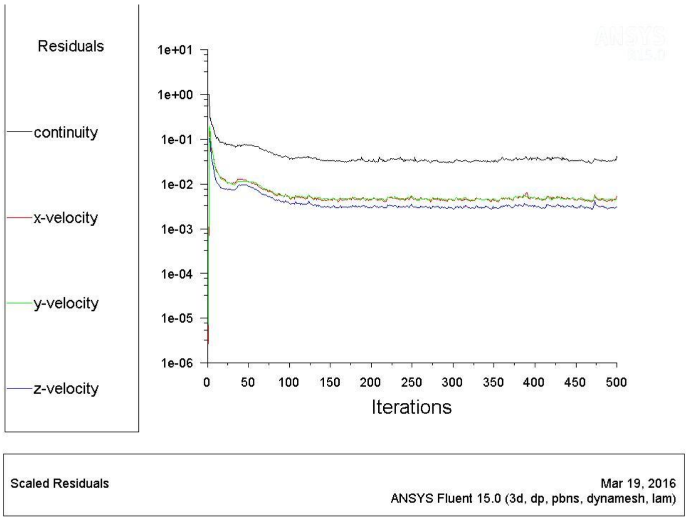


Fig :5 Relative Velocity Colored by Static Pressure



FORMULA USED

1.Cooling tower range

= Hot water temperature - Coldwater temperature

2.Cooling tower approach

= Water outlet temperature- Wet bulb temperature

3.Effectiveness = Range/ (Range + Approach) *100

4. L/G ratio = Water Flow in Kg/Air Flow in kg

5. Air mass flow/cell = Flow * Density of Air

6. Make up water consumption

= Evaporation Loss/(coc-1)

7. Total heat transfer $Q = k*s\ (h_w - h_a)$

8. Cooling load $Q_1 = m_a\ (ha_2 - ha_1)$

9. Convective heat transfer ratio

$Q = m_w * cp_w * (Tw_i - Tw_o)$

10. Evaporation loss (m^3/hr)

= 0.00085*1.8*circulation rate*($T_1 - T_2$)

11. Efficiency (ε) $= T_1 - T_0 / T_i - T_{wb} * 100$

Where,

Tw_i – Water inlet temperature

Tw_o – Water outlet temperature

T_1 - Inlet temperature

T_2 –outlet temperature

CONCLUSION

It has been shown that CFD can be used for performance and analysis of cooling tower in terms of cooling efficiencies and effectiveness. Water outlet temperature of cooling tower decreases as the air inlet angle decreases. Hence the cooling efficiency and effectiveness of cooling tower increases. Out of selected three air inlet angles, angle of 15^0c leads to maximum efficiency and effectiveness for selected cooling tower. On the other side, as the air inlet angle increases the water outlet temperature also increases and cooling efficiency and effectiveness of cooling tower decreases.

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