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Optimization Of Air Inlet Angle For Increase The Effectiveness Of Induced Draught Cross Flow Cooling Tower

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Abstract

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 applications include cooling the circulating water used in oil refineries, petrochemical and other chemical plants, thermal power stations and HVAC systems for cooling buildings. The efficiency and the effectiveness of cooling tower is depend on number of parameter like inlet air angle, inlet and outlet temperature of air and water, fill materials, fan speed etc. In current work the air inlet angle is optimize by selecting three different inlet angles. For this CFD analysis of induced draught cross flow cooling tower is done in ANSYS workbench.

I. INTRODUCTION

cooling tower is a heat rejection device that transfers waste heat from a process to the atmosphere though the cooling of the recalculated water flow. The type of heat rejection is commonly termed "evaporative cooling". Cooling Towers are used in facilities where process cooling is required in order to dissipate the heat that is created as a result of the process application, including power generation, oil refining, steel mills, pulp and paper plants, chemical processing and more. Cooling Towers are also a necessary component of the HVAC systems used to heat and cool large commercial buildings or server rooms.

There are number of factor affecting the performance of cooling tower like inlet temperature of water and air,outlet temperature of water and air,porosity in fins, speed of fan, mass flow rate of air and water. Out of this parameter inlet air angle is very effective parameter on the performance of the cooling tower. So we optimize this angle by CFD analysis of cooling tower.

II. CFD ANALYSIS

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

Fig 1,fig 2 and fig 3 show the cooling tower model in solid work for 30,15 and 45 degree air inlet angle respectively

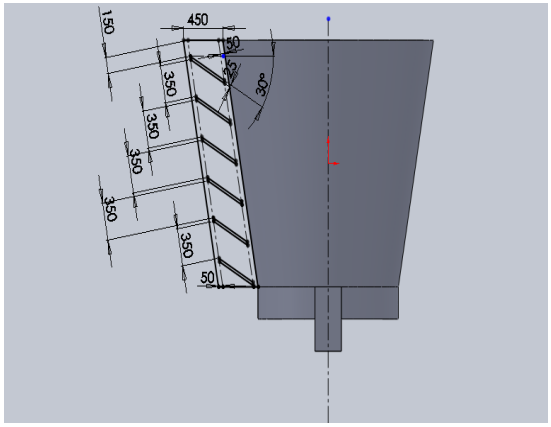

Fig 1: 3D Model of 30 Degree Air Angle

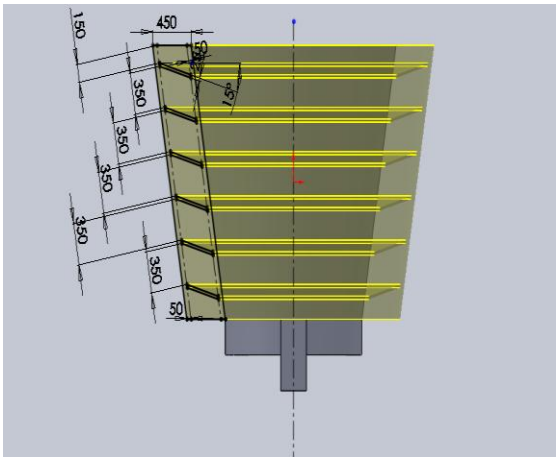

Fig 2: 3D Model of 15 Degree Air Angle

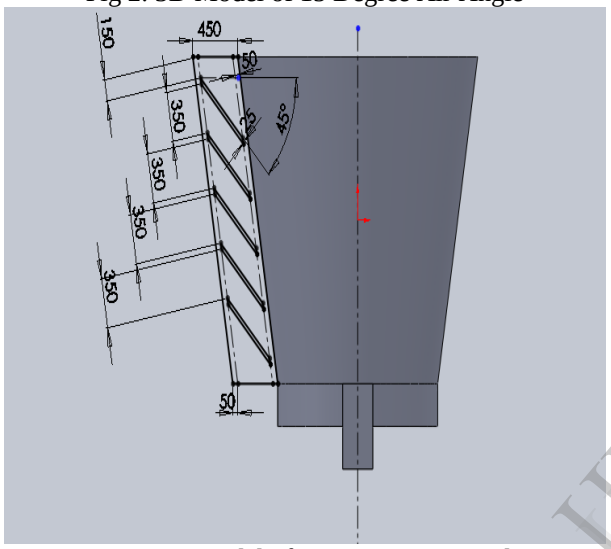

Fig 3: 3D Model of 45 Degree Air Angle

Fig 4 shows the meshing of cooling tower. The meshing detail of cooling tower is shown in Table 1.

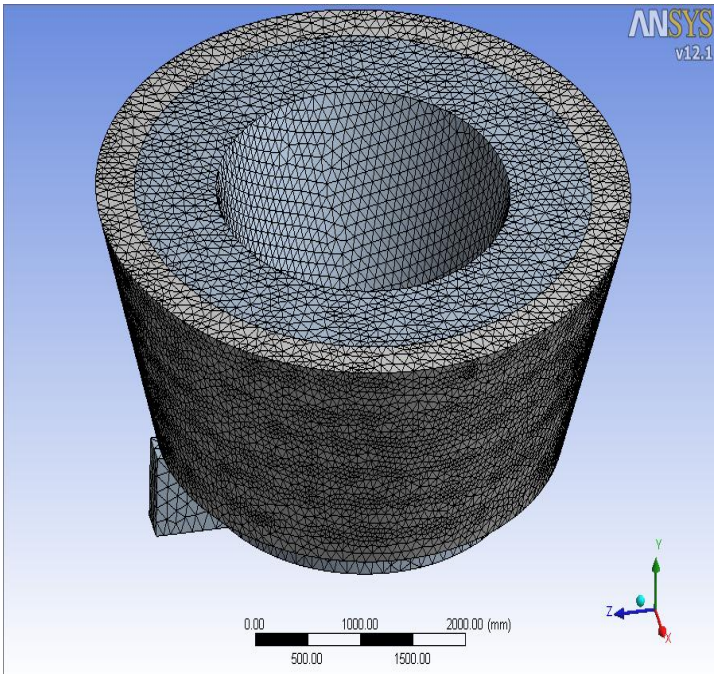

Fig 4: Meshing detail of cooling tower

Table 1: Meshing detail of cooling tower

DOMAIN	NODES	ELEMENT
DOMAIN 1	85825	415025

After meshing the boundary condition is shown in fig 5 and fig 6 and fig 7.

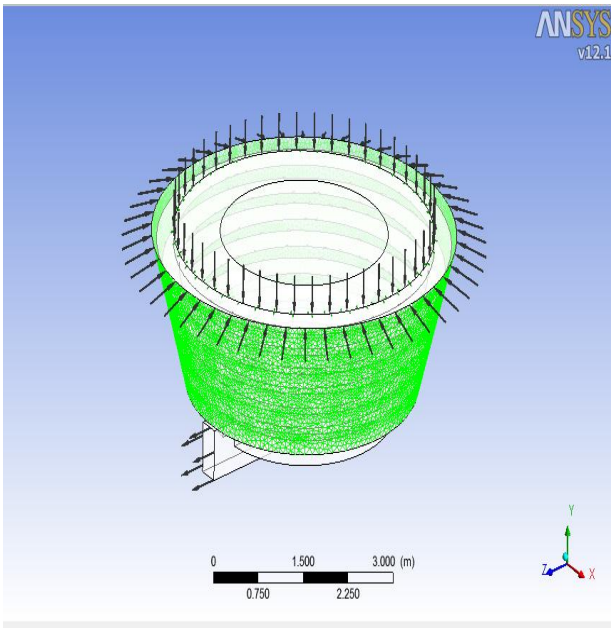

Fig 5: Inlet for Air Domain

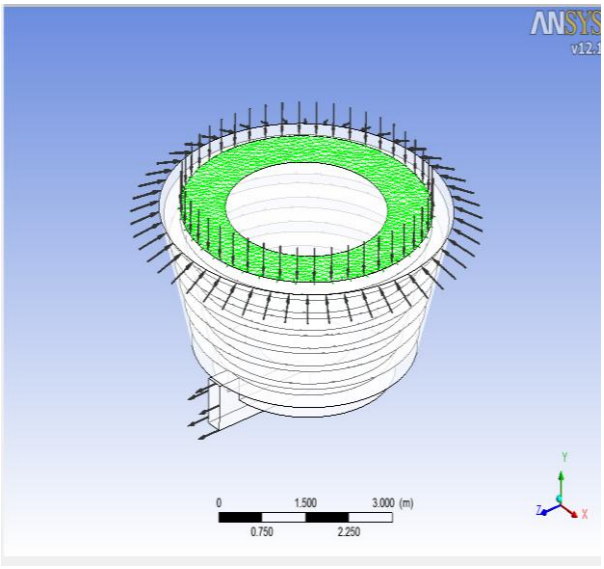

Fig:6 Define inlet for Water Domain

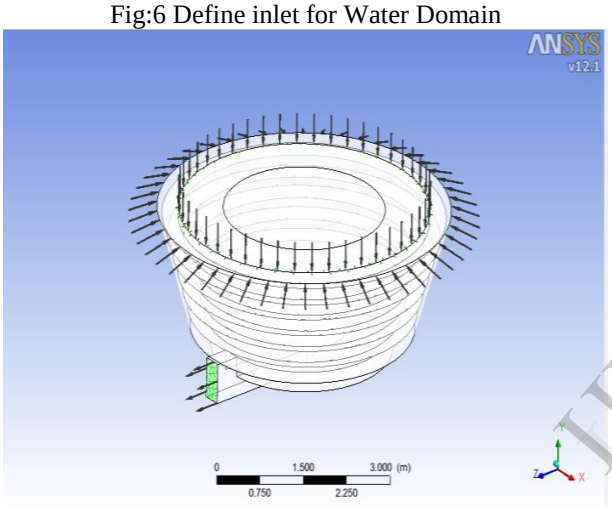

Fig 7: Outlet for Water Domain

Post processor result of ANSYS is shown in Fig 8,Fig 9,Fig 10 below.

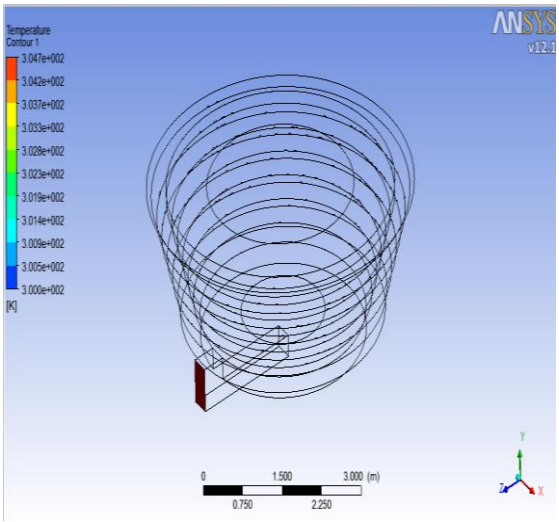

Fig :8 Temperature Contour for 30 Degree Air Angle

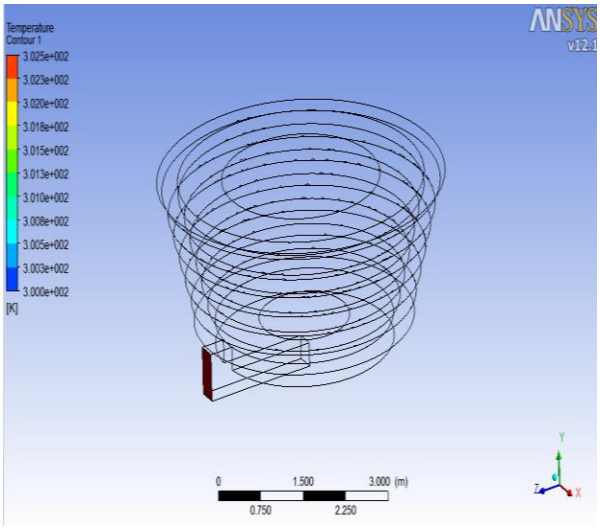

Fig :9 Temperature Contour for 15 Degree Air Angle

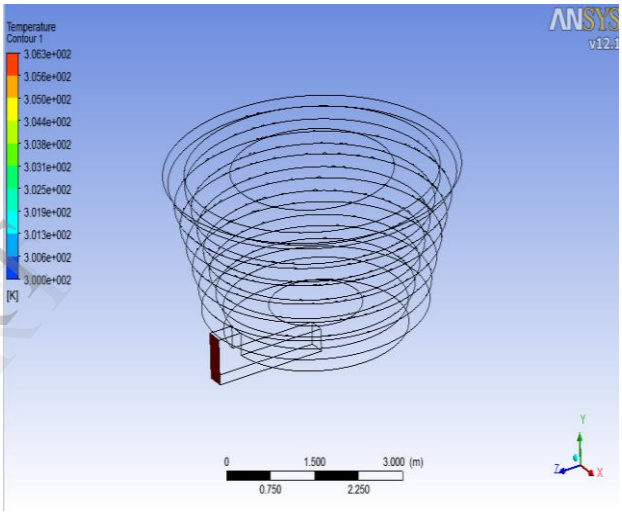

Fig :10 Temperature Contour for 45 Degree Air Angle

Table 2 shows the result of three different air inlet angle.

Sr No.	Air inlet Angle	Temperature
1	15	302.5
2	30	304.67
3	45	306.3

Temperature viruses air inlet angle graph is shown in fig 11.

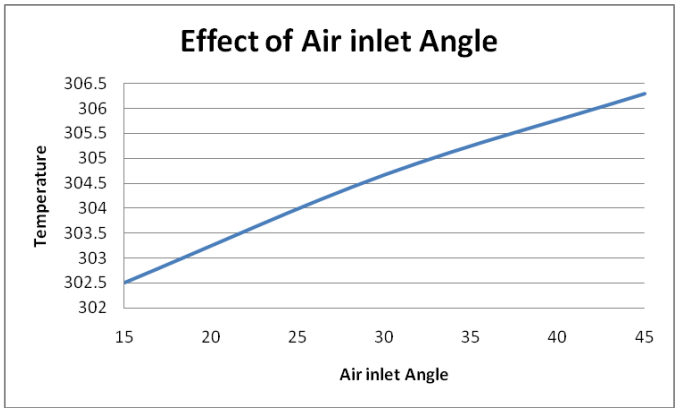

FIG 11: TEMPERATURE VIRUSES AIR INLET ANGLE

CONCLUSION

- It has been shown that CFD can be used for performance evaluation of cooling towers in terms of cooling efficiency 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 15^0 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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