Thermal Analysis of Induced Draught Cross-Flow Cooling Tower-A Review

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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. The efficiency of cooling tower is increased due to minimized losses. The estimation of evaporation rate is an important factor in the design and analysis of any cooling tower.

In present work, the predictions of the evaporation rate and the temperature distribution of water in an induced draught cooling tower of a large capacity power plant. For this, the online data captured during a normal working period of plant is used for thermal analysis. Finite difference method is used for temperature distribution of water. Also prepare program in computer code for temperature distribution. From the present study, it is seen that the rate of evaporative loss of water is linearly depend on the volume flow rate of water to be handled by the cooling tower. From the estimation of temperature distribution of water in the cooling tower, it is seen that the drop in temperature approximately is 10-11° C.

Keywords – Cooling Tower,Cross flow,Induced draught

I. INTRODUCTION

Cooling is an important operation on all chemical and on many other types of industrial plant. Large quantities of heat have often to be removed from the plant fluids, and water is one of the most readily available agents to which this heat may be transferred. To give some idea of the quantities of water involved, it may be noted that a large power station can require cooling water at a rate of about 15,000,000 gallons per hour, while one large chemical works pumps water from a river at the rate of over 7,700,000 gallons per hour. The most obvious source of water for a large industrial plant is a river, estuary, or canal, in fact many such plants are sited near to suitable bodies of water of this kind. It is clear from the foregoing that the large-scale use of cooling water may not always be consistent, for practical or economic reasons, with the use of a one – through cooling system, i.e. of a system in which the water, after passing once through the plant coolers, is discharged to waste. Under this condition, the use of a circulating system may become advisable. In this system, the water leaving the plant coolers is not allowed to run to waste but is circulated repeatedly, first passing through some device, such as a water cooling tower, in which the heat picked up from the plant fluids is transferred to the atmospheric air. In this way, it is much more economically water system then from canal or river.

A cooling tower is an enclosed device for the evaporative cooling of water by contact with the air. This is achieved partly by an exchange of latent heat resulting from the evaporation of some of the circulating water, and partly by a transfer of sensible heat. Cooling tower is a heat rejection device. Its main function is to extract waste heat from warm water to the atmosphere. Heat rejection device. Its main function is to extract waste heat from warm water to the atmosphere. Heat rejection in cooling tower is specified as convection between the fine droplets of water and the surrounding air, and also as evaporation which allows a small portion of water to evaporate into moving air. Therefore, the process involves both heat and mass transfer.

The principle of cooling the water in cooling tower is similar to the evaporative condenser. In evaporative cooling three processes go on simultaneously, viz.,

i. The transfer by convection of sensible heat from warm water to colder air,

ii. If the main body of the air is at a lower vapour pressure than that at the water surface, matter is transferred in the form of water molecules, and

iii. There is a movement of heat from the bulk of the liquid to the surfaces. This last effect is generally ignored in cooling calculations since the thermal resistance to such the thermal resistance to such direct internalconduction is slight.

The rate of evaporation of water in cooling tower and reduction of water temperature depends upon following factors :

i. The time of exposure

ii. Amount of water surface area exposed

iii. The direction of air flow relative to water

iv. The relative velocity of air passing over the water droplets formed in cooling tower

v. The relative humidity of air and difference between the inlet air wet bulb temperature and water inlet temperature

If cooled water is returned from the cooling tower to be reused, some water must be added to replace, or make-up, the portion of the flow that evaporates. Because evaporation consists of pure water, the concentration of dissolved minerals and other solids in circulating water will tend to increase unless some means of dissolved-solids control, such as blow-down, is provided. Some water is also lost by droplets being carried out with the exhaust air (drift), but this is typically reduced to a very small amount by installing baffle-like devices, called drift eliminators, to collect the droplets. The make-up amount must equal the total of the evaporation, blow down, drift and other water losses such as wind blowout and leakage, to maintain a steady water level.

Common applications for cooling towers are providing cooled water for air-conditioning, manufacturing and electric power generation. The primary use of large, industrial cooling tower systems is to remove the heat absorbed in the circulating cooling water systems used in power plants, petroleum refineries, petrochemical and chemical plants, natural gas processing plants and other industrial facilities. The absorbed heat is rejected to the atmosphere by the evaporation of some of the cooling water in mechanical forced-draught or induced draught towers.

The objective of the present study is the predictions of the evaporation rate and the temperature distribution of water in an induced draught cooling tower of a large capacity power plant. A case study is carried out using the on line data during normal operation of 125 MW power plant at Gujarat industrial power company limited.,(GIPCL), Surat. There are four unit of 125 MW Capacity power plant and total capacity of power plant is 500 MW

II. LITERATURE REVIEW

The first serious attempt in cooling tower analysis seems to have been made in 1907 when I. V. Robinson [1] produced a pioneer paper on natural draught towers. In this, the performance of the tower was reduced to a “figure of merit”. Unfortunately, being accustomed to working on condensers where the absorbent heat has a specific heat which is virtually constant, his calculations for the driving force were based upon the assumption that heat transfer depend upon the mean temperature difference instead of on the total heat content of the air. He also tried to determine a “friction constant” for the tower which combined the shell resistant and the water lift weight.

In 1922, P. Robinson and C. S. Roll [2] presented a thesis on cooling tower performance, followed by a theoretical analysis by Walker, Mc Adams and Lewis [3] in 1923. In both instances the investigators developed the basic equations for total mass and energy transfer, and considered each processes separately.

The practical use of basic differential equation, however, was first presented by Merkel [4] in which he combined the equations for heat and water vapour transfer and showed the utility of total heat or enthalpy difference as a driving force to allow for both sensible and latent heats. The basic postulation and approximations that are inherent in Merkel’s theory are:

(i)The resistance for heat transfer in the liquid film is negligible.

(ii)The mass flow rate of water per unit cross sectional area of the tower is constant, i.e. there is no loss of water due to evaporation.

(iii)The specific heat of the air – steam mixture at constant pressure is the same as that of dry air.

(iv)The Lewis number for humid air is unity.

The analysis of cooling tower performance has been studied and developed over the last century. Investigations on the performance and its factors have been widely studied. Heat and mass transfer are the core principles in these analyses.

Bahidarah [5] stated that the method generally used for cooling tower calculation was developed by Merkel over 70 years ago. The equation was presented in a differential from known as Merkel mathematical modelling and was used for describing the distributions of water and air-conditions along the cooling tower. However, an obvious disadvantage of Merkel equation was based on the assumptions that evaporation of water flow was neglected in energy balance and saturated air was at the exit. These assumptions made the results inaccurate.

A detailed explanation of the procedure for developing Merkel’s basic equation applied to counter – flow cooling towers was outlined by Baker and Shryock [6].

III. PROPOSED METHODOLOGY

Take data from Gujarat industrial power company limited.,(GIPCL), Surat ,cooling tower Section and after that validate that data with the help of CFD software.

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