WET COOLING TOWERS WITH ESSENTIAL COMPONENTS AND ITS TYPES (NATURAL DRAFT AND MECHANICAL DRAFT)

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Abstract: In present, cooling tower is a very popular and the biggest heat and mass transfer device, which is widely used in thermal power plants to cool the warmed water discharged from the condenser. This paper represents about the cooling tower, its essential components and types of cooling tower. Cooling tower may be wet or dry type but this paper discuss about only wet type cooling tower.
Keyword: Towers, Convection, Cooling draft

I. INTRODUCTION

Cooling tower is an essential component of thermal power plant. Cooling tower is used to cool the warmed water which is discharged from the condenser and this cold water is again fed into the condenser. Cooling tower is a device which can perform an effective heat and mass transfer. A cooling tower reduces the water stream temperature by rejecting the heat into atmosphere, which is extracting from the water. Cooling tower is able to reduce the temperature of water below the air used to cool it, but a cooling tower requires a careful maintenance. Cooling towers consist of larger chamber with trays. The water, which is to be cooled, is fed from the top of the tower and it goes top to down through the trays and air is flow from bottom to the top of the tower.

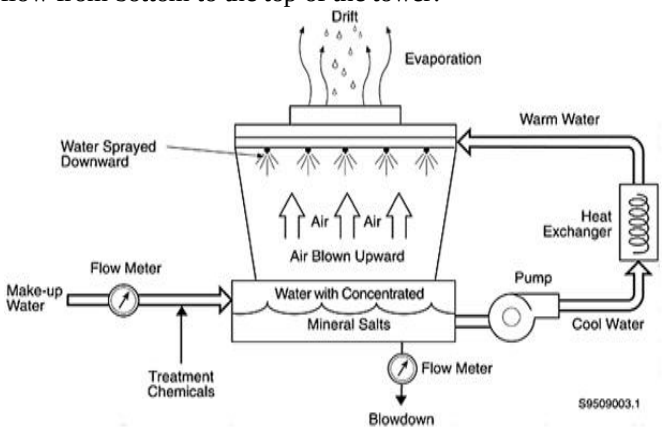

Fig.1. Schematic diagram of a cooling water system [1].

Walker et al. [2] was the first to propose a basic theory of cooling tower operation. The Practical use of basic differential equations, however, was first presented by Merkel [3], in which he combined the equations for heat and water vapor transfer. He showed the utility of total heat or enthalpy difference as a driving force to allow for both sensible and latent heats. The basic postulations and approximations that are inherent in Markel's theory are:

• The resistance for heat transfer in the liquid film is negligible;
• 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;
• The specific heat of the air–steam mixture at constant pressure is the same as that of dry air;
• The Lewis number for humid air is unity.

II. COMPONENTS OF COOLING TOWER

Essential components of cooling tower described as follows [4]

A. Frame and casing

Most towers have structural frames that support the exterior enclosures (casings), motors, fans, and other components. With some smaller designs, such as some glass fiber units, the casing may essentially be the frame.

B. Fill.

Most towers employ fills (made of plastic or wood) to facilitate heat transfer by maximizing water and air contact. There are two types of fill:

- Splash fill: waterfalls over successive layers of horizontal splash bars, continuously breaking into smaller droplets, while also wetting the fill surface. Plastic splash fills promote better heat transfer than wood splash fills.
- Film fill: consists of thin, closely spaced plastic surfaces over which the water spreads, forming a thin film in contact with the air. These surfaces may be flat, corrugated honeycombed, or other patterns. The film type of fill is the more efficient and provides same heat transfer in a smaller volume than the splash fill.

C. Cold-water basin.

The cold-water basin is located at or near the bottom of the tower, and it receives the cooled water that flows down through the tower and fill. The basin usually has a sump or low point for the cold-water discharge connection. In many tower designs, the coldwater basin is beneath the entire fill. In some forced draft counter flow design, however, the water at the bottom of the fill is channeled to a perimeter trough that functions as the coldwater basin. Propeller fans are mounted beneath the fill to blow the air up through the tower. With this design, the tower is mounted on legs,

providing easy access to the fans and their motors.

D. Drift eliminators.
These capture water droplets entrapped in the air stream that otherwise would be lost to the atmosphere.

E. Air inlet.
This is the point of entry for the air entering a tower. The inlet may take up an entire side of a tower (cross-flow design) or be located low on the side or the bottom of the tower (counter-flow design).

F. Louvers.
Generally, cross-flow towers have inlet louvers. The purpose of louvers is to equalize air flow into the fill and retain the water within the tower. Many counter flow tower designs do not require louvers.

G. Nozzles.
These spray water to wet the fill. Uniform water distribution at the top of the fill is essential to achieve proper wetting of the entire fill surface. Nozzles can either be fixed and spray in a round or square patterns, or they can be part of a rotating assembly as found in some circular cross-section towers.

H. Fans
Both axial (propeller type) and centrifugal fans are used in towers. Generally, propeller fans are used in induced draft towers and both propeller and centrifugal fans are found in forced draft towers. Depending upon their size, the type of propeller fans used is either fixed.

III. TYPES OF COOLING TOWER

The cooling tower may be of two types either wet or dry type. In this section only wet type cooling tower is discussed. Wet cooling tower cool the hot water by dissipating heat to the environment through the mechanism of (a) Addition of sensible heat to the air and (b) evaporation of a portion of the re-circulation water itself. When operated in the open mode, there is a third mechanism (c) Addition of sensible heat to the natural body of water.[5]. Wet cooling tower is may be natural draft type or mechanical draft type.

A. Natural draft cooling tower-
In natural draft cooling tower there is no fan used and it consist an empty shell of circular cross-section but with vertical hyperbolic profile. They depend for air flow upon the natural driving pressure caused by the difference in density between the cool outside air and the hot, humid air inside and this tower is selected under the following conditions [5]:-

(1).In cool humid climates.
(2).When there is combination of low wet bulb temperature and high condenser-water inlet and outlet temperatures.
(3).In cases of heavy winter loads.

Natural draft cooling tower may be either counter flow or cross flow type shown in fig. 2 and fig.3.

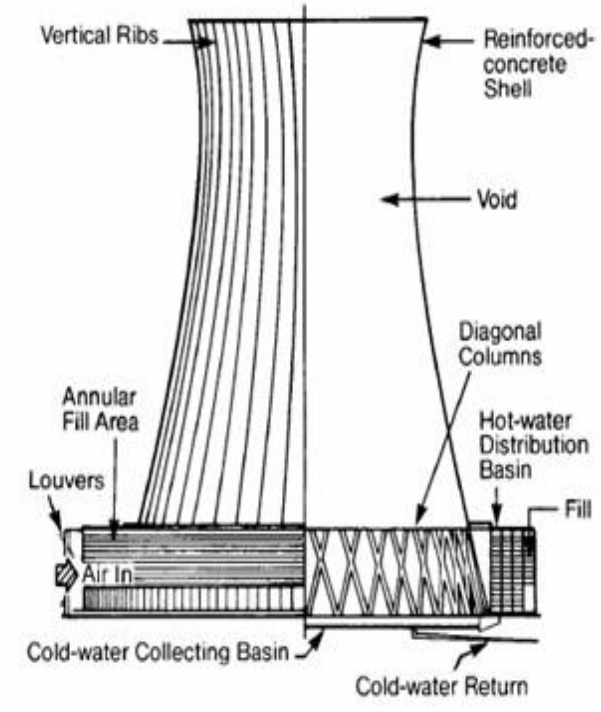

Fig.2. Cross flow natural draft cooling tower [6]

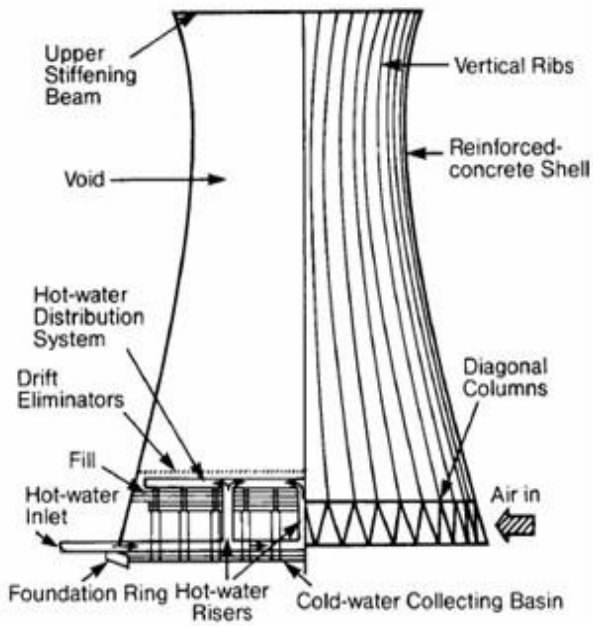

Fig.3. Counter flow natural draft cooling tower [6]

B. Mechanical draft cooling tower-
In this type of cooling tower there is mechanically driven fans are used to move the air. The fan used may be induced draft (ID) type or forced draft (FD) type. Therefore mechanical draft cooling tower may be induced draft or forced draft type either with counter flow or cross flow type as shown in fig.4, fig.5 and fig,6.

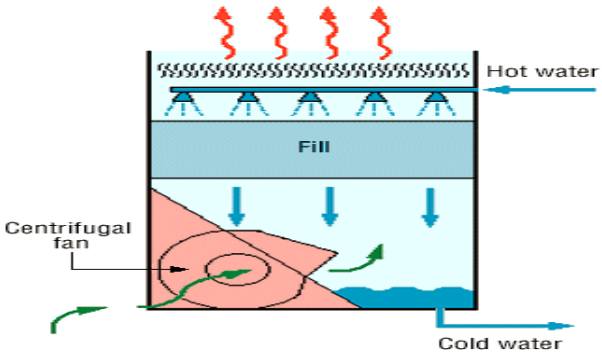

Fig. 4. Forced Draft Cooling Tower [7]

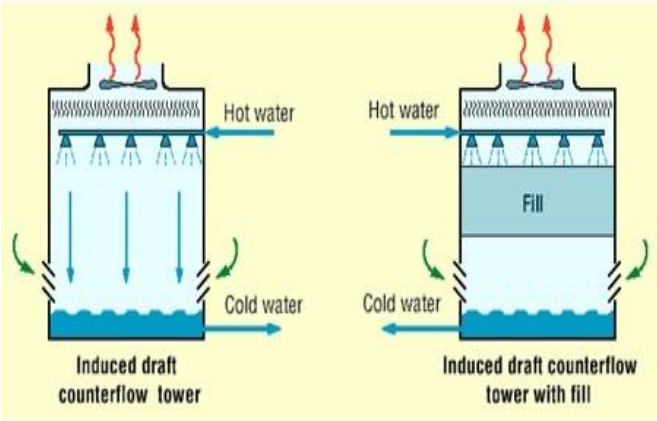

Fig 5. Induced draft counter flow cooling tower [7]

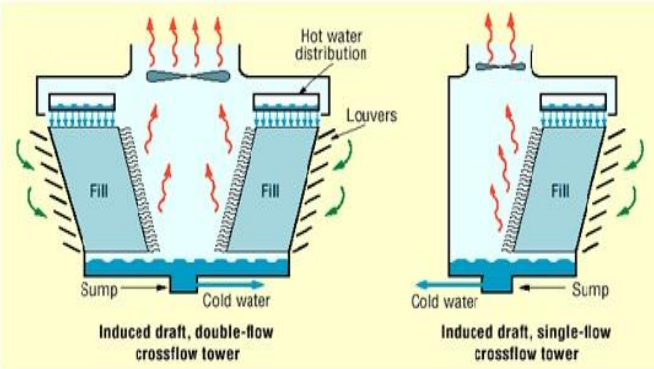

Figure 6. Induced draft cross flow cooling tower[7]

IV. CONCLUSION

Cooling tower is a device, which is used to cool the warmed water discharged from the condenser and feed the cooled water back to the condenser. The basic components of cooling towers are, the frame and casing, fill, cold-water basin, drift eliminators, air inlet, louvers, nozzles and fans. Cooling tower is able to effectively reduce the warmed water temperature as compared to devices on which only air is used to reject heat in the environment to cool the water. Natural draft and mechanical draft cooling towers are the types of wet cooling tower. In mechanical draft type one or more fans are used, but in natural draft type there is no fan used. The fan used may be induced draft (ID) type or forced draft (FD) type. Therefore mechanical draft cooling tower may be induced draft or forced draft type either with counter flow or cross flow type.

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