# Factor Embedded To Improve the Efficiency of Cooling Tower

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**ABSTRACT**: Cooling towers was originated out of the development in the 19th century of condensers for use with the steam engine. Condensers use relatively cool water, via various means, to condense the steam coming out of the pistons or turbines By the turn of the 20th century, several evaporative methods of recycling cooling water were in use in areas without a suitable water supply, such as urban locations relying on municipal water mains. In areas with available land, the systems took the form of cooling ponds; in areas with limited land, such as in cities, it took the form of cooling towers. Common applications for cooling towers are providing cooled water for air-conditioning, manufacturing and electric power generation. The smallest cooling towers are designed to handle water streams of only a few gallons of water per minute supplied in small pipes like those might see in a residence, while the largest cool hundreds of thousands of gallons per minute supplied in pipes as much as 15 feet (about 5 meters) in diameter on a large power plant. The generic term "cooling tower" is used to describe both direct (open circuit) and indirect (closed circuit) heat rejection equipment. While most think of a "cooling tower" as an open direct contact heat rejection device, the indirect cooling tower, sometimes referred to as a "closed circuit cooling tower" is nonetheless also a cooling tower. So far cooling towers design has reached its advance stage. But some scope still exists to improve its efficiency, so here some factors are embedded in the cooling tower to improve its efficiency about 9-10% by reducing the temperature inlet pipe inside the cooling tower.

**Key Words: -** Improve thermal efficiency of cooling tower, factors embedded in cooling tower

## INTRODUCTION

The Main aim of Cooling Tower is to reduce the temperature of fluid (water) which is used as a coolant for machines and in thermal power plant for conversion of steam. As we know that Cooling tower is a direct contact type heat exchanger in which both the Cold air & hot water comes in direct contact for heat exchange, it is a phenomenon of forced convection type heat transfer. Some useful terms, commonly used in the cooling tower industry:

**Drift -** Water droplets that are carried out of the cooling tower with the exhaust air. Drift droplets have the same concentration of impurities as the water entering the tower. The drift rate is typically reduced by employing baffle-like devices, called drift eliminators, through which the air must travel after leaving the fill and spray zones of the tower.

**Blow-out -** Water droplets blown out of the cooling tower by wind, generally at the air inlet openings. Water may also be lost, in the absence of wind, through splashing or misting. Devices such as wind screens, louvers, splash deflectors and water diverters are used to limit these losses.

**Plume -** The stream of saturated exhaust air leaving the cooling tower. The plume is visible when water vapors, it contains condenses in contact with cooler ambient air, like the saturated air in one's breath fogs on a cold day. Under certain conditions, a cooling tower plume may present fogging or icing hazards to its surroundings. Note that the water evaporated in the cooling process is "pure" water, in contrast to the very small percentage of drift droplets or water blown out of the air inlets.

**Blow-down -** The portion of the circulating water flow that is removed in order to maintain the amount of dissolved solids and other impurities at an acceptable level.

**Leaching -** The loss of wood preservative chemicals by the washing action of the water flowing through a wood structure cooling tower.

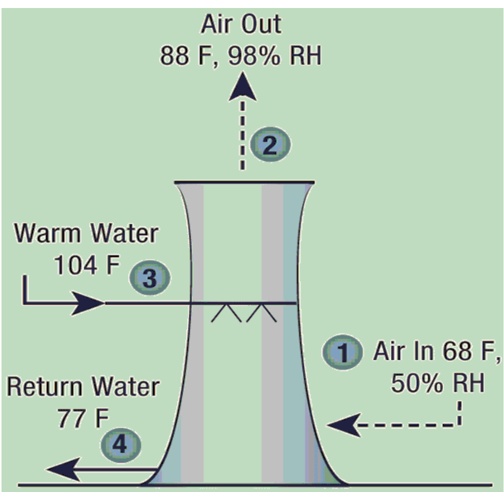
**Noise -** Sound energy emitted by a cooling tower and heard (recorded) at a given distance and direction. The sound is generated by the impact of falling water, by the movement of air by fans, the fan blades moving in the structure, and the motors, gearboxes or drive belts.

**Factors are added in the cooling tower to improve its efficiency are as follows:**

- ✓ Triangular fins are assemble at the inlets pipe under the action of forced air by Power fan
- ✓ Copper tray having holes in its surface assembles under each tube.

The addition of following factor results in decreasing inlet temperature and less humid air at outlet, so following factor reduce the temperature at inlet and also save the water due to evaporation.

The general calculation for heat exchange & transfer of water with air is given below with diagram




The first step is to determine the energy balance around the tower.

$(m_{a1} * h_{a1}) + (m_{w3}*h_{w3}) = (m_{a2} * h_{a2}) + (m_{w4}*h_{w4})$

$m_{a=}$ mass flow rate of dry air

$h_{a=}$ enthalpy of dry air streams

$h_{w=}$ enthalpy of water streams

Utilizing algebra, the fact that $m_{a1} = m_{a2}$, and that a mass balance on the water flow is $m_4 = m_3 - (W_2 - W_1)*m_a$, where W = humidity ratio; the energy balance equation can be rewritten in the following form.

$m_a = ((m_3*(h_4-h_3))/((h_1-h_2)+ (W_2-W_1)*h_4)$

The amount of water lost to evaporation can be simply calculated by a mass balance of water only. We have already seen that,

$m_4 = m_3 - (w_2-w_1)*m_a$

A very interesting aspect of this calculation is that only about 2 percent evaporation is sufficient to provide so much cooling. For those wishing to more quickly evaluate cooling tower evaporation, a simpler equation is available. The standard formula is,

E= (f*R*dT)/1000, where

E= Evaporation in gpm

R= Recirculation rate in gpm
dT=Temperature difference (range) between the warm and cooled circulating water
f= A correction factor that helps to account for sensible heat transfer, where f (average) is often considered to be .75 to .80, but will rise in summer and decline in winter

**Here we saw above calculation if inlet temperature of cooling tower is reduced, then it increases the efficiency as well as reduce the evaporation of water or we can say that the outlet air is less humid.** Now in detail the factors embedded in cooling tower are as follows

- ✓ **Triangular fins are assemble at the inlets pipe under the action of forced air by Power fan**

The first factor is to attach triangular fins at the inlet of cooling tower pipe which reduced the inlet temperature of cooling tower with forced air. As we know the heat transfer through fins with the mode of convection and it is given by Newton law of cooling.

$$Q = hAdT$$

Here,
Q= Rate of heat transfer in J/s
h = heat transfer coefficient in $W/m^{2o}C$
dT= Temperature difference $(T_s-T_a)$
$T_s$= Surface temperature of pipe.
$T_a$= Ambient temperature.

With the help of Power Fan attached with cooling tower laid forced atmospheric air on fins due to this it can change the value of heat transfer coefficient which is also help to increase the heat convection rate and which reduce the inlet temperature of cooling tower. The attachment of Triangular fins are shown in figure 'A'

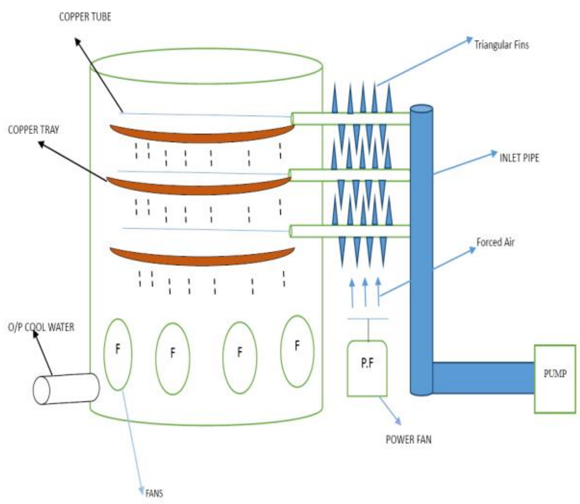



**Fig. 'A'**

If cooled water is returned from the cooling tower is 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 blow out and leakage, to maintain a steady water level.

✓ **Copper tray having holes in its surface assembles under each tube.**

The Second factor is to attach Copper tray with holes in it surface below every copper tube inside, due to this arrangement atomized water have enough time to contact with cool air and result of this water temperature is more reduced and percentage of water vapors mix with air is also reduced due to less temperature of water. The arrangement of copper tray is shown in figure' A', in detail the arrangement in just under the copper tube when hot water enter in a cooling tower through tube it will fall in atomized form due to hole present in tube at that time it will contact with forced air which flow due to fan presents at the base of cooling tower, during that period the water contact with air its temperature has reduced after it is laid on copper tray as the hole are also present in copper tray it will fall again downward due to gravitational force, so during the whole process of falling the water from tube to the surface of cooling tower it will having enough time to contact with water and hence through this factor temperature as well as high humid air or evaporate percentage of water is also controlled.

**Result adding following factor:** These two factors are embedded in cooling tower to improve Thermal efficiency of the cooling tower.

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