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Cooling Tower without Draught With New Type of Fill

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Abstract-The fill medium in the cooling tower which provides the surface for heat transfer,isa key factor in the performance of cooling tower.Currently used fill is made from PVC corrugated sheets with passages for air. It suffers from the limitations of scaling and more resistance to the flow of air. The range of cooling tower is 6 to 12°Cand approach of the order of 5 to 6°C. If we achieve a greater range and closure approach to wbt, the operating cost on pumping water can be considerably reduced. The reduction in resistance to air flow will save the operating cost on fan. This work is an attempt to develop the cooling tower with more porous nature of fill and without using any type of draught. The fill medium is a stretched nylon net in zigzag pattern arranged vertically in numbers.
The trials conducted on cooling tower without draught gives the range of 6°C and approach of 11°C for hot water temperature of 35°C. Thus the nylon net arranged in zigzag pattern can be used as the fill medium for cooling tower with better performance. Proper combination of size of zigzag net, density of fill and height of fill has to be worked out.

Key Words-Performance of cooling tower, fill medium of cooling tower.

I. INTRODUCTION

Cooled water is needed for, air conditioners, manufacturing processes and powergeneration. A cooling tower is an equipment used to reduce the temperature of a water streamby extracting heat from water and emitting it to the atmosphere. Cooling towers make use ofevaporation whereby some of the water is evaporated into a moving air stream andsubsequentlydischarged into the atmosphere. As a result, the remainder of the water is cooled downsignificantly.

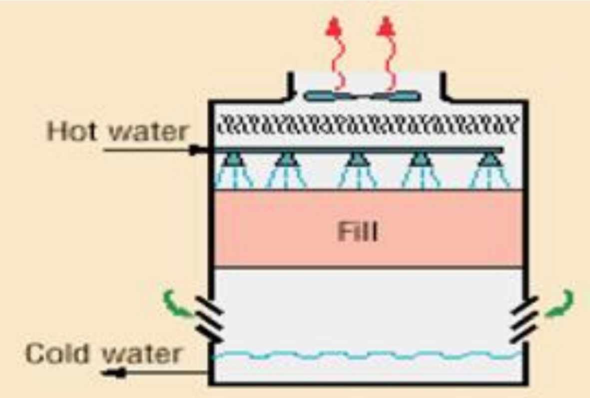

Fig2. film fill of PVC corrugated sheet

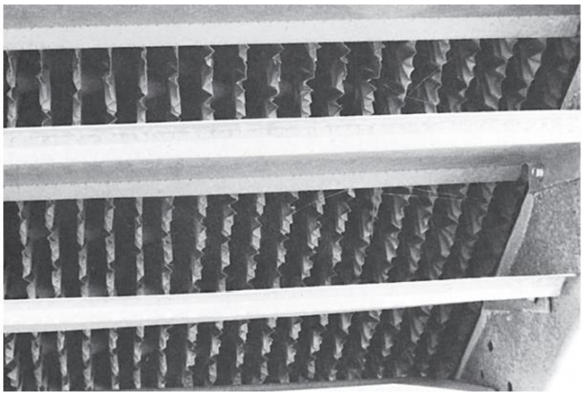

Fig1. Cooling Tower

The cooling tower as shown in fig1 consist of a cylindrical structure having basin for cold water at the bottom and inlet for air. In the middle fill medium is supported. The fill medium provides the surface area required for evaporative cooling of water. The hot water enters at the top of fill through the nozzles .The fan is located at the top of tower sucking the air through the bottom of tower. The hot water while passing through the fill comes in contact with upward flow of air, cooling the

water.The fill provides the surface for evaporation of water. Evaporative cooling of water takes place in fill. The heat transfer rate depends on the ability of fill medium to expose more surface area of water to the flow of air. The heat transfer rate in the fill depends on three factors.
a)Surface area of water exposed to flow of air.
b)Air velocity
c) Time available for water exposure to the flow of air
Thus the design of fill medium is critical in the performance of cooling tower.Film fill is most commonly used fill medium in cooling towers.In a film fill, water forms a thin film on either side of fill sheets. The surface area of the fill sheets is the area for heat exchange with the surrounding air.The fill film is made by assembling the corrugated PVC sheets to form the vertical passages for the flow of air (fig2). The hot water is admitted at the top and air enters at the bottom.

II. COOING TOWER WITH NEW TYPE OF FILL MEDIUM

The PVC film fill has following limitations.
a) The passages of air in film fill are blocked if the dirty water is used.
b)The PVC film fill develops scales on its surface due to exposure of water for long period. The formation of scales reduces the heat transfer rate.
c)The PVC film fill offers greater resistance to the flow of air increasing the operating cost on fan.
Thus because of the above limitations, the present designs of film fill can give the approach (difference between WBT of air and outlet cold water from cooling tower) of the order of 5 to10ºC and the range of the order of 10 to 12ºC .The approach increases with the heat load on the cooling tower. On the other hand ,the splash fill though not effective as film fill has the advantage of relative velocity between the air and free falling water droplets and less resistance to the flow of air.
Thus to improve the performance of cooling tower, it is necessary to develop the fill medium which will combine the advantages of both film fill and splash fill.
Fig 3 shows the new design concept of fill. The fill medium for the cooling tower will be formed by stacking the number of vertical arrays of stretched Nylon net in zigzag fashion. The hot water will enter at the top through the nozzles. The water will trickle down through the porous net,at the same time some water will flow along the slope of Nylon net. The flowing and trickling water on the slopes of net will fall and spread again and again. This action will spread the water through the fill. Also continues falling and spreading action of water on the net will maintain the water in the fill for longer period. It will result in exposure of water to the flow of air for a longer period, which will result in more evaporative cooling of water. The arrays of zigzag net will perform dual function, It will spread and brake up the water into fine droplets similar to splash fill and at same time Nylon net will allow the unrestricted flow of air. It will result in higher velocity of flow of air which yields higher heat exchange rate.

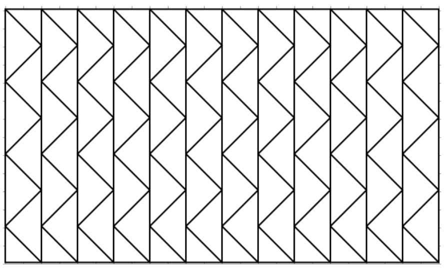

Fig 3. Fill with array of Nylon net with zigzag pattern

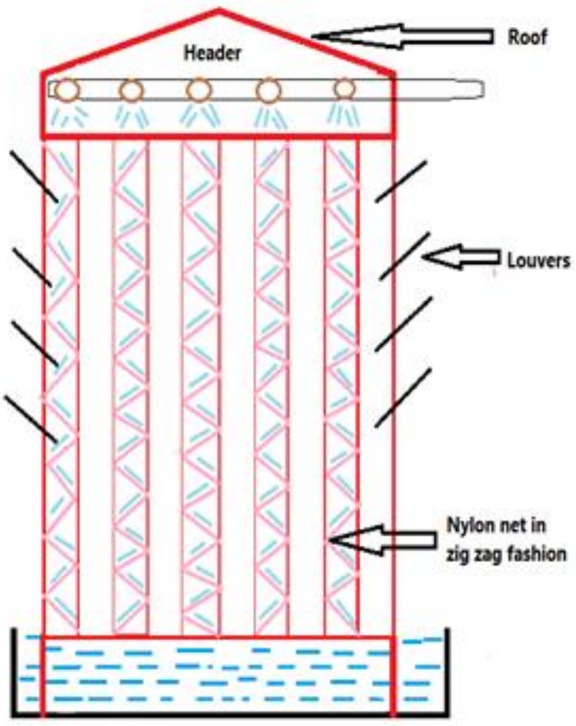

Fig4. Cooling Tower with zigzag nylon net as fill.

Fig 4 shows the construction of cooling tower with nylon net as fill medium. The cooling tower is fitted with five vertical zigzag net as shown in fig4.It consist of a tower made from MS angle frame. The cooling tower consist of a pipe header at the top to which inlet hot water is supplied. The pipe header has five branches of pipe and each pipe is provided with series of small holes.Water is sprayed over the zigzag netfrom these holes. The water after falling on the net, part of it drops down through the net and part of it flows over slope of net. The louvers are fitted on the sides of tower which arrest the water droplets flowing out of the tower, also it redirects the flowing water on the net. There after the water is collected in the basin at the bottom.The net arranged in zigzag fashion provide the surface area for evaporative cooling of water.The fan is not provided in the cooling tower.

III. EXPERIMENTAL SET UP AND TESTING

3.1 Experimental set up

The experimental set up is as shown in figure 5. The water is heated in the container with the help of gas stove. The heated water is fed into the inlet header with the help of pump. The by-pass with valve is provided to adjust the flow rate of heated water to the inlet header of cooling tower. The water from the cooling tower is collected in the water basin at the bottom. The water from the basin is pumped back into the container for heating with the help of pump. The thermometer is provided in the both pipeline to measure the temperature of outlet and inlet water from cooling tower. The valve is provided in the outlet line to control the flow rate. The rotameter in the inlet pipeline measures the water flow rate. The psychrometer is used to measure the dbt and wbt of ambient air.

3.2 Testing procedure

- First dry bulb temperature and wet bulb temperature for ambient air are noted down.
- The water in container is heated with the help of gas stove.
- The inlet and outlet pump are started and flow rate of the pump are adjusted, so that inlet and outlet flow rate are equal and the water level in the heating container remains same. The flow rates are adjusted with help of valves in the by-pass line and outlet line.
- When the temperature of water in inlet and outlet line are stabilized i.e. does not change with time. The temperature are noted down.
- The flow rate from the rotameter is noted down.
- Supply of gas is increased and again the temperature are allowed to stabilize and temperature are recorded again.

- The procedure is repeated up to the maximum possible temperature.
- The readings are taken for different flow rates of water.

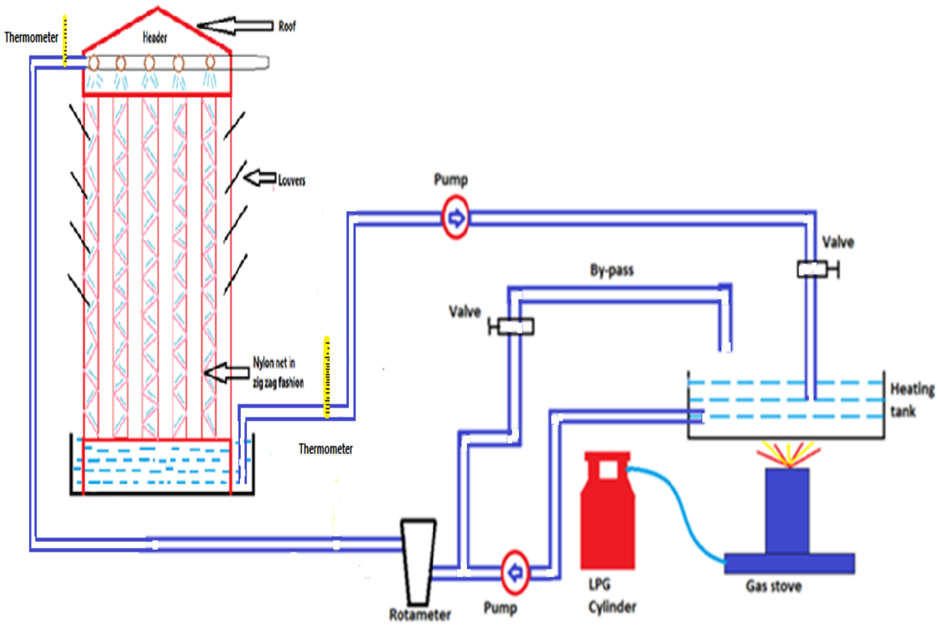

Fig 5. Experimental set up

IV. RESULTS AND DISSCUSSION

For dbt=29°C,wbt=16°C of ambient air and inlet hot water of 30°C the range is 5°C and approach is 8.5 °C.
For dbt=30°C,wbt=17°C of ambient air and inlet hot water of 35°C the range is 6°C and approach is 11 °C.
The flow rate is varied from 1.6 m^3 /hr to 0.56 m^3 /hr .The variation in flow rate does not affect the range and approach of cooling tower.

V. CONCLUSION

As the hot water temperature increases from 30 to 35 °C, the approach increases from 8.5 °C to 11 °C. The values of approach are high. Hence it is concluded that for achieving a closer approach to wbt, the various sizes and slopes of zigzag net, density of fill and height of cooling tower will have to be tried.

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