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TheEffect of Moisture Recovery System on Performance of Cooling Tower

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ABSTRACT

The cooling of liquid not only reduces the volume and temperature but and in some cases phase change from vapor to liquid too. The phenomenon of heat exchange in cooling tower is of direct contact and a complex one and Cooling tower is the best application of heat and mass transfer which is commonly used to dissipate heat from devices like thermal power plants, die casting application, process natural gas, chiller plants, blow molding and compression molding machine. In the cooling towers large quantity of water is used and the cooling tower is the best application to recovery of heat of hot water coming from condenser and during the process water cooling due to mixing of water and air after cooling of water moist air comes out from cooling tower and recovery of water from such moist air coming out from cooling tower and performance of cooling tower with and without moisture recovery system are the two major objectives of the present work.

KEYWORDS: Cooling Tower, Cooling pad, Heat and mass transfer, Moisture recovery unit, Thermo Hydrometer

INTRODUCTION

A cooling tower is a heat rejection device, which extracts waste heat to the atmosphere though the cooling of a water stream at a lower temperature. The type of heat rejection in a cooling tower is termed "evaporative" in that it allows a small portion of the water being cooled to evaporate into a moving air stream to provide significant cooling to the rest of that water stream. The heat from the water stream transferred to the air stream raises the air's temperature and its relative humidity to 100%, and this air is discharged to the atmosphere. Evaporative heat rejection devices such as cooling towers are commonly used to provide significantly lower water temperatures than achievable with "air cooled" or "dry" heat rejection devices, like the radiator in a car, thereby achieving more cost-effective and energy efficient operation of systems in need of cooling. Think of the times you've seen something hot be rapidly cooled by putting water on it, which evaporates, cooling rapidly, such as an overheated car radiator. The cooling potential of a wet surface is much better than a dry one. T.Jagadeesh et al[1] carried out performance analysis of natural draft cooling tower in different seasons. During summer and winter as the humidity is different how its value affects the performance of cooling tower is studied. Pushkar R. Chitale et al[2] focused on the effect of parameters like

Dry Bulb and Wet Bulb Temperature of Air, Fill Material And Its Size, Inlet Air Flow Rate, Air Inlet Angles, Water Flow Rate And Temperature Etc on performance of cooling tower. Lu Lu et al[3] proposed universal model of cooling tower which can be used for parallel flow as well as counter flow heat exchanger. The new engineering model for cooling towers, which can be used to formulate both counter flow andcross flow cooling towers, has been presented in this work. Neetesh Singh et al[4] discussed the methodology to improve the performance of natural draft cooling tower and optimization of shutdown maintenance strategy. Sunil J. Kulkarni et al[5] reviewed various research papers in the area of cooling tower and in which various ideas and methodologies are proposed to improve the performance of cooing tower. Jianfeng Qian et al[6] systematically reviews the research progress of the closed cooling tower at home and abroad. Due to current foreign closed cooling tower price is much higher than domestic products, and domestic closed cooling tower is restricted to material performance and design and manufacturing level, and quality is not high, it cannot reflect thermal efficiency advantages, comprehensive performance is not as good as foreign product, in a certain extent, these affected the application of the closed cooling tower in our country. T.Jagadeesh[7] verified the effect on the performance of cooling tower in various seasons. Bhupesh Kumar Yadav et al[8] included the working principle of cooling tower and a setup is fabricated and various parameters related to cooling tower is calculated i.e. range, approach, effectiveness and evaporation loss. Krishna S. Vishwakarma et al[9] studied the effect of various performance parameters like capacity, heatload and range on efficiency of cooling tower. Randhire Mayur A[10] focused on the performance of a natural draft cooling tower can be improved by optimizing the heat transfer along the cooling tower packing using a suitable water distribution across the plane area of the cooling tower. In natural draft cooling towers, a process of counter flow heat transfer, which the water is cooled by air, takes place. Xiaoni Qi et al[11] carried out exergy and energy analysis of shower cooling tower using mathematical model to predict the variation in temperature and exergy along the tower length. The main objective of present work is that to fabricate the setup of cooling tower in which introduction of moisture recovery system and its effect on performance of cooling tower.Anand Patel et. al[12] [13] [14] documents heat exchange thermal phenomenon in the cooling devices. Cooling Tower uses heat transfer phenomena which has many applications to be adopted in Solar HeaterAnand Patel et. al[15] [16] [17] [18] [19] [20] [21] [22] [23] [60]. Further the literature [24] [25] [26] [27] [28] [29] [30]evaluates cooling tower performance for a new mathematical model accounting the radii distribution function of water droplets.The research articles [31] [32] [33] [34] [35] [36] [37] [38] include research via experimental and numerical simulation of comparison between dry and wet cooling tower design.Further, historical studies [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50]include articles which evaluates thermal performance of wet cooling tower in different conditions and variation in parameters of the geometrics impacting heat transfer efficiency.The papers [51] [52] [53] [54] [55] [56] include studies involving thermal performance of cross flow on the cooling tower. Nikul Patel et. al [57] [58] SK Singh et. al [59] includes field of renewable energy study such as biofuel where cooling tower could be implemented to enhance the thermal performance via effective heat transfer phenomenon.

EXPERIMENTAL SET UP

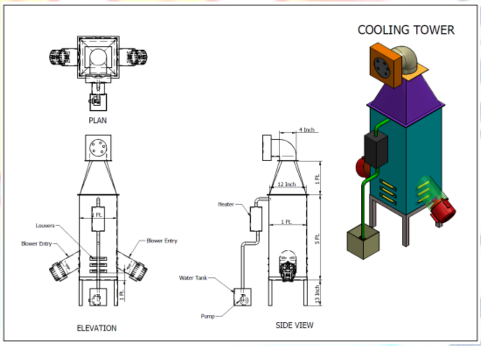

Fig 1 CAD Model of Experimental set up

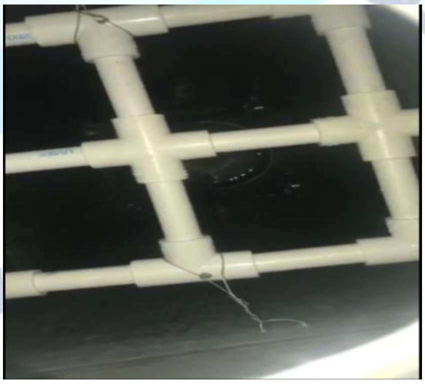

Plate 1 UPVC pipe Structure as nozzle

Plate 2 Blowers

Plate 3 Blower Arrangement

Plate 4 water collection Tray

Plate 5 Moisture Recovery unit

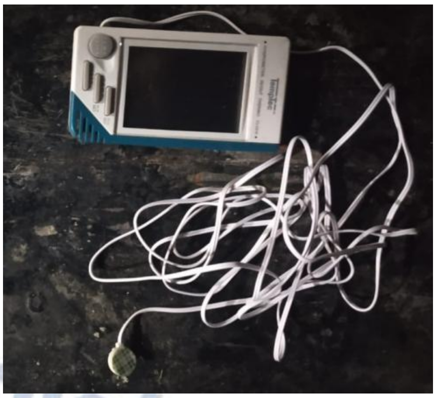

Plate 6 Thermo Hydrometer

Plate 7 Water Heater

Plate 8 Submersible Pump

Plate 9 Cooling Tower Unit

The forced draft cooling tower is fabricated from 300 mm X 300 mm cross section and 1500 mm height made of galvanized iron sheet of 1mm thickness as shown in Fig 1 and plate 9. The electric heater is attracted outside the cooling tower which is used to heat the water and submersible pump is used for supplying water to the system and hot water is sprayed inside the cooling tower water is sprayed with the help of structure of upvc pipe of ½" diameter with 1mm holes are provided over the surface of pipe (plate 1, plate 2, plate 7, plate 9). The two blowers are providing on two opposite side of the cooling tower as shown in plate 3 to supply air in the cooling tower. The water tray is placed at the bottom of the cooling tower and recirculated through pump and at the top of cooling tower moisture recovery system is placed in which sprung with small holes is placed. On the opposite faces of cooling tower where there is no blower louvers are placed to reduce back pressure inside the unit.

EXPERIMENTAL METHODOLOGY

In the first phase of experimentation water is supplied to upvc shower system through heater to sprinkle water inside the cooling tower and then both side blowers are started to supply cold air and moisture content is measured using hydro meter with and without moisture recovery unit. The quantity of water can be estimated by pump specification and air flow rate can be measured by measuring air velocity using anemometer and using cross section area of blower pipe.

RESULT AND DISCUSSION

Atm Conditions		Without Heater and with sponge	With Heater and with sponge	With Heater and without sponge	Without Heater and without sponge
T_{in} (⁰C)	33.8	31.5	35.5	36.2	31.5
T_{out} (⁰C)	33.5	32.3	35.4	36.1	32
RH	50 %	42 %	22 %	30 %	48 %

Table 1 Results of Cooling Tower with and without Moisture Recovery System

From result Table 1 it is quite obvious that the role of heater and sponge is significant; referring to column 1 RH value is closed to 50 x and almost similar results are there in column 4 while with heater and sponge (column 3) significant reduction in moisture value because of moisture recovery system. Comparing column 2 and column 4 without heater and with heater due less mixture of water with air less moisture recovery occurs while with heater without sponge more air is dissolved in water and so less moisture is available.

CONCLUSION

The major conclusion from present work is with the present proposed system effective water recovery from cooling tower is possible. To recover the water at larger scale more efficient system should be design.

FUTURE SCOPE

The work can be extended by varying air velocity and water flow rate and analyze the effect of both on moisture recovery system also the effect of insertion of cooling pad onmoisture recovery system.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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