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OPTIMIZATION OF THERMAL PERFORMANCE OF NATURAL DRAFT COOLING TOWER WITH THE CHANGE OF PROPERTIES OF MOIST AIR AND PSYCHOMETRIC CHART

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ABSTRACT

Cooling tower is an important system of thermal power plant. The performance that is efficiency of power plant is directly depends on the effectiveness of cooling tower. In cooling tower these are losses such as scale formation drift losses and evaporation losses are problems which affect its effectiveness and performance of cooling tower. In cooling tower before entering air is cooled at the bottom of cooling tower therefore its temperature decreases so that the efficiency of cooling tower can be improved. In every cooling tower manufacturer provide the scheduled maintenance check list so that the worker will perform their maintenance as per given instruction. In this work In summer season a system is installed around at the bottom of natural draft cooing tower in which water is flowing or the sprayed out. when the air is flowing from the bottom of cooling tower firstly air is cooled with the sprayed water and heat transfer is taking place between flowing air and sprayed outside water, therefore air is cool down so that some degree temperature of air decreases. Finally the air can absorb more heat from hot water, within the cooling tower so that actual temperature drop of water increases and thus the efficiency of natural draft cooling tower can be increase in the summer season.

Keywords: Cooling tower, Wet Bulb Temperature, Cooling tower Performance, Thermal Design, Different types of losses.

1. INTRODUCTION

Cooling towers are a very important part of many chemical plants. The primary task of a cooling tower is to reject heat into the atmosphere. They represent a relatively inexpensive and dependable means of removing low-grade heat from cooling water. The make-up water source is used to replenish water lost to evaporation. Hot water from heat exchangers is sent to the cooling tower. The water exits the cooling tower and is sent back to the exchangers or to other units for further cooling. Typical closed loop cooling tower system is shown in Figure 1.1.

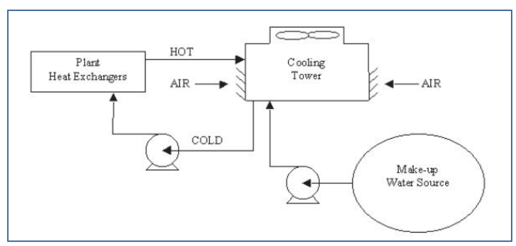

Figure 1 Cooling Water System

Cooling tower is a heat removal device, which removes heat from the hot water stream flowing inside the cooling tower and leaves the heat to the atmosphere. Evaporative type of cooling is done in the cooling tower in that it allows a small portion of the water being cooled to evaporate into a moving air stream to provide efficient cooling to the remaining of that water stream. The heat flows from water to the air stream therefore raise the temperature and relative humidity to 100%, and this air is discharged to the atmosphere. Evaporative heat refusal devices such as cooling towers are usually used to provide significantly lower water temperatures than achievable with air cooled or dry heat rejection devices, such as the radiator in a car, thereby achieving more cost-effective and energy efficient process of systems in need of cooling. Something hot surfaces be rapidly cooled by putting water on it as we have seen it many times, which evaporates, cooling rapidly, such as an overheated car radiator. The cooling potential of a wet surface is much better than adry one.

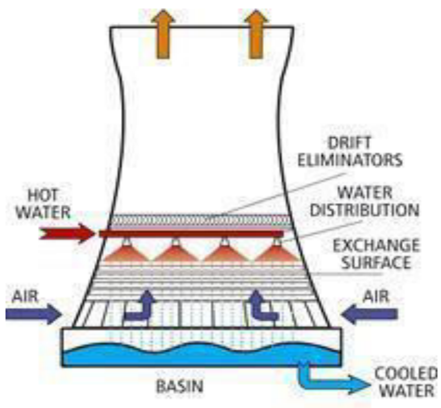

Figure 2. Components of Natural draft cooling tower

General applications

2. LITERATURE SURVEY

J. Smrekar [2005], Showed that how the efficiency of a natural draft cooling tower can be improved by optimizing the heat transfer along the cooling tower (CT) packing using a suitable water distribution across the plane area of the cooling tower. On the basis of cooling air measurements, it is possible to distribute the after in such a way that it approaches the optimal local water/air mass flow ratio andensures the homogeneity of the heat transfer. The velocity and temperature fields of the air flow were measured with the aid of a remote control mobile robot unit that was developed tenable measurements at a bitrary point above the spray zone over the entire plane area of the cooling tower. The moist air velocity profiles and the temperature profiles above the spray zone were used as input data or calculation of the local entropy generation in the tower. On the basis of the measured boundary conditions, a numerical analysis of the influence of the water distribution across the coolingtower_s plane area on entropy generation and exergy destruction in the cooling tower was conducted._ 2005 Elsevier Ltd. All rights reserved.

tower is high in winter season as comparison to summer season. The efficiency of cooling tower in winter season 71.429%. Efficiency of cooling tower in summer season = 61.538% the cooling tower efficiency difference between summer season and winter season is =9.891%.. The losses of the cooling tower are high in winter season as compare to summer season.

T.Jagadeesh,et.al,[2013]had studied that the performance of the natural draft cooling tower was dominated by wind speed,ambientairtemperaturesandmoistureinthe atmospheric conditions. They statedintheirpaperthatwhen the humidity was high in atmosphere, largequantity of water wasrequired for coolingcondensateandwhen moisture was low in atmosphere, small quantity of water was required for cooling condensate.The rateof relativehumidityintheatmosphere variesfromplacetoplaceandtime ofyear.Thevariouslossesinthecoolingtowersuchasflo atlosses,evaporationlossesand blowdownlossescouldbe calculated.The upholdingofcoolingtowerintheform of removal of scale orcorrosion hadplayed important role in the performanceof thetower.

Randhire Mayur A. [2014], showed that a natural draft cooling tower could 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. They described that in natural draft cooling towers, a method of counter flow heat transfer, where water was cooled by air. Between the water and the air, a boundary layer was recognized, which was considered to be saturated air at the same temperature as the water.

B Bhavani Sai, et. al, [2013] in their paper presented detailed methodology of a Induced draft cooling tower of counter flow type in which its efficiency, effectiveness, characteristics were calculated. The industrial data had been taken from a mechanical draft cooling tower. Cooling towers were heat removal devices used to transfer process waste heat to the atmosphere. Cooling towers made use of evaporation whereby some of the water was evaporated into a moving air stream and subsequently discharged into the atmosphere. As a result, the rest of the water was cooled down significantly.

3. BASIC THEORY OF COOLING TOWER

3.1 Main components ofcooling tower:-

Frame- The structure of a coolingtower mustaccommodate longdurationdeadloadsimposed bytheweightofthetowercomponents,circulatingwater, snowandice,andanybuildu pof internalfouling;plusshorttermloadscausedby wind,maintenanceand,insomeareas,seismic activity.Itmustmaintainitsintegritythroughoutavariety ofexternalatmosphericconditions, anddespiteaconstantinternalrainstorm. Wide-ranging temperatures must beaccepted, as well as the corrosiveeffects of high humidityand constant oxygenation.

Casing- Acoolingtowercasingactstocontainwaterwithintheto wer,provideanairplenum for thefan,andtransmitwindloadstothetower framework.Itmusthavediaphragmstrength,be watertight andcorrosionresistant, andhave fire retardant qualities. It mustalsoresist weathering,and should present a pleasing appearance.

Make-Up-Wateraddedtothe circulatingwater system,toovercome thelossesheldincooling tower.

MechanicalDraft- Airmovementisdonebytheexternallyapplieddeviceslik efans.**Module** - Apreassembledportionorsectionofacooling towercell.Onlargerfactory-assembledtowers two ormoreshipped modules mayrequirejoining to makeacell.

NaturalDraft- Airdrawninsidethecoolingtowerbymeansofnaturalcurr entorwecansay bydensitydifferential.

Packing-This portion constitutes primaryheat transfer surfaceofcooling tower.

Partition-Awallwhich subdividestheinteriorofthecoolingtowerand italsoseparatesthe other cells.

3.2Coolingtowerperformance

Important parameters

(i) Range=Coolingtowerwaterinlettemperature-Coolingtowerwater outlet temperature.

(ii) Approach=Coolingtoweroutletcoldwatertemperature-Ambientwet bulb temperature.

(iii) Cooling tower effectiveness:-

Cooling tower effectiveness = Range/Ideal range.

(iv) Ideal Range=(Range+Approach).

(v) Coolingcapacity(Q)=mxcx(T_1-T_2)inkCal/hrorTR,

3.3FactorsAffectingCoolingTowerPerformance

Capacity

The atmosphere from which a cooling towerdrawsitssupply of air incorporates infinitely v a r i a b l e psychrometricproperties,andthetowe rreactsthermallyorphysicallyto eachofthoseproperties.Thetoweracceleratesthatair; passesitthroughamazeofstructure andfill;heatsit;expandsit;saturatesitwithmoisture;s crubsit;compressesit;andresponds toallofthethermalandaerodynamiceffectsthatsuchtr eatmentcanproduce.

Finally,the coolingtowerreturnsthat“usedup”streamofairtothen earby atmosphere,withthefervent intentionthatatmosphericwindswillnotfindaway toreintroduceitbackintothetower.

Meanwhile,thewaterdropletsproducedby thetower’sdistribution systemarecompetingwith the airforthesamespace and,through naturalaffinity,areattemptingtocoalesceinto a commonflowing streamhavingminimumsurfacearea toexpose totheair.

4. RESULT AND ANALYSIS

Table 1 Specifications of Natural Draft Counter Flow Cooling Tower

Tower height	113meters
Air inlet height	8.6m
Fill depth	1.8m
Tower basin diameter	100.808m
Fill base diameter	90m
Tower top diameter	53.000m
Spray zone height	0.8m

Table 2 Data from Psychrometric Chart and Steam Table

Enthalpy of air at in let temperature(Ha1)	77 kJ / kg	78.5 kJ / kg
Enthalpy of air at in let temperature(Ha2)	117 kJ / kg	125 kJ / kg
Specific humidity of air at inlet temperature(W1)	0.0203 kg / kg of air	0.0208 kg/ kg of air
Specific humidity of air at outlet temperature(W2)	0.0365 kg / kg of air	0.039 kg / kg of air
Specific volume of air at inlet temperature(VS1)		0.908 m³ / kg
Specific volume of air at outlet temperature(VS2)	0.927 m³ / kg	0.930 m³ / kg
Enthalpy of water at inlet temperature(Hw1)	167.57 kJ / kg	180.10 kJ / kg
Enthalpy of water at inlet temperature(Hw1)	125.79 kJ / kg	138.33 kJ / kg

Table 3 comparison of parameter between winter time and summer time.

Parameter	Winter	Summer
Range	11^0C	11^0C
Approach	2^0C	3.94˚C
Efficiency of cooling tower	84.6%	73.6%
Heat loss by water	2953704.934 MJ / hr	2909957.090 MJ / hr
Mass of air	608535.362 Kg / hr	460671.79kg hr
Drift losses	1282.9 Kg / hr	1263.9 Kg / hr
Evaporation losses	1079591.149 kg /hr	1063601. kg / hr
Blow down losses	163574.416 kg/ hr	322303.4Kg / hr

Table 4 Efficiency with respect to air inlet temperature in winter season.

Temperature	% of Efficiency
31	92.59
32	90.90
33	84.6

34	78.1
35	76

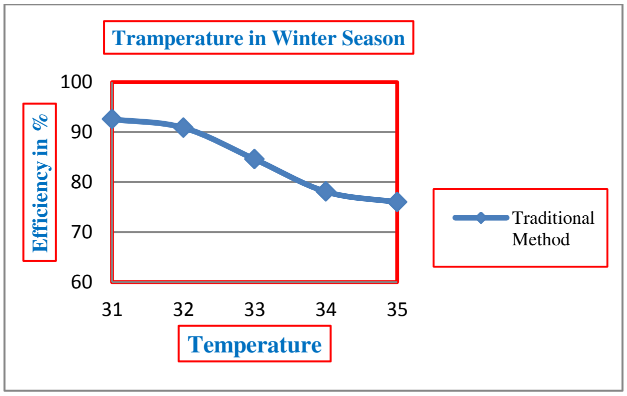

Figure 3 efficiency of winter season

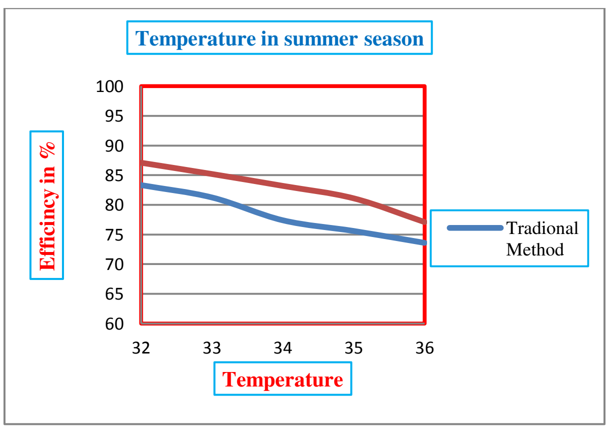

Figure 4 efficiency of summer season

Table 5 Comparative Efficiency of traditional and proposed method with respect to air inlet temperature in summer season.

Temperature	% of Efficiency	
	Traditional method	Proposed method
32	83.33	87.1
33	81.25	85.2
34	77.4	83.2
35	75.6	81.1
36	73.6	77.1

6. CONCLUSION

The efficiency of the cooling tower is high in winter season as comparison to summer season. The efficiency of cooling tower in winter season84.6%.Efficiency of cooling tower in summer season =73.6% the cooling tower efficiency difference between summer season and winter season is =11% the cooling tower is closely related to different types of losses generated in cooling tower. The losses of the cooling tower are high in winter season as compare to summer season. We can conclude that by increasing the efficiency of cooling tower is built in non-coastal areas (Humidity is low) we can increase the cooling tower efficiency.

In ideal condition, the heat loss by water must be equal to heat gain by air. But in actual practice it is not possible because of some type of losses. Cooling tower performance increases with increase in air flow rate, increase in air-water contact and characteristic decreases with increase in water to air mass ratio.

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