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Experimental Analysis of Induced Draft Cooling Tower Based on Temperature Difference

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***Abstract*— Cooling tower, a tool that convert quandary into cold water thanks to direct air contact. It rejects water heat to the atmosphere through the cooling of water steam to a tower temperature. cooling either use evaporation the method heat or cool the operating fluid to close the wet bulb air temperature or within the loop dry cooling cool the operating to close dry bulb air temperature. In iatrogenic draft cooling air is sucked from different finish the water cooling happens owing to humidification of air. the warmth loss by the water is gained by the air. Effectiveness of cooling depends on flow of air and water and water temperature.**
minimization of warmth loss is one in all the vital side of study. Its hyperbolic form has benefits thanks to higher space at heart. It provides aeromechanics strength and stability. cooling supply a wonderful different notably in locations wherever decent cooling water couldn't be simply getting from natural sources or wherever involved for the setting imposes some limits on the temperature at that cooling water is come back to the encompassing. the current review is in at summarizing studies and analysis on cooling for numerous expects.
***Keywords*— inlet and outlet water temperature, fills, efficiency etc.**

I.INTRODUCTION

Cooling tower is utilized to fulfil the aim of cooling with minimum usage of liquid. It circulates liquid for cooling to the machine and uses least structure water that is lost as a result of evaporation. Except trade cooled water is needed for, as associate example, air conditioners, or power generation. A cooling is that the instrumentality accustomed reduce the temperature of a water stream by extracting heat from water and emitting it to the atmosphere. Cooling towers build use of evaporation whereby variety of the water is gassy into a moving air stream and after discharged into the atmosphere. As a result, the remainder of the water is cooled down significantly as shown among the figure. Cooling towers unit ready to lower the water temperatures over devices that use only air to reject heat, similar to the radiator throughout associate automobile, and unit therefore additional value effective and energy economical.

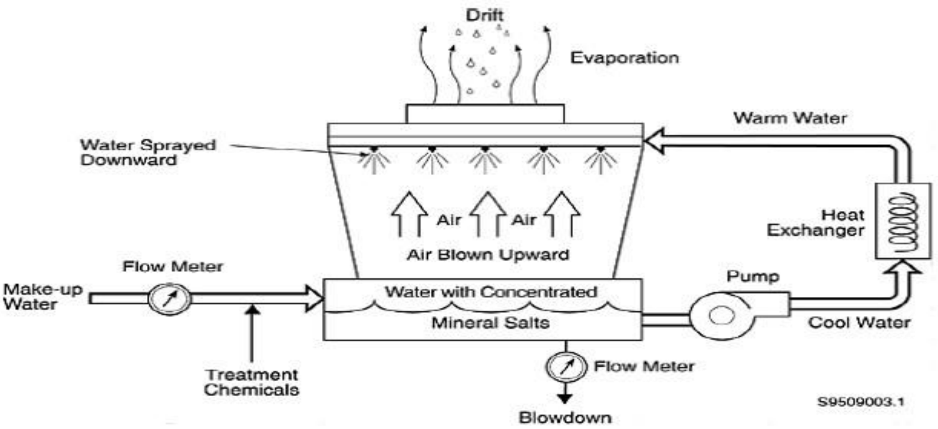
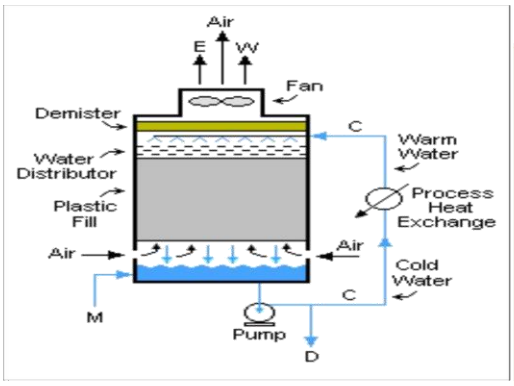


Fig. Induced Draft Cooling Tower

II. WORKING PRINCIPLE

Working principle of induced draft cooling tower

Cooling tower is basically a heat and mass transfer device. It removes heat from the water and loses a fraction of water throughout heat transfer to the air. once air is blown from down it came involved with coming water the physical property of that is higher and at the time of contact this air causes evaporation of water driblet. it's famed that so as to induce gaseous water needs to achieve certain quantity of heat of transformation. It will thus from close driblet and evaporates into vapour kind. owing to removal of wise heat, remaining water droplets loses temperature and cools down. owing to higher expanse in packing heat transfer rate will increase and water is any cooled to the need temperature. Air moving upward takes away certain quantity of water content in (vapour form) with it that isn't fascinating. so as to recover lost water drift eliminators square measure provided. coming air loses their speed and causes certain quantity of vapour to be born-again into water. The water falls downward and picked up within the basin.



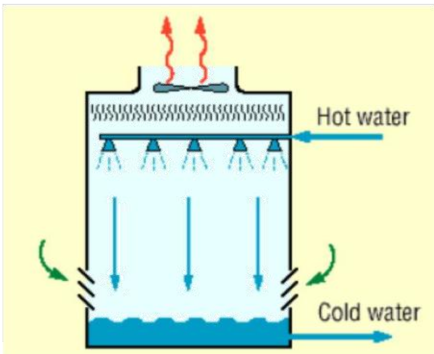


Fig:-Induced Draft cooling tower

III. DESIGN OF COOLING TOWER

Design consists of application of scientific principles, technical information and imagination for development of new and improved machine or mechanism to perform a specific function with maximum economy & efficiency.

System based on Physical Constraints:
While selecting any machine it must be checked whether it is going to be used in a large scaler industry or a small-scale industry. In our case it is to be used in both by a small-scale industry and large-scale industry. So, space is the major constrain. The mechanical design has direct norms with the system design. Hence the foremost job is to control the physical parameters, so that the distinction obtained after mechanical design can be well fitted into that.

Components	**Material**
P.V.C Fill	Plastic
Exhaust fan	M.S.
Frame	M.S.
Sheet	Plastic
Valve	Plastic
Door	G.I.
Sump	G.I.

IV. Model created in Creo Parametric 2.0

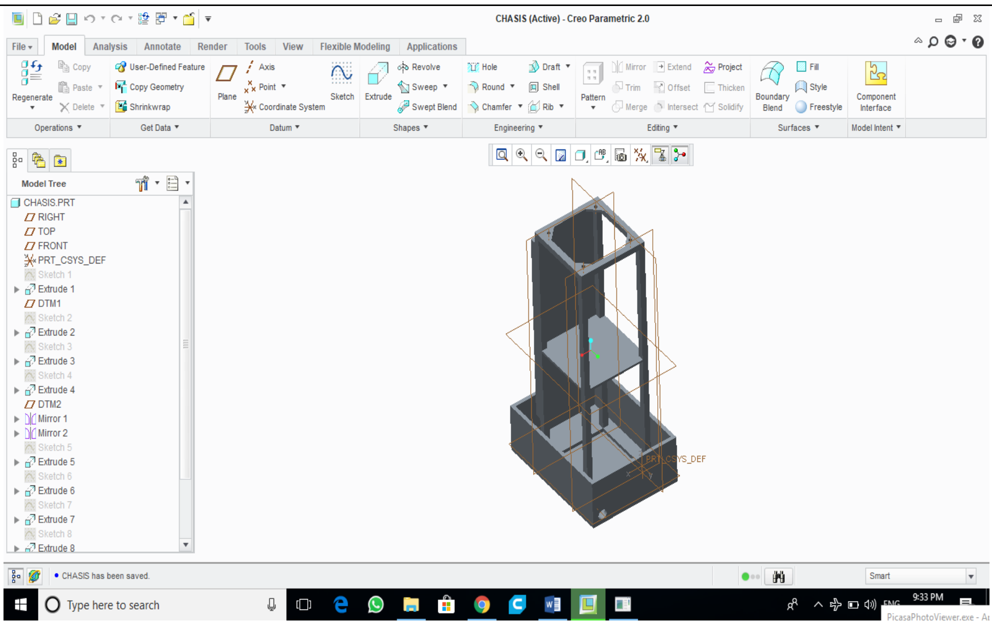
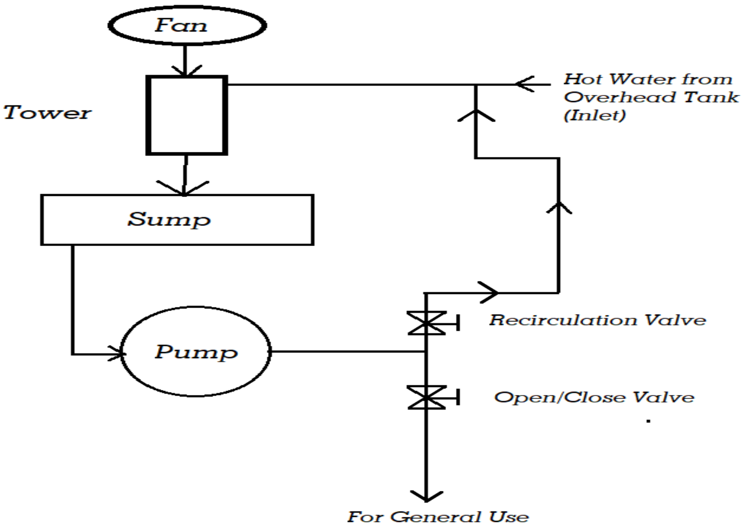


Fig: Model of Cooling Tower

V. Experimental Setup

Description:

- Hot water enters in cooling tower through pipe.
- Cooling tower is connected with sump, where all the water from the cooling tower gathers.
- A pump is connected to sump by a pipe.
- Pump is connected with two valves.
- Recirculating valve connected through pipe to inlet pipe of cooling tower. .



Appearance after completion

VI. Performance Calculation

COOLING TOWER CHARACTERISTICS

Merkel offers the cooling system characteristic equation as (KaV/ mw1) = [(T1 – T2) / 4] x (1.2) wherever, K = Mass transfer co-efficient (Kg / 60 minutes m2), a = Constant space (m2), V = Active cooling volume (m3), mw1 = Mass of water (Kg / hr)

T1 = quandary temperature (0 C)

T2 = Cold water temperature (0 C)

Now,

Mh1 = worth of Hw - HA at T2 + zero.1 (T1 – T2)

Mh2 = worth of Hw - HA at T2 + zero.4 (T1 – T2)

Mh3 = worth of Hw - HA at T1 - zero.4 (T1 – T2)

Mh4 = worth of Hw - HA at T1 - zero.1 (T1 – T2)

H1= T2 + 0.1 (T1 – T2)

Mh1 = Hw - HA

H2= T2 + 0.4 (T1 – T2)

H3= T1 - 0.4 (T1 – T2)

H4= T1 - 0.1 (T1 – T2)

potency of cooling system

N = (T1 – T2) / (T1 – WBT)

Effectiveness ofcooling system

P = (T1 – T2) / (T1 – Ta1)

VII. RESULT AND DISCUSSION

This experiment is carried out to measure the change in Temperature rate of hot cold fluid to investigate the efficiency of tower. The test is carried out with water without fin and with fin.

READINGS

Table 1 with PVC Fill Material

S.NO	T1 (°C)	T2 (°C)	Ta1 (°C)	Ta2 (°C)
01	43	33	29	39
02	50	39	29	41
03	57	44	30	45

Table 2 with Cooler Net Fill Material

S.NO.	T1 (°C)	T2 (°C)	Ta1 (°C)	Ta2 (°C)
01	43	38	29	33
02	50	43	31	39
03	57	49	30	42

Table 3 without Fill Material

S.NO	T1 (°C)	T2 (°C)	Ta1 (°C)	Ta2 (°C)
01	43	41	30	35
02	50	48	30	37
03	57	54	30	40

Where,
T1 - Inlet temperature of water ºC , T2 - Outlet temperature of water ºC , Ta1 - Inlet air temperature ºC
Ta2 - Outlet air temperature , WBT – Wet bulb temperature ºC

Example calculation of P.V.C fills

MODEL CALCULATION WITH PVC FILL

T1 = 43 ºC

T2 = 33 ºC

Ta1 = 29

Ta2 = 39

WBT = 27 ºC

COOLING TOWER APPROACH (CTA)

CTA = T2 – WBT

= (33 - 27) = 6 ºC

COOLING TOWER RANGE (CTR)

CTR = T1 – T2

= (43 - 33) = 10 ºC

HEAT LOSS BY WATER (HL)

HL = mw X Cpw X (T1 – T2)

Where

mw = mass of the water in Kg / hr

mw = volume of the collecting tank time taken

= 303 kg / hr

HL = 303 X 4.18 X (43- 33)

=12,665KJ/h

EFFICIENCY (η)

= (T1 - T2) / (T1 - WBT)

= (43 – 33) / (43 – 27)

= 55.55 %

EFFECTIVENESS (ε)

= (T1 - T2) / (T1 - Ta1)

= (43 – 33) / (43 – 29)

= 0.71

VARIOUS LOSSES

DRIFT LOSS

Drift loss are generally taken as 0.10 to 0.20% of circulating water.

DL = 0.15 x mw1 / 100

DL = 0.15 x 303 / 100

DL = 0.45 Kg / hr

WINDAGE LOSS (WL) Windage losses are generally taken as 0.005 of circulating water.

WL = 0.005 x mw1

WL = 0.005 x 303; WL = 1.51 Kg / hr

EVAPORATION LOSS (EL)

Evaporation losses are generally taken as 0.00085 of circulating water.

EL = 0.00085 x mw1 x (T1 – T2)

EL = 0.00085 x 303 x (43 - 33)

EL = 2.5755 Kg / hr

BLOW DOWN LOSS (BL)

Number of cycles required for cooling tower is given by Cycles = XC / XM

Where,

XC = Concentration of solids in circulating water

XM = Concentration of solids in Make-up water

Water balance equation for cooling tower is

M = WL + EL + DL

M = 1.51 + 2.57 + 0.45

M = 4.53 Kg / hr

XC / XM = M / (M - EL)

XC / XM = 4.53 / (4.53 – 2.57)

XC / XM = Cycles = 8.87

BL = EL / (Cycles - 1)

BL = 2.57 / (8.87 - 1)

= 20.24 KJ / hr

Total water loss = DL+WL+EV+BL

=25.77 Kg/hr

Table 3 Comparison Result Between With and Without Fill Material Cooling Tower

T1˚C	COOLING TOWER APPROCH	HEAT LOSS BY WATER (KJ / hr)	η %	ε	WATER LOSSES (Kg / hr)
43	Without fill material	2,533	12.5	0.15	4.45
43	With PVC fill material	12,665	55.55	0.71	25.77
43	With Cooler net fill material	6,332	31	0.35	10.13
50	Without fill material	2,533	10.8	0.1	4.45
50	With PVC fill material	13,931	47.8	0.52	50.61
50	With Cooler net fill material	8,865	30	0.368	15.24
57	Without fill material	3,799	10	0.11	6.095
57	With PVC fill material	16,465	43	0.48	36.79
57	With Cooler net fill material	10,132	26	0.296	14.17

1. Comparison of heat transfer with Different Fill Materials:

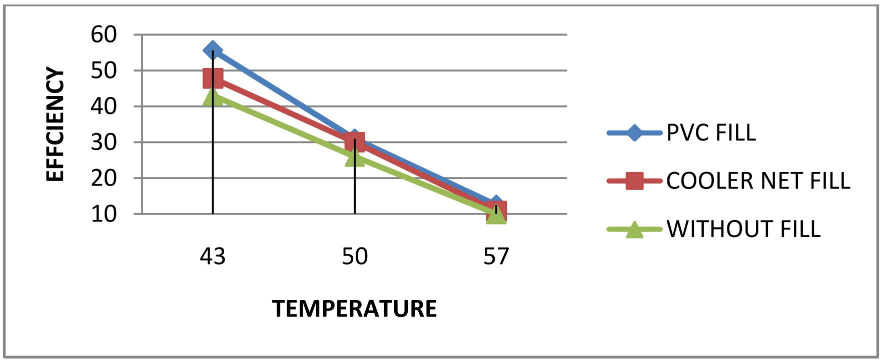


Fig: - Showing result of compression of heat transfer of different fill material performance

2. Comparison of effectiveness

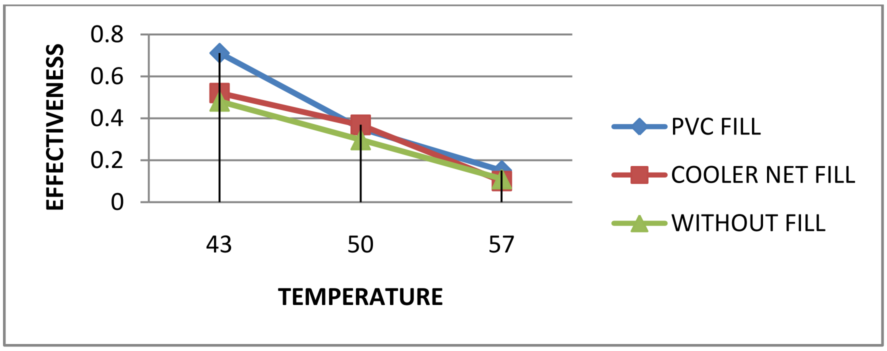


Fig: - Showing result of variation of Effectiveness of different fill material

3.COMPARISON OF HEAT LOSS BY WATER

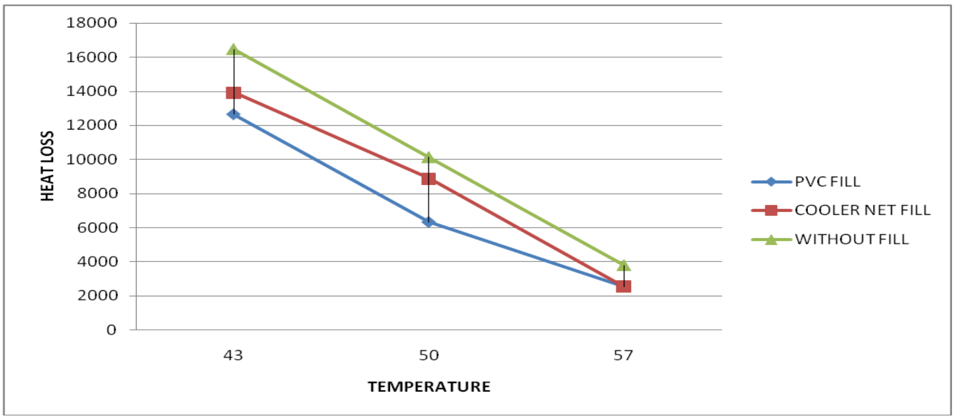


Fig: -Showing result of heat loss during Experiment of different fill material

VIII. CONCLUSION

Based on the experiments and calculation results of the work, it is concluded that:

- The efficiency of cooling tower with fill material is high compare to the efficiency of cooling tower without fill material. Fill material increase the water and air contact inside the cooling tower so the heat loss by water is also high compare to the cooling tower without fill material.

The evaporation loss of cooling tower with fill material is little high because the water and air contact time is high. Even though losses are generated in the cooling tower, the cooling is achieved due to heat transfer between air and water.

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