Experiment No: 07

Aim: To Determine the Cooling Capacity of Desert Cooler Trainer

Apparatus: Air coolers or desert coolers

Introduction:-

Evaporative coolers (also called **air coolers** or **desert coolers**) are cooling devices, which uses simple evaporation of water in air. They differ from refrigeration or absorption air conditioning, which use the vapor-compression or absorption refrigeration cycles. Small-scale evaporative coolers are called **swamp coolers** by some users due to the humid air conditions produced. **Air washers** and **wet cooling towers** utilize the same principles as evaporative coolers, but are optimized for purposes other than air-cooling.

Evaporative cooling is especially well suited for climates where the air is hot and humidity is low, if sufficient potable water is available. In dry climates, the installation and operating cost of an evaporative cooler can be much lower than air conditioning, often by 80% or so. However, evaporative cooling and vapor-compression air conditioning are sometimes used is combination to yield the optimal performance. Some evaporative coolers may also serve as humidifiers in the heating season.

In moderate humidity locations there are many cost-effective uses for evaporative cooling, in addition to their widespread use in dry climates. For example, industrial plants, commercial kitchens, laundries, dry cleaners, greenhouses, spot cooling (loading docks, warehouses, factories, construction sites, athletic events, workshops, garages, and kennels) and confinement farming (poultry ranches, hog, and dairy) all often employ evaporative cooling. In highly humid climates, evaporative cooling may have little thermal comfort benefit beyond the increased ventilation and air movement it provides.

Procedure:-

1. Fill up sufficient water in sump tank for pouring water lift up top lid & pour the water.
2. Fill up the water in the well of wet bulb thermometer.
3. Start the fan, start the pump and adjust the flow rate so that spray tank does not overflow.
4. Wait until the temperatures reach steady state. It may take around 15 min.
5. Note down the readings.

6. Repeat die procedures at different water flow rates.

Observation Table:

Sr. No.	Inlet 'C		Outlet "C		Flapper opening angle	Time for 10 Rev. of energymeter	Flow (LPH)
	D.B	W.B	D.B	W.B			

Calculation :-

1) Surrounding Air,

DBT= °C, WBT = °C

From the table of dry/ wet bulb thermometers, relative humidity, RH =_____ ,

Now, RH = Pw / Psat x 100

Where, Pw = Partial pressure of water vapour in air

Psat = Partial pressure of set water vapour at saturation at DBT

Therefore, Pw = bar.

Humidity Ratio,

W = 0.623 x Pw / (P - Pw) kg/ kg of dry air

Where, W = Humidity ratio

P = Atmospheric pressure

Total enthalpy of air at inlet,

Hi = ha + hs + hl + hsh

1) ha = Enthalpy of dry air, kJ/kg

= Cpa x DBT kJ/kg

Where, Cpa = Specific heat of dry air= 1 kJ/kg °C

2) hs = Sensible heat of moisture upto WBT, kJ/ kg of dry air

= W x Cpw x WBT kJ/kg

Where, Cpw = specific heat of moisture = 4.18 kJ/kg °C

3) hi = latent heat of evaporation of moisture at WBT

= WxL kJ/kg at WBT

(from table of psychrometric properties of air)

4) hsh = Heat of super heating of moisture from WBT to DBT

= 1.9 x w (DBT-WBT) kg/kg of dry air

Now, similarly, find out total enthalpy of air at outlet,

Ho = kJ/kg

Mass flow of air -

Velocity of air (see calibration chart)

Va = m/s

Area of duct 0.08 m^2

Therefore, volume flow of air,

Qa = Va x 0.08 m^3/s

Density of air at outlet,

$\rho a = 1.293 \times 273 / 273 + DBTo$

Where, DBTo = Outlet dry bulb temp., °C

Therefore, mass flow of air,

$ma = Qa \times \rho_a$, kg/ s

Therefore cooling capacity of the unit,

C = max(Hi-Ho) kJ/s.

Result:- Cooling Capacity of the Desert Cooler is_____

Precaution :-

1. Before starting the cooler, ensure that sufficient water is there in the lower tray.
2. Never close the flappers completely.
3. Always use clean water for the cooler.

Flapper closing (Degree)	Air Velocity (m /sec)
20	2.23
30	2.93
40	2.83
50	2.74
60	2.4
70	2.74
80	3.12

Temp. °c	Saturation of Water & Steam $p_{sat\ kg/cm^2}$	Enthalpy of Sat. Water $h_{sw,\ kJ/kg.}$	Latent Heat of Evaporation L ,KJ / Kg	Enthalpy of Saturated Steam h_{st} kJ / kg.
0	0.006228	0.0 0	2496.7	2496.7
1	0.007198	8.4 0	2492.10	2500.5
2	0.006664	4.22	2494.18	2498.4
3	0.007723	12.62	2489.48	2502.1
4	0.008289	16.80	2487.40	2504.2
5	0.008890	20.98	2484.12	2505.1
6	0.009530	25.21	2482.39	2507.6
7	0.010210	29.39	2480.31	2509.7
8	0.010932	33.61	2477.69	2511.3
9	0.011690	37.79	2475.21	2513.0
10	0.012513	41.97	2473.13	2515.1
11	0.013376	46.15	2470.65	2516.8
12	0.014291	50.33	2472.67	2523.0
13	0.015261	54.51	2465.59	2520.1
14	0.016289	58.69	2463.41	2522.1
15	0.017376	62.87	2461.43	2524.3
16	0.018527	67.04	2558.95	2526.0
17	0.019745	71.23	2456.37	2527.6
18	0.02103	75.41	2453.89	2529.3
19	0.02239	79.59	2451.81	2531.4
20	0.02383	83.77	2459.23	2533.0
21	0.02534	87.95	2446.85	2534.8
22	0.02694	92.13	2444.67	2536.8

	23	0.02863	96.31	2442.19	2538.5
	24	0.03041	100.45	2440.15	2540.6
	25	0.03229	104.63	2436.67	2542.3
26	26	0.03426	108.81	2435.09	2543.9
	27	0.03634	112.99	2433.01	2546.0
	28	0.03853	177.17	2429.93	2547.1
	29	0.04083	121.35	2427.75	2549.1
	30	0.04125	125.48	2426.02	2551.5
31	31	0.04580	129.66	2005.44	2135.1
	32	0.04847	133.84	2421.36	2555.2
	33	0.05123	138.2	2418.70	2556.9
	34	0.0.5423	142.20	2416.40	2558.6
35	35	0.0.5733.	146.34	2414.36	2560.7
	36	0.06057	150.52	2411.48	2562.0
	37	0.06398	154.70	2409.30	2564.0
	38	0.06755	158.88	2407.12	2566.1
	39	0.07120	163.06	2404.74	2567.8
	40	0.07520	167.24	2402.26	2569.5
	41	0.07930	171.42	2400.08	2571.5
	42	0.08360	175.56	2397.64	2573.2
	43	0.08809	179.74	2394.36	2574.1
	44	0.09279	183.92	2392.68	2576.6

PSYCHROMETRIC TABLE FOR PERCENTAGE RELATIVE HUMIDITY OF AIR

READING OF DBT.	DIFFERENCE BETWEEN READING OF DRY - BULB AND WET - BULB THERMOMETERS (WET - BULB DEPRESSION)											
°C	1	2	3	4	5	6	7	8	9	10	11	12
- 10	67	38	10									
- 8	70	45	22									
- 6	73	51	32	15								
- 4	77	57	38	22	9							
- 2	80	62	44	29	17							
0	82	65	48	3	20							
2	84	68	53	39	25	12						
4	85	71	58	43	31	18	7					
6	86	73	60	47	36	25	14	4				
8	87	75	63	51	40	30	20	10				
10	88	76	65	54	44	34	24	15				
12	89	78	68	57	48	38	29	20	11			
14	90	80	70	60	51	42	34	25	18	10		
16	91	81	71	62	54	46	38	30	23	16	8	
18	91	81	72	64	56	48	41	34	27	20	13	9
20	91	82	73	66	58	51	44	36	30	24	17	11
22	91	83	74	68	60	54	46	40	34	28	22	16
24	92	84	75	69	62	56	49	43	37	31	26	20
26	92	84	76	70	64	58	51	45	40	34	29	24
28	93	85	77	71	65	59	53	47	42	37	32	27
30	93	86	78	72	66	61	55	50	44	40	35	30
32	93	86	79	74	68	62	57	52	46	42	37	32
34	93	87	80	75	69	63	58	53	48	44	39	34
36	93	87	81	75	69	64	59	54	49	45	40	36
38	94	88	82	76	70	65	60	55	50	46	42	38
40	94	88	82	77	71	66	61	56	51	47	43	40
42	94	89	83	78	72	68	62	58	53	49	45	42
44	95	90	84	79	73	68	63	59	54	50	46	43
46	95	90	84	79	74	70	64	60	55	51	47	45
48	95	90	84	79	74	70	65	60	56	52	48	46
50	95	90	84	79	74	70	66	62	58	54	49	47
52	95	90	84	80	75	71	67	63	59	55	51	48
54	95	90	84	80	76	72	68	64	60	56	52	49
56	95	90	85	81	77	73	68	64	60	57	53	50
58	95	90	85	81	77	73	69	65	61	58	54	51
60	95	90	85	81	77	73	69	65	61	58	55	52
62	95	90	85	82	78	74	70	66	62	59	56	53
64	95	91	86	82	78	74	70	67	63	60	57	54
66	95	91	86	82	78	75	71	67	63	61	57	54
68	95	91	86	82	78	75	71	63	64	61	58	55
70	95	91	86	82	78	75	71	68	64	61	58	55