Condensation

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Abstract— In this paper we will study in HVAC system how the Air handling unit, treated fresh air unit. fan coil unit and ceiling suspended unit's drain line water can we collected and store in to makeup tank and then after treating that drain water and maintaining specific parameter, we can reuse that drain water in cooling tower and flushing system so that we can minimize the water uses in the building management system that affect the cost to management. we will discuss the calculation of drain water according to specific unit and drain line connection.

Keywords: AHU, TFA, Condensate, Relative humidity, DEWPOINT, CSU, FCU

I. Introduction

Condensate forms when moist air touches an air conditioner's cold evaporator coils. The air's water vapor condenses into water and either discharges directly or drains into a specific duct. Conservation groups in dry regions suggest collecting and using this water for gardening, flushing or in other use.

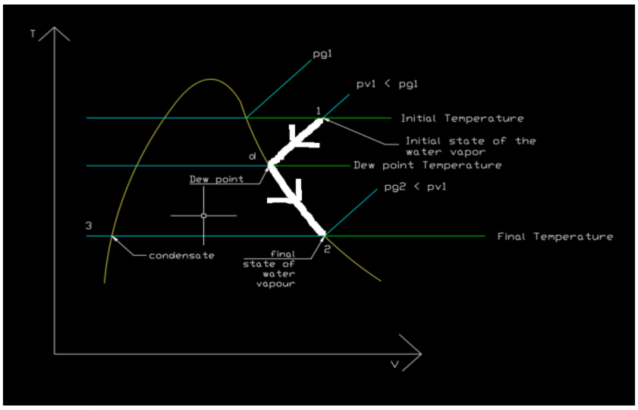
Condensation accumulates in your air conditioner as the unit cools the air. Indoor air is circulated across coils filled with cold refrigerant. These coils accumulate condensation just as a bottle of cold water does in a hot room. The water then drips down into a pan and drains outside the home. This is a by-product of the cooling process and is not cause for concern

II. Literature Review

During literature survey it is found that many researchers had worked on the condensation and its working principal Cooling systems rely on evaporator coils through which refrigerant fluid changes from liquid to vapor, cooling the coils in the process. Air blowing past the coils cools off as it goes by, and moisture from the air condenses on the coils. Condensate drains carry away the water, usually into the sewer. Instead of wasting it, more and more buildings, especially in parts of the country with hot, humid summers, are capturing that condensate for reuse. It makes so much sense there because of the large cooling load and high humidity. The collected condensate water, which is used to replenish the cooling tower losses, A six-month payback was calculated on the condensate-recovery system at the different building and as per their geological location. building management team estimate how much air-conditioner condensate could be recovered.

III. Calculation

First consider this. When the condensation does begins? When the moist air is cooled at a constant mixture pressure to a temperature below its dew point temperature, some of the water vapor present in the moist air condenses.



Moist air cooled from initial state of water vapor 1 to final state 2. Condensation begins at d when the temperature reaches the dew point temperature.

Relative humidity is defined as ratio of partial pressure of water vapor pv to the saturation pressure pg at the given temperature T

$$\phi = \frac{pv}{pg}$$

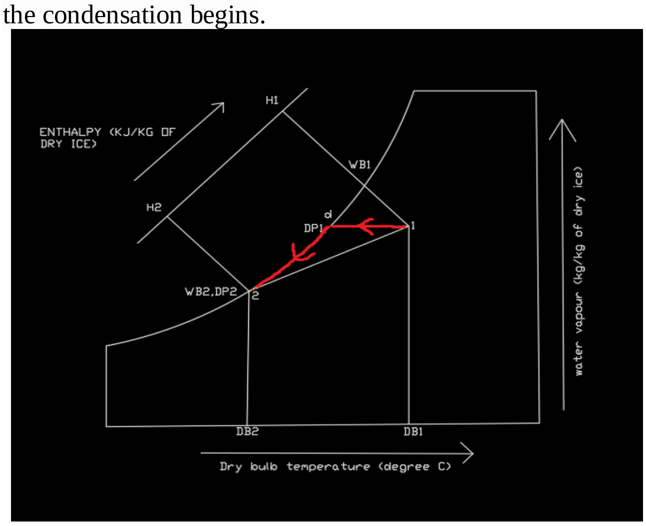
For condensation to occur, the partial pressure of the vapor pv has to equal to saturation pressure pg. In other words, relative humidity has to be equal to 100 % even though the initial relative humidity is less than 100% as evident by pv1<pg1pv1<pg1 in the above diagram.

The same process 1-d-2 can be understood on a psychometric chart as shown below.

Process 1-d: Constant pressure cooling. Note that the y axis represents vapor pressure which is constant for the process 1-d. Relative humidity at state 1 is less than 100 % and it increases to 100% as we move from 1-d but no condensation occurs since the temperature is above the dew point temperature.

Process d-2: Now as the temperature is decreased, the vapor pressure decreases and hence condensation begins. However, the relative humidity is already 100% at state d and it is also 100% at state 2.

Hence first relative humidity reaches 100% then the condensation begins.



As we know condensation water depend upon relativity humidity and temperature.

Since RH is a function of temperature. Hence it increases when temperature decreases and vice-versa. Now condensation won't occur unless the air is saturated or RH is 100%. So even though RH is not 100%, you can increase the RH by reducing the temperature at same pressure and hence achieve condensation. For e.g. you have probably noticed that when you buy a cold canned drink from a vending machine on a hot and humid day, dew forms on the can. The formation of dew on the can indicates that the temperature of the drink is below the dew-point temperature of the surrounding air and this reduced temperature has caused the surrounding air to become saturated or with a RH of 100%.

We are calculate the condensation water as we have

1 TFA of 25000 CFM

AND,

In Practical we are getting 200ml in 1 min

So, assuming in 60 min we are getting 1.2 litres

As per time schedule of TFA operating time 10hrs in day (except Saturday)

So, we are getting 1.2ltr*10hrs = 120 litres (Approximate)

So, in month we operator TFA IN 26 day so we are getting

We have Different condition as per climate currently we are assuming Mumbai city

Mumbai					
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5
Time	10:00am	12:00pm	2:00pm	4:00pm	6:00pm
Temperature	23°C	26°C	27°C	26°C	25°C
Relative Humidity	50%	40%	45%	48%	54%
Dew Point Temperature	12°C	11.3°C	14°C	14.1°C	15°C

Now we are assuming 5 cases as per the cases we calculate the condensation water

A. Case 1 at 10:00am

At that time the temperature of the Mumbai climate is 23°C Relative humidity 50% and Dew point is 12°C, we are getting low Dew point for condensation.

So, at 10:00am the condensation will be less than that of maximum condensation so we are getting less than 3.5 liter condense water.

B. Case 2 at 12:00pm

At that time the temperature of the Mumbai climate is 26°C Relative humidity 40% and Dew point is 11.3°C, we are getting very low Dew point for condensation.

So, at 12:00pm the condensation will be maximum condensation so we are getting maximum 4 liter condense water.

C. Case 3 at 02:00pm

At that time the temperature of the Mumbai climate is 27°C Relative humidity 45% and Dew point is 14°C, we are getting high Dew point for condensation.

So, at 02:00pm the condensation will be less than that of maximum condensation so we are getting maximum 3 liter condense water.

D. Case 4 at 04:00pm

At that time the temperature of the Mumbai climate is 26°C Relative humidity 48% and Dew point is 14.1°C, we are getting very high Dew point for condensation

So, at 04:00pm the condensation will be very less than that of maximum condensation so we are getting maximum 2.7 liter condense water.

E. Case 5 at 06:00pm

At that time the temperature of the Mumbai climate is 25°C Relative humidity 54% and Dew point is 15°C, we are getting high Dew point for condensation. So, at 06:00pm the condensation will be very less than that of maximum condensation so we are getting maximum 2.5 liter condense water.

Total condensation water				
Time	Temperature	Relative Humidity	Dew Point Temperature	Condensation water (ltr)
08:00am	20	68	13.9	3.4
09:00am	22	58	13.3	3.3
10:00am	23	50	12	3.5
11:00am	26	45	14.1	2.7
12:00pm	26	40	11.3	4
01:00pm	26	42	12.1	3.5
02:00pm	27	45	14	3
03:00pm	27	46	14.4	2.5
04:00pm	26	48	14.1	2.7
05:00pm	25	51	14.1	2.7
06:00pm	26	54	16	1.9
Total condensation water				33.2

Assume Total number of TFA = X

1) For X TFA condensation water

Y1= X*Total condense water/day

2) For Month condensation water

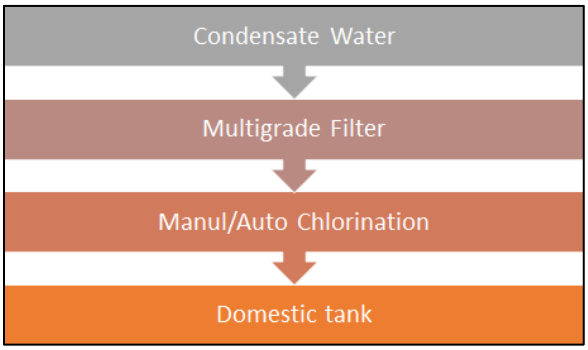
Z1=Y1*(30 or 31)

IV. Treatment

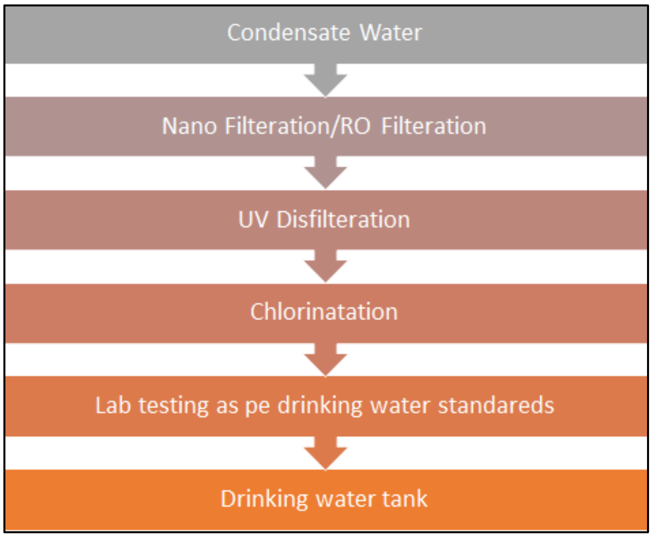
We can use collected water as per below list

1) Domestic purpose
2) Drinking water purpose
3) Cooling tower and in Flushing purpose

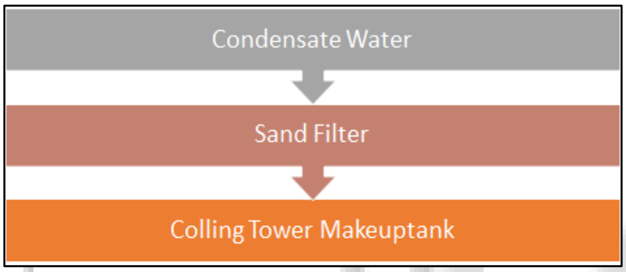
A. For Domestic purpose



B. For Drinking water



C. For Cooling tower and in Flushing



V. Conclusion

From above experiment we calculated how to save condensate water and stored and tank after some shown treatment in the experiment we can reuse the condensate water in drinking purpose domestic purpose and cooling tower and in flushing.

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