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INVESTIGATION OF DESICCANT COOLING SYSTEM

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ABSTRACT

Desiccant cooling systems are heat-driven cooling units and they can be utilized as an option to the ordinary vapor compression and absorption cooling systems. Its task is based on the utilization of a rotary dehumidifier Desiccant Wheel (DW) in which air is dehumidified. The coming about dry air is to some degree cooled in a reasonable heat exchanger Rotary Regenerator (RR), and after that further cooled by an evaporative cooler. The subsequent cool air is coordinated into the room. The system might be worked in a shut cycle or all the more generally in an open cycle in ventilation or then again distribution modes. A heat supply is required in the system to recover the desiccant (normal zeolite) and a second rate heat at a temperature of about 60^0C might be utilized. The warm and reversible COPs of an open desiccant cooling system rely upon working conditions of the system. In this paper, we propose a desiccant cooling system with certain working qualities for all parts. We utilize this activity as a standard model for figuring warm and reversible COPs for both ventilation and distribution methods of the system activity. Parametric examinations are performed to explore the impacts of surrounding temperature and relative stickiness on the different COP terms and cooling load.

Keywords: *COP, DW, 0C , Desiccants, Desiccant cycle, First and second law.*

I. INTRODUCTION

Desiccants has high fondness towards dampness they can draw water vapor specifically from the encompassing air This liking can be recovered constantly by applying warmth to the desiccant material to drive off the gathered dampness. A few materials are desiccants; that is they pull in and hold water vapor. common filaments, dirts ,wood and numerous synthetics materials pull in and discharge dampness like business Desiccants has high partiality towards dampness they can draw water vapor specifically from the encompassing air This proclivity can be recovered ceaselessly by applying warmth to the desiccant material to drive off the gathered dampness. A few materials are desiccants; that is they pull in and hold water vapor. regular filaments, muds ,wood and numerous synthetics materials pull in and discharge dampness like business desiccants do, yet they absence of holding limit of some unique desiccant materials. For instance, woolen floor covering filaments draw in up to 21% of their dry load in water vapor, and nylon can take up nearly 6% of its load in water. Conversely, a business desiccant takes up somewhere in the range of 10 and 110% of its dry load in water vapor, contingent upon its sort. Furthermore, the dampness accessible in the earth. Besides, business desiccants carry on to pull in dampness notwithstanding when the encompassing air is very dry.

All desiccants perform likewise that they pull in dampness from the encompassing until they achieve balance with the encompassing air. Dampness is generally isolates from the desiccant by warming it to temperatures somewhere in the range of 120 and 500 F and presenting it to a scrounger airstream. After the desiccant dries, it must be cooled with the goal that it can pull in dampness indeed. It generally creates reasonable warmth equivalent to the dormant warmth of water vapor taken up by the desiccant, in addition to an extra warmth of sorption that shifts somewhere in the range of 5 and 25% of the inert warmth of the water vapor. This warmth is exchanged to the desiccant and the encompassing air.

The way toward drawing in and holding dampness is portrayed as either adsorption or assimilation, contingent upon whether the desiccant experiences a concoction change as it goes up against dampness. Adsorption does not change the desiccant with the exception of by the expansion of the heaviness of water vapor, comparative somehow or another to a wipe splashing up water. Retention, then again, changes the desiccant. A case of this is table salt, which changes from a strong to a fluid as it retains dampness.

Sorbents are materials that have a capacity to draw in and hold gases or fluids. They can be utilized to draw in gases or fluids other than water vapor, a trademark that makes them extremely valuable in compound detachment forms. Desiccants are subset of sorbents; they have a specific fondness for water.

II. TYPES OF DESICCANTS

Desiccants can be solids or fluids, Liquid retention dehumidification can best be disclosed by contrasting it with the activity of an air washer. At the point when air goes through an air washer, its dewpoint approaches that of the temperature of the water provided to the hardware. Less sticky air is humidified and progressively damp air is dehumidified. Likewise, a fluid ingestion dehumidifier contacts air with a fluid desiccant arrangement. The fluid has a vapor weight lower than water at a similar temperature, and when the air ignoring this arrangement decreased vapor weight, and afterward it is dehumidified. The vapor weight of a fluid retention arrangement is specifically relative to its temperature and contrarily corresponding to fixation (Kanoglu and Yildirm, 2003).

In application, the conduct of a fluid desiccant can be constrained by altering its fixation, its temperature, or both. basic radiators and coolers controlled the Desiccant temperature. Focus is constrained by warming the desiccant to drive dampness out into a waste airstream or straightforwardly to the ambient. The ingestion process is restricted by the surface territory of a desiccant presented to the air being dehumidified and the contact time took into consideration the response. Increasingly surface zone and more contact time enables the desiccant to approach its hypothetical limit.

Adsorbents are strong materials with an astounding inner surface region per unit of mass; a solitary gram can have more than 50,000 ft2 of surface region. Fundamentally, they take after an unbending wipe, and the outside of the wipe thus takes after the sea coastline of a fjord. This relationship demonstrates the size of the diverse surfaces in an adsorbent. The fjords can be contrasted with the vessels in the adsorbent. The spaces between the grains of sand on the fjord shorelines can be contrasted with the spaces between the individual atoms of the adsorbent, all of which have the ability to hold water particles. The greater part of the adsorbed water is contained by buildup into the vessels, and most of the surface region That pulls in individual water atoms is in the crystalline structure of the material itself. Adsorbents draw in dampness on account of the electrical field at the desiccant surface. The field isn't uniform in either power or charge, so it draws in enraptured water particles that have a contrary charge from explicit destinations on the desiccant surface. At the point when the total surface is secured, the adsorbent can keep still more dampness, as vapor gathers into the principal water layer and fills the vessels all through the material (Dauo et al., 2004).

All desiccants work by a similar component exchanging dampness due to a contrast between the water vapor weight at their surface and that of the encompassing air. At the point when the vapor weight at the desiccant surface is lower than that of the air, the desiccant draws in dampness. At the point when the surface vapor weight is higher than that of the encompassing air, the desiccant discharges dampness. Figure 1 demonstrates the connection between the dampness substance of the desiccant and its surface vapor weight. As the dampness substance of the desiccant rises, so does the water vapor weight at its surface. Sooner or later, the vapor weight at the desiccant is equivalent to that of the air and the two are in balance (Ashrae, 1997). At that point dampness can't move in either bearing until some outer power changes the vapor weight at the desiccant or noticeable all around.

Figure 1: Desiccant Cycle

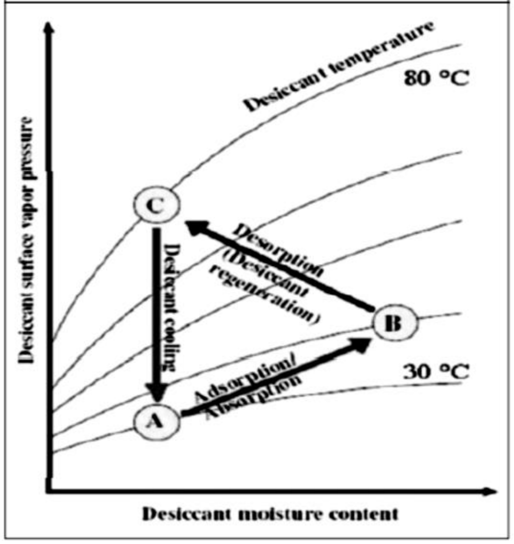


Figure 1 additionally demonstrates the effect of temperature on the vapor weight at the desiccant. Both higher temperatures and expanded dampness content increment the vapor weight at the surface. At the point when the surface vapor weight surpasses that of the encompassing air, dampness leaves (Hirunlabha et al., 2005) the desiccants procedure called reactivation or regeneration. After the desiccant is dried (reactivated) by the warmth, its vapor weight stays high, with the goal that it has next to no capacity to assimilate dampness. Cooling the desiccant lessens its surface vapor weight so it can assimilate dampness by and by. The total cycle is outlined in Ma et al. (2004) Figure 1.

III. MATHEMATICAL MODELLING

Ventilation Mode

In ventilation mode air is first enter in the desiccant wheel where it can dehumidify and warmed by the warmth of adsorption this warmed air is cooled reasonably in the rotator regenerator and after that is additionally cooled in evaporative cooler before go into the room Figure 2. An equivalent amount of air pulls back from the space for recovery (Arora, 2000). This recovery air is cooled first cooled in evaporative cooler (Konaglu et al., 2004) and afterward preheated in regenerative regenerator by the hotter air in procedure line and after that outer warmth is provided to this air in regenerative line before going through the desiccant wheel for reviving the

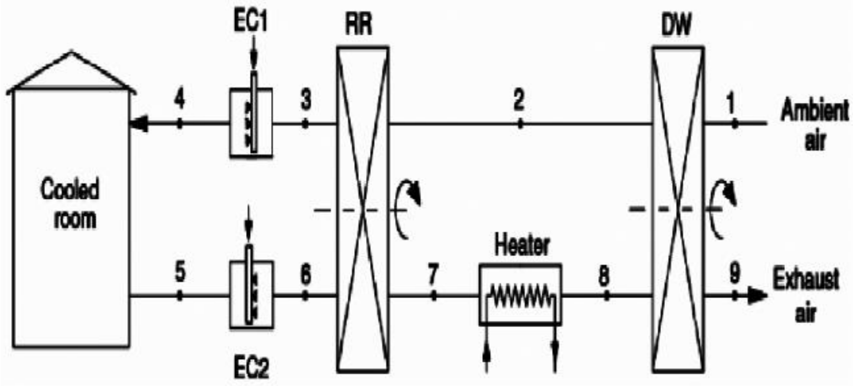


Figure 2

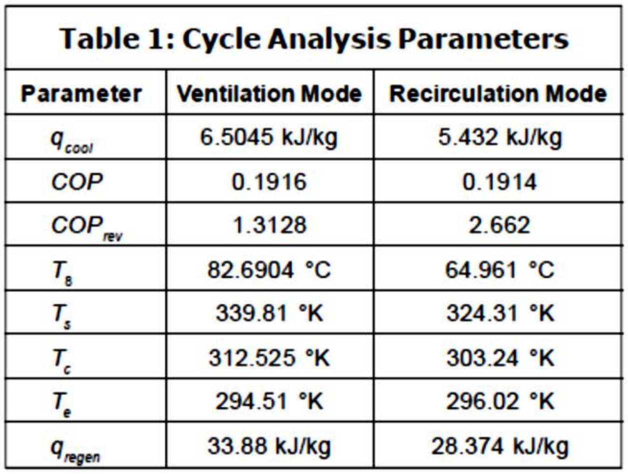


Table 1: Cycle Analysis Parameters		
Parameter	Ventilation Mode	Recirculation Mode
q_{cool}	6.5045 kJ/kg	5.432 kJ/kg
COP	0.1916	0.1914
COP_{rev}	1.3128	2.662
T_8	82.6904 °C	64.961 °C
T_s	339.81 °K	324.31 °K
T_c	312.525 °K	303.24 °K
T_e	294.51 °K	296.02 °K
q_{regen}	33.88 kJ/kg	28.374 kJ/kg

desiccant. A perfect at the DW leave (Pons and Kodama, 2000).

$$WIdeal = 0 \quad \ldots\ldots\ldots\ldots\ldots.(1)$$

A superior connection for the desiccant wheel is viability for explicit moistness, which is given by Vanden et al. (1988) as:

$$\varepsilon DW = (W1 - W2)/(W1 - Wideal) \quad \ldots\ldots..(2)$$

For an adiabatic desiccant wheel. By energy balance

$$(W1 - W2)\ hfg = H2 - H1 \ldots(3)$$

Where
hfg for water = 2257 kJ/kg

The RR basically a counter flow heat exchanger so

$$\varepsilon RR = (T2 - T3)/(T2 - T6)$$

$$\varepsilon EC2 = (T5 - T6)/(T5 - TWBT5) \ldots\ldots\ldots..(4)$$

Similarly the effectiveness of evaporative cooler 1 is

$$\varepsilon EC1 = T3 - T4/T3 - TWBT3 \ldots\ldots\ldots\ldots...(5)$$

Taking note of that the air mass stream rates are equivalent all the while and the recovery lines, A vitality balance on the adiabatic RR gives

$$H2 - H3 = H7 - H6 \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(6)$$

By Konaglu *et al.* (2004) another effectiveness of the desiccant wheel is

$$\varepsilon DW1 = (T2 - T1)/(T8 - T1) \ldots\ldots.(7)$$

For sensible heating process

$$W8 = W7 \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(8)$$

State 5 is the room state. The external heat supplied to the regeneration air is given by

$$qin = H8 - H7 \text{ ………………..(9)}$$

The cooling capacity of the system is given by

$$qcool = H5 - H4 \text{…………………...(10)}$$

$$qregen = H8 - H7 \text{ ……………...(11)}$$

$$COP = (qcool/qregen) = (H5 - H4)/(H8 - H7) \text{…………...(12)}$$

IV. DISTRIBUTION MODE

In distribution mode the room air is recycled to the procedure line while the surrounding air is drawn into the recovery line (Figure 4). Here state 1 is room and state 5 is the surrounding states inverse. At that point the warm COP of this framework move toward becoming:

$$COP = (H1 - H4)/(H8 - H7) \text{ …………...(13)}$$

the Carnot COP of the entire framework are

$$Wout = \eta th,cqin \text{ ……………...(14)}$$

$COPrev = (1 - Tc/Ts)\ (Te/Tc - Te)$ ....(15)

where Ts, Te and Tc are the equivalent temperatures for the heat source, evaporator,and condenser respectively.

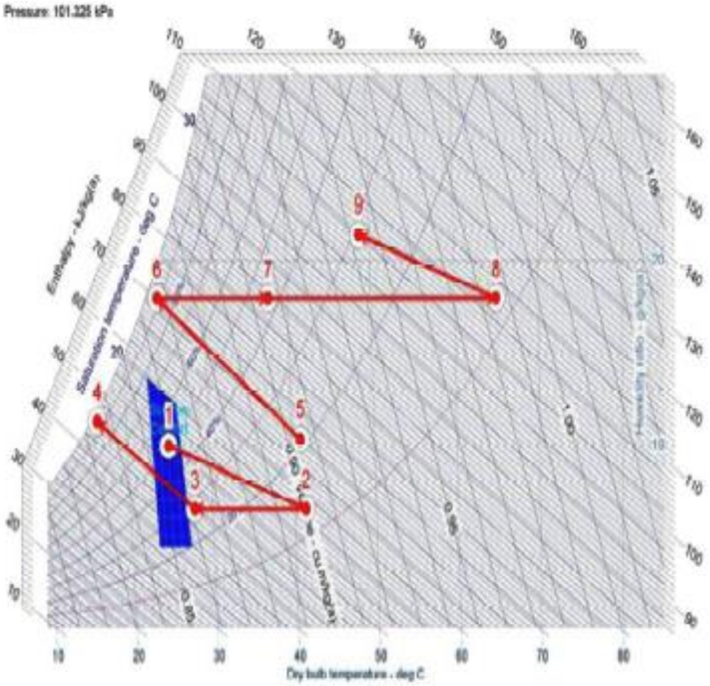
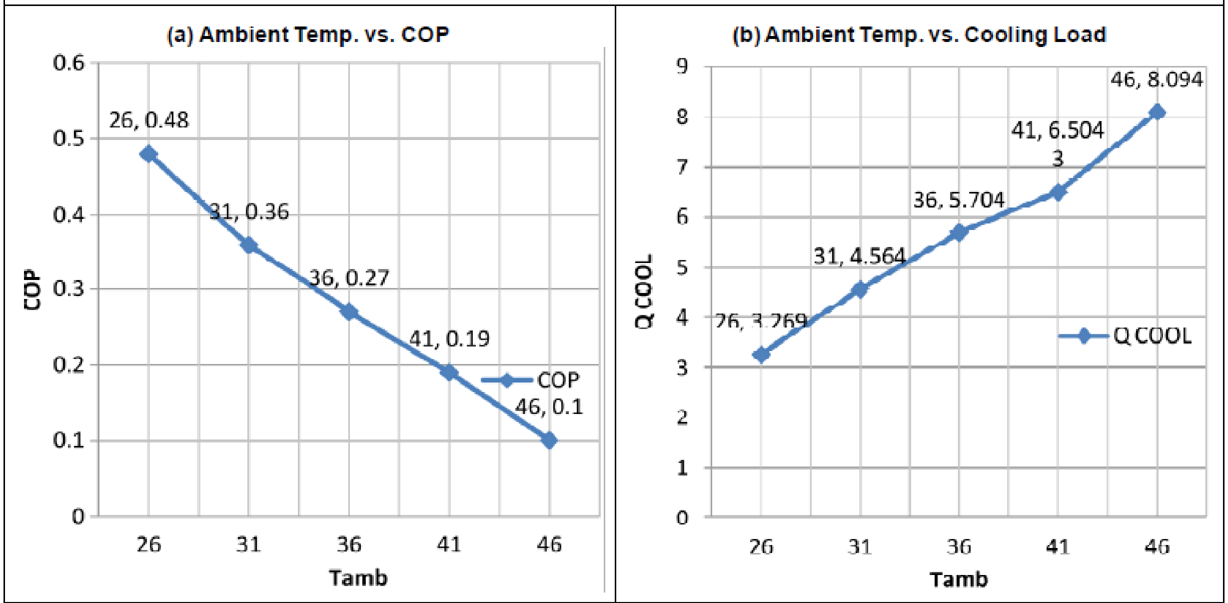


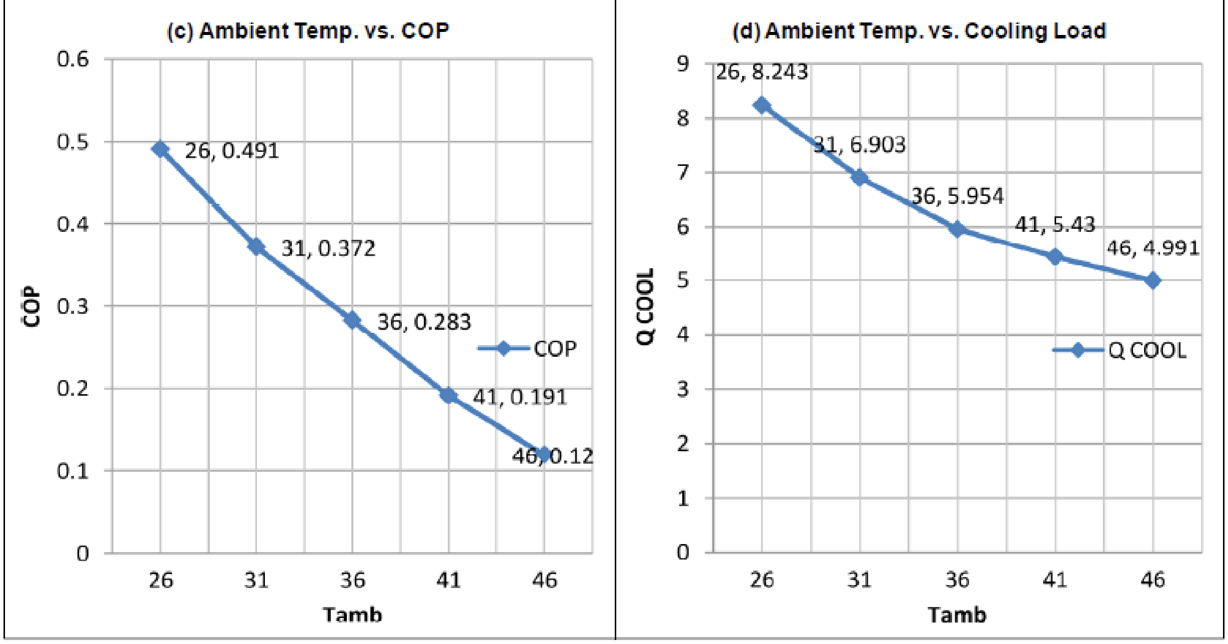
Figure 5: Psychometric Chart in Recirculation Mode

V. RESULTS AND DISCUSSION

- Ambient temperature expands the COP diminishes in Ventilation mode.
- Ambient temperature expands the COP diminishes in Recirculation mode too.

Figure 6: Graphs at Different Condition





- As encompassing temperature expands cooling load increments in Ventilation mode.
- As encompassing temperature builds cooling load diminishes in Recirculation mode (Figure 6).
- This can be clarified as in ventilation mode the base temperature got at state 4 was practically free of the encompassing temperature since the perfect D_W can totally dehumidify the delta surrounding air and an

expanded encompassing temperature with a similar relative moistness implies a higher explicit dampness at the channel and this requires a higher recovery warmth to be provided. In distribution mode, the recovery heat provided stays consistent since it is set equivalent the dormant warmth expelled from the recalculated room process air whose state does not change. The cooling load diminishes since a higher surrounding temperature compares to a higher temp. at state 4.

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