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Humidity Controll In Air Cooler Using Moisture Absorbing Material

'DEHUMIDIFIERS'

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Abstract *–In this paper, the principles underlying the operation of desiccant cooling systems are recalled and their actual technological applications are discussed. Through literature review, the feasibility of the desiccant cooling in different kinds of climates is shown and advantages and cost savings are underscored. There are two types of cooling technologies which are an AIR CONDITIONING & AIR COOLING.*

Home appliances, offices are requires Air cooler to control not only the indoor temperature but also the moisture that may be generated by water droplets, people & other processes. To overcome this problems how much desiccant cooling system is useful with compare to other cooling technologies is defined in this paper and also study of different humidifier have been reviewed in this paper.

Keywords- *Humidity, Desiccant Air Cooling, Regenerator, Dehumidification, Dehumidifier*

I. INTRODUCTION

Air Coolers are used in peak summer season for cooling in rooms, offices, hotels and restaurants etc. In general Air Coolers are used for cooling similar areas and desert coolers are used for larger area. Air cooler is gives the cooling air but the cooling air is with lots of moisture having in it. Because of this moisture there will be lots of humidity in the any room where we are using the air cooler. Climate control refers to the control of temperature and relative humidity in buildings, vehicles and other enclosed spaces for the purpose of providing for human comfort, health, and safety and of meeting environmental requirements of machines and technical processes. Humans are sensitive to high humidity because the human body uses evaporative cooling, enabled by perspiration, as the primary mechanism to rid itself of waste heat. Perspiration evaporates from the skin more slowly under humid conditions than under arid conditions. Because humans perceive a low rate of heat transfer from the body to be equivalent to a higher air temperature, the body experiences greater distress of waste heat burden at high humidity than at lower humidity, given equal temperatures. A major proportion of the air-conditioning systems in use are vapor compression-based systems that not only have low efficiency but also use refrigerants like CFC, HCFC and HFC, which are one of the main sources of ozone layer depletion. Other sources of ozone-depleting substances include refrigeration, heat pumps, fire extinguishers and fire protection systems, and solvents. CH_3CCl_2 was the only refrigerant whose concentration plummeted starting from 1994 until 2006.

In cold climates, the outdoors temperature causes lower capacity for water vapor to flow about. Thus although it may be snowing and at high humidity relative to its temperature outdoors, once that air comes into a building and heats up, its new relative humidity is very low, making the air very dry, which causes discomfort and can lead to ill health. Dry cracked skin can result from dry air.

Low humidity causes nasal passages to dry and become susceptible to cold viruses. Low humidity is a common cause of nose bleeds. The use of a humidifier in your home, especially the bedrooms can help with these symptoms.

Relative humidity (**RH**) is the ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature. Relative humidity depends on temperature and the pressure of the system of interest. It requires less water vapor to attain high relative humidity at low temperatures; more water vapor is required to attain high relative humidity in warm or hot air.

Indoor relative humilities should be kept above 30% to reduce the likelihood of the occupant's nasal passages drying out. Humans can be comfortable within a wide range of humilities depending on the temperature—from thirty to seventy percent. When the temperature is low and the relative humidity is high, evaporation of water is slow. When relative humidity approaches 100 percent, condensation can occur on surfaces, leading to problems with mold, corrosion, decay, and other moisture-related deterioration. Condensation can pose a safety risk as it can promote the growth of mold and wood rot as well as possibly freezing emergency exits shut.

Both desiccant dehumidifiers and mechanical refrigeration systems can remove moisture from the air, so the question is which type is best suited for a given application? There really are no simple answers to this question but there are several generally accepted guidelines which most dehumidifier manufacturers follow. Both desiccant-based and refrigeration-based dehumidification systems work most efficiently when used together. The advantages of each compensate for the limitations of the other.

Refrigeration-based dehumidification systems are more economical than desiccants at high temperatures and high moisture levels. In general, mechanical refrigeration systems are seldom used for applications below 45% RH. For example, in order to maintain an outlet condition of 40% RH it would be necessary to bring the coil temperature down to 30º F, which results in the formation of ice on the coil and a reduction in moisture removal capacity. Efforts to prevent this (defrost cycles, tandem coils, brine solutions etc.) can be very cumbersome and expensive.

Desiccant-based systems are more economical than refrigeration systems at lower temperatures and lower moisture levels. Typically, a desiccant dehumidification system is utilized for applications below 45% RH down to 1% RH. Thus, in many applications, a DX or chilled water pre- cooling coil is mounted directly at the dehumidifier inlet. This design allows for removal of much of the initial heat and moisture prior to entering the dehumidifier where the moisture is reduced even further. The difference in the costs of electrical power and thermal energy (i.e. natural gas or steam) will determine the ideal mix of desiccant to refrigeration-based dehumidification in a given application. If thermal energy is cheap and power costs are high, a desiccant based system will be most economical to remove the bulk of the moisture from the air. If power is inexpensive and thermal energy for reactivation is costly, a refrigeration based system is the most efficient choice.

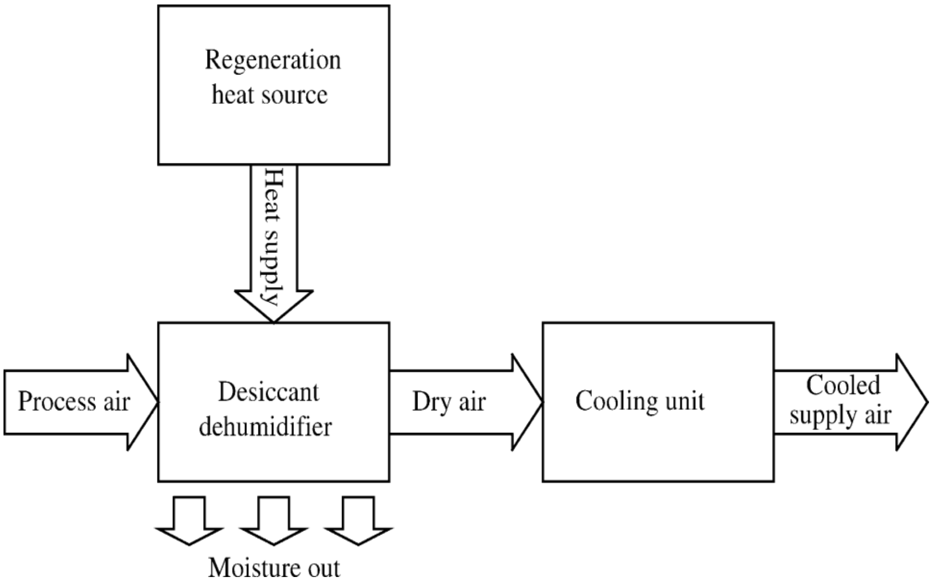

Fig.1 Principal of Desiccant cooling

DESICCANT DEHUMIDIFIERS:

A Desiccant is a substance that absorbs water. It is most commonly used to remove humidity that would normally degrade or even destroy products sensitive to moisture. There are many desiccant dehumidifiers like Activated alumina, Montmorillonite Clay, Molecular Sieves, Synthetic Zeolite, Calcium Oxide(Cao,), Calcium Sulfate(CaSO4).

COMPARISONS OF DIFFERENT HUMDIFIERS:

Montmorillonite Clay is a naturally occurring porous adsorbent. The mined clay is activated for use as a desiccant through careful drying. This clay will successfully regenerate for repeated use at very low temperatures without substantial deterioration or swelling. However, this property causes clay to give up moisture readily back into the container as temperatures rise. Clay is inexpensive and effective within normal temperature and relative humidity ranges (Table 1). Some variation in performance can be seen due to its source as a naturally occurring material.

Silica gel is a partially dehydrated form of polymeric colloidal silicic acid. Silica gel has an amorphous micro-porous structure with a distribution of pore opening sizes of roughly 3-60 angstroms. These interconnected pores form a vast surface area that will attract and hold water by adsorption and capillary condensation, allowing silica gel to adsorb up to 40% of its weight in water. The silica gel will pull in moisture at temperature up to 220°F (105°C). As temperature goes above 100°F, the rate of moisture pickup will slow down but the silica gel will still work. Silica gel performs best at room temperatures (70° to 90°F) and high humidity (60 to 90% RH) and will drop the relative humidity in a container down to around 40% RH. In the United States, silica gel is commonly used in food and pharmaceutical applications as only silica gel has been approved by the FDA for direct contact with these items.

Molecular sieves (also known as Synthetic Zeolite) absorb moisture more strongly than either silica gel or clay. This can be seen by the high initial slope of the adsorption isotherm for molecular sieve as compared to the other desiccants (Figure 3). This can also be seen in comparing their heats of adsorption for water. The heat of adsorption is the sum of the latent heat of vaporization of water and the heat of wetting. The heat of wetting will vary as a function of the saturation level of the desiccant. For purposes of comparison, the heat of adsorption for water on molecular sieve is about 1800 BTU/lb. of water adsorbed, as compared to 1300 BTU/lb. of water adsorbed on silica gel. Clay is roughly similar to silica gel in this respect. What does this mean? Where a very low relative humidity is required, molecular sieves are often the most economic desiccant because of their high adsorption capacity at low relative humidity. Also, molecular sieves will not give up moisture into the package as readily as silica gel or clay as temperatures rise (Figure 4). This is particularly important to packaged products which can potentially see a wide variety of environmental conditions.

Molecular sieve contains a uniform network of crystalline pores and empty adsorption cavities, which give it an internal adsorptive surface area of 700 to 800 sq. m per g (1/2 the total volume of the crystals). Because of its uniform structure, molecular sieve will not give up moisture into the package as readily as silica gel or clay as temperatures rise. Being synthetic rather than naturally occurring, molecular sieve is higher in cost per unit, but due to its extremely large range of adsorptive capabilities, it might often be the best value. Lack of government approval has limited a more widespread use of molecular sieve, presumably due to the industry's unwillingness to fund an expensive government study. Independent testing suggests that molecular sieve does meet all government requirements.

Calcium oxide (CaO) is calcinated or recalcinated lime having a moisture adsorptive capacity of not less than 28.5% by weight. The distinguishing features of calcium oxide (also known as Quick Lime) are: it will adsorb a much greater amount of water at low relative humidity than other materials (Figure 3); it is effective in retaining moisture at high temperatures; and it is relatively inexpensive as compared to many other desiccants.

Calcium sulfate (CaSO4), better known commercially as Drierite, is an inexpensive alternative available in suitable packaging forms. Calcium sulfate is created by the controlled dehydration of gypsum, acting as a general-purpose desiccant geared mainly toward laboratory use. It is chemically stable, non-disintegrating, nontoxic, non-corrosive, and does not release its adsorbed water when exposed to higher ambient temperatures. The low cost of calcium sulfate must be weighed against its equally low adsorptive capacity: it adsorbs only up to 10% of its weight in water vapor (Figure 3). Calcium sulfate also has regeneration characteristics that tend to limit its useful life. Although available, it is not normally sold in package form.

Table 1:
Properties of Adsorbents

Property	**Molecular Sieve**	**Silica Gel**	**Montmorillonite Clay**	**CaO**	**CaSO4**
Adsorptive Capacity at low H20 Concentrations	Excellent	Poor	Fair	Excellent	Good
Rate of Adsorption	Excellent	Good	Good	Poor	Good
Capacity for Water @77° F, 40% RH	High	High	Medium	High	Low
Separation by Molecular Sizes	Yes	No	No	No	No
Adsorptive Capacity at Elevated Temperatures	Excellent	Poor	Poor	Good	Good

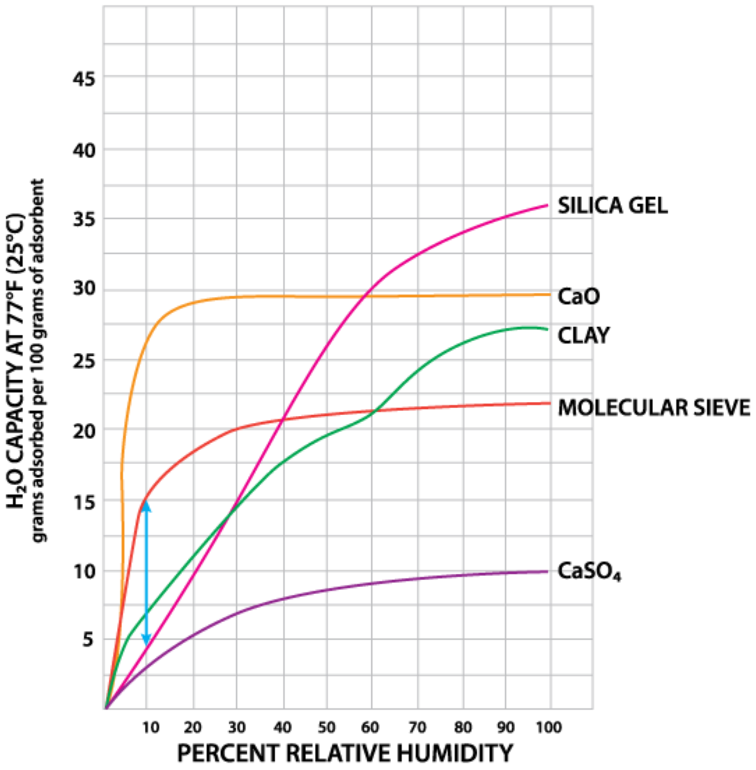

Figure 2:
Adsorption Rate (H2O)
of Various Adsorbents

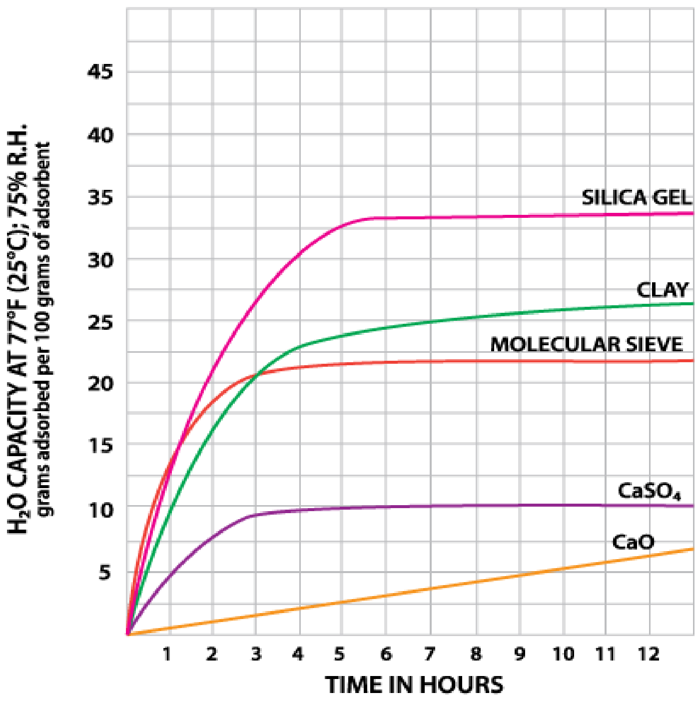

Figure 3:
Equilibrium Capacity (H2O)
of Various Adsorbents

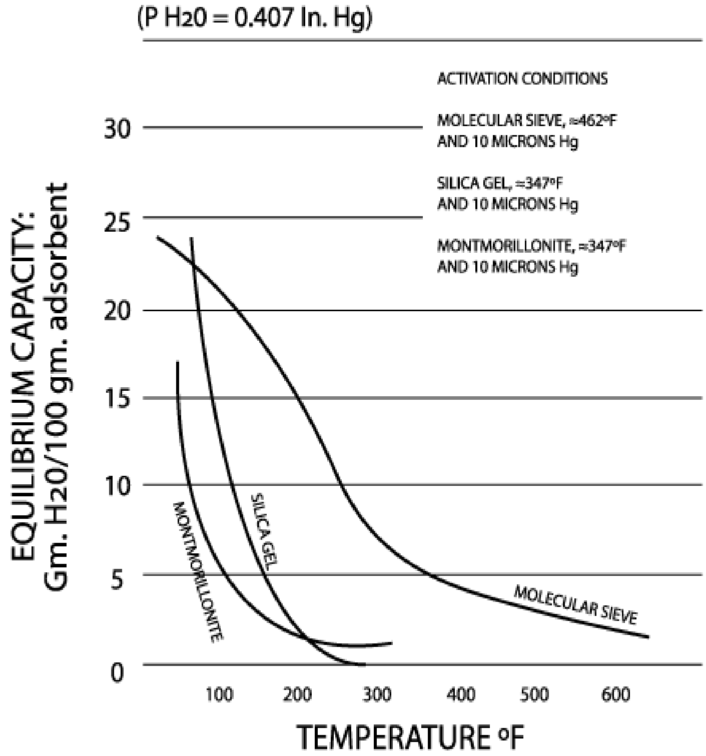

Figure 4:
Equilibrium H2O Capacity

II. LITERATURE REVIEW

In February 2012, Amin Rudd presented “Residential Humidity Control Strategies”. He said that there are mainly two goals of humidity control (1) Comfort and Indoor air quality (2) Durability and Customer satisfaction. He considered conventional humidity control techniques and give limitation of it also.

In March 2010, Mark Hydeman, P.E., Fellow ASHARE and David E. Swenson published a guideline “Humidity Controls For Data Centers” saying that humidity must be controlled for better performance of servers. When the data and studies were studied, controlling humidity in data centers is actively difficult. The operating installed cost increase the control that reduce the reliability of data centers, and have no benefits that are in published paper or comprehensive forensic analysis. There is proof that ESD is responsible for data centers, mostly where components inside the servers are being handled. In this they conclude that effective means to prevent ESD failures. High humidity levels are seldom an issue in most data centers.

In December 2013, Dr Ayman Mohamed Afifi, High Institute of Applied Science, Egypt published a paper “Handy Air Cooler Design to Face Rising Temperature Outside the Home” in International Journal of Scientific and Research Publication, Volume 3. In Summer Egypt hot, and to be a characteristic by weather day strong heat, which increase pain and hotter with the act of passing summer days, but a little wind refreshing and increase suffocation to the inability of most of them to go to the resorts a as result of the summer in the intense heat. The problem with this research is high temperature in summer day and shines strongly the length of the day and open spaces is difficult to control or deodorants out, causing disturbance to the people and their sense during the walk cause overheating damage for chronic diseases. This research aims to contribute to solving the difficulty of high temperature in hot areas or to minimize the effects and to design the air cooler that can be carried out during the walk in the outdoor spaces. The researchers would able to design air cooler manually to cope with rising heat in summer days and specially outside areas.

In 2013 Tarunkumar Das and Yudhjit Das said that the exhaust fan and humidifier is controlled and maintain the correct humidity level for that temperature. These research work will increase the capability of fuzzy logic control system in process automation with benefits.The model consists of two fuzzy logic controllers to control the temperature and humidity respectively. In this first controller accepts the two inputs values like the current temperature as detected by temperature sensor and its deviation from user set temperature and control the speed of heat fan and cool fan accordingly. When the current temperature in the room reaches set point, it serves as one of the input for second fuzzy logic controller that controls the humidity. Current humidity in % as detected by the humidity sensor in the room serves as the second input to the controller. The exhaust fan and humidifier is controlled to maintain the correct humidity level for that temperature. This research work will increase the capability of fuzzy logic control system in process automation with benefits

In September 2004 K.Daou, R.Z Wang, Z.Z. Xia presented a paper on "Desiccant Cooling Air Conditioning". In which they concluded the feasibility of the desiccant cooling in different climates and the advantages it can offer in terms energy
and cost savings.

A Review Paper on "Desiccants Cooling Systems" by Minalal Sahlot and Saffa B. Riffat. In this review they concluded that Desiccant cooling systems do not use any ozone-depleting refrigerants. Moreover, they can operate successfully on low-grade heat from solar energy, combined heat and power plant or waste heat from factories or chimneys.

A Review Paper on "Desiccant Chart Comparisons" by IMPAK Corporation. In this paper the different dehumidifier's properties are shown and the indicating silica gel of the Dri-Box canister has been tested and identified and concluded as a best desiccant for cooling system.

III. CONCLUSION

From above literature and review papers we can concluded that the research of desiccant materials that can be regenerated under lower temperature, (near-ambient) is the key of augmenting even greater the contribution that the desiccant cooling can bring to the amelioration of comfort, energy and cost savings. Desiccant cooling systems do not use any ozone-depleting refrigerants. Moreover, they can operate successfully on low-grade heat from solar energy, combined heat and power plant or waste heat from factories or chimneys. From all dehumidifiers the Indicating Silica Gel is the best desiccant can used for the desiccant cooling system.

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