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Dehumidification process by desiccant wheel in Air conditioning

Ritesh Patel[1], Sagar Patel[2], Parth Patel[3], Prof. Pragnesh Kandoliya[4]

[1]*Student, Dept. Of mechanical engineering, Vadodara institute of engineering, Gujarat, India*
[2]*Student, Dept. Of mechanical engineering, Vadodara institute of engineering, Gujarat, India*
[3]*Student, Dept. Of mechanical engineering, Vadodara institute of engineering, Gujarat, India*
[4]*Professor, Dept. Of mechanical engineering, Vadodara institute of engineering, Gujarat, India*

Abstract - *The most commonly used cooling systems are vapor compression refrigeration system (VCR) in Air conditioners and direct evaporative cooling system (DEC) in swamp coolers. The drawback of DEC systems is increased humidity and we cannot achieve temperature below wet bulb temperature, while harmfulness of refrigerants and cost are main drawbacks of VCR systems. So we are making combined unit consisting dehumidifier and cooling unit with the use of solid desiccant wheel. Introducing new air conditioning system by using desiccant wheel for dehumidification process. Making a unit having two chambers hot and cold. Passing air from desiccant wheel for dehumidification and then feeding it to heat exchanger for making air chilled and implementation of seasonal efficiency by varying the speed of desiccant wheel. The optimum speed of desiccant wheel would be 10-20 RPH. We are trying to make an air conditioning system which is efficient, environment friendly, low cost and less electricity bills.*

Key Words: **Desiccative cooling, desiccant wheel, adsorption, dehumidification, regeneration, heat exchanger.**

1. INTRODUCTION

A conventional air conditioner consumes large amount of electrical energy especially in hot and humid climatic conditions due to high latent load[4]. Desiccant wheel based hybrid air conditioning system is one of the promising alternative to handle the high latent load efficiently[4]. Desiccant wheel is replica of thermal wheel having difference of coating applied for dehumidifying the air. Desiccant is nothing but silica Gel. As the wheel rotates, the desiccant passes alternately through the incoming air where the moisture is absorbed, and through regenerating zone where the desiccant is dried and the moisture is removed. As the wheel continue to rotate this process is continuously repeat. Regeneration is done by the use of electric heating coil. Silica gel is not a "Gel" as the name implies, but it is a porous granular form of silica which is made from sodium silicate. The internal structure of each silica granule is made up of a network of interconnecting microscopic pores which attract and holds moisture within each granule by physical adsorption or capillary condensation process. Most commonly there are two types of silica gel available in the market which are indicating and non-indicating type. Standard silica gel is referred to as being non-indicating, as it absorbs moisture it remains physically unchanged. Non-indicating silica gel is both cheap and effective available loose in bulk packs. Use of desiccant wheel gives most appropriate conditions like low temperature and dry air for storing foodstuffs maintaining their colour, texture, aroma and nutrients[6].

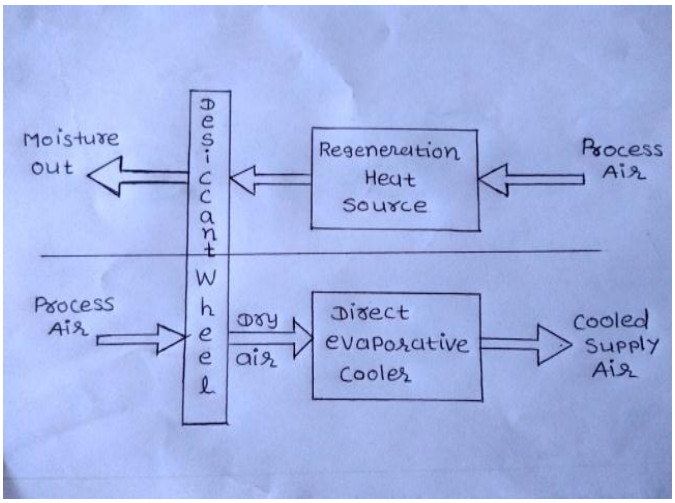

Fig -1: Schematic diagram of the system

2. Literature review

Our group carried out an experiment which consist use of silica gel as a desiccant material in swamp cooler and we came to a conclusion that use of silica gel gives efficient cooling.

3. Analytical method

To determine the performance of the unit various analytical methods are used.

3.1 Dehumidification and cooling

It is the process of removing the moisture from the air, which is done by the desiccant wheel present in the unit. When the air passes through the desiccant wheel the granules of silica gel absorb moisture present in the air and gives dry air. This dry air is fed to heat exchanger which

cools down this dry air. The medium in the heat exchanger is cold water which we get from the evaporative cooler.

3.2 Regeneration process

It is the process of removing moisture from the desiccant material so that it can be reused. Desiccant wheel having absorbed moisture is passed through hot region. This hot region can be maintained by small electric heater or small gas burner or heat exchanger containing hot water. The temperature of this region is maintained at 50^0c-70^0c. When desiccant wheel comes in this region, the moisture entrapped in the granules of silica gel gets released.

3.3 Load calculation

Table -1: Load calculation

Load due to		Sensible heat	Latent heat
Walls/ceiling	East	140.78	
	West	486.26	
	North	525.57	
	South	153.73	
	Ceiling	78.33	
	Floor	209.7	
Fenestration	On north wall	226.068	
Wooden door		0.3387	
Infiltration		178.05	534.89
Occupants		285	335
Electrical lights		86.4	
Fans		80	
Total load		2450.326	869.89
Total load		3320.216	

This data was recorded for a room having length 3.835m, width 2.959m and height 2.959m on 04 Oct, 2016 at a day time 12 noon to 4 pm. Required capacity of indirect evaporative cooler is,

Total load/3500[8] = 0.9486 TR

3.4 Amount of silica gel required

Amount of silica gel required is calculated by,

$Q= (C_{eq}D)V(Nt)/(M_HF)$

= (20*0.15)*33.57*(1*1)/(2*10)

= 5.0355 kg silica gel required

4. Working

This unit consists of two zone which are dehumidifying in cooling zone and regeneration zone. Process air is drawn by the blower and this air is fed to desiccant wheel where all the moisture present in that air is absorbed by desiccant material present in wheel. Now, this dry air is fed into evaporative cooler. After passing through evaporative cooler there is drop in temperature due to change in sensible heat. This cooled air is now fed into room.

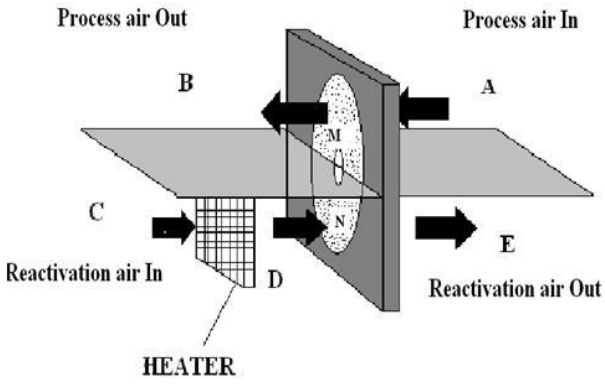

Fig -2: Working of solid desiccant Air conditioning[2]

The desiccant wheel is continuously rotating at a speed of 10-20 rph. Now, moisture locked into desiccant material is passed into regeneration zone whose temperature is maintained at 55^0c-75^0c with the help of small electric heater. That part of desiccant wheel gets regenerated due to the removal of moisture. This moisture is evacuated out of the room by the duct. This cycle is repeated.

5. CONCLUSIONS

From the results obtained that the use of desicool system is more efficient, eco friendly and less costly. When the dry air comes in contact with moisture there is a drop in temperature due to change in energy. Dehumidification of air by desiccant wheel and regeneration of desiccant wheel can be done at a same time successfully which is achieved by rotating desiccant wheel in two chambers hot and cold respectively.

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