

## Fabrication of Desiccant Assisted Cooling system

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**Abstract - Solid desiccant cooling (SDC) system is an alternative air conditioning system. Desiccant plays a vital role in overall performance of the whole system particularly in dehumidification and regeneration capacity. By this review we recapitulate that novel solid desiccant materials like zeolites, silica can be adopted in the SDC system. In order to resolve environmental and economic issues with the present space cooling system, the implementation of the SDC system will be the better answer to the problem. The Aim of the proposed system is to develop drying technology reduce the moisture content in air provider cooling in space and produce a good quality cold air. Zeolites are used as moisture adsorbents. When this system is build up we can achieve EEE i.e. Environmental friendly, good Energy efficiency low power consumption and more Economic cooling system. This system is used for industrial prevention fungus control and reduces many health affects like asthma.**

**Index words - Solid desiccant cooling, Desiccant material, dehumidification and regeneration, comfort air conditioning.**

### I. INTRODUCTION

In present, Swift growth of society and environment brings greatest pressure on globe. World faces more serious environmental problems such as global warming and haze that is smoke, dust, liquid moisture droplets. Study on any field must think about seriously on less contamination of environment by harmful substances. Researches on air conditioning are no exception. Till now, commonly adopted refrigeration air conditioning technology is vapor compression which consumes lots of electricity and releases green house gases. Desiccant assisted refrigeration air conditioning system will be the promising desirable alternate to commercial vapor compression refrigeration air conditioning system .When fresh outdoor air enters into building it comes with high humid load comparative to building internal latent load. Conventional vapor compression cooling system is not suited to efficiently treat large humid

loads. So desiccants are used to improve the indoor quality of all types of buildings efficiently controlling humidity in large quantities fresh, ventilation air.

In this method, a desiccant with great attraction to moisture removes wetness from air via sorption process.

This releases heat and increases air temperature. The Fusion of heat exchange with surrounding air and evaporative or conventional cooling coils then cools and dries air. Humid loads, temperature are very effectively met by separating this way. This desiccant with hygroscopic material property is dried out to complete cycle using thermal energy supplier waste heat. Commercial available desiccants include silica gel, zeolite, activated alumina, titanium silicate, and lithium chloride.

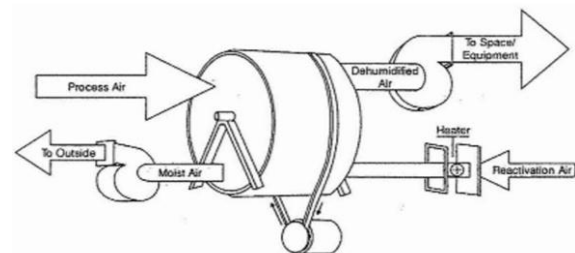


Fig. 1 Desiccant air flow process chart

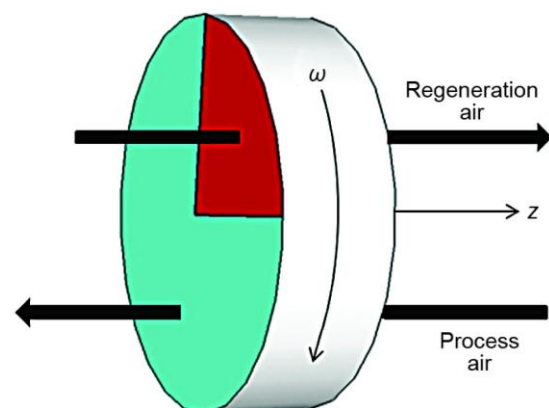


Fig. 2 Air flow process direction

The eminent benefit of this system is being environmental friendly saving energy and controlling humidity temperature separately. SDC subjects to less corrosion it reduces total residential electricity by 25% or more in humid regions. Providing dry, clean and more comfortable indoor environment with low electricity bill.

## II. LITERATURE SURVEY

[1] X. Zheng et al made a study and concluded that solid desiccant cooling which can be driven by low grade heat is considered as promising method for assuring clean and economic air conditioning.

[2] Hazeeb Halid et al, conducted an experimental analysis of solid desiccant wheel dehumidifier and stated that regeneration temperature increases more moisture is removed from the process air due to enhanced heating of desiccant wheel surface.

[3] A.Z. Zainal et al, have found that desiccant dehumidifier has the ability to reduce humidity within a period of time.

[4] M.A.Mandegari et al, have carried out many experiments using both liquid and solid desiccants in air conditioning systems concluded that the solid desiccants show considerable promise producing a higher degree of the humidification than the liquid desiccants. The electrical energy requirement can be very low comparing with conventional cooling systems. The origin of thermal energy can be distinct (i.e., solar, waste heat, natural gas).

[5] Kodama A et al showed that the dehumidifier is the prime component of a desiccant cooling system and the cooling COP (coefficient of performance) is significantly improved by enhancing the performance of this component.

## III. DESICCANT WHEEL

Desiccant wheel is an air to air heat and mass exchanger, with a relatively low rotation speed. Wheel has a frame with film of desiccant material layered on the same. The channels in the frame come in various shapes such as sinusoidal, honeycomb, triangular etc. The frame Wheel is axially crossed by two main streams. The porous desiccant medium of the matrix is cylindrically operated for adsorption and desorption. In process part of the wheel, dehumidification of air takes place, and in the reactivation part of the wheel humidification of the air takes place. The rotation of the wheel causes periodic reactivation of the adsorption part.

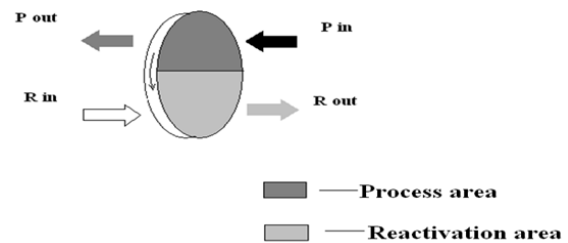


Fig. 3 Desiccant Wheel is Equally Divided for Adsorption and Desorption

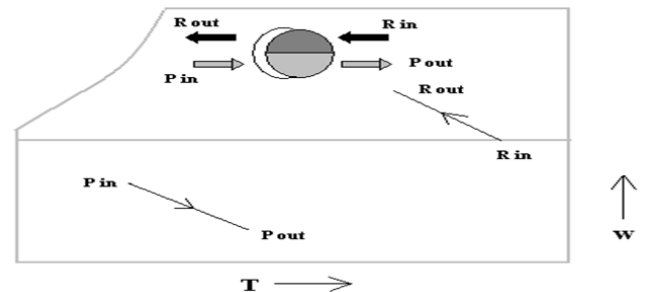


Fig. 4 Psychrometric changes occurring in the desiccant wheel

## IV. DESICCANT MATERIAL

There are several commercially available desiccants. The most commonly applied in desiccant wheels are silica gel and lithium chlorides. Activated carbon, activated alumina, molecular sieves, activated clay and calcium chlorides are also used. The material used in this wheel is a Zeolite which has one of the hygroscopic characters. Zeolites are synthetic desiccants derived from sodium or calcium crystalline and can be manufactured with specific pore sizes so as to allow

for the adsorption of a particular molecule characteristic. For instance, decreasing the Si/Al ratio in aluminosilicate zeolites results in a structure with increased hydrophilic characteristics. They have a good adsorption capacity over low levels of air relative humidity. When compared to silica gel, it exhibits half of average capacity per unit weight, although it also exhibits an adsorption capacity less sensible to increased temperatures. It is an efficient desiccant, allowing for the humidity to be lowered beyond detectable levels. Moreover, it can be shaped to 3 Å, providing a selective sorption of 2.8 Å water molecules, mitigating indirect contamination.

## V. DEHUMIDIFICATION

Air dehumidification can be achieved by two methods: (1) Cooling the air below its dew point and removing moisture by condensation (2) Absorption by a desiccant material.

Dehumidification is the process of removing water vapor from moist air. Here, absorption method is used due to the easiness created by the solid desiccants. In absorption method of dehumidification,

desiccant particle (zeolite) absorbs the water vapor in air. The solid desiccant particle is a compact packed arrangement, where cold and moist air enters which interacts with the desiccant and loses the moisture to the desiccant. As the desiccant absorbs water. To maintain the dehumidifying capacity of the system, the absorbed water must be removed from the desiccant. This is achieved by regenerating the desiccant particle where the water vapor in the desiccant is evaporated. The wheel is then rotated so that the desiccant portion that has picked up moisture is exposed to hot reactivation air and its moisture removed. Another desirable situation is when the cost of dehumidification with a desiccant is lower than the cost of dehumidification with a refrigeration system. The figure-8 shows the concept of dehumidification.

## VI. EXPERIMENTAL SETUP

An experimental set up is established as shown in figure. The experimental set up consists of main components like desiccant wheel, compressor, condenser, evaporator, blower, insulation air duct. The operation of system includes 2 modes one is operating in dehumidification process and second is regeneration process. A desiccant wheel of 300 mm dia has been constructed using 100 mm width and 2.5 mm thickness. The desiccant wheel has four major parts outer layer, separation part, sheet metal with fine holes and rod. It is circular plate with honey comb structure the zeolites and carbon are stuffed in place between the spokes in wheel. The frame has made for 3feet in mild steel width of frame is 400mm and its height is 750 mm. Desiccant wheel is placed in middle of the frame where 12V D.C motor is used to rotate the wheel. The wheel and its supporting structures are welded.



Fig. 5 Inner partition of Desiccant wheel



Fig. 6 Fabricated Desiccant Wheel

Zeolites are solid desiccant and that can carry water in crystalline structure. Zeolites have a very high capacity of absorbing moisture more strongly than the silica or clay. Zeolites are most economic desiccants because of its high adsorption capacity at lower relative humidity. It has hygroscopic property that water is absorbed or deabsorbed by the micro capillary until vapor pressure equilibrium is achieved with relative humidity of surrounding air. Channel size of zeolite is 2.5 to 4.3 angstroms in dia. The rotational speed of the rotary desiccant dehumidifier is inversely proportional to sorption time. When the desiccant wheel rotates must faster than the optimum speed, the adsorption and regeneration process will too small which results in poor performance. From the previous study the optimum rotational speed of desiccant wheel is calculated around 25-30 rph. In our project for obtaining this rph a small DC motor of 12v is used and a pulley of dia 3cm is connected to shaft of the motor. The desiccant wheel is of 30cm dia and by using belt drive to drive wheel thereby obtaining necessary speed reduction. Calculation of RPM of desiccant wheel is 5RPM. Thermocouples and subzero is used for measuring the hot and cold temperatures.



Fig. 7 Overall Setup

## VII. WORKING PRINCIPLE

The rotor is made up of corrugated sheets, which are filled with desiccant. It is divided into two sectors which are separated with the help of seals, the dehumidifier or process zone (approx. 75%) and the reactivation or regeneration zone ( approx. 25%) as shown in fig. Air passes through the rotating desiccant wheel (approx.0.5-1rpm), its moisture is transferred to the desiccant wheel then warm & dry air is passed to the part2 (conditioned air). In desiccant wheel the hot and humid air is passed where the desiccants will remove the moisture present in it now the temperature

increases. The process air temperature is now hotter and drier this is reduced to the comfort condition by means of sensible coolers (E.g. Cooling coils, heat exchangers). The warm and humid return air from conditioned space is further heated up of the required regeneration temperature of desiccant and this regeneration steam of air is passed through desiccant to remove the moisture from desiccant.

### VIII. RESULTS AND DISCUSSIONS

As the moisture being removed in desiccant, the process air outlet temperature is more compared to the inlet air temperature. Experimental values of the inlet air and outlet process air temperature is measured using the thermocouple and tabulation is made. The final cooling temperature is measured with the help of the sub zero measuring equipment. As the moisture is removed in air the cooling takes place rapidly and the efficiency of the system is more and low power consumption.

TABLE I. Experimental Values of Outlet and Inlet Temperature

Inlet Temperature(°C)	Outlet temperature(°C)
30.4	40.6
31.7	43.9

TABLE II. Experimental Values of inlet temperature & final cooling temperature

Inlet Temperature(°C)	Cooling temperature(°C)
30.4	10
31.7	11.5

### IX. CONCLUSIONS

Rotary desiccant cooling system is typically a thermal activated method mainly consumes low grade heat sources. There by alleviating the peak electrical demand caused by the traditional cooling systems. Due to moisture removal the corrosion problem in equipments may be reduced. We achieved improved indoor quality by implementing this system. It has huge application in food processing industry, Dairy, schools, and Meteorological laboratories and in many other domestic applications. In conclusion, further improvement in energy utilization rate, reduction in cost and size, standardization in design and production are the key issues faced by the rotary desiccant air conditioning technology for achieving more extensive application.

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