Advanced Technology in Desiccant Wheel Air Conditioning System: A Review

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Abstract. Desiccant wheel air conditioning have been considered as one of the effective process to control humidity of ambient air. Desiccant wheel air conditioning system do not use any ozone-depleting refrigerant and also intake lesser energy compared to vapour compression system. All the types and kind of desiccants have been discussed here. Such as solid desiccant system, liquid system have been reviewed briefly. Finally, a summary of economic prospect, future scope, environmental friendly technology and future scope of desiccant wheel air conditioning system have been discussed briefly.

Keywords: Desiccant, solid desiccant wheel air conditioning system, liquid desiccant wheel air conditioning.

1. Introduction.

The energy used by the air-conditioning system in the homes and in the commercials places now accounts for nearly 45%; the International Institute of Refrigeration in Paris conducted this research. Of the world total energy consumption, almost 15% of the energy is used by the air conditioning system (1). As we know, there is continuous rise in the world population and with advancement of new technology; there is increase in the per capita energy demand, this lead to the increase in the energy consumption worldwide. In spite of great progress in technology, we still rely upon fossil fuels as the primary source of energy to fulfil our demands. Most air conditioning system uses vapour compression based system and uses coolant like chlorofluorocarbons, hydrochlorofluorocarbons which are major gases for ozone layer depletion. Other causes of ozone depleting involve refrigeration, coolant. Fire protection system etc. which are being used today. Some refrigerant such as CFC, HCFC have been in there cooling system for 70 years (4).

The major concern of engineers while designing a building is to regulate the balance between thermal comfort, inside space air quality and energy utilization. Air-conditioning systems are designed in such a way to give maximum human comfort. In the space provided best inside air quality is given. An operating parameter of temperature varying between 18.8°C to 26.6°C and humidity between 40 to 70% is commonly considered acceptable for human comfort (5). Additionally, the physical activity and clothing also determines the thermal comfort of human
being and ventilation plays major role. High percentage of moisture in the interior space can also give rise to various problems, such as various health problem decay of wooden furniture.

2. DESICCANT

A desiccant is a substance or chemical that absorbs or attracts moisture from the air, causing a state of dryness (desiccation) in its vicinity. This chemical used to attract and remove moisture from air or gas and keep the products dry which, in turn, inhibits the corrosion process. These chemicals are used in product containers during shipping to protect against moisture damage. Descants also prevent condensation of moisture between window panes. Desiccants are available in various forms and are widely used in many industries, such as:

- Packing
- Electronics
- Manufacturing

There are two major categories for types of desiccants, each with their own set of chemical properties and functional requirements. These categories include:

- solid desiccants and
- liquid desiccant

3. DESICCANT SYSTEMS:

Desiccant cooling systems include rotary desiccant wheel, processed air, evaporative cooling system, hot air for regeneration of desiccant. Desiccant wheel air conditioning systems can be divided on the basis of type of desiccant material used:

(1) Liquid desiccant air conditioning systems,
(2) Solid desiccant air conditioning systems

Fig2: Principle of Desiccant Dehumidification and Air Conditioning

A. Liquid Desiccant Air Conditioning Systems

Figure below shows simple liquid desiccant systems containing a conditioner and a regenerator. Water vapour from the incoming ambient air is removed in the conditioner. Where desiccant material soaks the humidity from the incoming air. Due to the difference in vapour pressure there mass transfer takes place and heat is liberated due to the condensation.
of water molecule present in the processed air, this air is sent to the evaporative cooler to bring down the temperature of air and further the desiccant is pumped back to the regenerator to further absorb the moisture from the incoming air. Before the desiccant enter to the regenerator its moisture is removed by sending it to the liquid –liquid sensible heat chamber. Where temperature of the desiccant is increased and moisture is removed. This liquid desiccant is further send to the regenerator to absorb the moisture from the incoming air.

**FIG 3: Liquid Desiccant Air Conditioning System (7)**

**B. Solid Desiccant Air Conditioning Systems**

In solid desiccant systems, air is circulated through a bed of absorptive material like silica gel or zeolite. As the moist air passes through the bed, it gives up water vapour to the desiccant. Then the saturated desiccant is heated. The basic process of solar assisted desiccant cooling system is describe on the figure below. Hot and humid air enters the slowly rotating desiccant wheel and moisture is removed by adsorption of water (1-2). Since the air is get heated up by the adsorption heat, this heated air is further passed through a heat recovery wheel (2-3), which shows drop in temperature of the incoming ambient air. Further, the air is humidified and thus cooled by a controlled humidifier (3-4) according to the supply value of air temperature and moisture content. The exhaust air, which is coming from the room, is humidified (6-7) near to the saturation point in order to show an effective heat recovery (7-8). Finally, the desiccant wheel has to be regenerated (9-10) by applying hot air in a comparatively low temperature range from 50°C to 75°C and to allow continuous process of the dehumidification of air.

Flat-plate solar thermal collectors or evacuated solar thermal collector are normally used as heating system in solar assisted desiccant cooling systems. Typically desiccant material is loaded in to the rotating wheel or attached in to the honey-comb wheel, wheel rotates slowly between the processed air and heated air flow (2).
4. ADVANTAGE

Desiccant cooling systems can decrease the moisture levels in the desired spaces, saving hundreds of rupees in unnecessary repairs. Desiccant systems also enhance indoor air, rate of air ventilation is improved, and clear away air pollutants and odours. Similarly, restaurants, schools, and hospitals and other commercial places can use desiccants cooling system to remove air moisture, smell, and pollutants for a healthier environment and productive environment. Improved perseveration of frozen foods and refrigerated products.

5. ENVIRONMENTAL FRIENDLY TECHNOLOGY

The vapour compression cycle are old and traditional system, which heavily causes serious environmental effect like greenhouse effect, ozone layer depletion and global warming. In order to decrease these effects traditional cooling system need to be replaced by desiccant cooling system. Desiccant wheel air conditioning cools and dehumidify to produce fresh air whereas VC system uses some refrigerant to cool the air. Desiccant wheel air conditioning system is free from refrigerant in comparison to VC system thus produces no harmful effect. Desiccant wheel air conditioning system facilitate zero ozone depletion potential and zero global warming potential, these is due to the working fluid used is natural in nature. Therefore desiccant wheel air conditioning system can be reflected as eco-friendly air conditioning system. The above statement produces strong view that desiccant wheel air conditioning system can be considered as economical and eco-friendly technology which reduces serious environmental problem and ensure better air quality in cooling which ensure the better health quality of the users. In comparison to vapour compression system and desiccant wheel air conditioning system confirms that the three is decrease in the carbon dioxide up to 13%. The major advantage of the desiccant wheel air conditioning is principally heat driven cycle. Therefore it allow to use low grade waste heat energy and many other renewable energy like solar energy geothermal energy etc. when we impregnate waste heat in desiccant cooling system it reduces the cost or save the cost of the system up to the 87% (8).

![Diagram of Solid Desiccant Wheel Air Conditioning System](image-url)
6. ECONOMIC PROSPECT

Desiccant wheel air conditioning system with sensible cooling technologies have already started showing its presence in the market. Countries mainly which have hot and humid climatic conditioning have already started using other means of cooling system which are economical and eco-friendly and in comparison to the conventional VC system. A comparison study and economic evaluation between vapour compression system and desiccant wheel air conditioning system shows that the hybrid desiccant system performance increased by the use of the solar thermal energy and ambient air for refrigeration. Analysis indicated that replacing the.

7. GENERATING FUTURE SCOPE

Today’s need of the hour is to generate awareness, identify various hurdles to wider acceptance and deriving solutions through commercialization of the technology in the country. In order to make desiccant coolingsystems more acceptable, the industry along with the government must work as partners to Adopt advanced desiccant materials, equipment available in the market to design systems with low costs and improved performance (1). Demonstrate desiccant systems in real-world environment.

8. CONCLUSIONS

Desiccant wheel air conditioning was reviewed in this work. Both liquid and solid desiccant air conditioning system were strongly discussed in this paper. Conclusions are as follows:

- Desiccant wheel air conditioning system do not use any ozone-depleting refrigerants.
- Desiccant wheel air conditioning system is mainly suitable for removing moisture from the air. If cooling is needed than a hybrid, system is to be installed

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