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RESEARCH ARTICLE OPEN ACCESS

"Improving energy consumption in air conditioning using desiccant"

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ABSTRACT
For air dehumidification, liquid desiccant systems or solid desiccant systems. Can be used. A liquid desiccant air conditioning system is drawing more and more attention in recent years. Using liquid can reduce latent heat to improve energy consumption in air-conditioning. The aim of dehumidification process is to remove the water vapour from the processed air to liquid desiccants. Dehumidification is considered as a key feature of HVAC systems for thermal comfort. Chemical dehumidification can remove the water vapour from the air by transferring it towards a desiccant material (absorption or adsorption). Results illustrate that the application of liquid desiccant in air-conditioning can improve indoor air quality by removes moisture and latent and sensible heats, reduce energy consumption from 25% - 35% (KWh) and bring environmentally friendly products.
Keywords: HVAC systems; dehumidification; chemical desiccant; energy consumption.

The dehumidification unit uses lithium chloride (LiCl) solution as the working material

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I. Introduction

1-Benefits of Good Indoor Air Quality

Air quality is very important for people how suffer from asthma or allergic to dust but it's also very important for the general public poor air quality has been linked to many heaths problem including headache, fatigue, difficulty sleeping and even cancer. Meanwhile, if you maintain good air quality in your home, it will help everyone in your family be energized and healthy. Families with pets need to be especially conscious of indoor air quality. In part, that's because pet hair contributes to air quality issues, but the main reason is that animals are at least as sensitive to air quality issues as humans are. Poor air quality has been linked to a host of health problems in cats, dogs and birds, so if your family includes a furry or feathered member, you have more incentive to invest in an IAQ system.

2-Types of IAQ Systems

Depending on your home and your family's needs, there is a wide range of air quality products that could make a real difference for you. Some of the most common systems that install include:

- Air Cleaners and Air Purifiers: These systems are your frontal assault in the world of indoor air quality. They directly remove contaminants from your indoor air, providing relief for everyone who breathes.
- Air Humidifiers: Maintaining a good humidity level is just as important as keeping the air clean, especially for people with asthma. Humidifiers not only help you breathe easier but also extend the life of your wooden furniture.
- Ventilators: These systems work in conjunction with your air conditioner or heat pump to replace stale indoor air with clean, fresh outdoor air, saving energy in the process.
- UV Lamps: Best used in conjunction with your other HVAC systems, these lamps use ultraviolet light to kill germs and other contaminants.

3-There are three Ways to Improve Air Conditioner's Energy Efficiency

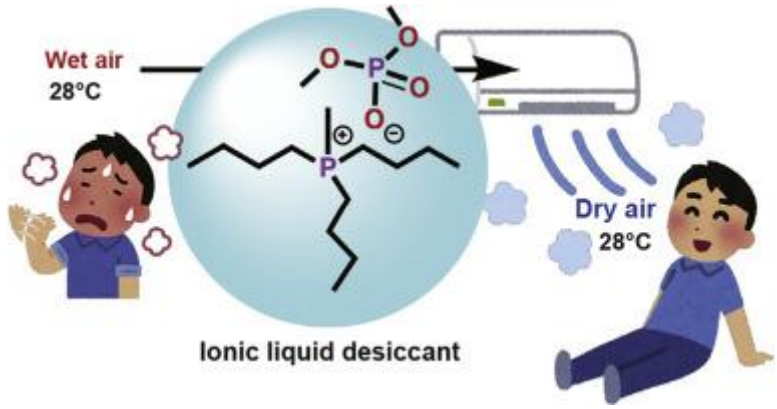
- Arrange the Space around Your UnitOne significant factor that affects your air conditioner's energy efficiency is the physical space around the indoor and outdoor unit. Clearing the space around your air conditioner promotes better air flow, which in turn improves efficiency and reduces wear and tear on the system. Make sure the outdoor unit is in the shade, which makes it easier to release heat. It's a good idea to take a few minutes at the beginning of the cooling season to clear the space around your air conditioner and take another quick look every few weeks to make sure you still have good air flow.
- Change or Clean the Air FilterDepending on the type of filter, your air conditioner's air filter may need to be replaced or cleaned every one

to three months. If you have a reusable filter, clean it with water and let it dry completely before putting it back into your air conditioner. If your air conditioner uses disposable filters, the best option for energy efficiency is to go to an authorized dealer for replacements instead of getting one-size-fits-all options from a hardware store.

- Invest in AC Maintenance PlansGood home maintenance is the first step toward improved air conditioning efficiency, but to really get the most out of your cooling system, you should concentrate on maintenance.

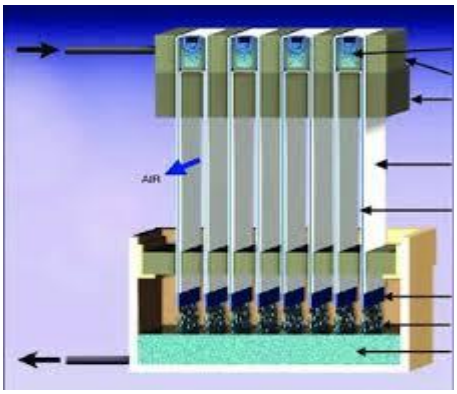
High Humidity Reducing AC System's Performance If you live in Kuwait City, you know the summer months can feel brutally hot and humid. The high humidity levels can do havoc on your air conditioner, causing it to work overtime to keep your home cool and comfortable. Read on to learn the effects of high humidity levels on your AC system. Increases Energy Consumption When the air is humid, it contains more water vapor than dry air. This means there's more heat present in the air, which you need to remove to achieve a comfortable indoor temperature. As a result, air conditioners must work harder in humid conditions, using more energy and driving up cooling bills andaccelerateswear and tear high humidity can have a significant impact on the performance of an AC system. Because the system relies on evaporation to remove heat from the air, it'll have to work harder in humid conditions. The system will run for longer periods, and the cycle of evaporation and condensation will put additional stress on the system. Over time, this can lead to premature wear and tear as well as reduced efficiency. In extreme cases, high humidity can cause an AC system to fail entirely. Air conditioning repair or replacement will then be necessary to restore comfort to the home.

humidity and indoor moist surrounding affect air cleanliness and protects harmful microorganisms when relative humidity is above 70%.In humid climates, the humidity issues are a major contributor to energy inefficiency in HVAC device see Fig(1)..The use of liquid desiccant dehumidification systems of supply air is a viable alternative to reduce the latent heat load on the HVAC system and improve efficiency. Thermal energy, at temperature as low as 40-50C, required for the operation of aliquid desiccant hybrid air conditioner see Fig(2) can be efficiently obtained using aflat plate solar collector



Fig(1)

The liquid desiccant must exhibit low equilibrium water vapour pressures at the available heat rejection temperature level to achieve low air dew point temperatures and thus a strong air dehumidification with comparably low driving temperatures. Desiccant mass fractions should be as low as possible, but in order to achieve low vapour pressures required desiccant mass fractions may surpass the solubility limit. In this paper, first experimental results of an internally cooled and heated, open liquid desiccant system working with an ionic liquid designed for air dehumidification are presented. It is demonstrated that ionic liquids designed according to the boundary conditions of the respective application may be a promising alternative to commonly used desiccants such as lithium chloride for solar air dehumidification with comparably high heat rejection and low drivin temperatures.



Fig(2)Liquid desiccant dehumidification

the system allows both reducing the humidity or adding humidity to the air by switching the circulation loop with ventilation during use of the air-conditioners see Fig(3). Triethylene glycol and lithium chloride (LiCl) aqueous solutions are well recognized as efficient desiccant liquids.Triethylene glycol is, however, used as desiccant for the industrial applications of drying, freezing and storage and not for a dehumidification system. On the other hand, the latter is now used for buildings,schools,hospitalsandsupermarkets in their humidification systems. However, the LiCl aqueous solution has serious disadvantages, such as being corrosive to metals like iron or copper, and the LiCl aqueous solution tends to crystallize when mixed with other salts to increase the desiccant capability. Therefore, we need to design the desiccant liquid circulationsystem using special pipes coated with corrosion resistant materials, but this results in increasing the price of the system and prevents its wide use.

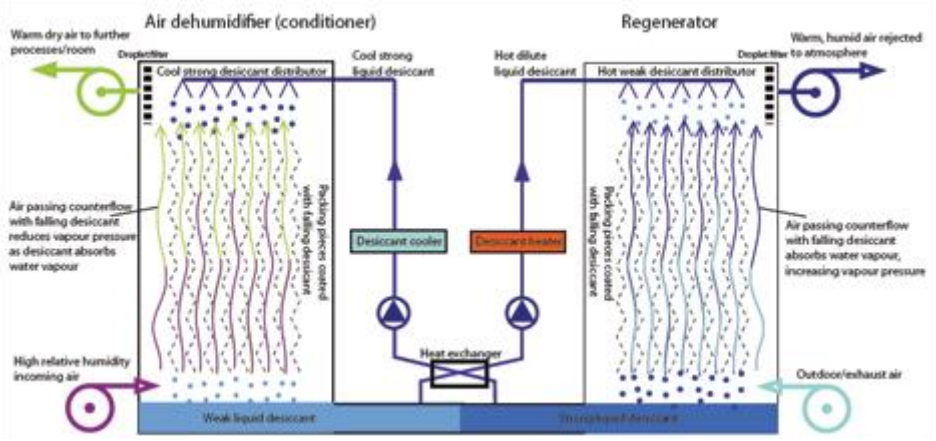


Figure 3: Simplified outline desiccant dehumidification system for ventilation air

The required cooling capacity for cooling air below its dew point consists of sensible heat and latent heat of condensation or even desublimation. An air stream of a temperature of 30°C and a relative humidity of 75% for instance requires a cooling demand consisting of 40% sensible heat and 60% latent heat in order to be cooled down to 10°C and 100% relative humidity. To separate the amount of latent heat needed for the air cooling thus bears a potential for reducing primary energy consumption. Open sorption systems can dehumidify the air and require heat as driving energy; thus, they can be driven by thermal solar energy see fig (4).

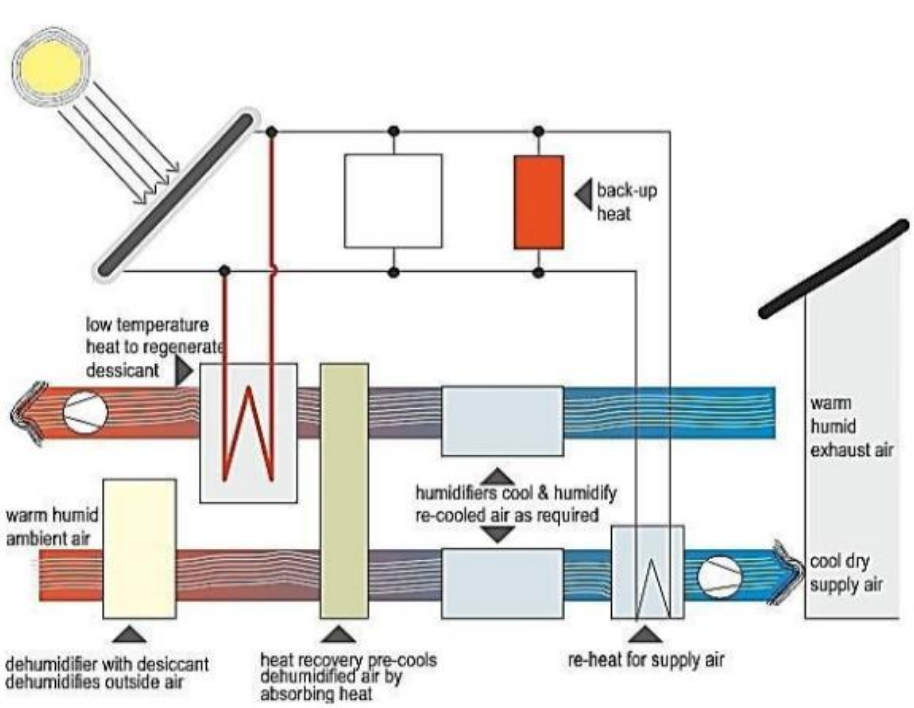
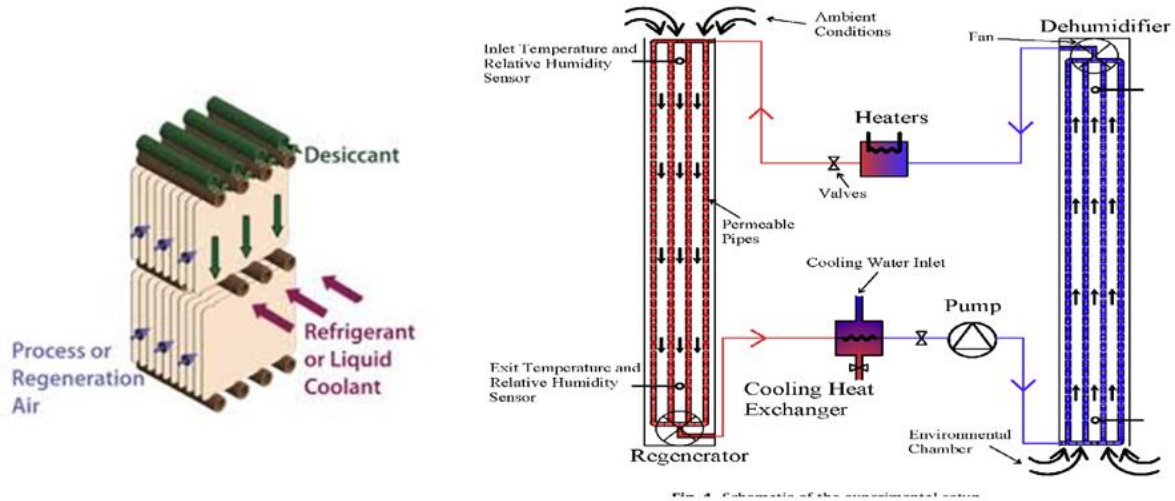


Fig (4) Liquid desiccants for dehumidification in building air conditioning systems

Air moisture is ab- or adsorbed in open sorption systems in direct contact with a desiccant at temperatures above the dew point temperature in contrast to conventional vapor compression or absorption chillers which provide the cooling at a certain dew point temperature level. The sensible cooling may then be achieved in a consecutive step after the dehumidification. Open sorption systems consist either of adiabatic or internally cooled dehumidifiers and internally heated regenerators. The internally cooled and/ or heated systems like the one presented in the paper at hand are found to be more efficient . Liquid desiccants permit a heat recovery between concentrated and diluted desiccant solution as they can be pumped, in contrast to solid desiccants fig(5). Inorganic desiccants are commonly preferred over organic desiccants as their loss is negligible due to their comparably low volatility. Lithium chloride is most used in open liquid sorption systems since it exhibits favorable equilibrium water vapor pressures for air dehumidification. However, lithium chloride is corrosive and usually crystallizes at large vapor pressure depression, i.e., for low dew point temperatures. Alternative substances such as ionic liquids are investigated to solve the mentioned problems. Ionic liquids do usually not corrode stainless steel. Besides, ionic liquids may be designed to meet specific system requirements in terms of achievable dew point temperatures at comparatively low driving temperatures which cannot be met by lithium chloride. Ionic liquids may thus be an alternative to be used for solar-driven dehumidification.



Fig(5)Liquid desiccant air conditioning

Types of Liquid Desiccants

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

- Hygroscopic Salts: These are desiccants that have salts, such as lithium chloride, added to a water solution. Lithium chloride is one of the most used hygroscopic salts because it is highly effective and has relatively few corrosive properties. The concentration of salt generally determines the quality of the solution. When cooled to a significant degree at a concentration under 33 percent, lithium chloride may form ice, while a higher concentration causes it to become solid salt. In its liquid form, it can retain considerably more moisture than it would as a solid.
- Glycols: Glycol's function much like hygroscopic salts but require higher concentrations to achieve equilibrium and may also evaporate. Glycol concentrations may be as high as twice those of hygroscopic salts, requiring a significantly larger amount of solution to work as a desiccant. Due to the potential for evaporation, the solution may need to be periodically replaced and is typically used in lower temperature operations in which evaporation rates are lower. Propylene glycol has relatively low toxicity, making it suitable for food-related applications, while triethylene glycol provides reduced evaporation potential.

Benefits of Liquid Desiccant Energy Efficient Air Conditioning

- Liquid Desiccant Energy-efficient air conditioning is an innovative technology meant to save cost and energy by effectively controlling the humidity in the atmosphere. The liquid desiccant absorbs the moisture before cooling its dew point air since it comprises a concentrated salt solution. It works more effectively on hot-humid applications where Case doors do not allow condensation. Most industries will embrace the use of liquid desiccants due to the following reasons.
- It reduces the maintenance cost Most industrial applicants require regular maintenance due to the electrical demand needed to reduce the heat load, which requires regular monitoring and maintenance. Ergo, the liquid desiccant efficient air conditioner will cool and dry the air in the atmosphere without applying the approach of the compressor-based to reduce the heat load.
- Minimizes the energy cost Globally, electricity is becoming very costly. Liquid desiccant efficient air conditioners get designed to either use solar energy or fossil fuel hence saving the cost of energy usage and storage. Also, it works best for movie shops, retail stores, and restaurants.
- Improves workforce productivity Since liquid desiccant air conditioners applications come with a humid climate, the performance of the students or the workers improves their productivity.
- It conserves the environment and makes it cleanthe engineers who use fossil fuel to design the system conserve the environment. Also, it lowers the indoor humidity hence preventing mildew and mold.

II. Conclusion

The future is for liquid desiccant air conditioner because it can improve indoor air quality and reduce energy consumption since the cost of energy was increase by time. For solving corrosion and crystallizes of lithium chlorides, ionic liquids can be used as alternative dehumidifiers.

Acronyms and Abbreviations

Cfm	cubic feet per minute
COP	coefficient of performance
DB	dry-bulb (temperature)
DD	design day
DOAS	dedicated outdoor air system
DP	dew-point (temperature)
DX	direct expansion
EER	energy efficiency ratio
gpm	gallons per minute
HR	humidity ratio
HVAC	heating, ventilation, and air conditioning
IAQ	indoor air quality
LDAC	liquid desiccant air conditioning
LDDX	liquid desiccant direct expansion
LiCl	lithium chloride
NREL	National Renewable Energy Laboratory
psi	pounds per square inch
RH	relative humidity
RSHI	regeneration specific heat input
RTU	rooftop unit
scfm	standard cubic feet per minute
WB	wet-bulb (temperature)

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