Liquid Dessicant Solar Air-Conditioner - System Overview

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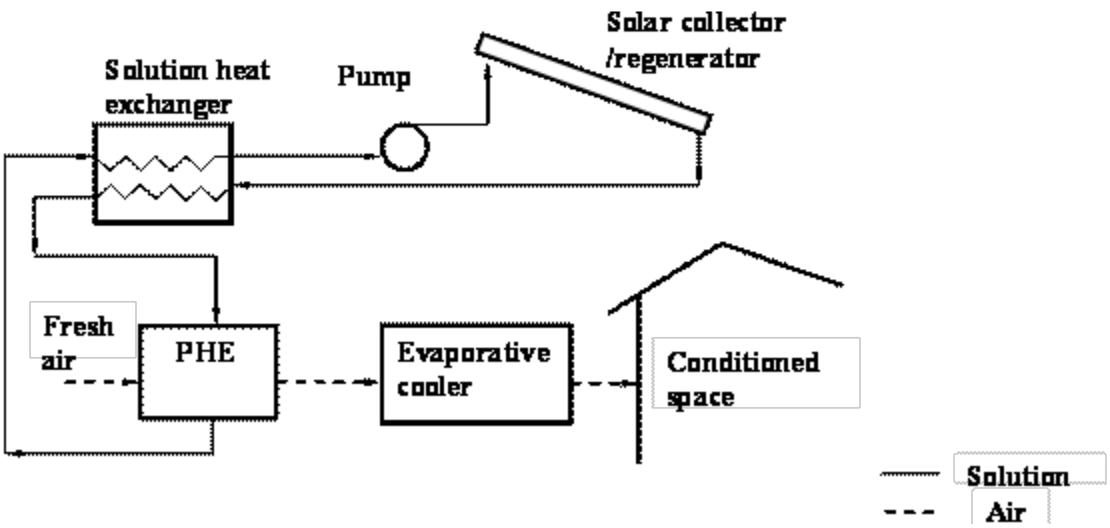
[Return to original version]

Abstract

The objective of this project is to investigate an energy efficient air conditioner to be able to compete with conventional vapour compression systems. Liquid desiccant air dehumidifier/indirect evaporative cooling using cross-flow type Plate Heat Exchanger (PHE) as dehumidifier offers a cost effective and more environmentally friendly air conditioning system. It removes moisture form the air and provides 100% fresh air without the application of Chlorofluorocarbon (CFC). Low grade energy such as waste heat, heat from co-generation or solar energy could be used for the liquid desiccant regeneration. The liquid desiccant solar air conditioner is primarily considered for commercial applications. By reducing the initial costs, however, it would also be feasible for domestic and residential use.



Schematic diagram of LDSAC system

LDSAC Aim

This project is concerned with the investigation of a desiccant system for air conditioning of commercial buildings and air-conditioning is the dominating energy consuming in buildings. In many regions of the world, the demand for cooling and dehumidification of indoor air is growing due to increasing comfort and increasing cooling loads. Industry needs and goals presently focus on promoting the mainstream acceptance of desiccant systems and overcoming barriers to widespread commercialisation, which include:

- Establishing a method for system testing and rating criteria that assess product quality
- Developing a clear analysis of the energy use and potential for energy savings when using desiccant systems to lower the humidity in building ventilation and air conditioning systems.

This project will address this need by undertaking research and development of the LDSAC system. The Industry partner in this project, DACO Building Services Pty Ltd, has a proven record in the air conditioning technology in both domestic and commercial sectors.

Background

Under humid outdoor conditions, conventional electric vapour compression cooling systems are not capable of removing the moisture without first cooling the air down below the dew point temperature and then reheating. This method would result in excessive energy requirements and higher utility demand charges. Using desiccant systems to treat the air and remove the moisture from the conventional cooling systems would enable conventional vapour compression systems to meet the new operating requirements without incurring severe energy wastages.

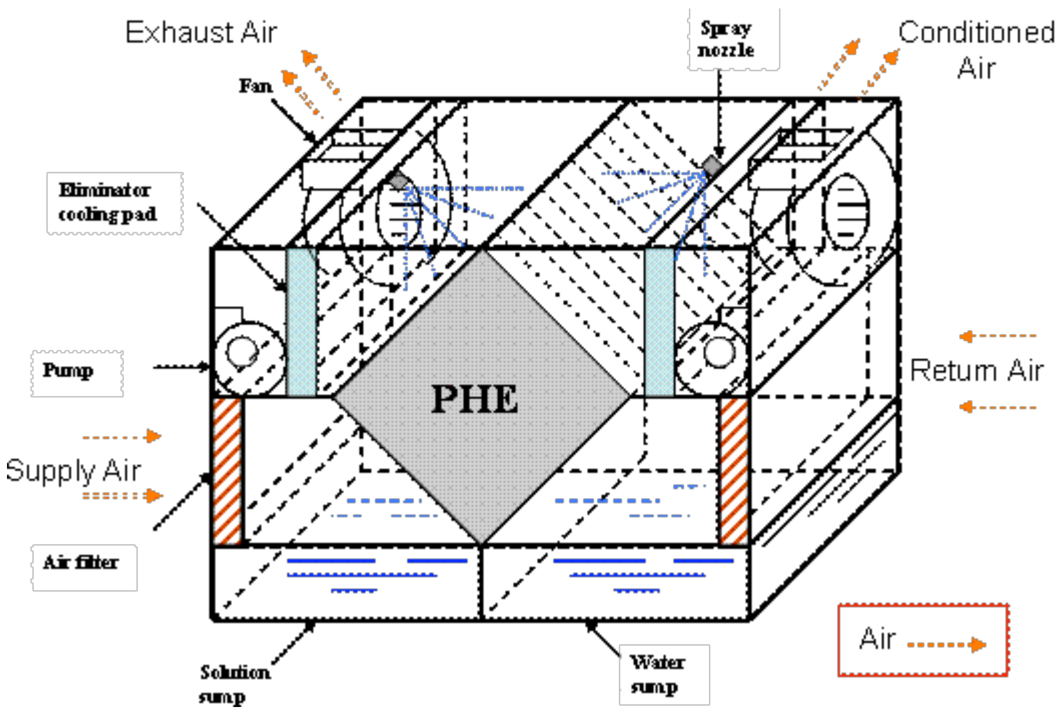
Desiccant systems are growing in popularity because of their ability to independently control humidity levels (latent loads) in buildings, thereby allowing conventional air-conditioning systems to primarily control temperature (sensible loads). In hospital operating rooms as an extreme example of a critical building heating, cooling and ventilation application, humidity and temperature can be controlled separately, allowing the surgeon and operating staff to work comfortably under intense lighting while wearing several layers of protective clothing. There is no need to compromise conditions in, one operating suite because of the demands of a procedure being performed in another served by the same system.

In recent years, applied researchers have become increasingly interested in solar powered cooling systems. The closed cycle adsorption cooling system clearly offers an alternative to conventional cooling technologies. It has a very important advantage in that it needs only low grade thermal energy instead of high grade electricity. Air conditioning is usually carried out using vapour compression systems. However, increased global warming and the environmental impact of chlorofluorocarbon (CFC) and other similar refrigerants on the ozone layer has stimulated interest in developing “environmentally-friendly” air conditioning systems. Liquid desiccants employ packed beds, packed towers, spray chambers or sprayed coil units. These systems have several advantages including lower pressure drop of air across the desiccant material, suitability for dust removal by filtration, lower regeneration temperature and ease of manipulation.

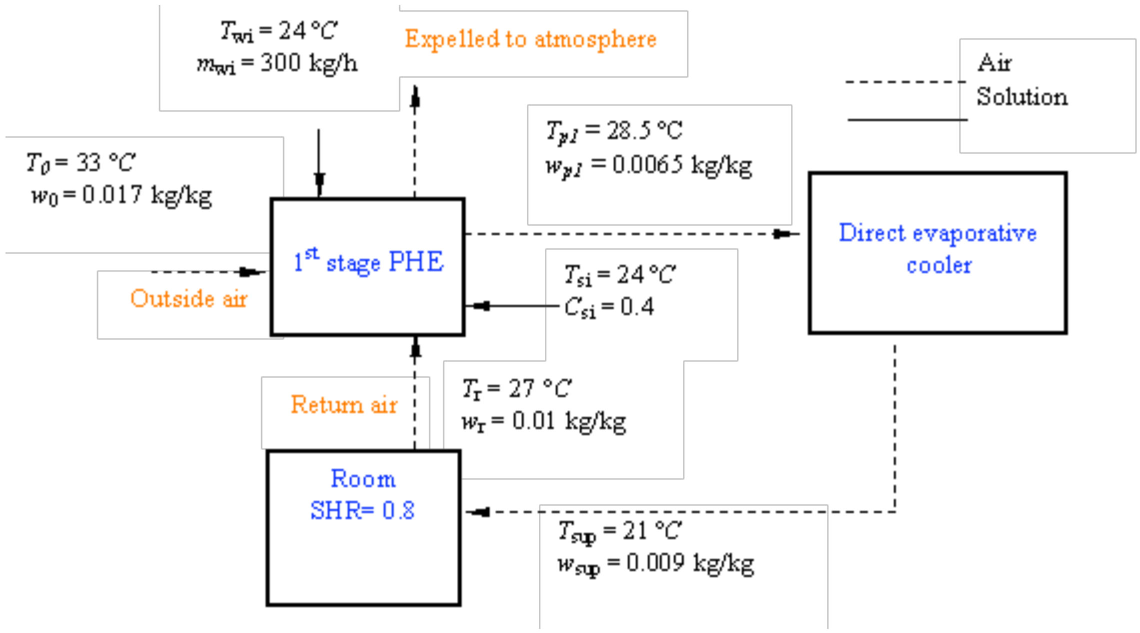
Significance

A cooling system powered by solar thermal energy could be an important part of a renewable solution to the preceding problems. With the availability of solar insolation coinciding roughly with cooling loads, solar energy appears to be an ideal energy source for an air conditioner. However, there are some technical challenges of developing an efficient heat pump that runs on low-temperature thermal energy and can deliver cooling when the energy source is not available.

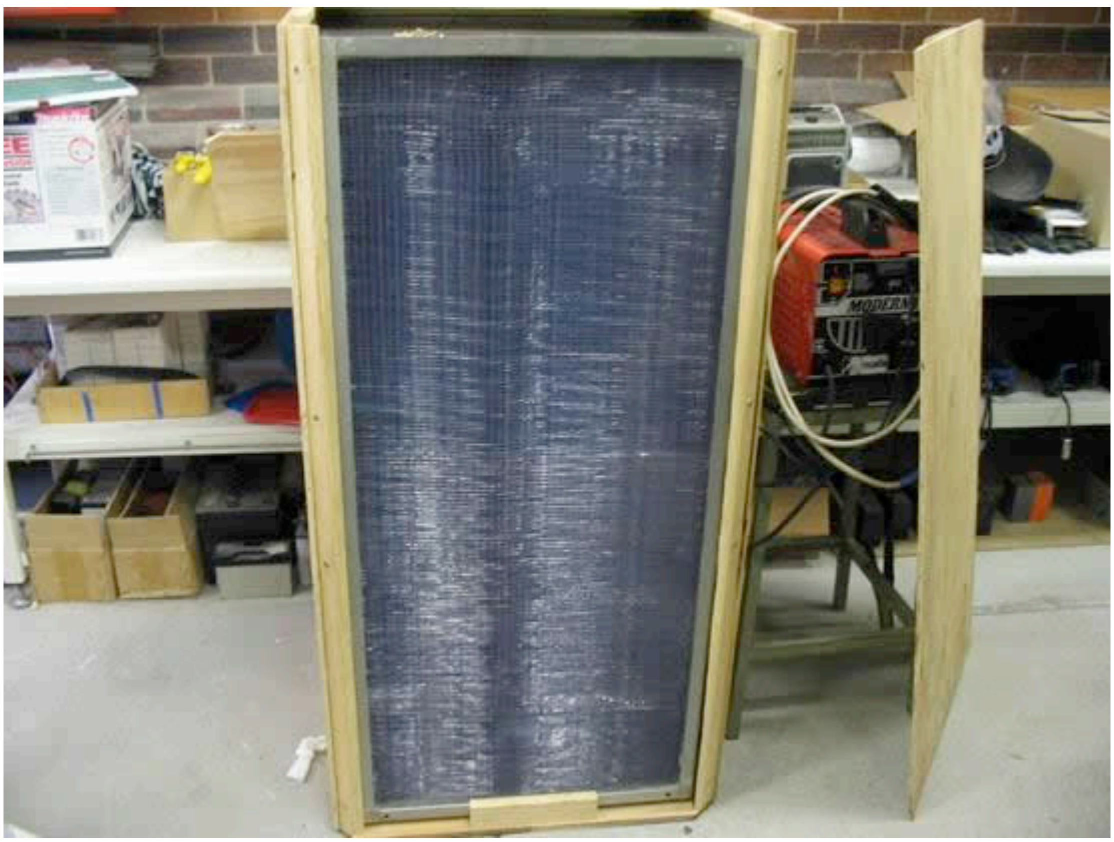
The LDSAC described above will be considered for commercialisation in the Phase II of the project. In that phase an advanced system will be developed and a number of shortcomings of the system will be eliminated. These are mainly to optimize the LDSAC with respect to the performance, initial costs and the overall size of the system. Other major issues in the commercialisation and the innovation of the system are: (a) elimination of the desiccant carry over into the conditioned space and (b) to improve the wetting performance characteristics of the polymer plates of the heat exchanger in order to enhance the dehumidification and cooling performance of the PHE.



Assembly view of LDSAC system



Schematic of double stage dehumidification/indirect and direct evaporative cooling using Lithium Chloride (LiCl) solution as desiccant



Photograph of 570 x 570 x 1175 mm cross-flow type PHE

Photograph of LDSAC model using CardBoard
