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Air Humidity Control Using Liquid Desiccant Driven by Solar Energy.

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ABSTRACT

The major purpose of the present research is to develop and implement a simplified model that carries out the performance investigation of each component of a flat-plate liquid-desiccant dehumidifier and regenerator allowing for complete simulation of the mass and heat balance equations using ambient and inlet conditions. Engineering Equation Solver program (EES) is utilized to accomplish the model in the presented work.

A performance study of the liquid desiccant conditioning system using calcium chloride as a desiccant is investigated in this thesis. The system consists of two main components, the desiccant dehumidifier and the regenerator, which are low flow, falling-film, parallel-plate, heat and mass exchangers.

In order to regenerate the desiccant solution, the role of the regenerator comes in getting rid of the moisture that is gained in the conditioner, thus re-concentrating the liquid desiccant solution where the clean solar energy is used in the presented system as a regeneration heat source.

A parametric analysis is applied to evaluate the influence of some of the most important operational parameters on mass and heat transfer performance, such as air and desiccant solution mass flow rates, inlet temperatures, and desiccant concentration. This is carried out taking into account the water (heating/cooling).

It is observed from the results that the inlet desiccant solution concentration, the water temperature and inlet air properties highly affect the dehumidifier and regenerator performance. Moreover, the performance of water vapor transfer in the humidifier is improved by raising the desiccant concentration entering the conditioner, but inversely affects moisture desorption in the regenerator part. The calculations of the proposed model achieve good performance comparing with the experimental data mentioned in the literature.

The mass balance between the dehumidifier and regenerator should be achieved for the system steady operation. Conditioner thermal $COP_{th,c}$ of 0.4854 and regenerator thermal $COP_{th,r}$ of 0.2861 are achieved respectively under steady inlet conditions at $CaCl_2$ concentration ratio of 37.2%, process-air temperature of 25℃, 50% relative humidity and 30℃ solution temperature.