Numerical Simulation of Heat and Mass Transfer in a Desiccant Rotor Regenerated by Concentrated Solar Irradiance

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The study aims at making a theoretical model of the performance analysis for a desiccant rotor regenerated by concentrated solar energy with a direct heating process, and at developing a humidity control system driven by renewable energy. The objectives of this investigation are to develop a simulation model considering the absorptivity of solar rays in the desiccant rotor, to clarify the distribution of humidity and amount of adsorbed water in the rotor, and to evaluate the dehumidification performance and the influence of rotor material and parameters. Concentrated solar rays irradiate energy to the rotor material directly. In an airflow channel of the rotor, a portion of the solar rays are absorbed by the rotor and the remainder is reflected. There is a distribution of the received energy to the direction of the channel. In a previous study, the received energy distribution in the rotor was clarified numerically, that heated effectively at an assumed high absorptivity condition. In this study, a measured absorptivity was used for the simulation. The concentrated heat was relatively small at low absorptivity, therefore it was difficult to regenerate the rotor effectively. Enlargement of the rotor length can improve the energy concentration slightly. A suitable rotor length was 0.1m at the absorptivity of 0.2. An adoption of metal as a base material of the rotor leads to a decrease of the performance in this condition. It is important to develop a high absorptivity material to improve the performance.