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Solar Liquid Desiccant Regenerator for Two Stage KCOOH Based Fresh Air Dehumidifier

Authors : M. V. Rane, Tareke Tekia

Abstract : Liquid desiccant based fresh air dehumidifiers can be gainfully deployed for air-conditioning, agro-produce drying and in many industrial processes. Regeneration of liquid desiccant can be done using direct firing, high temperature waste heat or solar energy. Solar energy is clean and available in abundance; however, it is costly to collect. A two stage liquid desiccant fresh air dehumidification system can offer Coefficient of Performance (COP), in the range of 1.6 to 2 for comfort air conditioning applications. High COP helps reduce the size and cost of collectors required. Performance tests on high temperature regenerator of a two stage liquid desiccant fresh air dehumidifier coupled with seasonally tracked flat plate like solar collector will be presented in this paper. The two stage fresh air dehumidifier has four major components: High Temperature Regenerator (HTR), Low Temperature Regenerator (LTR), High and Low Temperature Solution Heat Exchangers and Fresh Air Dehumidifier (FAD). This open system can operate at near atmospheric pressure in all the components. These systems can be simple, maintenance-free and scalable. Environmentally benign, non-corrosive, moderately priced Potassium Formate, KCOOH, is used as a liquid desiccant. Typical KCOOH concentration in the system is expected to vary between 65 and 75%. Dilute liquid desiccant at 65% concentration exiting the fresh air dehumidifier will be pumped and preheated in solution heat exchangers before entering the high temperature solar regenerator. In the solar collector, solution will be regenerated to intermediate concentration of 70%. Steam and saturated solution exiting the solar collector array will be separated. Steam at near atmospheric pressure will then be used to regenerate the intermediate concentration solution up to a concentration of 75% in a low temperature regenerator where moisture vaporized be released in to atmosphere. Condensed steam can be used as potable water after adding a pinch of salt and some nutrient. Warm concentrated liquid desiccant will be routed to solution heat exchanger to recycle its heat to preheat the weak liquid desiccant solution. Evacuated glass tube based seasonally tracked solar collector is used for regeneration of liquid desiccant at high temperature. Temperature of regeneration for KCOOH is 133°C at 70% concentration. The medium temperature collector was designed for temperature range of 100 to 150°C. Double wall polycarbonate top cover helps reduce top losses. Absorber integrated heat storage helps stabilize the temperature of liquid desiccant exiting the collectors during intermittent cloudy conditions, and extends the operation of the system by couple of hours beyond the sunshine hours. This solar collector is light in weight, 12 kg/m2 without absorber integrated heat storage material, and 27 kg/m2 with heat storage material. Cost of the collector is estimated to be 10,000 INR/m2. Theoretical modeling of the collector has shown that the optical efficiency is 62%. Performance test of regeneration of KCOOH will be reported.

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