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Dehumidification Performance Evaluation of a Desiccant Rotor Coated With MIL-100 (Fe) Under Process Air Conditions

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Extended Abstract

Adsorbents are the main design factor in the desiccant rotor of a solid dehumidification system because they are directly related to the dehumidification and energy performance [1,2]. Silica gel and zeolite have been widely used in conventional desiccant rotors owing to their wide range of temperature and humidity conditions. However, they have a limitation to dramatically enhance the dehumidification and energy performance of a desiccant rotor owing to its high regeneration temperature and low water adsorption capacity [3]. In this regard, MIL-100 (Fe) has attracted attention to overcome this challenge because it has a low regeneration temperature and high-water adsorption capacity [4,5]. However, studies on the desiccant rotor coated with MIL-100 (Fe) have been very limited. Therefore, the moisture removal capacity (MRC) and dehumidification coefficient of performance (DCOP) of a desiccant rotor coated with MIL-100 (Fe) must be investigated to figure out the dehumidification and energy performance.

In this study, the MRC and DCOP of the desiccant rotor coated with MIL-100 (Fe) were investigated through experiments under various process air conditions. The experimental setup was constructed in the environmental chamber based on the NREL desiccant wheel test guide [6] and ASHRAE standard 174 [7]. The desiccant rotor was fabricated by coating MIL-100 (Fe) on the polystyrene substrate of the rotary sensible heat exchanger. Three parameters were set as variables for operating conditions. The inlet temperature was set to 20, 25, 30, and 35 °C, and the inlet absolute humidity was changed from 8 to 12 $g_v\ kg_{da}^{-1}$ within 5 steps. The volumetric flow rate was varied from 400 to 800 $m^3\ h^{-1}$ within 5 steps by controlling the rotating speed of the blower. The regeneration temperature was fixed at 55 °C for depicting the low regeneration energy input. As the inlet temperature increased, the MRC and DCOP decreased owing to the low vapor pressure difference between the desiccant surface and moist air. The increase in the inlet absolute humidity resulted in decreased MRC and DCOP owing to the high vapor pressure difference between the desiccant surface and moist air. As the volumetric flow rate of process air increased, the MRC increased while the DCOP decreased due to the limitation of the dehumidification capacity per unit time. Finally, the specific moisture removal capacity (SMRC) of the desiccant rotor coated with MIL-100 (Fe) increased by 35% in the dehumidification performance compared with the desiccant rotor coated with silica gel under the standard condition.

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