SIMULATION AND OPTIMIZATION OF DESICCANT BASED WHEEL INTEGRATED HVAC SYSTEMS

by

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ABSTRACT

Energy recovery ventilation (ERV) systems are designed to decrease the energy consumed by building HVAC systems. ERV's scavenge sensible and latent energy from the exhaust air leaving a building or space and recycle this energy content to pre-condition the entering outdoor air. A few studies found in the open literature are dedicated to developing detailed numerical models to predict or simulate the performance of energy recovery wheels and desiccant wheels. However, the models are often computationally intensive, requiring a lot of time to perform parametric studies. For example, if the physical characteristics of a study target change (e.g., wheel diameter or depth) or if the system runs at different operating conditions (e.g., wheel rotation speed or airflow rate), the model parameters need to be recalculated. Hence, developing a mapping method with better computational efficiency, which will enable the opportunity to conduct extensive parametric or optimal design studies for different wheels is the goal of this research. In this work, finite difference method (FDM) numerical models of energy recovery wheels and desiccant wheels are established and validated with laboratory test results. The FDM models are then used to provide data for the development of performance mapping methods for an energy wheel or a desiccant wheel. After validating these new mapping approaches, they are employed using independent data sets from different laboratories and other sources available in the literature to identify their universality. One significant characteristic of the proposed mapping methods that makes the contribution unique is that once the models are trained, they can be used to predict performance for other wheels with different physical geometries or different operating conditions if the desiccant material is identical. The methods provide a computationally efficient performance prediction tool; therefore, they are ideal to integrate with transient building energy simulation software to conduct performance evaluations or optimizations of energy recovery/ desiccant wheel integrated HVAC systems.