Numerical and Experimental Evaluation of Membrane Based Energy Recovery Ventilator Performance with an Internal Support Structure

By Paul D. Armatis

Candidate for Master of Science in Mechanical Engineering

Major Professor: Dr. Fronk

Abstract

Large amounts of energy are wasted when conditioned air in buildings is exhausted to meet ventilation requirements. There are several technologies to recover some of this energy, including the recent development of membrane based energy recovery ventilators (ERVs). ERVs exchange sensible heat and moisture between incoming fresh and outgoing exhaust air, reducing the amount of energy required to maintain the building environment at the set condition. Membrane based ERV market penetration has been limited by high manufacturing costs and relatively low volumetric efficiency. In this thesis, the potential to decrease the cost and improve performance of membrane based ERVs using minichannel flow paths enabled by additive manufacturing techniques will be explored. First, 1D and 2D resistance network models of the heat and mass transfer and pressure drop in a "quasi-counterflow" membrane ERV are developed. The models are verified by comparing to results from the literature for a similar architecture. The verified models are used to parametrically evaluate the performance of membrane based ERVs with pin-fin and strip-fin internal minichannel type support structures fabricated using additive manufacturing techniques. At the same time, experiments are conducted to iteratively evaluate the capability limits of the manufacturing method with respect to repeatability, resolution, and fabrication time. Based on the thermal hydraulic models and the manufacturing experiments, a test scale exchanger was designed and fabricated with additive manufacturing techniques that demonstrate the potential to achieve specified performance and size requirements while being commercially viable. Insights from this study can be used to guide the fabrication of full scale commercial membrane based ERVs.

Tuesday, November 28, 2017

8:00 AM, Rogers 226

School of Mechanical, Industrial and Manufacturing Engineering

Oregon State University