Proceedings of the International Conference on Fluid Flow and Thermal Science (ICFFTS'20)
Virtual Conference – September 9-10, 2020
Paper No. 121

2D Frost Growth and Densification Model in Counterflow Heat Exchanger

Alexandre Coulombe*, Hachimi Fellouah, Sébastien Poncet
Mechanical engineering department, Université de Sherbrooke
2500 boulevard de l'université, Sherbrooke (QC), J1K 2R1 Canada
*Corresponding author: Alexandre.Coulombe@usherbrooke.ca

Abstract **-** When a heat recovery ventilator is operating under winter conditions, the water vapor present in the exhaust airflow can lead to frost formation. The outside temperature at which frost formation occurs depends on many variables such as the heat exchanger plate temperature, the exhaust air humidity ratio, the exhaust airflow and the plate spacing. In this study, a new 2D frost formation model is proposed and applied to counterflow parallel plate heat exchangers. The method is based on a frost growth and densification model. The frost densification depends on the square root of the time and the ratio of supercooling and supersaturation degree. An energy balance equation for the heat conduction through the frost layer and the heat and mass transfer from the moist air to the frost layer is used as a convergence criterion on the frost surface temperature prediction. The proposed 2D model showed that the airflow from a 2.5 mm parallel plate spacing heat exchanger can be reduced as much as 33% over a 25 minutes period. While a larger plate spacing, such as a 4.0 mm spacing, is less prone to airflow reduction due to frost growth, less than 5% reduction over the same time period, the 2.5 mm spacing is still more efficient than the 4.0 mm spacing at the end of the 25 minutes period, with efficiencies of 77% and 55% respectively.

Keywords**:** Numerical Modelling, Frost Formation, Parallel Plate Heat Exchanger