# Transient Simulation of an Air-Source Heat Pump under Cycling of Frosting and Reverse-Cycle Defrosting

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Frost accumulation is a common but undesired phenomenon for air-source heat pump (ASHP) systems in winter operations. The continued buildup of frost eventually necessitates a defrosting mode to remove the accumulated frost and return the system to its normal operating characteristics. Reverse-cycle defrosting (RCD) that applies heat to the outdoor coil by reversing the thermodynamic cycle, is one of the predominant means for periodic removal of the accumulated frost. A simulation tool capable of captureing the system dynamics with continuous mode-switching between heating and defrosting operation is extremely useful in the development and evaluation of improved control designs. This paper presents a dynamic modeling framework for ASHPs under cycling of frosting and defrosting operations. A uniform model structure was applied to frost formation and melting models, which were incorporated into a finite-volume evaporator model, without a need for reinitializing the system when the operating mode switches between heating and defrosting. A switching algorithm based on the Fuzzy logic was developed for multistage frost melting models to improve robustness. The developed cycle model was simulated to predict transients of a residential ASHP unit under multiple cycles of frosting and RCD operations. Simulation results of the refrigerant dynamics and air-side performance yield good agreement with the measurements, and can provide insights into heat and mass transfer phenomena of non-uniform frost formation and melting which are typically challenging to characterize experimentally at a heat pump system level.