Entropy Generation of Air-Driven Evaporation for Frost-Free Air-Source Heat Pump Antifreeze Regeneration

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Abstract:

Energy and environmental concerns are critical challenges facing humanity today, and heat pumps are increasingly recognized for their efficiency and cleanliness. Among them, air-source heat pumps (ASHPs) are the most widely used. However, frost formation during winter remains a major obstacle to their development. Frost-free air-source heat pumps (FFASHPs) utilizing antifreeze solutions have fundamentally addressed this issue. To ensure their continuous and stable operation, it is essential to regenerate the antifreeze solution to maintain its moisture absorption capacity from the air. This regeneration process consumes energy and affects the overall efficiency of the heat pump. This paper focuses on the most commonly applied air-driven evaporation method, analyzing the entropy generation of each component or process involved. The results indicate that the temperature and humidity gradients in the packed tower are the primary contributors to the entropy generation in the regeneration system. The findings of this study provide valuable insights for the energy-efficient design of regeneration methods.

Keywords:

heat transfer, entropy, frost-free air-source heat pump, antifreeze regeneration.