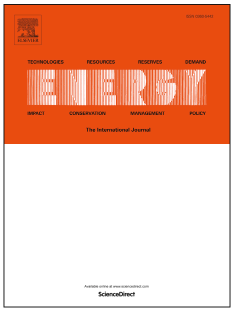

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Abstract

To improve the performance of an air-source heat pump cycle under low ambient temperature, a solar-driven ejector-cascade heat pump cycle which consists of an ejector sub-cycle and a vapor compression sub-cycle is discussed. Energy and exergy models are developed to conduct analyses on the cascade cycle, in which the ejector sub-cycle takes R134a, R1234yf or R141b as a working fluid and the vapor compression sub-cycle uses R1234yf as a refrigerant. The results indicate that the proposed cycle can significantly improve the thermodynamic performance of the air-source heat pump under low ambient temperature, especially when the ejector sub-cycle employs an R141b ejector. Energy investigation finds that the variation of the thermal coefficient of performance (COPh) exhibits the opposite trend to that of the mechanical coefficient of performance (COPm) as the generation temperature, the intermediate condensation/evaporation temperature or the condensation temperature varies. Exergy analysis indicates that the exergy destructions in the solar collector-generator, the ejector, the compressor and the expansion valve of vapor compression sub-cycle are much larger than those in other components. We hence conclude that decreasing various losses in these components are the key tasks to improve the performance and exergy efficiency of the cascade system.

Keywords: Ejector; Solar; Air-source heat pump; Energy; Exergy

1. Introduction

Over recent decades, air-source heat pump cycles (ASHPCs) have been widely applied to water heating applications due to their significant energy-saving potential compared to other conventional water heating technologies, such as electric heaters or gas boiler. However, the coefficient of performance (COP) and heat

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