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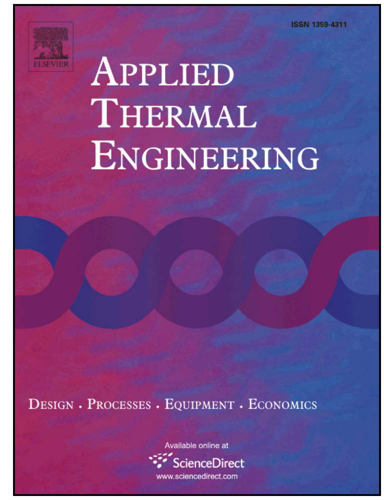

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ABSTRACT

This work compares the annual energy performance of heat pumping systems using R744 and R410A as refrigerant. Focus is the annual energy efficiency of R744 hybrid ground-coupled heat pumping system. The hybrid system uses both ambient air and ground as heat sinks in the cooling mode. This is important to eliminate the underground heat accumulation phenomenon in warm climates. Several quasi-steady state models of heat pumping systems, using R744 and R410A, have been developed. Simulation results show that the annual COP_c and COP_h of an R744 hybrid system reaches 3.55 and 3.32, and its cooling performance is 42% better than for a R744 ASHP and 23% better than for a R744 GCHP system. The annual energy performance factor of a R410A ASHP system is better than for a R744 hybrid system, but the COP_c for the R410A system will be lower when the ambient temperature is higher than 30 ºC.

Keywords: R744; R410A; Hybrid ground-coupled heat pump; Energy efficiency

1. INTRODUCTION

Environmental sustainability and energy conservation have become the key issues facing the development of modern society (Omer, 2008). This is the reason that 195 countries' delegation gathered at Paris in December of 2015 and committed that the world to limit a rise in global temperature this century below 2°C. One of the important strategies to achieve this goal is energy efficiency improvement in the different society sectors. For example in the building sectors, EIA (2012) surveyed that HVAC system accounts 44% of commercial building's total energy usage in the United States, and chiller or boiler consumes most of the energy in the HVAC system. Therefore, the energy efficiency improvement of a heat pumping system, which is defined as the system extracting heat from a low temperature and rejecting the heat to a higher temperature, is critical to reduce the energy consumption in the building sectors.

In the past 80 years, the synthetic halocarbon refrigerants had wide applications i.e. in the industrial refrigeration, commercial refrigeration, mobile air condition, and indoor air conditioning industry. However, halocarbons' high ozone depletion potential and global warming potential limited their further development, as agreed in Montreal and Kyoto protocol respectively. According to IPCC's data (Stocker et al., 2013), synthetic halocarbon refrigerants' contribution to the total well-mixed greenhouse gases anthropogenic radiative forcing is 12.8 % during the period of 1750 to 2005. This is due to their chemical structure result in much higher global