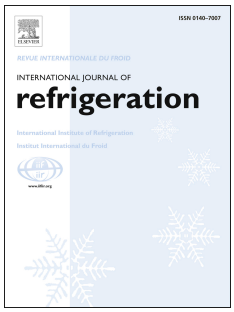
Accepted Manuscript



Comparison analysis of different refrigerants in Solar-Air hybrid heat source heat pump water heater

Shanshan Li, Shuhong Li, Xiaosong Zhang

PII: S0140-7007(15)00137-1

DOI: 10.1016/j.ijrefrig.2015.05.008

Reference: JIJR 3045

To appear in: *International Journal of Refrigeration*

Received Date: 26 December 2014

Revised Date: 22 May 2015

Accepted Date: 23 May 2015

Please cite this article as: Li, S., Li, S., Zhang, X., Comparison analysis of different refrigerants in Solar-Air hybrid heat source heat pump water heater, International Journal of Refrigeration (2015), doi: 10.1016/j.ijrefrig.2015.05.008.

Comparison analysis of different refrigerants in Solar-Air hybrid heat source heat pump water heater

Shanshan Li, Shuhong Li*, Xiaosong Zhang
School of Energy and Environment, Southeast University, Nanjing 210096, Jiangsu, China
*Corresponding author: sslinj@163.com , Tel: 86-15195907230

Abstract: An original collector/evaporator that gathering solar and air energy is a promising device to reduce energy consumption. And the performances of self-designed heat pump with hybrid heat source using different refrigerants were simulated in the present work. Based on lumped parameter method, the steady state models, including collector/evaporator, compressor and gas cooler, were established. The effects of R22, R134a and R744 were analyzed in terms of power consumption, coefficient of performance (COP), solar energy input ratio and so on. The results showed that three refrigerants performed an analogous operating performance. R22 and R134a had a little difference considering different evaluation factors. By contrast, CO_2 had a poor COP, but it had a good low temperature performance.

Keywords: Heat pump water heater; Solar-Air hybrid heat source; R134a; R22; R744

1. Introduction

It is urgent to cut energy consumption and protect global environment in view of the use of heat pump water heater in heat resource and refrigerant. To heat pump water heater for domestic water heating, it is not limited to choose ordinary air source, but also to apply potential heat source. Some researchers had applied heat came from different approaches to heat water, including air-conditioner room and hybrid solar air（Jie et al., 2014; Zhi et al.,2014）. For the system of combining solar energy, they could be classified to direct-coupled and indirect-coupled system. In indirect-coupled system, the collector/evaporator gathering solar radiation and convection heat of air was designed as evaporating equipment, which could operate at a higher temperature than ambient temperature, thus increasing the COP of heat pump (Sun et al.,2014; Lertsatitthanakorn et al.,2013; Jorge et al., 2014). At present, structure of collector/evaporator is single. One of them applied bare plate solar collector as evaporator (Cervantes et al., 2002; Huang et al., 2001; Kuang et al., 2005). However, when the plate temperature was higher than ambient temperature, the disadvantage was that heat came from solar would flow to environment. The other one, superior to former, was a collector/evaporator with internal spiral-finned tube (Xu et al., 2006). It had been validated by experiment that refrigeration in the collector/evaporator could absorb enough solar and air energy. However, heat transfer between air and refrigerant is inadequate due to a part of collecting area is occupied by the fin tube. Therefore, collector/evaporator with an improved spiral-fin tube is presented in present work. The design would reduce heat loss of solar panel and enhance heat transfer between air and refrigerant.

Besides, the selection of appropriate refrigerant is also vital considering environment issues. Since the last century, R22 was as most common refrigerant in heat pump water heater because of its good thermal properties. M.V. Venkataramana and Padmanabhan et al. had proven that R22 was superior to R134a in terms of coefficient of performance and exergy efficiency in the system with separate refrigerant of R22 and R134a (Venkataramana et al., 2013). For a long time, R134a was considered as a good substitute of CFC and widely used in HVAC&R systems. According to simulation research, J.B. Chen et al. proposed that R134a was superior to R22 with respect to the system performance (Chen et al., 2010). But it still should be verified by experiment. However, the harm of R22 and R134a is obvious to all. They all had an unfriendly environment. So, it is necessary to choose right