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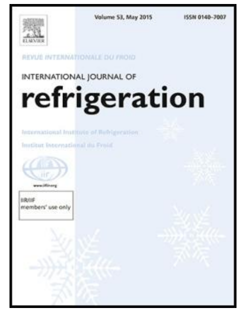

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Performance comparison of an air/water heat pump using a minichannel coil as evaporator in replacement of a fin-and-tube heat exchanger

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Highlights

- The performance of an air/water heat pump is experimentaly measured.
- Two different evaporators, minichannel and fin-and-tube coil are compared.
- Experimental results are used to validate a model developed using a design software.
- In all cases the refrigerant charge and the efficiency are lower using a minichannel coil.
- The advantage of replacing a fin-and-tube evaporator by a minichannel evaporator is not clear.

ABSTRACT

This paper reports the results of an experimental and numerical study of the use of a minichannel coil and a fin-and-tube coil in an air/water heat pump working as evaporator when the system is working in heating mode. The experimental installation developed to test the heat pump unit is briefly described and then the experimental results are presented. Alternatively, the heat pump is modelled using a refrigeration system design program. The results obtained using this model are compared to experimental results allowing the validation of the model. Once the model is validated, it is used to numerically determine the distribution of refrigeration charge and other interesting parameters not experimentally measured. Finally, an analysis of the numerically obtained results is presented in order to study the influence of several operating conditions on refrigerant charge, system COP and heating power for both types of evaporators tested.

Keywords: Minichannels; Heat pump; Refrigerant charge

1. INTRODUCTION

Refrigeration and air conditioning sectors have a strong environmental impact mainly because of their contribution to the greenhouse effect, both due to the direct emission of gases with high global warming potential (GWP) as well as due to the energy consumption associated with these systems. There are three measures that can be considered the most important in order to reduce the environmental impact of refrigeration and air conditioning systems: replace conventional refrigerants by environmentally friendly refrigerants, reduce the charge of refrigerant and increase the energy efficiency. Frequently, these three measured are related.

Refrigerant replacement is focused on reducing the environmental impact in case of leakage by decreasing the GWP of the fluid employed, but it can also affect the mass charge. Poggi et al. (2008) report that replacing HFCs by low GWP refrigerants such as ammonia or propane, the necessary charge will be reduced to half because of the lower density of these fluids. On the other hand, alternative refrigerants present some disadvantages related to security aspect (mainly toxicity and flammability) that can lead to legal limitations to the maximum charge of these fluids in certain applications.

Alternatively, charge reduction is focused in decreasing the environmental impact in case of leakage by reducing the total amount of fluid emissions although, on the other hand, it can also affect the energy efficiency of the system. Refrigerant mass charge into a given system is directly related to its performance so reducing the mass charge will affect the cooling capacity and the coefficient of performance (COP) of the system. Although optimal refrigeration charge depends on a lot of factors, according to Colasson et al. (2001), the COP remains nearly constant within a charge range around 25 % of the optimal charge.

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