

Research regarding the eco-efficiency of an air-water heat pump

Cercetări privind eco-eficiența unei pompe de căldură aer-apă

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Rezumat. Studiul privind sistemul frigorific din această lucrare a fost realizat la Universitatea Tehnică de Construcții București (U.T.C.B) - Complexul Laboratoare Colentina. Tema aleasă își propune să contribuie la baza teoretică și la cercetarea practică în ceea ce privește dezvoltarea și utilizarea agenților frigorifici ecologici. În ultimii zece ani, s-au făcut numeroase cercetări în domeniul agenților frigorifici alternativi ecologici, la nivel internațional, ținând cont de restricțiile severe ale legislației prevăzute de lege: Protocolul de la Kyoto, Regulamentul (UE) 517/2014, Acordul de la Paris / 2015, Amendamentul Kigali / 2016 / Protocolul de la Montreal. În acest sens, cercetarea are în vedere implementarea legislației UE în domeniul sistemelor frigorifice, pompelor de căldură și aerului condiționat.

Cuvinte cheie: Pompa de căldură, agent frigorific ecologic, COP/EER

Abstract. The study on refrigeration systems in this paper was made at the Technical University of Civil Engineering of Bucharest (U.T.C.B) - Colentina Laboratories Complex. The chosen topic is aiming to contribute to the theoretical basis and practical research in terms of development and use of ecological refrigerants. In the last ten years, a lot of research has been done in the field of ecological alternative refrigerants, at international level, taking into consideration the severe legislation restrictions stipulated by law: Kyoto Protocol, Regulation (EU) 517/2014, Paris Agreement / 2015, Kigali Amendment / 2016 / Montreal Protocol. In respect of this, the research, considers the implementation of EU legislation in the field of refrigeration systems, heat pumps and air conditioning.

Key words: Heat Pump, Ecological Refrigerant, COP/EER

1. Introduction

The ecological refrigerants proposed in this scientific work are chemicals obtained by mixing in different proportions of various current ecological refrigerants with one or more natural or synthetic substances that have zero values of ozone depletion potential (ODP) and low global warming potential (GWP).

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The results of the simulations from this paper performed with the help of the high-performance program EES (Engineering Equation Solver) for the refrigerants: R134a, R1234yf, MV3T, MV3TN in the case of an air-water heat pump (Figure 1).

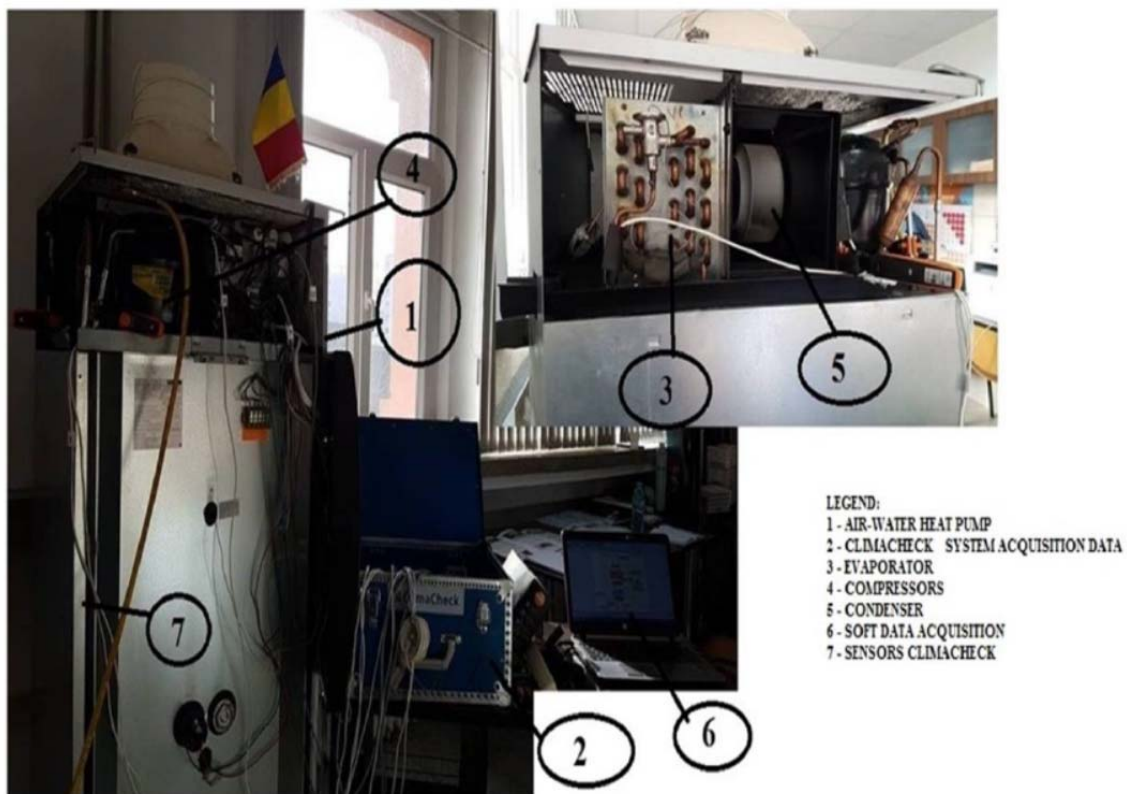


Fig. 1. Air water heat pump experimental stand

2. Ecological And Energy Efficiency Analysis

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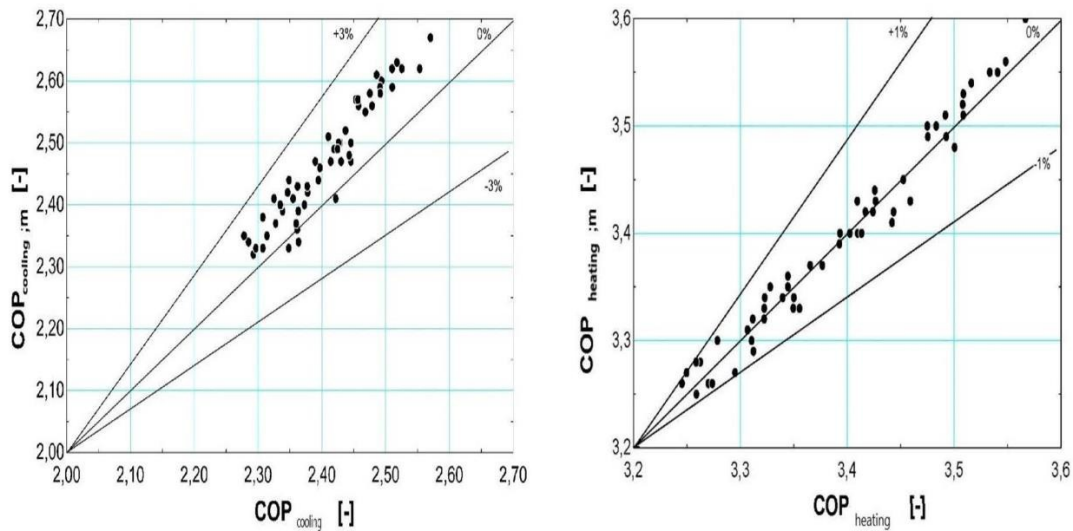
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The comparative study (Figure 2) of these facilities followed the coefficient of performance (COP/EER). Also the TEWI factor (Total Equivalent Warming Impact – in respect with EN 378-1 as it was shown in the Table).

Table 1

The theoretical results for factor TEWI of the ecological alternatives

Refrigerant	R134a	R1234yf	MV3T	MV3TN
GWP [-]	1430	4	717	560
L [kg/s]	0,0624	0,0580	0,0601	0,0596
n [an]	15	15	15	15
m [kg]	0,78	0,725	0,751	0,745
α_{rec} [-]	0,8	0,8	0,8	0,8
E_{annual} [kWh /an]	1153,62	1153,62	1153,62	1153,62
β [kg/kWh of CO ₂]	0,28985	0,28985	0,28985	0,28985
GWPx Lx n	1338,48	3,48	646,40	500,75
$GWP \times m(1 - \alpha_{rec})$	223,08	0,58	107,73	83,46
$n \times E_{annual} \times \beta$	5015,65	5015,65	5015,65	5015,65
TEWI [kg CO ₂]	6577,21	5019,71	5769,78	5599,86
TEWI [tons of CO ₂]	6,577	5,019	5,769	5,599



Calculated vs. measured cooling COP and heating COP of the best MV3T refrigerant used in the experimental stand AIR-WATER HP

Fig. 2. Coefficient of performance (COP/EER)

3. Conclusion

In conclusion, from an ecological point of view, the refrigerant must be chosen so that according to the regulations of the current legislation, it has zero ODP and GWP low and TEWI as small as possible.

In the Figure 2 it can be observed the validation of the calculated vs. measured cooling and heating COP of the best MV3T refrigerant used in the experimental stand AIR-WATER HP.

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