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R513A AND R1234yf ALTERNATIVE REPLACEMENT OF R134a REFRIGERANT

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Abstract: *This work consists in R1234yf and R513A- R134a comparisons. Thermodynamic properties were simulated with the aid of the Refprop software. The analysis of both TEWI factor and COP was carried out for an air-water heat pump working with R134a.*

Key words: *Refrigerant, GWP, TEWI factor.*

1. Introduction

R-513A is a non-ozone depleting, low global warming potential (GWP) hydrofluoro-olefin (HFO) based refrigerant replacement for R-134a.

The refrigerant R513A is an azeotropic refrigerant and is suitable for new and retrofit of existing systems, offering excellent capacity. R1234yf is a synthetic HFO refrigerant. The analyses of both TEWI factor and COP was made for an air-water heat pumps working with R134a. [1], [2], [3]. Thermodynamic properties of these simulations were done using the software RefProp [7].

The COP was calculated with DUPREX 4.0, a software tool specifically developed to allow users to easily and quickly generate data for DuPont Refrigerants [8].

From Table 1, which shows properties of the refrigerants, one can observe that the mixture's pressure is lower in comparison with R134a's.

The vapour pressure and density differences versus temperature of proposed refrigerants are presented in figure 1 and figure 2.

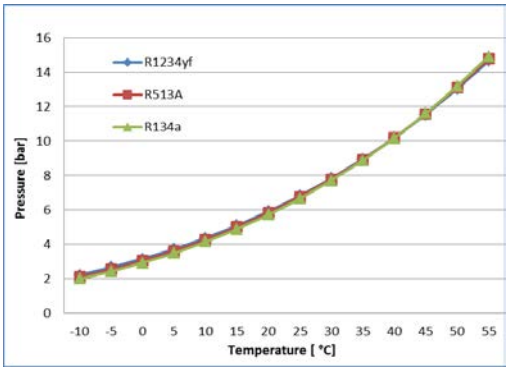

Fig. 1. *Pressure vs. temperature*

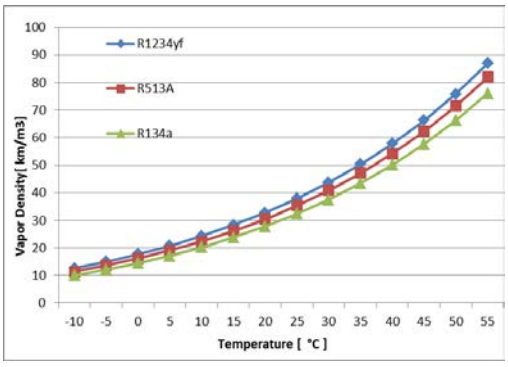

Fig. 2. *Vapour Density vs. temperature*

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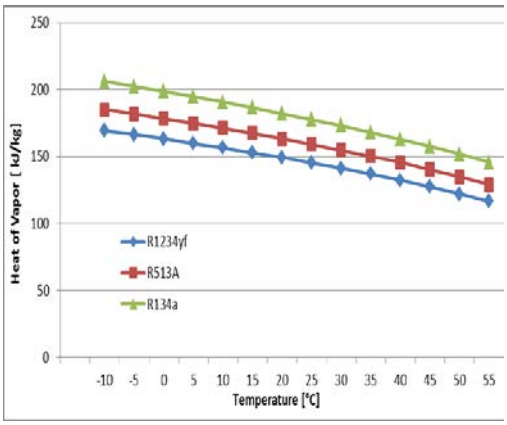

Fig. 3. *Heat of vaporization vs. temperature*

2. Theoretical Study

The study case has a refrigeration capacity of 0.377kW [4].

The temperature of vaporisation for the refrigeration system is -10°C and condensation temperature is +55°C.

The COP for the air conditioning refrigeration systems was calculated with DUPREX 4.0 software and TEWI factor was calculated in according with UE legislation and R134a it seems to be the best.

The total global warming potential method calculation (GWP) of the Ecological Alternative was done in according with REGULATION (EC) No 842/2006 (from 1 January 2015 REGULATION (EC) No 517/2014) [5], [6].

The TEWI factor was determined taking account of the Standard SR EN 378-1.

Comparison between ecological alternative and R134a Table 1

Refrigerant	**R1234yf**	**R-513A**	**R-134a**
Critical temperature [°C]	94.7	97.674	101.06
Critical pressure [bar]	33.822	36.806	40.593
Critical density [kg/m^3]	475.55	490.89	511.9
Molar mass [kg/kmol]	114.04	108.43	102.03

The leakage of refrigerant was 8% from refrigerant charge with a recovery factor of 0.75. Operating time of the system was 15 years, and the CO_2 emission was 0.6 kg / kWh.

The theoretical results Table 2

Refrigerant	**R1234yf**	**R-513A**	**R-134a**
Refrigerant charge [kg]	0.725	0.748	0.780
ODP	0	0	0
GWP	4	631	1430
TEWI Tons of CO_2	14.91	15.59	16.52

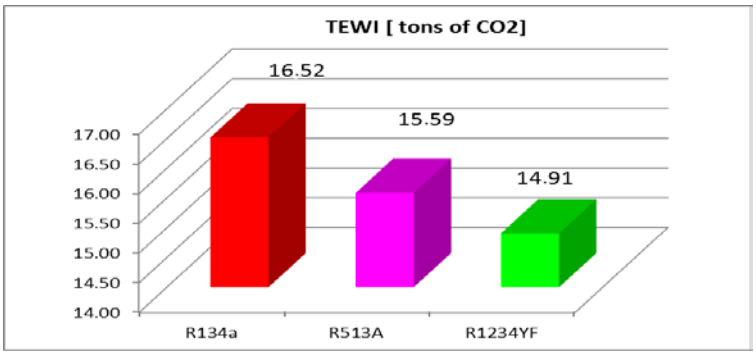

Fig. 4. *TEWI Factor*

3. Conclusions

The transport refrigeration sector comprises the equipment, technologies and services used to transport and dispense frozen and fresh foods at the appropriate temperatures. Travel time, ambient temperatures, and risk of spoilage often make temperature controlled transportation necessary. Because some commodities are sensitive to the relative humidity and chemical composition of their surrounding atmosphere, these conditions may also need to be controlled.

Vehicles used for temperature-controlled transport are similar in construction and outward appearance to those in general freight service, but have three fundamental differences which are as follows:

1. Insulation that is usually foamed in place.
2. Provisions for conditioned air circulation through and around the cargo.
3. Machinery for cooling/heating.

Historically, HCFC-22 was used for transport refrigeration applications which were converted to HFCs in the 1990s—primarily to R-404A, R-507A,R-410A, R-407C, and **HFC-134a**. Currently, significant research on zero- and lower-GWP refrigerants has focused on “natural” or non-fluorinated, chemicals such as CO2 (R-744), NH3 (R-717), Liquid Nitrogen (LN2), and hydrocarbons (HCs), as well as other man-made chemicals such as hydrofluoroolefins (HFOs). HFOs are a new class of unsaturated HFC refrigerants which have lower GWPs and shorter atmospheric lifetimes when compared to other HFCs. Some of the applications of these refrigerants in transport refrigeration are highlighted in this work as a first theoretical step.

The paper shows the advantages and disadvantages of the two types of refrigerants which may replace the R134a refrigerant and could be used in air conditioning equipment. Making a comparison with these alternatives from Figure 4, Table 2 it is shown that the global warming impact of TEWI for the refrigerant R1234yf is lower than R513A and R134a. After determinations of the thermodynamic properties we could observe (Table 1) that critical temperature and critical pressure are decreasing for these alternatives (R513A AND R1234yf) in comparison with R134a refrigerant.

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References

1. Țârlea, G. M., *Codes of Practice (1, 2). Domain refrigerating and air conditioning* Bucharest, Publisher AGIR, 2008, 2009.
2. Țârlea, G. M.,Vinceriuc, M., *Agenti frigorifici ecologici – Înlocuitori ai R134a (Ozone friendly refrigerants -*

R134a Substitutes), 47th National Conference of Installations, Sinaia 2012, ISBN 978-973-755-857-2
3. Ţârlea, G. M., Vinceriuc, M., Ţârlea A., Popescu, G., *Theoretical Comparative Study Case, Hydrocarbons and HFC Mixture Alternatives Retrofit*, The 10 th IIF/IIR Gustav Lorentz Conference on Natural Refrigerants, Delft, The Netherlands, 2012 , ISBN 978-1-62276-273-6, ISSN 0151-1637
4. Ţârlea, G. M., Vinceriuc, M., *Alternative ecologice de agenti frigorifici pentru o pompa de caldura aer-apa (Environmentally friendly alternative refrigerants for air-water heat pump),* Technical-Scientific Conference with international participation,, Building services and energy saving ", XXII edition, Iasi, 2012, Academic Society Publishing Matei-Teiu Botez, ISSN 2069-1211;
5. ****Regulation (EC) No 842/2006 of the European Parliament and of the council on certain fluorinated greenhouse gases*
6. ****Regulation (EC) No 517/2014 of the European Parliament and of the council on certain fluorinated greenhouse gases*
7. ****The National Institute of Standards and Technology (NIST) - REFPROP V 8.0, Reference Fluid Thermodynamic and Transport Properties.*
8. ****DUPREX* software versiunea 4.0