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THEORETICAL ECOLOGICAL STUDY -REFRIGERANT COMPARISON-

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Abstract: *The present paper is about the refrigerant R32 as an alternative solution for R134a. The thermodynamic properties were determined using the program Refprop. The comparative analysis regarding the TEWI factor was made for an air-water heat pump that currently works on R134a.*

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

1. Introduction

Because of the more and more severe measures undertaken in order to eliminate HFC and HCFC type refrigerants, synthetic substances which nature cannot rapidly dissociate and which, by accumulating could contribute to global warming and ozone depletion, extensive research is done, in which various ecological refrigerants are analized [1],[2],[3].

The paper presents a comparative study for an air-water heat pump in terms of the contribution of refrigerants to global warming.

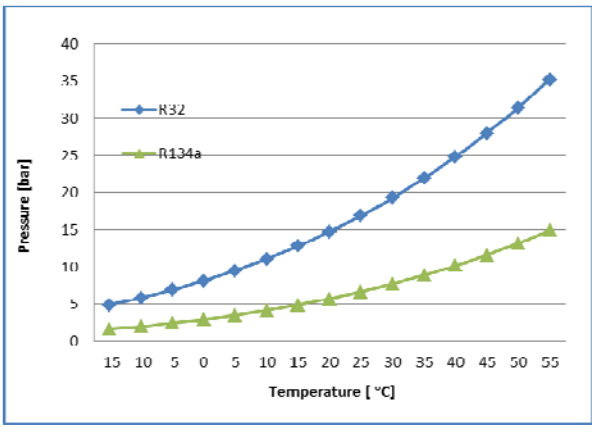

Fig. 1: *Pressure refrigerants vs. temperature*

Thermodynamic properties of these simulations were determined using RefProp software [8]. From Table 1, it can be observed that the pressure of R32 is higher, in comparison to R134a's. Figure 1

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and Figure 2 show the vapour pressure and density differences on the temperature variation of the proposed refrigerant.

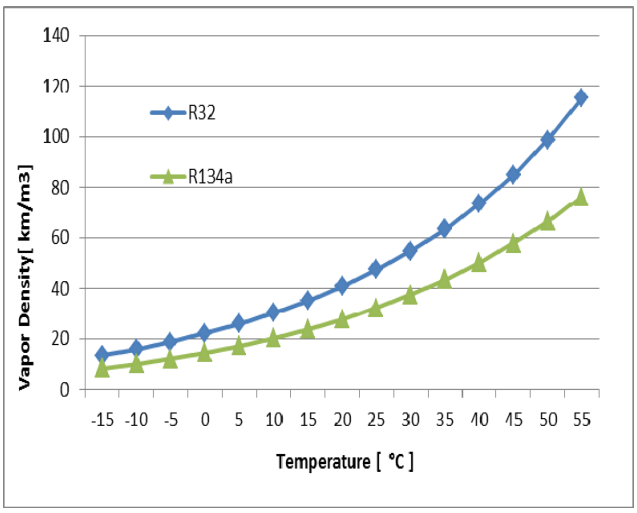

Fig. 2: *Vapour Density vs. temperature*

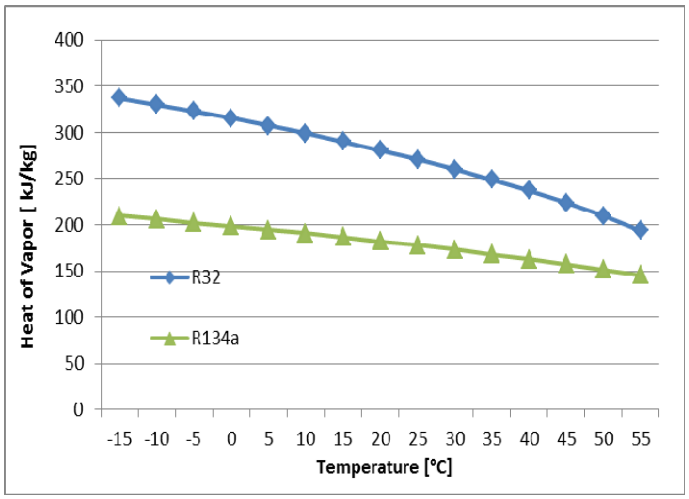

Fig. 3: *Heat of vaporization vs. temperature*

2. The theoretical study

The study case is for a refrigeration capacity of 0.4 kW. The vaporisation temperature of the refrigeration system is -10°C and the condensation temperature is +55°C.

The TEWI factor was calculated according to UE legislation. The total global warming potential method calculation (GWP) of the Ecological Alternative was done according to REGULATION (EC) No 842/2006 (from 1 January 2015 REGULATION (EC) No 517/2014) [1], [4], [5], [6], and [7].

The TEWI factor was determined respecting the Standard SR EN 378-1:

The following assumptions were made in order to calculate the TEWI factor: mass of Alternative R32 - 0,646kg and 0,780 kg for R134a.:

Comparison between the ecological alternative and R134a Table 1

Refrigerant	R32	R-134a
Critical temperature [^{o}C]	78,105	101,06
Critical pressure [bar]	57,82	40,593
Critical density [kg/m^{3}]	424	511,9
Molar mass [kg/kmol]	52,024	102,03

The theoretical results Table 2

Refrigerant	R32	R-134a
Refrigerant charge [kg]	0,646	0,780
ODP	0	0
GWP	650	1300
TEWI Tons of CO_2	43,37	41,01

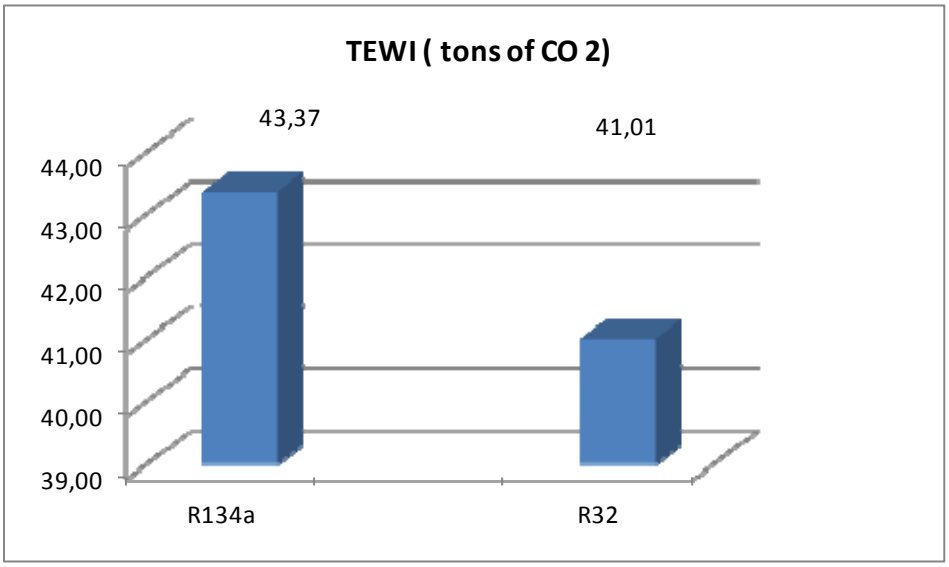

Fig. 4: *TEWI Factor*

The refrigeration system operated 20 hours per day, 200 days per year. The leakage of refrigerant was 8% from charge with a usual recovery factor. The total operating time of the system was 15 years and CO2 emissions were 0.6 kg / kWh.

3. Conclusions

The paper shows the advantages and disadvantages of the refrigerant R32, which could replace R134a and could be used in air conditioning equipment.

By comparing the alternatives in Figure 4, Table 2 it is clear that the global warming impact (TEWI) of refrigerant R32 is the lowest and of R134a is the highest.

As a consequence to the determination of the thermodynamic properties, one could observe (Table 1) that the critical temperature is decreasing and the critical pressure is increasing for alternative R32 in comparison with refrigerant R134a.

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