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Evaluation of mixtures efficiency in refrigerating systems

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Abstract

The use of many common refrigerants is under restriction or phase out because of their high ODP (ozone depletion potential) or GWP (global warming potential). The regulations on environmentally acceptable substances are different from country to country and are subject to frequent updates. In our article, the following mixtures are under consideration: R-401B, R-401C, R-402A, R-404A, R-406A, R-408A, R-409A, R-410A, R-410B and R-507. Some of them do not have zero ODP, but they are in use due to their low ODP.

We are focused on performance comparisons of these working fluids in vapor compression refrigerating cycles. Our effort was conducted on the basis of exergy aspects. Various parameters of the cycles were changed within a suitable range, and the results obtained were plotted in graphs of exergy efficiency factors or presented in Grassmann diagrams and tables.

Keywords: Vapor compression refrigerating systems; Refrigerant mixtures; Exergy

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Nomenclature

COP	coefficient of performance
c^{id}_{Pmixt}	ideal gas mixture heat capacity
$\overset{\circ}{E}Q_o$	cooling load exergy flux
$\overset{\circ}{E}_U$	exergy losses
GWP	global warming potential
$\overset{\circ}{m}$	refrigerant mass flow rate
n_{motor}	compressor motor efficiency
ODP	ozone depletion potential
p	pressure
p_c	critical pressure
p_0	reference pressure
p_r	p/p_c
$\overset{\circ}{P}$	power
$\overset{\circ}{Q}_o$	cooling load
R	universal gas constant
s	entropy
S_0	reference entropy
T	temperature
T_c	critical temperature
T_o	temperature of cold space
T^*_o	evaporation temperature
T_r	T/T_c
T_u	ambient temperature
V	volume
V_c	critical volume
V_r	V/V_c
ρ	density
ρ_c	critical density
ζ	exergy efficiency factors

1. Introduction

In this paper, different refrigerant mixtures have been chosen in order to observe their use in vapor compression refrigerating cycles. Table 1 indicates their composition and the corresponding values for ozone depletion potential and global warming potential [1,2].

Refrigerating cycle modelling is very sensitive to the successful choice of the thermophysical refrigerant properties. In the literature, we have encountered various aspects such as: thermodynamic formulations [3,4], tables and equations for PVT data [5,6], ASHRAE information [7], NIST database [8] and Coolpack software [9]. In previous articles, the first author has presented thermophysical property calculations in Refs. [10–12].