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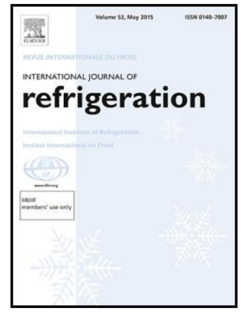

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Author: Shuang Jiang, Shugang Wang, Xu Jin, Yao Yu

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The role of optimum intermediate pressure in the design of two-stage vapor compression systems: A further investigation

Shuang Jiang[a], Shugang Wang[a, *], Xu Jin[b] and Yao Yu[c]

[a] Faculty of Infrastructure Engineering, Dalian University of Technology, Dalian 116024, China
[b] School of Energy and Power Engineering, Northeast Dianli University, Jilin 132012, China
[c] Department of Construction Management and Engineering, North Dakota State University, Fargo, ND 58108-6050, USA

Highlights

- A further study on optimum intermediate pressure is performed.
- The influence of the subcooling parameter is introduced and discussed.
- The efficiency of each compressor is treated separately.
- Revised formulas for both ideal and real cycles are established.

Abstract

The determination of the optimum intermediate pressure ($p_{m,opt}$) is critical for the design of Two-Stage Vapor Compression (TSVC) systems, and there exist many researches on it. However, the inter-stage subcooling parameters (ε) and the respective efficiencies of the two compressors were not included in the existing estimation formulas for $p_{m,opt}$. In this paper, six types of TSVC cycles are classified into two categories, and then based on a general expression of COP, the influences of ε and the compressor efficiencies on $p_{m,opt}$ are analyzed for the cycles using R22 and Ammonia as the refrigerants. Results show that, for the ideal cycles, ε is a critical influence factor on $p_{m,opt}$ in addition to the condensing and evaporating conditions; whereas for the real cycles, both ε and the efficiencies affect $p_{m,opt}$ significantly. Two revised formulas are established to estimate $p_{m,opt}$ for the ideal and real cycles respectively with satisfactory results.

Keywords: Two-stage system; Optimization; Vapor pressure; Design

Nomenclature

Nomenclature		*Subscripts*	
a_1-a_9	coefficients [-]	ari	arithmetic
$b_{i,j}$	biases [-]	c	condensing
COP	coefficient of performance [-]	crit	critical
h	specific enthalpy [kJ kg^{-1}]	dis	discharge
$\dot{m}$	refrigerant mass flow rate [kg s^{-1}]	e	evaporating
p	pressure [kPa]	el	electric
r	ratio [-]	geo	geometric
R_m	ratio of refrigerant mass flows [-]	H	high-stage compressor
R_V	ratio of compressor displacements [-]	is	isentropic
T	temperature [°C]	in	input
$u_{i,j}$, $v_{i,j}$	weights [-]	L	low-stage compressor
w	specific work [kJ kg^{-1}]	m	intermediate
ε	heat exchanger subcooling parameter [-]	opt	optimum
η	efficiency [-]	r	reduced
		suc	suction

1. Introduction

In a vapor compression system, a large difference between the condensing and evaporating temperature will result in deteriorated heating or cooling capacities, declining Coefficient Of Performance (COP), and even abnormal shut down of compressor due to a high discharge temperature. An efficient approach to improve the thermodynamic performance of the high

* Corresponding author: Tel./fax.: +86-411-84706407; E-mail address: sgwangln@aliyun.com, sgwang@dlut.edu.cn