Cairo University

DESIGN OPTIMIZATION OF HYDROCARBON ABSORPTION REFRIGERATION CYCLES

By

Mohamed Ismail Ahmed Marghany

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Chemical Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Under the Supervision of

Prof. Dr. Hamdy Abdelaziz Mostafa	Dr. Ahmed Soliman Mohamed Fawzy
……………………………….	……………………………….
Professor of Chemical Engineering Chemical Engineering Faculty of Engineering, Cairo University	Associate Professor Chemical Engineering Faculty of Engineering, Cairo University

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Approved by the
Examining Committee

____

Prof. Dr. Hamdy Abdelaziz Mostafa, Thesis Main Advisor

____

Dr. Ahmed Soliman Mohamed Fawzy, Thesis Advisor

____

Prof. Dr. Nagwa Mahmoud El Mansy, Internal Examiner

____

Eng. Ibrahim Sayed Abdelsalam El-Kinawy, External Examiner
Chairman and Managing Director
United Gas Derivatives Company (UGDC)

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2015

Engineer: Mohamed Ismail Ahmed Marghany
Date of Birth : 4 / 9 / 1990
Nationality : Egyptian
E-mail : mohamed_marghany@live.com
Phone. : 01285434370
Address : 12 Moussa El Kazem street, Nasr city

Registration Date : 1 / 10 / 2012
Awarding Date : / /
Degree : Master of Science
Department : Chemical Engineering

Supervisors : Prof. Dr. Hamdy Abdelaziz Mostafa
Dr. Ahmed Soliman Mohamed Fawzy

Examiners : Prof. Dr. Hamdy Abdelaziz Mostafa
Dr. Ahmed Soliman Mohamed Fawzy
Prof. Dr. Nagwa Mahmoud El-Mansy
Eng. Ibrahim Sayed Abdelsalam
Chairman and Managing Director
United Gas Derivatives Company (UGDC)

Title of Thesis : **Design Optimization of Hydrocarbon Absorption Refrigeration Cycles**

Key Words: Absorption Refrigeration, COP, Hydrocarbons, Optimization.

Summary :

In this work, the use of hydrocarbon solvent-refrigerant pairs in absorption refrigeration cycles was studied in order to determine the optimum solvent for each refrigerant at different operating conditions based on the coefficient of performance (COP) of the cycle and the solution pumping power. The performance of these hydrocarbon absorption refrigeration cycles was studied and compared to the commercially available absorption chillers and to vapor compression refrigeration cycles. The results of this study showed that the choice of the optimum solvent-refrigerant pair depends on the process conditions and that the performance of the cycle is enhanced at conditions of high evaporator temperature and/or low condenser temperatures. It was found that hydrocarbon absorption refrigeration systems can compete effectively with the commercial absorption refrigeration cycles without experiencing the limitations of these cycles. When compared to vapor compression cycles, hydrocarbon absorption chillers save a significant amount of the electric power required in the cycle despite having lower coefficients of performance and are recommended to replace the traditional vapor compression cycles in plants where surplus amounts of waste heat energy are available. Cycles using hexane-propane or heptane-propane as solvent-refrigerant pairs were suggested for use industrially and their performance was studied along with the effect of the refrigerant recovery and purity on the cycle's performance.

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Dedication

This thesis is dedicated to my mother hoping I am on track to fulfilling her dreams for me. I also dedicate this to my father Mr. Ismail Marghany and my brother Karim.

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Nomenclature

ARC	Absorption Refrigeration Cycle
C_n	Hydrocarbon containing (n) carbon atoms
CFC	Chlorofluorocarbon
COP	Coefficient of Performance
COP_{opt}	Coefficient of Performance using the optimum solvent
CP	Cyclopentane
DM-CC_5	Dimethyl Cyclopentane
E-CC_5 [ECP]	Ethyl Cyclopentane
M-CC_5 [MCP]	Methyl Cyclopentane
M-CC_6	Methyl Cyclohexane
NBP	Normal Boiling Point
P_{crit}	Critical pressure
Q_L	Heat at the low pressure level
Q_H	Heat at the high pressure level
S/R	Solvent to refrigerant ratio
SRP	Solvent-Refrigerant Pairs
T_c	Condensation temperature
T_{crit}	Critical temperature
T_e	Evaporator temperature
VCC	Vapor Compression Cycle
W_{in}	Input work to the cycle