A NEW APPROACH FOR COMBINED MASS AND HEAT EXCHANGER NETWORKS DESIGN

By

May Omar El Farouk Badran Mostafa Badran

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

DOCTOR OF PHILOSOPHY
in
Chemical Engineering

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Keywords: combined mass and heat exchanger network; temperature dependent mass exchange; simultaneous synthesis; process integration

Summary:

In many chemical processes, mass exchanger network and heat exchanger network are interconnected. Therefore, combining heat exchanger networks (HENs) and mass exchanger networks (MENs) can result in significant process improvements. These improvements can lead to the conservation of resources and to the reduction of the total annual cost of the process. Developing an optimum combined mass and heat exchange network (CMHEN) is still challenging for grassroots and retrofit design. This study suggest new approaches for the synthesis of CMHEN grassroots and retrofit design. Several case studies are investigated to validate the suggested approaches. The suggested approaches lead to significant combined cost reductions.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: May Omar El Farouk Badran Date: / /

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Dedication

To

My beloved parents

Acknowledgments

First, I would like to thank God for giving me the opportunity and strength to complete this thesis. I am thankful to all people whose support and assistance were milestones for the completion of this thesis.

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Nomenclature

Symbols

A	heat transfer area (m^2)
$A.F.$	annualization factor
C	concentration (kg kg^{-1})
C_p	heat capacity (kJ kg^{-1} K^{-1})
$CTAC$	combined total annual cost (\$ y^{-1})
CU	cold utility
FC_p	heat capacity flow rate (kW K^{-1})
G	rich stream flow rate (kg s^{-1})
HU	hot utility
k	index of composition interval/ blocks
L	liquid flow rate (kg s^{-1})
M	mass load
m_j	equilibrium dependency constant
R_i	rich stream
S_j	lean stream or MSA
T	actual temperature of stream (°C or K)
$Op.C$	annual operating cost (\$ y^{-1})
x	composition in lean phase (kg kg^{-1})
y	composition in rich phase (kg kg^{-1})
ε	minimum composition difference

Superscripts

in	inlet
lo	lower bound
out	outlet
s	supply
t	target
up	upper bound
*	equilibrium concentration