شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

شبكة المعلومـــــات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الالكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأفلام قد اعدت دون آية تغيرات

يجب أن

تحفظ هذه الأفلام بعيداً عن الغبار

في درجة حرارة من 15 – 20 مئوية ورطوبة نسبية من 20-40 %

To be kept away from dust in dry cool place of
15 – 25c and relative humidity 20-40 %

شبكة المعلومات الجامعية

بعض الـوثـــائق

الأصـلية تـالفـــة

بالرسالة صفحات

لم ترد بالأصـــــل

El-Minia University
Faculty of Eng. & Tech.
Chemical Eng. Dept.

Modeling and Control of a Plate Heat Exchanger

Ph.D. Thesis

Submitted to

Chemical Engineering Department
Faculty of Engineering and Technology
El-Minia University

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For the requirement of the Degree of Doctor Philosophy in Chem. Eng.

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To:

The soul of my father, my dear departed.

proposed models were experimentally tested and their performance under control action were theoretically tested by estimate the closed loop responses to set point changes. M-files programs using **MATLAB** language were developed for using through **MATLAB** software for the simulation of the models and control of the system purposes.

Two types of controller mechanisms are studied, the first namely the proportional, while the second called proportional plus integral. The theoretical closed loop responses under servo operation are computed. Feedback controller gain (K_c) under full state observer design is computed based on either pole placement technique and linear quadratic optimal control theory. However, the study shows that using proportional control is not sufficient and gives large offset error, so adding integral action is necessary. However, the study shows that PHE can be used for the condensation application depending on the available pressure drop. Also, the study shows that, using pole placement technique give better results than linear quadratic optimal control. The present study may constitute a part of the researches on dynamics, modeling and control synthesis for plate heat exchangers used as a condenser.

Nomenclature

A	: Total surface area of PHE ;	[m^2]
A	: n by n matrix.	
a	: The ratio of the condensate area to the total area.	
A_{ch}	: Channel flow area $= s.w = d_e.w/2$;	[m^2]
A_{pl}	: Plate area ;	[m^2]
B	: n by r matrix.	
b	: The maximum trough spacing for intermating type, Fig.(2.6 a), or trough depth for chevron type, Fig.(2.6 b & c) ;	[m]
C	: m by n matrix.	
c	: Minimum channel gap for intermating plate type, Fig.(2.6 a) ;	[m]
C^*	: Heat capacity rate ratio, Eq.(3.5) & Eq.(3.6).	
C_p	: Fluid specific heat ;	[j/kg.K]
D	: m by r matrix.	
d_e	: Channel equivalent diameter $= 2s$ or $2s/\varphi$;	[m]
F	: Logarithmic mean temperature difference correction factor ;	
$G(s)$	: Transfer function.	
H	: Fluid enthalpy ;	[j/Kg]
$\hat{H}$	: Height of intermating trough, Fig.(2.6 a) ;	[m]
h	: Heat transfer coefficient ;	[$W/m^2.K$]
h_f	: The fouling coefficient on both sides of plate ;	[$W/m^2.K$]
J_e	: Specific pressure drop ;	[Pa/NTU]
J_h	: Heat transfer factor based on Nu ;	
J	: Quadratic performance index.	
k	: Thermal conductivity ;	[W/m.K]
K_c	: The state feedback gain matrix.	
K_e	: The state observation gain matrix.	
l	: Length per channel ;	[m]
LMTD	: Logarithmic mean temperature difference ;	[K]
m	: Total mass flow rate ;	[Kg/s]
m_{ch}	: Channel mass flow rate ;	[Kg/s]
N_T	: Total number of plates including the two end plates.	
N_e	: Total effective number of thermal plates.	
n	: Number of moles.	
n_a	: Air mole fraction.	
n_s	: Steam mole fraction.	

n_p	: Number of parallel channel per pass .	
n_s	: Number of passes in series .	
P	: Pressure ;	[Pa]
P_a	: Partial pressure of air ;	[Pa]
P_s	: Partial pressure of steam ;	[Pa]
p	: Plate pitch ;	[m]
Q	: Heat transfer rate ;	[W]
R	: Gas constant	[bar. m^3 / Kgmole. K]
r_f	: Fouling factor ;	[$W/m^2.k$ $]^{-1}$
r_{wall}	: Plate wall resistance ;	[$W/m^2.K$ $]^{-1}$
s	: Spacing between plates (channel gap) ;	[m]
T	: Temperature ;	[K]
T_{sat}	: Saturation temperature ;	[K]
t	: Time ;	[s]
V	: Volume of one channel.	[m^3]
U	: Overall heat transfer coefficient ;	[$W/m^2.K$]
u	: Control vector (r vector).	
w	: Effective plate width ;	[m]
x	: State variable vector (n vector)	
Z	: Thermal effectiveness , Eq.(3.4) & Eq.(3.7).	

<u>Greek Letters.</u>

α	: Base angle of trough, Fig.(2.6 a).	
β	: Chevron angle, "Corrugation inclination angle to flow direction", see Fig.(2.2) & Fig.(2.5 b).	
ΔP	: Pressure drop ;	[Pa]
δ	: Plate thickness ;	[m]
θ	: Number of heat transfer units (NTU or HTU).	
λ	: Latent heat of condensation ;	[j/Kg]
μ	: Fluid viscosity ;	[$N.s/m^2$]
ρ	: Fluid density ;	[Kg/m^3]
φ	: Enlargement factor (developed area / projected area), Fig.(2.8) & Eq.(2.2).	
Φ	: Viscosity correction factor= [μ_{bulk} / μ_{wall}].	

Index.

1	*: Section number one.*
2	*: Section number two.*
a	*: Air.*
av	*: Average.*
c	*: Cold fluid "cold stream condition ".*
ch	*: Channel.*
d	*: Condensate.*
h	*: Hot fluid "hot stream condition ".*
i	*: Inlet conditions.*
l	*: Liquid phase.*
max	*: Maximum.*
min	*: Minimum.*
o	*: Outlet conditions.*
pl	*: Plate.*
s	*: Steam.*
sat	*: Saturation.*
st	*: Steady state values.*
T	*: Total..*
w	*: Water.*
wall	*: Condition at the wall.*

Dimensionless Groups.

N_u	*: Nusselt number* $= (h.d_e)/k$;
P_r	*: Prandtl number* $= (\mu.C_p)/k$;
R_e	*: Reynolds number* $= (\rho.u.d_e) / \mu$;

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