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TEST FOR HEAT TRANSFER PERFORMANCE OF A PLATE HEAT EXCHANGER

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งานวิจัยนี้มีวัตถุประสงค์เพื่อหาสมการสหสัมพันธ์ของเครื่องแลกเปลี่ยนความร้อนแบบแผ่นและเขียน
 โปรแกรมออกแบบเครื่องแลกเปลี่ยนความร้อนแบบแผ่นโดยใช้สมการสหสัมพันธ์ที่ได้จากการทดลอง

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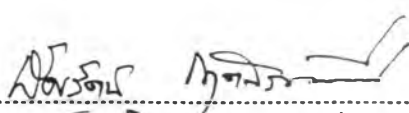
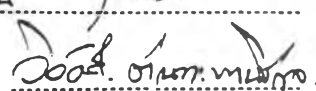
ในการศึกษาสารผลิตภัณฑ์ที่ใช้คือ น้ำ, น้ำหวาน (สารละลายน้ำตาลความเข้มข้น 20, 30 , และ
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 แลกเปลี่ยนความร้อนแบบแผ่นเครื่องนี้คือ

$$Nu = 0.02 Re^{0.87} Pr^{0.78}$$

สมการสหสัมพันธ์ที่ได้นี้สอดคล้องกับผลการทดลอง โดยมีค่าเบี่ยงเบนมาตรฐานเท่ากับ 0.081.

โปรแกรมคำนวณออกแบบเครื่องแลกเปลี่ยนความร้อนแบบแผ่นได้นำสมการสหสัมพันธ์นี้ ตลอดจน
 คุณสมบัติทางกายภาพของของเหลวที่ใช้ในการศึกษารวมในโปรแกรม. โปรแกรมนี้เขียนด้วยภาษาเทอร์โบ-
 เบสิก และใช้วิธีเอฟเฟคทีฟเนส-เอ็นทยู (Effectiveness-NTU) ผลลัพธ์การคำนวณออกแบบของโปร
 แกรมพบว่าสอดคล้องกับผลการทดลองและกระบวนการพาสเจอไรซ์

ภาควิชา วิศวกรรมเคมี
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 ลายมือชื่ออาจารย์ที่ปรึกษา 



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The objectives of the present study are to find a suitable heat transfer correlation for a pilot-scale plate exchanger and to develop a computer program to aid in the design of plate heat exchangers using the correlation obtained.

The pilot-scale plate heat exchanger studied has a plate gap of 0.00313 m, a width of 0.1125 m., a length of 0.445 m, it has chevron corrugations (angle = 50 degrees), and a surface area of 0.05 m². The exchanger tested has three sections.

The range of products tested includes water, syrup (sucrose solution of 20 wt%, 30 wt% and 40 wt% concentration), and glycerine (glycerine in water at 40 vol%, 50 vol% and 60 vol% concentration). Their flow rates were varied to yield Reynolds numbers ranging from 100 to 4,000. The Prandtl numbers of the products ranged from 2.11 to 40. One of the heat transfer correlations for the tested plate heat exchanger is

$$Nu = 0.02 Re^{0.87} Pr^{0.78}$$

The proposed correlation is found to correlate the experimental data reasonably well with a standard deviation of 0.081.

To aid in the design of plate heat exchangers a computer program has been developed, using the obtained correlation and incorporating the physical properties of all the tested liquids. The program is coded in TURBO BASIC and uses the effectiveness-NTU approach as design procedure. The design and calculation results of the program are found to agree well with experimental results as well as with actual HTST processes.

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CONTENTS

	Page
THAI ABSTRACT	IV
ENGLISH ABSTRACT	VI
ACKNOWLEDGEMENT	VII
LIST OF TABLES	XII
LIST OF FIGURES	XVII
NOMENCLATURE	XXIX
CHAPTERS	
1 INTRODUCTION	1
1.1 Background	1
1.2 Objective	2
1.3 Scope of Work	3
2 REVIEW OF LITERATURE	4
2.1 Literature Survey of Heat Transfer Correlation ..	4
2.2 Theory of Heat Transfer	5
2.3 Pressure Drop	13
2.4 Fouling	16
2.5 Heat Transfer Method of Plate Heat Exchanger	17
3 CHARACTERISTICS OF PLATE HEAT EXCHANGERS	31
3.1 Construction of Plate Heat Exchanger	31
3.1.1 General Description	31
3.1.2 Plate Construction Features	33
3.1.3 Gasket	36
3.1.4 Frame	36
3.1.5 Channel Construction	38

CHAPTERS	Page
3.2 Operation	39
3.3 Plate Arrangement	40
3.3.1 Type of Pass Arrangements	40
3.3.1.1 Single Pass	40
3.3.1.2 Multipass With Equal Passes	40
3.3.1.3 Multipass With Unequal Passes	40
3.3.2 End Effects	41
3.3.2.1 End Passages	42
3.3.2.2 Equal Number of Passes	42
3.3.2.3 Unequal Passes	42
4 EXPERIMENTAL APPARATUS AND PROCEDURE	43
EXPERIMENTAL APPARATUS	43
4.1 Plate Heat Exchanger	43
4.1.1 Description	43
4.1.2 Flow Diagram of Plate Heat Exchanger	48
Experimental Procedure	50
4.2 General Experimental Procedure	50
4.3 Experiment Conditions Investigated	51
4.3.1 Case I: Product is water	51
4.3.1.1 Case I-1: Equal flow rates	51
4.3.1.1.1 Case I-1(a): Hot water at 75 °C ...	51
4.3.1.1.2 Case I-1(b): Hot water at 35 °C ...	52
4.3.1.1.3 Case I-1(c): Hot water at 98 °C ...	52
4.3.1.2 Case I-2: Unequal flow rates	52
4.3.1.2.1 Case I-2(a): Hot water at 75 °C ...	52
4.3.1.2.2 Case I-2(b): Hot water at 85 °C ...	52
4.3.1.2.3 Case I-3(c): Hot water at 98 °C ...	53
4.3.2 Case II: Product is syrup(Sucrose solution)	53

CHAPTERS	Page
4.3.2.2 Case II-2: 30 wt% syrup	53
4.3.2.3 Case II-3: 40 wt% syrup	53
4.3.3 Case III: Product is glycerine(in water) .	53
4.3.3.1 Case III-1: 40 vol% glycerine	53
4.3.3.2 Case III-2: 50 vol% glycerine	53
4.3.3.3 Case III-3: 60 vol% glycerine	53
4.4 Summary of Experimental Conditions	53
5 RESULTS AND DISCUSSIONS	73
5.1 Equal water/water flow rates	73
5.2 Unequal water/water flow rates	81
5.3 Equal syrup/syrup flow rates	91
5.4 Equal glycerine/glycerine flow rates	145
5.5 Unequal water/syrup flow rates	158
5.5.1 Theoretical correlation is used to estimate h_w	159
5.5.2 Constrained correlation (5-7) is used to estimated h_w	159
5.5.3 Unconstrained correlation (5-8) is used to estimated h_w	160
5.6 Unequal water/glycerine flow rates	165
5.6.1 Theoretical correlation is used to estimate h_w	166
5.6.2 Constrained correlation (5-7) is used to estimated h_w	166
5.6.3 Unconstrained correlation (5-8) is used to estimated h_w	166
5.7 Generalized heat transfer correlation	167
6 COMPUTER PROGRAM FOR THE DESIGN OF PLATE HEAT EXCHANGERS	197
6.1 Design Examples	206
6.2 Application to Industrial Problem	217

CHAPTERS	Page
7 CONCLUSIONS AND RECOMMENDATIONS	230
7.1 CONCLUSIONS	230
7.2 RECOMMENDATIONS	231
REFERENCES	234
APPENDICES	238
A FLOW CHARTS OF PROGRAMS	239
A1 PROGRAM 1	262
A2 PROGRAM 2	268
A3 PROGRAM 3	271
A4 PROGRAM 4	278
A5 PROGRAM 5	292
A6 PROGRAM 6	304
8 Physical properties of liquids	319
B.1 Water	319
B.1.1 Viscosity	319
B.1.2 Thermal Conductivity	319
B.1.3 Specific heat	320
B.1.4 Density	320
B.2 Syrup solution (Sucrose Solution)	321
B.2.1 Viscosity	321
B.2.2 Thermal Conductivity	326
B.2.3 Specific heat	326
B.2.4 Density	327
B.3 Glycerine	328
B.3.1 Viscosity	328
B.3.2 Thermal Conductivity	330
B.3.3 Specific heat	332
B.3.4 Density	332

LIST OF TABLES

Table	Page
3.1 Gasket material applications	36
4.1 Summary of experimental for equal flow rates. Hot water flow rate(H) = Cool water flow rate(C) = Product water flow rate(P), LPM. Each run number consists of three cases, namely, T10 = 98, 85, and 75 °C, respectively	54
4.2 Summary of experimental conditions for unequal water/water flow rates (LPM) Each run number consists of three cases, namely, T10 = 98, 85, and 75 °C, respectively	55
4.3 Experimental conditions for equal water/water flow rates	58
4.4 Experimental conditions for unequal water/water (H=C=3 and vary P (LPM))	59
4.5 Experimental conditions for unequal water/water (H=C=4 and vary P (LPM))	60
4.6 Experimental conditions for unequal water/water (H=C=5 and vary P (LPM))	61
4.7 Experimental conditions for unequal water/water (H=C=6 and vary P (LPM))	62
4.8 Experimental conditions for unequal water/water (H=C=7 and vary P (LPM))	63
4.9 Experimental conditions for unequal water/water (H=C=7.5 and vary P (LPM))	64

Table	Page
4.10 Experimental conditions for unequal water/water (H=C=9 and vary P (LPM))	65
4.11 Experimental conditions for unequal water/water (H=C=12 and vary P.(LPM))	66
4.12 Experimental conditions for equal syrup/syrup flow rates.(20 wt% concentration)	67
4.13 Experimental conditions for equal syrup/syrup flow rates.(30 wt% concentration)	68
4.14 Experimental conditions for equal syrup/syrup flow rates.(40 wt% concentration)	69
4.15 Experimental conditions for equal glycerine/glycerine flow rates.(40 vol% concentration)	70
4.16 Experimental conditions for equal glycerine/glycerine flow rates.(50 vol% concentration)	71
4.17 Experimental conditions for equal glycerine/glycerine flow rates.(60 vol% concentration)	72
5.1 Experimental and estimated values of the Nusselt number; System: Equal water/water flow rates	76
5.2 Experimental and estimated values of the heat transfer coefficient; System: Equal water/water flow rates	85
5.3.1 Experimental and estimated values of the heat transfer coefficient; System: Unequal water/water flow rates; Flow rate of product = 2,3,4,5,6,7 LPM. Flow rate of cooling water = Flow rate of hot water = 12 LPM.	92

Table	Page
5.3.2 Experimental and estimated values of the heat transfer coefficient; System: Unequal water/water flow rates; Flow rate of product = 2,3,4,5,6,7 LPM. Flow rate of cooling water = Flow rate of hot water = 9 LPM.....	94
5.3.3 Experimental and estimated values of the heat transfer coefficient; System: Unequal water/water flow rates; Flow rate of product = 2,3,4,5,6,7 LPM. Flow rate of cooling water = Flow rate of hot water = 7.5 LPM.	96
5.3.4 Experimental and estimated values of the heat transfer coefficient; System: Unequal water/water flow rates; Flow rate of product = 2,3,4,5,6,7.5 LPM. Flow rate of cooling water = Flow rate of hot water = 7 LPM.	98
5.3.5 Experimental and estimated values of the heat transfer coefficient; System: Unequal water/water flow rates; Flow rate of product = 2,3,4,5,7,7.5 LPM. Flow rate of cooling water = Flow rate of hot water = 6 LPM.	100
5.3.6 Experimental and estimated values of the heat transfer coefficient; System: Unequal water/water flow rates; Flow rate of product = 2,3,4,6,7,7.5 LPM. Flow rate of cooling water = Flow rate of hot water = 5 LPM.	102

Table	Page
5.3.7 Experimental and estimated values of the heat transfer coefficient; System: Unequal water/water flow rates; Flow rate of product = 2,3,5,6,7,7.5 LPM. Flow rate of cooling water = Flow rate of hot water = 4 LPM.	104
5.3.8 Experimental and estimated values of the heat transfer coefficient; System: Unequal water/water flow rates; Flow rate of product = 2,4,5,6,7,7.5 LPM. Flow rate of cooling water = Flow rate of hot water = 3 LPM.	106
5.4 Experimental and estimated values of the Nusselt number; System: Equal syrup/syrup flow rates.	133
5.5 Experimental and estimated values of the heat transfer coefficient; System: Equal syrup/syrup flow rates.	140
5.6 Experimental and estimated values of the Nusselt number; System: Equal glycerine/glycerine flow rates...	146
5.7 Experimental and estimated values of the heat transfer coefficient; System: Equal glycerine/glycerine flow rates	153
5.8 The calculation results of Nusselt number in various cases; System: water/syrup	161
5.9 The calculation results of Nusselt number in various cases: System: water/glycerine	168
5.10 Experimental and estimated values of the heat transfer coefficient; System: water/syrup	181

Table		Page
5.11	Experimental and estimated values of the heat transfer coefficient; System: water/glycerine	184
B-1	Viscosity of Sucrose Solution	322
B-2	Experimental measurement of viscosity of 30% by weight sugar solution	325
B-3	Viscosity measurement of glycerine solution as a function of concentration in volume % and temperature	328

LIST OF FIGURES

Figure	Page
1	For same material, plate exchanger costs less 1
2.2.1	Heat transfer through a composite plane wall with convection at the surfaces 7
2.2.2	Axial temperature distribution in heat exchangers 10
2.3.1	Performance characteristics of a small chevron-trough plate heat exchanger 15
2.5.1	Mechanism of heat transfer in a plate heat exchanger ... 18
2.5.2	Typical arrangement of plates and flow channels 19
2.5.3	LMTD correction factors for multipass systems 24
2.5.4	Countercurrent E-NTU relationships for loop patterns ... 27
2.5.5	Cocurrent E-NTU relationships for loop patterns 28
2.5.6	Series-series E-NTU relationships for 4 channels, types I and III, and 8 channels 29
2.5.7	Series-series E-NTU relationships for 4 channels, types II and IV 29
3.1	Typical plates showing intermating and chevron troughs . 31
3.2	Typical plate and frame heat exchanger 32
3.3	Diagram of heat exchanger plate 33
3.4	Vertical flow plate with chevron troughs 34
3.5	Diagonal flow plate with intermating troughs 35
3.6	Industrial frame with tie bar tightening 36
3.7	Stainless steel-clad hygienic frame with screw closure . 37
3.8	Schematic representation of mixed plates 39
3.9	n-parallel plate single and multipass arrangements 41

Figure	Page
4.1 Photograph of Plate Heat Exchanger Investigated	44
4.2 Type Eurocal 5; Chevron Corrugation (angle = 50 degrees).	44
4.3 Flow Arrangement in Each Section of the Plate Heat Exchanger	45
4.4 Flow Diagram of Plate Heat Exchanger	47
5.1 Experimental results for the case of equal water/water flow rates; (at hot water temperature , $T_{10} = 98, 85,$ and 75°C , \bigcirc : $b = 0.4$, \square : $b = 1.38$)	79
5.2 Comparison between Nu_{exp} , the experimental value of the Nusselt number and Nu_{the} , the theoretical value based on eqn(5-6) for the case of equal water/water flow rates	82
5.3 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-7) for the case of equal water/water flow rates	83
5.4 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-8) for the case of equal water/water flow rates	84
5.5 Comparison between the experimental value of the overall heat transfer coefficient and the theoretical value given by eqn(5-6) for the case of equal water/water flow rates	85
5.6 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-7) for the case of equal water/water flow rates	88

Figure	Page
5.7 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-8) for the case of equal water/water flow rates	89
5.8(a) Comparison between the experimental value of U and the theoretical value given by eqn(5-6) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,6,7 LPM., Flow rate of cooling water = Flow rate of hot water = 12 LPM.).....	108
5.8(b) Comparison between the experimental value of U and the value estimated from eqn(5-7) for the case of unequal water/water flow rates; (Flow rate of product = 2,3,4,5,6,7 LPM., Flow rate of cooling water = Flow rate of hot water = 12 LPM.).....	109
5.8(c) Comparison between the experimental value of U and the value estimated from eqn(5-8) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,6,7 LPM., Flow rate of cooling water = Flow rate of hot water = 12 LPM.).....	110
5.9(a) Comparison between the experimental value of U and the theoretical value given by eqn(5-6) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,6,7 LPM., Flow rate of cooling water = Flow rate of hot water = 9 LPM.).....	111

Figure	Page
5.9(b) Comparison between the experimental value of U and the value estimated from eqn(5-7) for the case of unequal water/water flow rates; (Flow rate of product = 2,3,4,5,6,7 LPM., Flow rate of cooling water = Flow rate of hot water = 9 LPM.).....	112
5.9(c) Comparison between the experimental value of U and the value estimated from eqn(5-8) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,6,7 LPM., Flow rate of cooling water = Flow rate of hot water = 9 LPM.).....	113
5.10(a) Comparison between the experimental value of U and the theoretical value given by eqn(5-6) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,6,7 LPM., Flow rate of cooling water = Flow rate of hot water = 7.5 LPM.).....	114
5.10(b) Comparison between the experimental value of U and the value estimated from eqn(5-7) for the case of unequal water/water flow rates; (Flow rate of product = 2,3,4,5,6,7 LPM., Flow rate of cooling water = Flow rate of hot water = 7.5 LPM.).....	115
5.10(c) Comparison between the experimental value of U and the value estimated from eqn(5-8) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,6,7 LPM., Flow rate of cooling water = Flow rate of hot water = 7.5 LPM.).....	116

Figure	Page
5.11(a) Comparison between the experimental value of U and the theoretical value given by eqn(5-6) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,6,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 7 LPM.).....	117
5.11(b) Comparison between the experimental value of U and the value estimated from eqn(5-7) for the case of unequal water/water flow rates; (Flow rate of product = 2,3,4,5,6,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 7 LPM.).....	118
5.11(c) Comparison between the experimental value of U and the value estimated from eqn(5-8) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,6,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 7 LPM.).....	119
5.12(a) Comparison between the experimental value of U and the theoretical value given by eqn(5-6) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 6 LPM.).....	120
5.12(b) Comparison between the experimental value of U and the value estimated from eqn(5-7) for the case of unequal water/water flow rates; (Flow rate of product = 2,3,4,5,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 6 LPM.).....	121

Figure	Page
5.12(c) Comparison between the experimental value of U and the value estimated from eqn(5-8) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,5,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 6 LPM.).....	122
5.13(a) Comparison between the experimental value of U and the theoretical value given by eqn(5-6) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,6,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 5 LPM.).....	123
5.13(b) Comparison between the experimental value of U and the value estimated from eqn(5-7) for the case of unequal water/water flow rates; (Flow rate of product = 2,3,4,6,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 5 LPM.).....	124
5.13(c) Comparison between the experimental value of U and the value estimated from eqn(5-8) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,4,6,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 5 LPM.).....	125
5.14(a) Comparison between the experimental value of U and the theoretical value given by eqn(5-6) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,5,6,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 4 LPM.).....	126

Figure	Page
5.14(b) Comparison between the experimental value of U and the value estimated from eqn(5-7) for the case of unequal water/water flow rates; (Flow rate of product = 2,3,5,6,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 4 LPM.).....	127
5.14(c) Comparison between the experimental value of U and the value estimated from eqn(5-8) for the case of unequal water/water flow rates ; (Flow rate of product = 2,3,5,6,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 4 LPM.).....	128
5.15(a) Comparison between the experimental value of U and the theoretical value given by eqn(5-6) for the case of unequal water/water flow rates ; (Flow rate of product = 2,4,5,6,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 3 LPM.).....	129
5.15(b) Comparison between the experimental value of U and the value estimated from eqn(5-7) for the case of unequal water/water flow rates; (Flow rate of product = 2,4,5,6,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 3 LPM.).....	130
5.15(c) Comparison between the experimental value of U and the value estimated from eqn(5-8) for the case of unequal water/water flow rates ; (Flow rate of product = 2,4,5,6,7,7.5 LPM., Flow rate of cooling water = Flow rate of hot water = 3 LPM.).....	131

Figure	Page
5.16 Experimental results for the case of equal syrup/syrup flow rates; (at hot water temperature , $T_{10} = 98, 85,$ and 75°C , \bigcirc : $b = 0.4$, \square : $b = 0.54$)	135
5.17 Comparison between Nu_{exp} , the experimental value of the Nusselt number and Nu_{th} , the theoretical value based on eqn(5-6) for the case of equal syrup/syrup flow rates	136
5.18 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-9) for the case of equal syrup/syrup flow rates	137
5.19 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-10) for the case of equal syrup/syrup flow rates	138
5.20 Comparison between the experimental value of the overall heat transfer coefficient and the theoretical value given by eqn(5-6) for the case of equal syrup/syrup flow rates	142
5.21 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-9) for the case of equal syrup/syrup flow rates	143
5.22 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-10) for the case of equal syrup/syrup flow rates	144
5.23 Experimental results for the case of equal glycerine/glycerine flow rates; (at hot water temperature , $T_{10} = 98, 85,$ and 75°C , \bigcirc : $b = 0.4$, \square : $b = 0.57$)	148

Figure	Page
5.24 Comparison between Nu_{exp} , the experimental value of the Nusselt number and Nu_{th} , the theoretical value based on eqn(5-6) for the case of equal glycerine/glycerine flow rates	149
5.25 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-11) for the case of equal glycerine/glycerine flow rates	150
5.26 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-12) for the case of equal glycerine/glycerine flow rates	151
5.27 Comparison between the experimental value of the overall heat transfer coefficient and the theoretical value given by eqn(5-6) for the case of equal glycerine/glycerine flow rates	155
5.28 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-11) for the case of equal glycerine/glycerine flow rates ...	156
5.29 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-12) for the case of equal glycerine/glycerine flow rates ...	157
5.30 Experimental results for the case of water/syrup flow rates; (at hot water temperature ,T10 = 98, 85, and 75 °C , ○ : b = 0.4, □ : b = 1.02)	164
5.31 Experimental results for the case of water/glycerine flow rates; (at hot water temperature ,T10 = 98, 85, and 75 °C , ○ : b = 0.4, □ : b = 0.89)	171

Figure	Page
5.32 Experimental results for the case of overall data of equal flow rates;(at hot water temperature ,T10 = 98, 85, and 75 °C , ○: b = 0.4, □: b = 0.89)	172
5.33 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-27) for the case of equal water/water flow rates	174
5.34 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-28) for the case of equal water/water flow rates	175
5.35 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-27) for the case of equal syrup/syrup flow rates	176
5.36 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-28) for the case of equal syrup/syrup flow rates	177
5.37 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-27) for the case of equal glycerine/glycerine flow rates	178
5.38 Comparison between the experimental value of the Nusselt number and value estimated with eqn(5-28) for the case of equal glycerine/glycerine flow rates	179
5.39 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-27) for the case of equal water/water flow rates	187

Figure	Page
5.40 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-28) for the case of equal water/water flow rates	188
5.41 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-27) for the case of equal syrup/syrup flow rates	189
5.42 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-28) for the case of equal syrup/syrup flow rates	190
5.43 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-27) for the case of equal glycerine/glycerine flow rates ...	191
5.44 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-28) for the case of equal glycerine/glycerine flow rates ...	192
5.45 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-27) for the case of water/syrup flow rates	193
5.46 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-28) for the case of water/syrup flow rates	194
5.47 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-27) for the case of water/glycerine flow rates	195

Figure	Page
5.48 Comparison between the experimental value of the overall heat transfer coefficient and the estimated from eqn(5-28) for the case of water/glycerine flow rates	196
B-1 Viscosity of sucrose solution as a function of temperature and percentage of sucrose by weight. (Based on Perry's Chemical Engineer's Handbook Fourth Edition, 1963.)	323
B-2 Temperature-viscosity relation for 30 wt% sucrose solution (Based on measured data)	324
B-3 Temperature-viscosity relations for glycerine solution (Based on measured data)	329
B-4 Thermal conductivity versus Glycerine concentration (vol%) (Based on Perry's Chemical Engineer's Handbook Fourth Edition, 1963)	331
B-5 Specific heat versus Glycerine concentration (mole %) (Based on Perry's Chemical Engineer's Handbook Fourth Edition, 1963)	333



NOMENCLATURE

a, A_p	Area of plate, m^2 ($2A_p$ = area per channel bounded by two plates).
A_t	Total area of the thermal plates ($A_t N$), m^2 .
b_p	Distance between plates or plate gap, m.
C_p	Heat capacity of the fluid, kJ/kgK .
d_f	Fouling factor, $m^2 K/W$.
D_e	Equivalent diameter of the flow channel ($D_e = 2b_p$), m.
E	Heat transfer effectiveness.
F	Correction factor for LMTD.
f	Friction factor.
G	Mass flow rate of fluid, $kg/m^2 s$.
h	Heat transfer film coefficient fluid, $W/m^2 K$.
k	Thermal conductivity, W/mK .
L	Length of flow passage, m.
m	Exponent in Eq. (2.2.1)
n	Exponent in Eq. (2.2.1) and number of thermal plates.
N	Number of thermal plates.
NTU	Number of transfer units or thermal length, θ or performance factor, or temperature ratio, TR.
Nu	Nusselt number (hD_e/k).
Pr	Prandtl number ($C_p \mu/k$).
ΔP	Pressure drop, kN/m^2 .
Q	Heat transfer rate, kW.
Re	Reynolds number ($2w/b_p$).
T	Temperature, K.
T_i	Inlet temperature of the process fluid.

T_o	Outlet temperature of the process fluid.
ΔT	Temperature difference, K.
ΔT_{lm}	Log mean temperature difference, K.
U	Overall heat transfer coefficient, $W/m^2 K$.
W	Width of the plate, m.
w	Mass flow rate of fluid, kg/s.
x	Exponent in Eq.(2.2.1) or plate thickness, m.
θ	Thermal length, or NTU.
μ	Fluid viscosity, kg/ms.
ρ	Fluid density, kg/m^3 .

Subscripts.

av	Average.
c	Cold.
ci	Cold fluid, inlet.
co	Cold fluid, outlet.
h	Hot.
hi	Hot fluid, inlet.
ho	Hot fluid, outlet.
max	Maximum.
min	Minimum.