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APPENDIX A

EXPERIMENT DATA

Table A 1 Results of studying effects of pressure, recirculation flow rate and biomass on permeate flux (at operating temperature 33 °C)

Run	Liquid	Pressure kg_f/cm^2	Recirculation flow rate (m^3/hr)	Permeate flow rate (m^3/hr) X 10^{-3}
A	Cleaning water	0.0^+	0.4	11.4467
		0.0^+	0.5	13.1148
		0.0^+	0.6	16.0786
		0.2^+	0.4	26.4123
		0.4^+	0.4	39.6913
		0.6^+	0.4	50.3497
		0.8^+	0.4	67.2837
B	Fermentation broth with cell dry weight = 1.70 g/lit	0.0^+	0.4	2.4903
		0.0^+	0.5	2.5470
		0.0^+	0.6	3.1535
		0.2^+	0.4	3.7290
		0.4^+	0.4	4.1204
		0.6^+	0.4	4.4319
		0.8^+	0.4	4.9786
C	Fermentation broth with cell dry weight = 11.24 g/lit	0.0^+	0.4	1.8308
		0.0^+	0.5	2.1050
		0.0^+	0.6	2.4470
		0.2^+	0.4	2.4565
		0.4^+	0.4	2.9605
		0.6^+	0.4	3.4864
		0.8^+	0.4	3.6735

Table A 1 (continue)

Run	Liquid	Pressure kg_f/cm^2	Recirculation flow rate (m^3/hr)	Permeate flow rate (m^3/hr) X 10^{-3}
D	Fermentation broth	0.0^{+}	0.4	1.4536
	with a cell dry	0.0^{+}	0.5	1.7344
	weight = 49.42 g/lit	0.0^{+}	0.6	2.1159
		0.2^{+}	0.4	1.7002
		0.4^{+}	0.4	1.8024
		0.6^{+}	0.4	1.8592
		0.8^{+}	0.4	1.8650
E	Fermentation broth	0.0^{+}	0.4	1.3307
	with a cell dry weight	0.0^{+}	0.5	1.4749
	= 64.40 g/lit	0.0^{+}	0.6	1.8025
		0.2^{+}	0.4	1.5014
		0.4^{+}	0.4	1.5030
		0.6^{+}	0.4	1.4883
		0.8^{+}	0.4	1.4890

Table A 2 The results of ABE fermentation from cell recycle system in run K (with 42.4 g/l feeding glucose concentration)

Operating condition	Solvent concentration (gl^{-1})			Total Solvent (gl^{-1})	Acid Concentration (gl^{-1})		Cell Concentration (gl^{-1})
	Butanol	Acetone	Ethanol		Butyric Acid	Acetic Acid	
Batch (1.00 LIT)	5.35	2.77	0.71	8.83	0.16	0.41	4.0
Batch (2.75 LIT)	5.18	2.82	0.71	8.71	–	0.44	3.8
Continuous (D = 0.11 hr^{-1})	4.21	3.49	0.35	8.05	–	–	31.1
Continuous (D = 0.22 hr^{-1})	5.89	4.18	0.34	10.41	–	–	69.0
Continuous (D = 0.36 hr^{-1})	6.20	4.38	0.36	10.94	–	–	79.0
Continuous (D = 0.55 hr^{-1})	6.26	4.40	0.37	11.03	–	–	81.6

Table A 3 The results of ABE fermentation from cell recycle system in run L (with 52.0 g/l feeding glucose concentration)

Operating condition	Solvent concentration (gl^{-1})			Total Solvent	Acid Concentration (gl^{-1})		Cell Concentration
	Butanol	Acetone	Ethanol	(gl^{-1})	Butyric Acid	Acetic Acid	(gl^{-1})
Batch (1.00 LIT)	6.07	4.00	0.46	10.53	-	0.98	4.8
Batch (2.75 LIT)	5.36	3.63	0.30	9.29	-	0.77	5.9
Continuous (D = 0.11 hr^{-1})	6.92	4.76	0.30	11.98	-	-	55.4
Continuous (D = 0.22 hr^{-1})	7.86	4.87	0.34	13.07	-	-	57.4
Continuous (D = 0.36 hr^{-1})	7.11	4.64	0.32	11.98	-	0.34	68.7

Table A 4 The results of ABE fermantation from cell recycle system in run M (with 64.8 g/l feeding glucose concentration)

Operating condition	Solvent concentration (gl^{-1})			Total Solvent (gl^{-1})	Acid Concentration (gl^{-1})		Cell Concentration (gl^{-1})
	Butanol	Acetone	Ethanol		Butyric Acid	Acetic Acid	
Batch (1.00 LIT)	6.80	3.51	0.77	11.08	0.05	1.01	3.74
Batch (2.75 LIT)	5.69	3.11	0.56	9.36	0.69	0.76	4.08
Continuous (D = 0.11 hr^{-1})	4.76	3.43	0.31	8.50	0.50	1.09	60.08
Continuous (D = 0.22 hr^{-1}	2.38	1.54	0.20	4.12	0.62	0.68	65.02

Table A 5 The results of ABE fermentation from cell recycle system in run N (with 42.3 g/l feeding glucose concentration)

Operating condition	Solvent concentration (gl^{-1})			Total Solvent (gl^{-1})	Acid Concentration (gl^{-1})		Cell Concentration (gl^{-1})
	Butanol	Acetone	Ethanol		Butyric Acid	Acetic Acid	
Batch (1.00 LIT)	5.19	3.03	0.39	8.61	-	1.20	4.43
Batch (2.75 LIT)	4.57	3.16	0.31	8.04	-	0.24	4.10
1st Continuous (D = 0.55 hr^{-1})	5.65	4.83	0.22	10.70	-	0.50	36.40
2nd Continuous (D = 0.55 hr^{-1})	5.01	4.31	0.18	9.50	-	0.63	42.00

Table A 6 The result of ABE fermentation from cell recycle system in run 0 (with 43.6 g/l feeding glucose concentration)

Operating condition	Solvent concentration (gl^{-1})			Total Solvent (gl^{-1})	Acid Concentration (gl^{-1})		Cell Concentration (gl^{-1})
	Butanol	Acetone	Ethanol		Butyric Acid	Acetic Acid	
Batch (1.00 LIT)	4.12	2.32	0.34	6.78	-	1.03	3.84
Batch (2.75 LIT)	4.04	2.49	0.36	6.89	-	0.91	3.01
Continuous (D = 0.65 hr^{-1})	0.85	0.28	0.21	1.34	0.75	1.27	40.40

Table A 7 The result of ABE fermentation from batch process in run P
(with 43.8 g/l feeding glucose concentration)

Operating condition	Solvent concentration (gl^{-1})			Total Solvent (gl^{-1})	Acid Concentration (gl^{-1})		Cell Concentration (gl^{-1})
	Butanol	Acetone	Ethanol		Butyric Acid	Acetic Acid	
Batch (2.00 LIT)	6.20	3.62	2.60	12.42	0.63	0.45	4.34

Table A 8 Glucose consumption (r_s), solvent productivity (r_p), acid productivity (r_{acid}), cell productivity (r_x) and production yield ($y_{p/s}$) in run K

Operating Condition	r_s ($gl^{-1}hr^{-1}$)	r_p ($gl^{-1}hr^{-1}$)	r_{acid} ($gl^{-1}hr^{-1}$)	r_x ($gl^{-1}hr^{-1}$)	$y_{p/s}$
Batch (1.00 Lit)	0.66	0.20	0.02	0.09	0.30
Batch (2.75 Lit)	0.71	0.22	0.01	0.10	0.31
Continuous (D = 0.11 hr^{-1})	4.90	1.16	-	1.74	0.24
Continuous (D = 0.22 hr^{-1})	9.39	2.67	-	1.86	0.28
Continuous (D = 0.36 hr^{-1})	14.80	4.15	-	1.11	0.28
Continuous (D = 0.55 hr^{-1}	19.30	6.06	-	0.10	0.31

Table A 9 Glucose consumption (r_s), solvent productivity (r_p), acid productivity (r_{acid}), cell productivity (r_x) and production yield ($y_{p/s}$) in run L

Operating Condition	r_s ($gl^{-1}hr^{-1}$)	r_p ($gl^{-1}hr^{-1}$)	r_{acid} ($gl^{-1}hr^{-1}$)	r_x ($gl^{-1}hr^{-1}$)	$y_{p/s}$
Batch (1.00 Lit)	1.14	0.33	0.03	0.13	0.29
Batch (2.75 Lit)	1.29	0.40	0.01	0.18	0.31
Continuous (D = 0.11 hr^{-1})	4.64	1.36	-	0.06	0.29
Continuous (D = 0.22 hr^{-1})	10.58	3.13	-	0.05	0.30
Continuous (D = 0.36 hr^{-1})	13.54	4.31	0.03	0.01	0.32

Table A 10 Glucose consumption (r_s) solvent productivity (r_p), qacid productivity (r_{acid}), cell productivity (r_x) and production yield ($y_{p/s}$) in run M

Operating Condition	r_s ($gl^{-1}hr^{-1}$)	r_p ($gl^{-1}hr^{-1}$)	r_{acid} ($gl^{-1}hr^{-1}$)	r_x ($gl^{-1}hr^{-1}$)	$y_{p/s}$
Batch (1.00 Lit)	0.76	0.23	0.03	0.09	0.30
Batch (2.75 Lit)	0.69	0.21	0.02	0.08	0.30
Continuous (D = 0.11 hr^{-1})	2.80	0.94	0.12	0.06	0.33
Continuous (D = 0.22 hr^{-1})	2.81	0.91	0.38	0.03	0.31

Table A 11 Glucose consumption (r_s), solvent productivity (r_p), acid productivity (r_{acid}), cell productivity (r_x) and production yield ($y_{p/s}$) in run N

Operating Condition	r_s ($gl^{-1}hr^{-1}$)	r_p ($gl^{-1}hr^{-1}$)	r_{acid} ($gl^{-1}hr^{-1}$)	r_x ($gl^{-1}hr^{-1}$)	$y_{p/s}$
Batch (1.00 Lit)	0.68	0.19	0.03	0.09	0.28
Batch (2.75 Lit)	0.76	0.21	0.01	0.11	0.28
1st continuous (D = 0.55 hr^{-1}	19.35	5.98	0.20	0.07	0.31
2nd Continuous (D = 0.55 hr^{-1}	19.00	5.67	0.30	0.04	0.30

Table A 12 Glucose consumption (r_s), solvent productivity (r_p), acid productivity (r_{acid}), cell productivity (r_x) and production yield ($y_{p/s}$) in <u>run O</u>

Operating Condition	r_s ($gl^{-1}hr^{-1}$)	r_p ($gl^{-1}hr^{-1}$)	r_{acid} ($gl^{-1}hr^{-1}$)	r_x ($gl^{-1}hr^{-1}$)	$y_{p/s}$
Batch (1.00 Lit)	0.58	0.17	0.02	0.09	0.29
Batch (2.75 lit)	0.52	0.15	-	0.11	0.29
Continuous ($D = 0.65\ hr^{-1}$)	3.65	0.88	1.21	2.72	0.24

Table A 13 Glucose consumption (r_s), solvent productivity (r_p), acid productivity (r_{acid}), cell productivity (r_x) and production yield ($y_{p/s}$) in <u>run P</u>

Operating Condition	r_s ($gl^{-1}hr^{-1}$)	r_p ($gl^{-1}hr^{-1}$)	r_{acid} ($gl^{-1}hr^{-1}$)	r_x ($gl^{-1}hr^{-1}$)	$y_{p/s}$
Batch (2.00 Lit)	0.86	0.25	0.02	0.09	0.29

APPENDIX B

THE IMPORTATION OF BUTANOL AND PROPYLENE FROM 1980-1986

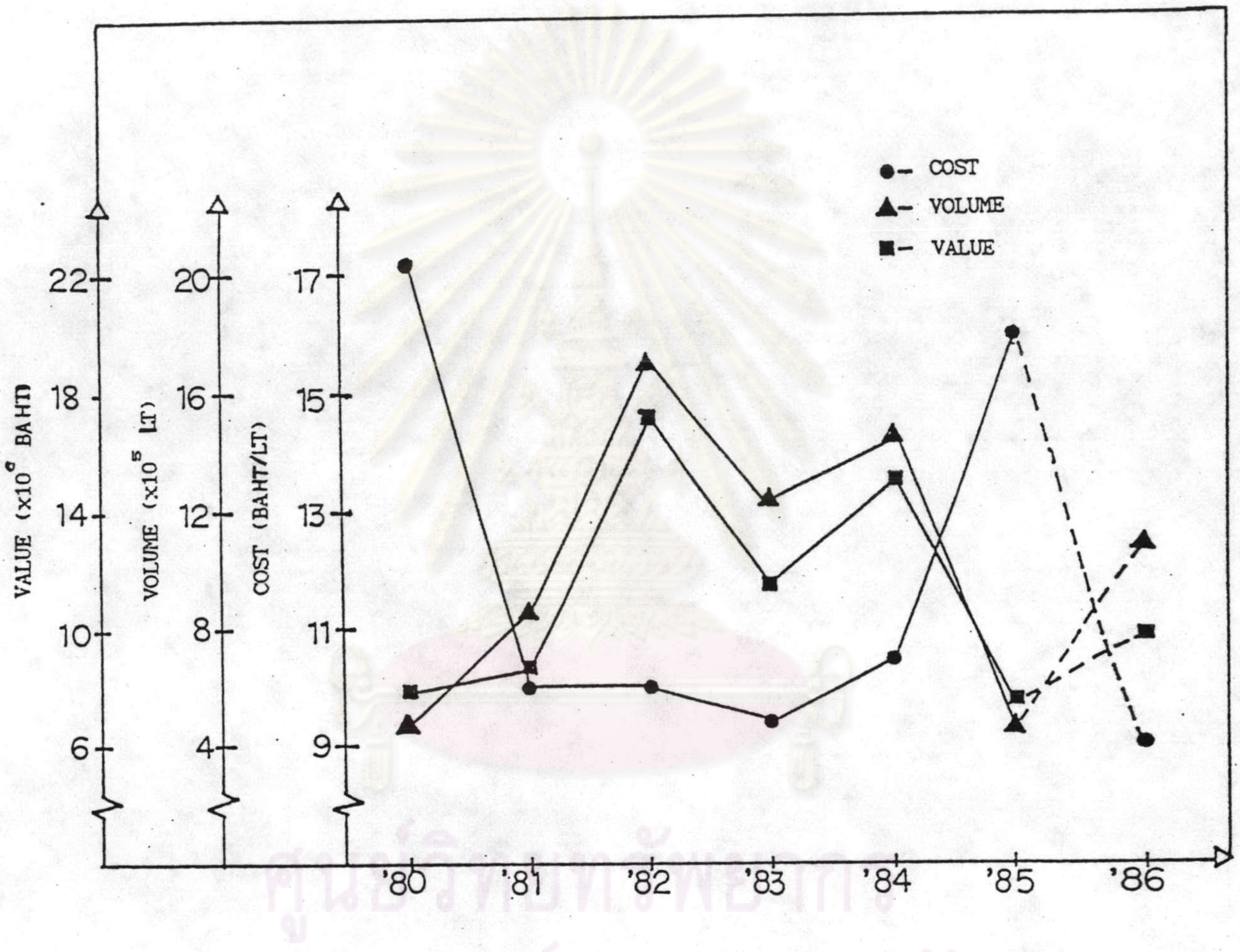

Figure B1 The importation of butanol from 1980-1986

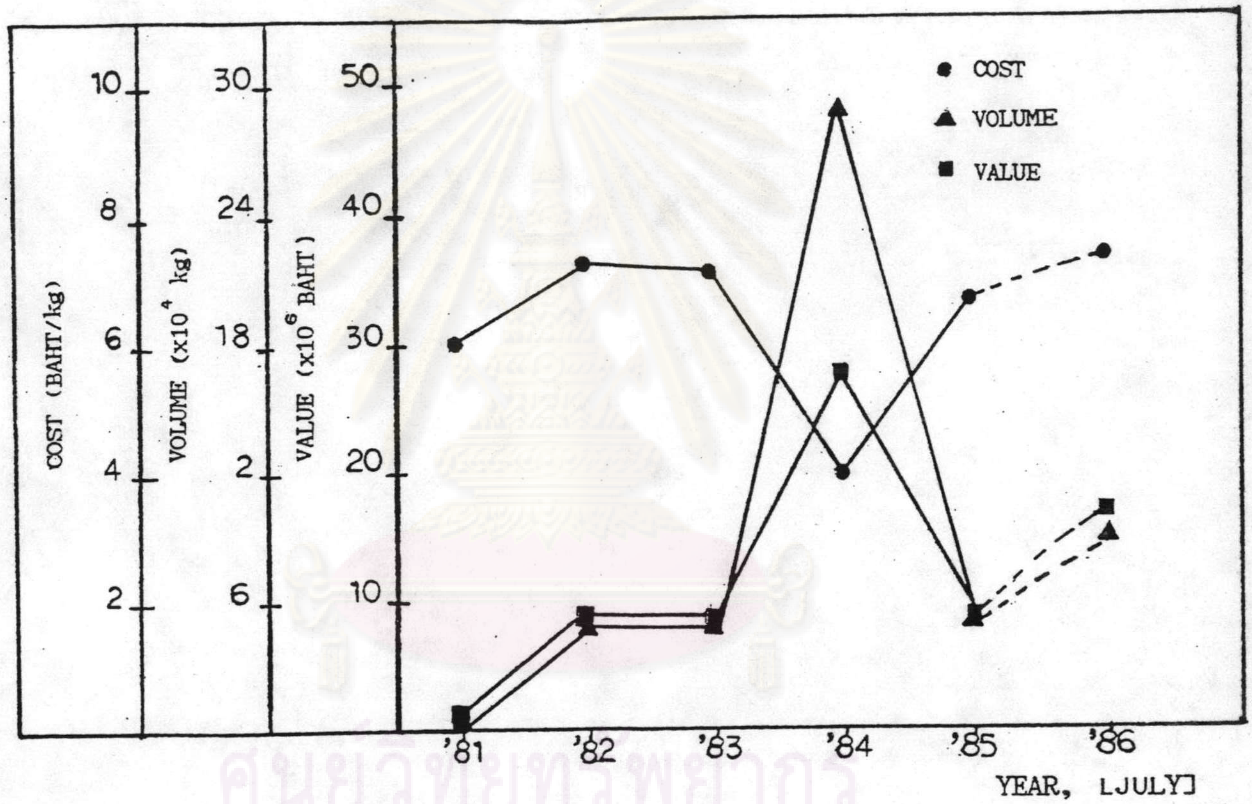

Figure B2 The importation of propylene from 1980-1986

AUTOBIOGRAPHY

Muenduen Phisalaphonge was born on April 3, 1964 in Bangkok, Thailand. She attended Triumudomsuksa High school in Bangkok and graduated in 1982. She recieved her Bachelor Degree of Science in Biotechnology from Agro-industry faculty, Kasetsart University, Thailand, in March 1986. She continued her Master's Study at Chulalongkorn University in 1986. She was granted the degree in June, 1989.