REFERENCES

THAI

โอเฮะ, โชโช. **วิศวกรรมการกลั่นจากห้องทดลองถึงโรงงาน**. แปลโดย วีรพจน์ ลือประสิทธิ์สกุล. กรุงเทพมหานคร: คัลเลอร์ สโฟร์, 2536.

ENGLISH

Borland International, Inc. **Turbo C++ for Windows Version 3.0: Programmer's Guide**. California: Borland International, 1991.

Chan, W.K., Boston, J.F., and Evans, L.B. Select the software for modeling separation processes. **Chemical Engineering Progress**. 87 (1991): 63-68.

Colussi, I.E., Fermeglia, M., Gallo, V., and Kikic, I. Supercritical multistaged multicomponent separation: process simulation. **Computer & Chemical Engineering**. 16 (1992): 211-224.

Gundersen, T. Numerical aspects of the implementation of cubic equations of state in flash calculation routines. **Computer & Chemical Engineering**. 6 (1982): 245-255.

Henry, E.J., and Seader, J.D. **Equilibrium-Stage Separations in Chemical Engineering**. New York: John Wiley & Sons, 1981.

Hollow, C.D. **Multicomponent Distillation**. New Jersey: Prentice-Hall, 1963.

Humphrey, J.H. Separation processes: playing a critical role. **Chemical Engineering Progress**. 91(1995): 31-41.

Hyprotech Ltd. **HYSIM User's Guide**. Alberto: Hyprotech Ltd., 1991.

Kunesh, J.G., Kister, H.Z., Lockett, M.J., and Fair, J.R. Distillation: still towering over other options. **Chemical Engineering Progress**. 91(1995): 43-54.

Onana, A, and Hikolo, A.M. SOR Method for multistaged separation columns computations. **Computer & Chemical Engineering**. 17 (1993): 799-805.

Pierucci, S., Trolani, F., Ranzi, E., and Biardi, G. Solve separation units by combining sure and fast models. **Computer & Chemical Engineering**. 6 (1982): 39-49.

Porter, K.E. Why research is needed in distillation. **Trans IChemE**. 73 (1995): 357-362.

Reid, R.C., Prusnitz, J.M., and Poling, B.E. **The Properties of Gases & Liquids**. 4th ed. New York: McGraw-Hill, 1988.

Sandler, S.I. **Chemical and Engineering Thermodynamics**. 2nd ed. Singapore: John Wiley & Sons, 1989.

Seader, J.D. The rate-based approach for modeling staged separations. **Chemical Engineering Progress**. 85 (1989): 41-49.

Shacham, M., Macchietto, S.L.F., Stutzman, L.F. and Babcock. P. Equation oriented approach to process flowsheeting. **Computer & Chemical Engineering**. 6 (1982): 79-55.

Thanit Sawasdisevi. **Development of a database system for searching and estimating properties of gases and liquids**. Master's Thesis, Chulalongkorn University, 1996.

Van Ness, H.C., and Abbott, M.M. **Classical Thermodynamics of Nonelectrolyte Solutions With Applications to Phase Equilibria**. New York: McGraw-Hill, 1982.

Vazquez-Esparragoza, J.J., McLaughlin, B. E., Naugle, N. W., and Holland, C.D. Solution of difficult distillation problems by use of a combination of the Newton-Raphson and functional transformation methods. **Computer & Chemical Engineering**. 12 (1988): 1167-1169.

Venkatarraman, S. and Lucia, A. Solving distillation problems by Newton-Like methods. **Computer & Chemical Engineering**. 12 (1988): 55-69.

Wilhelm, C.E., and Swaney, R.E. Robust solution of algebraic process modeling equations. **Computer & Chemical Engineering**. 18 (1994): 511-531.

Winter, P. Computer-Aided process engineering: the evolution continues. **Chemical Engineering Progress**. 88 (1992): 76-83.

APPENDIX A

TABLES OF THE OUTPUTS

Table A-1 The results of case I calculated by simulator using PR model.

Stage No.	temp.	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition			Liquid Composition		
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	n-butane	n-pentane	propane	n-butane	n-pentane	propane
1	301.83	0.00	0.000001	45.000004	0.00	22.50	1209888.5	0.157493	0.009552	0.832955	0.347910	0.063321	0.588769
2	321.35	0.00	67.500008	41.279350	0.00	0.00	0.0	0.347837	0.063283	0.588880	0.477664	0.234803	0.287533
3	337.17	45.80	63.779350	90.758430	0.00	0.00	0.0	0.431815	0.174184	0.394001	0.423895	0.427221	0.148884
4	351.02	0.00	67.458435	88.767136	0.00	0.00	0.0	0.482633	0.324037	0.193330	0.365345	0.574473	0.060182
5	362.3	0.00	65.467140	23.299997	0.00	0.00	-1354662.8	0.405128	0.520432	0.074440	0.253570	0.726281	0.020149

Table A-2 The results of case I calculated by simulator using SRK model.

Stage No.	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition			Liquid Composition		
		(K)	Vapor	Liquid	Vapor	Liquid	(J/h)	n-butane	n-pentane	propane	n-butane	n-pentane	propane
1	301.35	0.00	0.000001	45.000004	0.00	22.50	1219213.5	0.156113	0.009055	0.834832	0.348919	0.061820	0.589260
2	320.90	0.00	67.500008	41.328114	0.00	0.00	0.0	0.348842	0.061781	0.589377	0.480735	0.233133	0.286132
3	336.76	45.80	63.828114	90.873260	0.00	0.00	0.0	0.434189	0.172613	0.393198	0.425563	0.427033	0.147404
4	350.62	0.00	67.573265	88.839363	0.00	0.00	0.0	0.485111	0.323444	0.191445	0.365587	0.575333	0.059080
5	361.87	0.00	65.539368	23.299997	0.00	0.00	-1364771.5	0.405765	0.521117	0.073118	0.252584	0.727788	0.019628

Table A-3 The results of case I calculated by HYSIM using PR model.

Stage No	temp.	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition			Liquid Composition		
	(K)	kgmol/h	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	n-butane	n-pentane	propane	n-butane	n-pentane	propane
1	301.70	0.00	0.00	45.00	0.00	22.50	-1.240	0.155673	0.009813	0.834513	0.345682	0.064485	0.589832
2	321.40	0.00	67.50	40.30	0.00	0.00	0.000	0.345682	0.064485	0.589832	0.475888	0.238284	0.285828
3	337.20	45.80	62.80	85.60	0.00	0.00	0.000	0.429248	0.176029	0.394722	0.421495	0.430986	0.147519
4	350.80	0.00	62.30	86.20	0.00	0.00	0.000	0.483394	0.321459	0.195147	0.367161	0.572648	0.060191
5	362.10	0.00	62.90	23.30	0.00	0.00	1.327	0.408358	0.516604	0.075038	0.255881	0.724032	0.020087

Table A-4 The results of case I calculated by HYSIM using SRK model.

Stage No	temp.	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition			Liquid Composition		
	(K)	(kgmol/	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	n-butane	n-pentane	propane	n-butane	n-pentane	propane
1	301.25	0.00	0.00	45.00	0.00	22.50	-1.253	0.154369	0.009449	0.836182	0.346226	0.063552	0.590222
2	320.95	0.00	67.50	40.30	0.00	0.00	0.000	0.346226	0.063552	0.590222	0.477794	0.237675	0.284531
3	336.75	45.80	62.80	85.10	0.00	0.00	0.000	0.430687	0.175331	0.393981	0.422179	0.431578	0.146243
4	350.35	0.00	61.80	85.80	0.00	0.00	0.000	0.485025	0.321076	0.193899	0.367263	0.573321	0.059416
5	361.55	0.00	62.50	23.30	0.00	0.00	1.329	0.408968	0.516831	0.074201	0.255363	0.724890	0.019748

Table A-5 Show the error calculated by PR for case I.

Stage No.	n-butane	n-pentane	propane	Total mass balance
1	-0.0359	-0.0140	0.0545	0.0047
2	0.0012	-0.0291	0.0375	0.0097
3	0.0175	-0.0639	0.0677	0.0213
4	0.0460	-0.0450	0.0140	0.0150
5	-0.0009	0.0043	-0.0048	-0.0014

Table A-6 Show the error calculated by SRK for case I.

Stage No.	n-butane	n-pentane	propane	Total mass balance
1	-0.0378	-0.0144	0.0575	0.0053
2	0.0008	-0.0311	0.0403	0.0100
3	0.0192	-0.0673	0.0705	0.0225
4	0.0497	-0.0482	0.0145	0.0161
5	-0.0020	0.0059	-0.0059	-0.0020

Table A-7 The results of case II calculated by simulator using PR model

Stage No	temp	Feed	Interstage		Sidestream		Duty	Vapor Composition			Liquid Composition		
			Vapor	Liquid	Vapor	Liquid	(J/h)	n-heptane	phenol	toluene	n-heptane	phenol	toluene
1	382.18	0.00	0.000001	458.000000	0.00	91.60	17166212.00	0.979447	0.000520	0.020034	0.974732	0.001991	0.023277
2	382.37	0.00	549.599976	456.915314	0.00	0.00	0.00	0.974732	0.001991	0.023277	0.965301	0.007665	0.027034
3	382.92	0.00	548.515320	453.233429	0.00	0.00	0.00	0.966877	0.006717	0.026406	0.943256	0.026153	0.030591
4	384.72	0.00	544.833435	438.556915	0.00	0.00	0.00	0.948550	0.022089	0.029360	0.877152	0.089191	0.033657
5	391.67	349.60	530.156921	1127.109131	0.00	0.00	0.00	0.893909	0.074211	0.031880	0.605123	0.360852	0.034025
6	391.74	0.00	869.109131	1126.971924	0.00	0.00	0.00	0.883850	0.073676	0.042474	0.595131	0.359582	0.045287
7	391.85	0.00	868.971985	1126.751831	0.00	0.00	0.00	0.869935	0.073023	0.057042	0.580971	0.358311	0.060718
8	392.01	0.00	868.751892	1126.404175	0.00	0.00	0.00	0.850737	0.072239	0.077024	0.561086	0.357157	0.081757
9	392.27	0.00	868.404236	1125.899536	0.00	0.00	0.00	0.824381	0.071311	0.104308	0.533583	0.356216	0.110200
10	392.63	0.00	867.899536	1125.514648	0.00	0.00	0.00	0.788582	0.070160	0.141258	0.496871	0.355000	0.148129
11	393.04	0.00	867.514709	1128.359619	0.00	0.00	0.00	0.741402	0.068025	0.190574	0.453763	0.348191	0.198046
12	392.54	183.20	870.359680	1324.118641	0.00	0.00	0.00	0.685994	0.058854	0.255151	0.434167	0.297736	0.268097
13	393.12	0.00	882.981628	1321.802734	0.00	0.00	0.00	0.644227	0.058379	0.297395	0.392798	0.298743	0.308459
14	394.02	0.00	880.602783	1317.580811	0.00	0.00	0.00	0.583933	0.058059	0.358008	0.336052	0.300809	0.363140
15	395.39	0.00	876.308798	1310.155762	0.00	0.00	0.00	0.501388	0.058265	0.440347	0.265188	0.304280	0.430532
16	397.29	0.00	868.955811	1297.682617	0.00	0.00	0.00	0.397792	0.059613	0.542594	0.188198	0.309704	0.502098
17	399.69	0.00	856.482666	1277.915181	0.00	0.00	0.00	0.284079	0.063039	0.652882	0.117951	0.319744	0.562305
18	402.76	0.00	836.715149	1244.593262	0.00	0.00	0.00	0.179131	0.072210	0.748659	0.063144	0.350755	0.586101
19	409.39	0.00	803.393311	1182.986206	0.00	0.00	0.00	0.096431	0.110447	0.793122	0.023285	0.480385	0.496029
20	429.81	0.00	741.786255	441.199982	0.00	0.00	-26578478.00	0.035283	0.298982	0.665735	0.003149	0.785739	0.211112

Table A-8 The results of case II calculated by simulator using SRK model

Stage No.	temp	Feed	Interstage		Sidestream		Duty	Vapor Composition			Liquid Composition		
			Vapor	Liquid	Vapor	Liquid	(J/h)	n-heptane	phenol	toluene	n-heptane	phenol	toluene
1	382.07	0.00	0.000001	458.000000	0.00	91.60	17398098.00	0.981251	0.000415	0.018334	0.976799	0.001660	0.021541
2	382.23	0.00	549.599976	457.001984	0.00	0.00	0.00	0.976800	0.001660	0.021540	0.968038	0.006665	0.025297
3	382.74	0.00	548.601990	453.471222	0.00	0.00	0.00	0.969503	0.005829	0.024668	0.947441	0.023657	0.028901
4	384.47	0.00	545.071228	438.876129	0.00	0.00	0.00	0.952379	0.019958	0.027663	0.883988	0.083936	0.032076
5	391.37	349.60	530.476135	1134.523682	0.00	0.00	0.00	0.899912	0.069815	0.030273	0.611542	0.355771	0.032687
6	391.44	0.00	876.523743	1134.388550	0.00	0.00	0.00	0.890160	0.069339	0.040501	0.601688	0.354629	0.043683
7	391.55	0.00	876.388611	1134.184448	0.00	0.00	0.00	0.876542	0.068753	0.054706	0.587600	0.353503	0.058897
8	391.72	0.00	876.184448	1133.860107	0.00	0.00	0.00	0.857578	0.068043	0.074379	0.567647	0.352515	0.079838
9	391.98	0.00	875.860107	1133.379883	0.00	0.00	0.00	0.831305	0.067196	0.101499	0.539823	0.351740	0.108412
10	392.37	0.00	875.379944	1132.967041	0.00	0.00	0.00	0.795288	0.066144	0.138567	0.502330	0.350832	0.146838
11	392.8	0.00	874.967041	1135.751709	0.00	0.00	0.00	0.747328	0.064207	0.188440	0.457635	0.344639	0.197726
12	392.39	183.20	877.751770	1331.843140	0.00	0.00	0.00	0.690110	0.055672	0.254218	0.435752	0.295202	0.269228
13	393	0.00	890.643127	1329.372559	0.00	0.00	0.00	0.646080	0.055241	0.298678	0.391936	0.296250	0.311814
14	393.97	0.00	888.172607	1324.941895	0.00	0.00	0.00	0.582528	0.054977	0.362495	0.332236	0.298494	0.369270
15	395.42	0.00	883.741943	1317.112427	0.00	0.00	0.00	0.495859	0.055257	0.448884	0.258646	0.302025	0.439330
16	397.41	0.00	875.912415	1303.973389	0.00	0.00	0.00	0.388223	0.056670	0.555100	0.180372	0.307302	0.512327
17	399.84	0.00	862.773438	1283.518921	0.00	0.00	0.00	0.272395	0.060031	0.667574	0.110987	0.316759	0.572254
18	402.82	0.00	842.318970	1250.218506	0.00	0.00	0.00	0.168550	0.068540	0.762910	0.058602	0.346013	0.595385
19	409.2	0.00	809.018555	1188.328125	0.00	0.00	0.00	0.089430	0.104376	0.806193	0.021456	0.473879	0.504664
20	429.71	0.00	747.128174	441.199982	0.00	0.00	-27159124.00	0.032493	0.289381	0.678127	0.002808	0.785733	0.211459

Table A-9 The results of case II calculated by HYSIM using PR model

Stage No.	temp.	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition			Liquid Composition		
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	n-heptane	phenol	toluene	n-heptane	phenol	toluene
1	382.20	0.00	0.00	458.00	0.00	91.60	-16.301	0.976149	0.000583	0.023068	0.972375	0.002249	0.025377
2	382.30	0.00	549.60	455.50	0.00	0.00	0.000	0.972375	0.002249	0.025377	0.963621	0.008706	0.027672
3	393.00	0.00	547.10	447.00	0.00	0.00	0.000	0.965087	0.007625	0.027288	0.940413	0.029890	0.029697
4	395.00	0.00	538.70	416.30	0.00	0.00	0.000	0.945848	0.025189	0.028962	0.865830	0.102953	0.031217
5	393.30	349.60	507.90	900.70	0.00	0.00	0.000	0.885044	0.084792	0.030164	0.525948	0.444259	0.039793
6	393.40	0.00	642.70	900.20	0.00	0.00	0.000	0.875687	0.084382	0.039931	0.516513	0.444078	0.039409
7	393.50	0.00	642.20	899.20	0.00	0.00	0.000	0.862738	0.083844	0.053418	0.503389	0.443964	0.052648
8	393.60	0.00	641.20	897.80	0.00	0.00	0.000	0.844849	0.083146	0.072004	0.485302	0.443895	0.070804
9	393.80	0.00	639.80	895.90	0.00	0.00	0.000	0.820218	0.082257	0.097524	0.460645	0.443832	0.095523
10	394.10	0.00	637.90	894.20	0.00	0.00	0.000	0.786607	0.081070	0.132323	0.428493	0.442709	0.128798
11	394.40	0.00	636.20	900.20	0.00	0.00	0.000	0.742258	0.078554	0.179187	0.394762	0.431673	0.173565
12	393.30	183.20	642.20	1097.70	0.00	0.00	0.000	0.692045	0.066487	0.241468	0.403487	0.354652	0.241861
13	393.50	0.00	656.50	1095.70	0.00	0.00	0.000	0.670794	0.066117	0.263090	0.382938	0.354931	0.262130
14	394.00	0.00	654.50	1092.40	0.00	0.00	0.000	0.637219	0.065692	0.297089	0.351262	0.355633	0.293105
15	394.80	0.00	651.20	1087.40	0.00	0.00	0.000	0.585359	0.065417	0.349224	0.304636	0.357233	0.338131
16	396.10	0.00	646.20	1080.50	0.00	0.00	0.000	0.508719	0.065852	0.425429	0.241782	0.360530	0.397688
17	398.20	0.00	639.30	1071.40	0.00	0.00	0.000	0.404691	0.068276	0.527033	0.168529	0.367956	0.463516
18	401.50	0.00	630.20	1051.70	0.00	0.00	0.000	0.282498	0.076697	0.640805	0.097190	0.394143	0.508667
19	408.60	0.00	610.50	989.70	0.00	0.00	0.000	0.163287	0.112393	0.724320	0.037764	0.508679	0.453557
20	428.60	0.00	548.50	441.20	0.00	0.00	21.473	0.063532	0.287211	0.649257	0.005731	0.783997	0.210272

Table A-10 The results of case II calculated by HYSIM using SRK model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition			Liquid Composition		
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	n-heptane	phenol	toluene	n-heptane	phenol	toluene
1	382.05	0.00	0.00	458.00	0.00	91.60	16.525	0.978600	0.000535	0.020865	0.975027	0.002096	0.022877
2	382.25	0.00	549.60	455.50	0.00	0.00	0.000	0.975027	0.002096	0.022877	0.966666	0.008251	0.025083
3	382.85	0.00	547.10	447.40	0.00	0.00	0.000	0.968066	0.007221	0.024713	0.944184	0.028766	0.027050
4	384.85	0.00	539.00	417.20	0.00	0.00	0.000	0.949426	0.024234	0.026341	0.870803	0.100615	0.028582
5	393.05	349.60	508.00	902.40	0.00	0.00	0.000	0.889567	0.082878	0.027555	0.530190	0.442259	0.027551
6	393.05	0.00	644.30	901.70	0.00	0.00	0.000	0.881086	0.082505	0.036409	0.521442	0.442172	0.036385
7	393.15	0.00	643.70	900.70	0.00	0.00	0.000	0.869199	0.082007	0.048794	0.509179	0.442104	0.048718
8	393.35	0.00	642.70	899.20	0.00	0.00	0.000	0.852553	0.081351	0.066096	0.492040	0.442077	0.065883
9	393.55	0.00	641.20	897.30	0.00	0.00	0.000	0.829292	0.080501	0.090208	0.468308	0.442049	0.089643
10	393.85	0.00	639.20	895.40	0.00	0.00	0.000	0.797028	0.079339	0.123632	0.436723	0.441052	0.122225
11	394.15	0.00	637.40	900.60	0.00	0.00	0.000	0.753614	0.076884	0.169502	0.402554	0.420551	0.166896
12	393.05	183.20	642.60	1098.50	0.00	0.00	0.000	0.703137	0.065142	0.231720	0.410626	0.353668	0.235807
13	393.25	0.00	657.30	1096.30	0.00	0.00	0.000	0.682768	0.064798	0.252433	0.390437	0.354014	0.255550
14	393.75	0.00	655.10	1092.60	0.00	0.00	0.000	0.649912	0.064389	0.285699	0.358613	0.354818	0.286569
15	394.55	0.00	651.40	1087.00	0.00	0.00	0.000	0.597975	0.064131	0.337894	0.310637	0.358633	0.332731
16	395.95	0.00	645.80	1079.30	0.00	0.00	0.000	0.519305	0.064658	0.416038	0.244623	0.360355	0.395022
17	398.25	0.00	638.10	1069.60	0.00	0.00	0.000	0.410179	0.067407	0.522414	0.167245	0.368310	0.464445
18	401.85	0.00	628.40	1050.40	0.00	0.00	0.000	0.281018	0.076447	0.642535	0.093482	0.394812	0.511706
19	408.95	0.00	609.20	990.60	0.00	0.00	0.000	0.157419	0.112950	0.729630	0.035081	0.509159	0.455760
20	428.75	0.00	549.40	441.20	0.00	0.00	21.826	0.059081	0.288431	0.652487	0.005196	0.784016	0.210788

Table A-11 Show the error calculated by PR for case II.

Stage No.	n-heptane	phenol	toluene	Total mass balance
1	0.0000	0.0000	0.0000	0.0000
2	0.0007	-0.0001	-0.0003	0.0002
3	0.0006	-0.0002	-0.0004	0.0000
4	-0.0607	0.0135	0.0099	-0.0373
5	-3.3936	0.9213	-0.0844	-2.5566
6	-0.9489	0.2610	-0.0357	-0.7237
7	-0.8559	0.2352	-0.0316	-0.6523
8	-0.6364	0.1715	-0.0111	-0.4760
9	-0.2590	0.0592	0.0353	-0.1646
10	0.3193	-0.1079	0.0849	0.2963
11	1.2141	-0.3223	0.0017	0.8935
12	0.5440	-0.2975	0.6268	0.8733
13	1.1567	-0.3069	-0.0644	0.7855
14	1.7287	-0.4420	-0.1338	1.1529
15	1.7806	-0.4539	0.0132	1.3399
16	0.9404	-0.3041	0.2019	0.8382
17	0.0685	-0.0811	0.2292	0.2166
18	-0.2913	0.1074	-0.1101	-0.2940
19	-0.2804	0.3776	-0.7297	-0.6325
20	-0.0174	-0.0462	-0.1895	-0.2531

Table A-12 Show the errors calculated by SRK for case II.

Stage No.	n-heptane	phenol	toluene	Total mass balance
1	0.0006	0.0000	-0.0006	0.0000
2	0.0007	-0.0001	-0.0005	0.0002
3	0.0013	-0.0003	0.0004	0.0014
4	-0.0617	0.0136	0.0097	-0.0385
5	-3.2567	0.8821	-0.0734	-2.4480
6	-0.8669	0.2371	-0.0270	-0.6568
7	-0.7573	0.2061	-0.0216	-0.5729
8	-0.5187	0.1361	0.0044	-0.3783
9	-0.1310	0.0273	0.0557	-0.0479
10	0.4469	-0.1584	0.0940	0.3825
11	1.3335	-0.3629	0.0594	1.0300
12	0.7509	-0.4058	0.4978	0.8429
13	1.4007	-0.2990	-0.0051	1.0966
14	1.8139	-0.4787	-0.0051	1.3302
15	1.4907	-0.4359	0.1426	1.1975
16	0.4710	-0.2189	0.3495	0.6016
17	-0.3231	0.0251	0.2212	-0.0767
18	-0.4735	0.1976	-0.2639	-0.5398
19	-0.3336	0.3556	-0.9700	-0.9479
20	-0.0203	0.0733	-0.2493	-0.1963

Table A-13 Comparison of temperature profile on case II.

Stage No.	Temperature (K)				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	382.18	382.07	382.20	382.05	0.01	-0.01
2	382.37	382.23	382.30	382.25	-0.02	0.01
3	382.92	382.74	383.00	382.85	0.02	0.03
4	384.72	384.47	385.00	384.85	0.07	0.10
5	391.67	391.37	393.30	393.05	0.41	0.43
6	391.74	391.44	393.40	393.05	0.42	0.41
7	391.85	391.55	393.50	393.15	0.42	0.41
8	392.01	391.72	393.60	393.35	0.40	0.41
9	392.27	391.98	393.80	393.55	0.39	0.40
10	392.63	392.37	394.10	393.85	0.37	0.38
11	393.04	392.80	394.40	394.15	0.34	0.34
12	392.54	392.39	393.30	393.05	0.19	0.17
13	393.12	393.00	393.50	393.25	0.10	0.06
14	394.02	393.97	394.00	393.75	-0.01	-0.06
15	395.39	395.42	394.80	394.55	-0.15	-0.22
16	397.29	397.41	396.10	395.95	-0.30	-0.37
17	399.69	399.84	398.20	398.25	-0.37	-0.40
18	402.76	402.82	401.50	401.85	-0.31	-0.24
19	409.39	409.20	408.60	408.95	-0.19	-0.06
20	429.81	429.71	428.60	428.75	-0.28	-0.22

Table A-14 Comparison of vapor composition of n-heptane profile on case II.

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.979447	0.981251	0.976149	0.978600	-0.3379	-0.2709
2	0.974732	0.976800	0.972375	0.975027	-0.2424	-0.1818
3	0.966877	0.969503	0.965087	0.968066	-0.1855	-0.1484
4	0.948550	0.952379	0.945848	0.949426	-0.2857	-0.3110
5	0.893909	0.899912	0.885044	0.889567	-1.0016	-1.1629
6	0.883850	0.890160	0.875687	0.881086	-0.9322	-1.0299
7	0.869935	0.876542	0.862738	0.869199	-0.8342	-0.8448
8	0.850737	0.857578	0.844849	0.852553	-0.6969	-0.5894
9	0.824381	0.831305	0.820218	0.829292	-0.5075	-0.2427
10	0.788582	0.795288	0.786607	0.797028	-0.2511	0.2183
11	0.741402	0.747328	0.742258	0.753614	0.1153	0.8341
12	0.685994	0.690110	0.692045	0.703137	0.8744	1.8527
13	0.644227	0.646080	0.670794	0.682768	3.9605	5.3734
14	0.583933	0.582528	0.637219	0.649912	8.3623	10.3682
15	0.501388	0.495859	0.585359	0.597975	14.3452	17.0770
16	0.397792	0.388223	0.508719	0.519305	21.8052	25.2418
17	0.284079	0.272395	0.404691	0.410179	29.8035	33.5912
18	0.179131	0.168550	0.282498	0.281018	36.5903	40.0216
19	0.096431	0.089430	0.163287	0.157419	40.9439	43.1898
20	0.035283	0.032493	0.063532	0.059081	44.4642	45.0026

Table A-15 Comparison of liquid composition of n-heptane profile on case II.

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.974732	0.976799	0.972375	0.975027	-0.2424	-0.1817
2	0.965301	0.968038	0.963621	0.966666	-0.1743	-0.1419
3	0.943256	0.947441	0.940413	0.944184	-0.3023	-0.3450
4	0.877152	0.883988	0.865830	0.870803	-1.3076	-1.5141
5	0.605123	0.611542	0.525948	0.530190	-15.0538	-15.3439
6	0.595131	0.601688	0.516513	0.521442	-15.2209	-15.3892
7	0.580971	0.587600	0.503389	0.509179	-15.4119	-15.4015
8	0.561086	0.567647	0.485302	0.492040	-15.6158	-15.3660
9	0.533583	0.539823	0.460645	0.468308	-15.8339	-15.2709
10	0.496871	0.502330	0.428493	0.436723	-15.9578	-15.0226
11	0.453763	0.457635	0.394762	0.402554	-14.9460	-13.6829
12	0.434167	0.435752	0.403487	0.410626	-7.6037	-6.1190
13	0.392798	0.391936	0.382938	0.390437	-2.5748	-0.3839
14	0.336052	0.332236	0.351262	0.358613	4.3301	7.3553
15	0.265188	0.258646	0.304636	0.310637	12.9492	16.7369
16	0.188198	0.180372	0.241782	0.244623	22.1621	26.2653
17	0.117951	0.110987	0.168529	0.167245	30.0115	33.6381
18	0.063144	0.058602	0.097190	0.093482	35.0304	37.3120
19	0.023285	0.021456	0.037764	0.035081	38.3407	38.8387
20	0.003149	0.002808	0.005731	0.005196	45.0532	45.9584

Table A-16 Comparison of vapor composition of phenol profile on case II.

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.000520	0.000415	0.000583	0.000535	10.8062	22.4299
2	0.001991	0.001660	0.002249	0.002096	11.4718	20.8015
3	0.006717	0.005829	0.007625	0.007221	11.9082	19.2771
4	0.022089	0.019958	0.025189	0.024234	12.3070	17.6446
5	0.074211	0.069815	0.084792	0.082878	12.4788	15.7617
6	0.073676	0.069339	0.084382	0.082505	12.6875	15.9578
7	0.073023	0.068753	0.083844	0.082007	12.9061	16.1620
8	0.072239	0.068043	0.083146	0.081351	13.1179	16.3587
9	0.071311	0.067196	0.082257	0.080501	13.3071	16.5277
10	0.070160	0.066144	0.081070	0.079339	13.4575	16.6312
11	0.068025	0.064207	0.078554	0.076884	13.4035	16.4885
12	0.058854	0.055672	0.066487	0.065142	11.4804	14.5375
13	0.058379	0.055241	0.066117	0.064798	11.7035	14.7489
14	0.058059	0.054977	0.065692	0.064389	11.6194	14.6174
15	0.058265	0.055257	0.065417	0.064131	10.9329	13.8373
16	0.059613	0.056670	0.065852	0.064658	9.4743	12.3542
17	0.063039	0.060031	0.068276	0.067407	7.6703	10.9425
18	0.072210	0.068540	0.076697	0.076447	5.8503	10.3431
19	0.110447	0.104376	0.112393	0.112950	1.7314	7.5910
20	0.298982	0.289381	0.287211	0.288431	-4.0984	-0.3294

Table A-17 Comparison of liquid composition of phenol profile on case II.

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.001991	0.001660	0.002249	0.002096	11.4718	20.8015
2	0.007665	0.006665	0.008706	0.008251	11.9573	19.2219
3	0.026153	0.023657	0.029890	0.028766	12.5025	17.7606
4	0.089191	0.083936	0.102953	0.100615	13.3673	16.5771
5	0.360852	0.355771	0.444259	0.442259	18.7744	19.5560
6	0.359582	0.354629	0.444078	0.442172	19.0273	19.7984
7	0.358311	0.353503	0.443964	0.442104	19.2928	20.0408
8	0.357157	0.352515	0.443895	0.442077	19.5402	20.2594
9	0.356216	0.351740	0.443832	0.442049	19.7408	20.4296
10	0.355000	0.350832	0.442709	0.441052	19.8119	20.4556
11	0.348191	0.344639	0.431673	0.420551	19.3392	18.0506
12	0.297736	0.295202	0.354652	0.353668	16.0484	16.5313
13	0.298743	0.296250	0.354931	0.354014	15.8307	16.3169
14	0.300809	0.298494	0.355633	0.354818	15.4159	15.8741
15	0.304280	0.302025	0.357233	0.356633	14.8231	15.3121
16	0.309704	0.307302	0.360530	0.360355	14.0976	14.7224
17	0.319744	0.316759	0.367956	0.368310	13.1027	13.9966
18	0.350755	0.346013	0.394143	0.394812	11.0082	12.3601
19	0.480385	0.473879	0.508579	0.509159	5.5623	6.9291
20	0.785739	0.785733	0.783997	0.784016	-0.2222	-0.2190

Table A-18 Comparison of vapor compostion of toluene profile on case II.

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.020034	0.018334	0.023068	0.020865	13.1524	12.1304
2	0.023277	0.021540	0.025377	0.022877	8.2752	5.8443
3	0.026406	0.024668	0.027288	0.024713	3.2322	0.1821
4	0.029360	0.027663	0.028962	0.026341	-1.3742	-5.0188
5	0.031880	0.030273	0.030164	0.027555	-5.6889	-9.8639
6	0.042474	0.040501	0.039931	0.036409	-6.3685	-11.2390
7	0.057042	0.054706	0.053418	0.048794	-6.7842	-12.1162
8	0.077024	0.074379	0.072004	0.066096	-6.9718	-12.5318
9	0.104308	0.101499	0.097524	0.090208	-6.9562	-12.5166
10	0.141258	0.138567	0.132323	0.123632	-6.7524	-12.0802
11	0.190574	0.188440	0.179187	0.169502	-6.3548	-11.1727
12	0.255151	0.254218	0.241468	0.231720	-5.6666	-9.7091
13	0.297395	0.298678	0.263090	0.252433	-13.0393	-18.3197
14	0.358008	0.362495	0.297089	0.285699	-20.5053	-26.9800
15	0.440347	0.448384	0.349224	0.337894	-26.0930	-32.8476
16	0.542594	0.555100	0.425429	0.416038	-27.5404	-33.4253
17	0.652882	0.667574	0.527033	0.522414	-23.8788	-27.7864
18	0.748659	0.762910	0.640805	0.642535	-16.8310	-18.7344
19	0.793122	0.806193	0.724320	0.729630	-9.4988	-10.4934
20	0.665735	0.678127	0.649257	0.652487	-2.5380	-3.9296

Table A-19 Comparison of liquid compostion of toluene profile on case II.

Stage No.	Liuid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.023277	0.021541	0.025377	0.022877	8.2752	5.8399
2	0.027034	0.025297	0.027672	0.025083	2.3056	-0.8532
3	0.030591	0.028901	0.029697	0.027050	-3.0104	-6.8429
4	0.033657	0.032076	0.031217	0.028582	-7.8163	-12.2245
5	0.034025	0.032687	0.039793	0.027551	14.4950	-18.6418
6	0.045287	0.043683	0.039409	0.036385	-14.9154	-20.0577
7	0.060718	0.058897	0.052648	0.048718	-15.3282	-20.8937
8	0.081757	0.079838	0.070804	0.065883	-15.4695	-21.1815
9	0.110200	0.108412	0.095523	0.089643	-15.3649	-20.9375
10	0.148129	0.146838	0.128798	0.122225	-15.0088	-20.1375
11	0.198046	0.197726	0.173565	0.166896	-14.1048	-18.4726
12	0.268097	0.269228	0.241861	0.235807	-10.8476	-14.1730
13	0.308459	0.311814	0.262130	0.255550	-17.6741	-22.0168
14	0.363140	0.369270	0.293105	0.286569	-23.8942	-28.8590
15	0.430532	0.439330	0.338131	0.332731	-27.3270	-32.0376
16	0.502098	0.512327	0.397688	0.395022	-26.2542	-29.6958
17	0.562305	0.572254	0.463516	0.464445	-21.3130	-23.2124
18	0.586101	0.595385	0.508667	0.511706	-15.2229	-16.3529
19	0.469029	0.504664	0.453557	0.455760	-3.4113	-10.7302
20	0.211112	0.211459	0.210272	0.210788	-0.3995	-0.3183

Table A-20 The result of case III calculated by simulator using PR model

Stage No	temp.	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition			Liquid Composition		
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	benzene	ethylbenzene	p-xylene	benzene	ethylbenzene	p-xylene
1	354.21	0.00	0.000001	156.300003	0.00	52.10	6492161.0	0.991094	0.005284	0.003622	0.951903	0.027649	0.020447
2	359.58	0.00	208.400009	146.954188	0.00	0.00	0.0	0.951926	0.027636	0.020437	0.782865	0.120841	0.096294
3	372.05	0.00	199.064194	136.813599	0.00	0.00	0.0	0.827353	0.096316	0.076330	0.483915	0.278935	0.237150
4	386.1	100.00	188.913605	232.738037	0.00	0.00	0.0	0.613824	0.209185	0.176991	0.253359	0.392453	0.354188
5	399.34	0.00	184.838043	232.598083	0.00	0.00	0.0	0.318154	0.366022	0.315825	0.097505	0.471167	0.431328
6	406.16	0.00	184.698090	234.517288	0.00	0.00	0.0	0.122019	0.465098	0.412883	0.032416	0.498926	0.468658
7	408.73	0.00	186.617294	235.583115	0.00	0.00	0.0	0.039978	0.500046	0.459976	0.010083	0.501888	0.488029
8	409.59	0.00	187.683121	47.900002	0.00	0.00	-6755729.0	0.011903	0.503758	0.484339	0.002951	0.494564	0.502485

Table A-21 The result of case III calculated by simulator using SRK model

Stage No	temp.	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition			Liquid Composition		
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	benzene	ethylbenzene	p-xylene	benzene	ethylbenzene	p-xylene
1	354.59	0.00	0.000001	156.300003	0.00	52.10	6601652.5	0.991411	0.005110	0.003479	0.952214	0.027525	0.020261
2	360.04	0.00	208.400009	146.961853	0.00	0.00	0.0	0.952239	0.027511	0.020250	0.779879	0.122662	0.097459
3	372.74	0.00	199.061859	136.987457	0.00	0.00	0.0	0.825244	0.097621	0.077136	0.476467	0.283214	0.240319
4	386.81	100.00	189.087463	233.357101	0.00	0.00	0.0	0.608402	0.212310	0.179287	0.247296	0.395892	0.356812
5	399.92	0.00	185.457108	233.242126	0.00	0.00	0.0	0.310370	0.370416	0.319214	0.093813	0.473290	0.432897
6	406.52	0.00	185.342133	235.003769	0.00	0.00	0.0	0.117336	0.467775	0.414889	0.030862	0.499352	0.469285
7	408.97	0.00	187.103775	235.958145	0.00	0.00	0.0	0.038054	0.501190	0.460755	0.009522	0.502224	0.488254
8	409.78	0.00	188.058151	47.900002	0.00	0.00	-6870893.0	0.011243	0.504160	0.484597	0.002768	0.494623	0.502609

Table A-22 Show the error calculated by PR for case III.

Stage No.	n-butane	n-pentane	propane	Total mass balance
1	0.0096	-0.0108	-0.0083	-0.0096
2	0.0886	-0.0961	-0.0816	-0.0892
3	0.2206	-0.2319	-0.2086	-0.2198
4	0.1743	-0.1590	-0.1888	-0.1735
5	0.0330	-0.0235	-0.0433	-0.0338
6	0.0025	0.0012	-0.0062	-0.0026
7	0.0003	0.0003	-0.0008	-0.0003
8	0.0001	-0.0006	0.0004	-0.0001
overall	0.5290	-0.5205	-0.5373	-0.5288

Table A-23 Show the error calculated by SRK for case III.

Stage No.	n-butane	n-pentane	propane	Total mass balance
1	0.0104	-0.0117	-0.0092	-0.0104
2	0.0932	-0.1006	-0.0849	-0.0924
3	0.2181	-0.2304	-0.2074	-0.2196
4	0.1617	-0.1453	-0.1774	-0.1610
5	0.0282	-0.0193	-0.0372	-0.0282
6	0.0024	0.0007	-0.0054	-0.0022
7	0.0004	0.0005	-0.0014	-0.0006
8	-0.0003	0.0000	0.0005	0.0002
overall	0.5141	-1.9623	-0.5223	-1.9705

Table A-24 The results of case IV calculated by simulator using PR model

Stage No	Temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition				Liquid Composition			
	(K)	(kgmol/h	Vapor	Liquid	Vapor	Liquid	(J/h)	n-butane	n-hexane	n-pentane	propane	n-butane	n-hexane	n-pentane	propane
1	322.45	0.00	0.000001	10.000002	0.0	5.0	255888.0	0.245134	0.000182	0.013633	0.741051	0.438121	0.002094	0.062561	0.497224
2	340.35	0.00	15.000003	9.262304	0.0	0.0	0.0	0.438059	0.002093	0.062532	0.497316	0.547442	0.014283	0.184829	0.253446
3	354.15	0.00	14.262305	8.714096	0.0	0.0	0.0	0.509049	0.009998	0.141865	0.339088	0.498592	0.04768	0.310048	0.143679
4	364.70	0.00	13.714097	8.242974	0.0	0.0	0.0	0.476511	0.031013	0.219598	0.272878	0.393996	0.115251	0.389041	0.101712
5	373.74	10.00	13.242975	17.148623	0.0	0.0	0.0	0.410704	0.072413	0.265484	0.251399	0.296748	0.220677	0.39796	0.084614
6	385.38	0.00	12.148628	17.108391	0.0	0.0	0.0	0.39358	0.106348	0.381317	0.118755	0.243127	0.253771	0.467323	0.03578
7	394.71	0.00	12.108392	17.071732	0.0	0.0	0.0	0.318252	0.152625	0.479219	0.049904	0.175374	0.304126	0.506616	0.013884
8	403.06	0.00	12.071733	17.003357	0.0	0.0	0.0	0.222745	0.223426	0.534839	0.01899	0.11167	0.38324	0.500143	0.004948
9	411.45	0.00	12.003358	4.999999	0.0	0.0	-255641.1	0.132807	0.334958	0.525874	0.006361	0.060953	0.499126	0.438362	0.001559

Table A-25 The results of case IV calculated by simulator using SRK model

Stage No	Temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition				Liquid Composition			
	(K)	(kgmol/h	Vapor	Liquid	Vapor	Liquid	(J/h)	n-butane	n-hexane	n-pentane	propane	n-butane	n-hexane	n-pentane	propane
1	321.90	0.00	0.000001	10.000002	0.0	5.0	257372.6	0.243936	0.000163	0.013156	0.742745	0.439173	0.001951	0.061663	0.497213
2	339.83	0.00	15.000003	9.271083	0.0	0.0	0.0	0.439107	0.001949	0.061632	0.497312	0.549712	0.013669	0.184414	0.252205
3	353.62	0.00	14.271084	8.725847	0.0	0.0	0.0	0.510911	0.009551	0.141299	0.338239	0.499944	0.046455	0.311092	0.142509
4	364.10	0.00	13.725848	8.255464	0.0	0.0	0.0	0.477772	0.030194	0.219998	0.272036	0.393995	0.113868	0.391349	0.100788
5	373.27	10.00	13.255465	17.137558	0.0	0.0	0.0	0.411087	0.071533	0.266683	0.250697	0.295756	0.220216	0.400197	0.083831
6	384.91	0.00	12.137559	17.090698	0.0	0.0	0.0	0.392712	0.105521	0.384069	0.117698	0.241333	0.253330	0.470091	0.035246
7	394.21	0.00	12.090699	17.049557	0.0	0.0	0.0	0.316280	0.151777	0.482755	0.049188	0.173401	0.303702	0.509283	0.013614
8	402.51	0.00	12.049559	16.97801	0.0	0.0	0.0	0.220497	0.222597	0.538273	0.018634	0.110026	0.382987	0.502155	0.004835
9	410.86	0.00	11.978011	4.999999	0.0	0.0	-256157.1	0.130979	0.334413	0.528389	0.006220	0.059857	0.499320	0.439302	0.001520

Table A-26 The results of case IV calculated by HYSIM using PR model

Stage No.	Temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition				Liquid Composition			
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	n-butane	n-hexane	n-pentane	propane	n-butane	n-hexane	n-pentane	propane
1	322.65	0	0.0	10.0	0.0	5.0	-0.265	0.236554	0.00034	0.016952	0.746154	0.422098	0.003774	0.076746	0.497382
2	342.05	0	15.0	9.1	0.0	0.0	0.000	0.422098	0.003774	0.076746	0.497382	0.512361	0.024294	0.217761	0.245584
3	357.35	0	14.1	9.5	0.0	0.0	0.000	0.480329	0.017012	0.167718	0.334941	0.446772	0.074671	0.343572	0.134985
4	368.75	0	13.5	8.1	0.0	0.0	0.000	0.437664	0.043501	0.245082	0.268753	0.339596	0.163983	0.402049	0.094372
5	378.15	10	13.1	11.8	0.0	0.0	0.000	0.371111	0.102784	0.277785	0.24832	0.2251063	0.285254	0.385107	0.078575
6	386.55	0	6.8	12.1	0.0	0.0	0.000	0.378927	0.129467	0.356928	0.134678	0.229486	0.302066	0.428987	0.039462
7	393.95	0	7.1	12.3	0.0	0.0	0.000	0.336409	0.165108	0.433016	0.065467	0.185923	0.333649	0.462422	0.018006
8	401.35	0	7.3	12.4	0.0	0.0	0.000	0.259832	0.222413	0.489202	0.028553	0.131816	0.393026	0.467756	0.007401
9	409.75	0	7.4	5.0	0.0	0.0	0.158	0.168067	0.323644	0.497654	0.010635	0.077882	0.496255	0.423274	0.002589

Table A-27 The results of case IV calculated by HYSIM using SRK model

Stage No.	Temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition				Liquid Composition			
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	n-butane	n-hexane	n-pentane	propane	n-butane	n-hexane	n-pentane	propane
1	322.15	0.0	0.0	10.0	0.0	5.0	-0.267	0.235254	0.000311	0.016650	0.747786	0.422367	0.003590	0.076645	0.497397
2	341.55	0.0	15.0	9.1	0.0	0.0	0.000	0.422367	0.003590	0.076645	0.497397	0.512802	0.023688	0.219128	0.244382
3	356.85	0.0	14.1	8.6	0.0	0.0	0.000	0.480726	0.016559	0.168591	0.334124	0.445962	0.073881	0.346274	0.133883
4	368.35	0.0	13.6	8.1	0.0	0.0	0.000	0.437260	0.047957	0.246833	0.267950	0.337819	0.163930	0.404731	0.093520
5	377.75	10.0	13.1	11.6	0.0	0.0	0.000	0.370092	0.102726	0.279496	0.247686	0.248921	0.286944	0.386263	0.077872
6	386.05	0.0	6.6	12.0	0.0	0.0	0.000	0.377958	0.129147	0.353320	0.134575	0.227846	0.303246	0.429669	0.039240
7	393.35	0.0	7.0	12.2	0.0	0.0	0.000	0.335813	0.164406	0.434206	0.065574	0.184911	0.334246	0.462872	0.017971
8	400.75	0.0	7.2	1.3	0.0	0.0	0.000	0.259331	0.221298	0.490395	0.028676	0.131307	0.393141	0.468138	0.007414
9	409.05	0.0	7.3	5.0	0.0	0.0	0.156	0.168017	0.322511	0.498766	0.010705	0.077632	0.496411	0.423356	0.002601

Table A-28 The error of the result calculated by PR (Case IV)

Stage No.	n-butane	n-hexane	n-pentane	propane	Total mass balance
1	-0.0037	-0.0001	-0.0017	0.0055	0.0000
2	-0.0002	-0.0006	-0.0040	0.0047	0.0000
3	0.0020	-0.0019	-0.0063	0.0062	0.0000
4	0.0044	-0.0035	-0.0034	0.0025	0.0000
5	0.0056	-0.0051	-0.0037	0.0033	0.0001
6	0.0055	-0.0050	-0.0023	0.0017	-0.0002
7	0.0039	-0.0050	0.0008	0.0004	0.0001
8	0.0015	-0.0037	0.0021	0.0000	-0.0001
9	-0.0005	0.0005	0.0002	-0.0001	0.0001
overall	0	0	0	0	0

Table A-29 The error of the result calculated by SRK (Case IV)

Stage No.	n-butane	n-hexane	n-pentane	propane	Total mass balance
1	-0.0040	-0.0001	-0.0019	0.0059	0.0000
2	-0.0002	-0.0006	-0.0043	0.0051	0.0000
3	0.0023	-0.0020	-0.0066	0.0064	0.0000
4	0.0046	-0.0036	-0.0035	0.0026	0.0000
5	0.0060	-0.0055	-0.0039	0.0034	0.0000
6	0.0059	-0.0052	-0.0024	0.0017	0.0000
7	0.0039	-0.0052	0.0010	0.0003	0.0001
8	0.0015	-0.0039	0.0022	0.0000	-0.0002
9	-0.0005	0.0006	0.0001	-0.0001	0.0002
overall	0.0000	0.0000	0.0000	0.0000	0.0000

Table A-30 Temperature profile of case IV

Stage No.	Temperature (K)				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	322.45	321.90	322.65	322.15	0.06	0.08
2	340.35	339.83	342.05	341.55	0.50	0.50
3	354.15	353.62	357.35	356.85	0.90	0.91
4	364.70	364.10	368.75	368.35	1.10	1.15
5	373.74	373.27	378.15	377.75	1.17	1.19
6	385.38	384.91	386.55	386.05	0.30	0.30
7	394.71	394.21	393.95	393.35	-0.19	-0.22
8	403.06	402.51	401.35	400.75	-0.43	-0.44
9	411.45	410.86	409.75	409.05	-0.41	-0.44

Table A -31 Vapor composition profile of n-butane (case IV)

Stage No.	Composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.245134	0.243936	0.236554	0.235254	-3.6271	-3.6905
2	0.438059	0.439107	0.422098	0.422367	-3.7813	-3.9634
3	0.509049	0.510911	0.480329	0.480726	-5.9792	-6.2790
4	0.476511	0.477772	0.437664	0.437260	-8.8760	-9.2650
5	0.410704	0.411087	0.371111	0.370092	-10.6688	-11.0770
6	0.39358	0.392712	0.378927	0.377958	-3.8670	-3.9036
7	0.318252	0.316280	0.336409	0.335813	5.3973	5.8166
8	0.222745	0.220497	0.259832	0.259631	14.2735	15.0729
9	0.132807	0.130979	0.168067	0.168017	20.9797	22.0442

Table A-32 Liquid composition profile of n-butane (case IV)

Stage No.	Composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.438121	0.439173	0.439173	0.422367	0.2395	-3.9790
2	0.547442	0.549712	0.549712	0.512802	0.4129	-7.1977
3	0.498592	0.499944	0.499944	0.445962	0.2704	-12.1046
4	0.393996	0.393995	0.393995	0.337819	-0.0003	-16.6290
5	0.296748	0.295756	0.295756	0.248921	-0.3354	-18.8152
6	0.243127	0.241333	0.241333	0.227846	-0.7434	-5.9193
7	0.175374	0.173401	0.173401	0.184911	-1.1378	6.2246
8	0.11167	0.110026	0.110026	0.131307	-1.4942	16.2071
9	0.060953	0.059857	0.059857	0.077632	-1.8310	22.8965

Table A-33 Vapor composition profile of n-hexane (case IV)

Stage No.	Composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.000182	0.000163	0.00034	0.000311	46.4706	47.5884
2	0.002093	0.001949	0.003774	0.003590	44.5416	45.7103
3	0.009998	0.009551	0.017012	0.016559	41.2297	42.3214
4	0.031013	0.030194	0.048501	0.047957	36.0570	37.0394
5	0.072413	0.071533	0.102784	0.102726	29.5484	30.3652
6	0.106348	0.105521	0.129467	0.129147	17.8571	18.2939
7	0.152625	0.151777	0.165108	0.164406	7.5605	7.6816
8	0.223426	0.222597	0.222413	0.221298	-0.4555	-0.5870
9	0.334958	0.334413	0.323644	0.322511	-3.4958	-3.6904

Table A-34 Liquid composition profile of n-hexane (case IV)

Stage No.	Composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.002094	0.001951	0.003774	0.003590	44.5151	45.6546
2	0.014283	0.013669	0.024294	0.023688	41.2077	42.2957
3	0.04768	0.046455	0.074671	0.073881	36.1466	37.1219
4	0.115251	0.113868	0.163983	0.163930	29.7177	30.5386
5	0.220677	0.220216	0.285254	0.286944	22.6384	23.2547
6	0.253771	0.253330	0.302066	0.303246	15.9882	16.4606
7	0.304126	0.303702	0.333649	0.334246	8.8485	9.1382
8	0.38324	0.382987	0.393026	0.393141	2.4899	2.5828
9	0.499126	0.499320	0.496255	0.496411	-0.5785	-0.5860

Table A-35 Vapor composition profile of n-pentane (case IV)

Stage No.	Composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.013633	0.013156	0.016952	0.016650	19.5788	20.9850
2	0.062532	0.061632	0.076746	0.076645	18.5208	19.5877
3	0.141865	0.141299	0.167718	0.168591	15.4146	16.1883
4	0.219598	0.219998	0.245082	0.246833	10.3982	10.8717
5	0.265484	0.266683	0.277785	0.279496	4.4282	4.5843
6	0.381317	0.384069	0.356928	0.358320	-6.8330	-7.1860
7	0.479219	0.482755	0.433016	0.434206	-10.6700	-11.1811
8	0.534839	0.538273	0.489202	0.490395	-9.3289	-9.7632
9	0.525874	0.528389	0.497654	0.498766	-5.6706	-5.9393

Table A-36 Liquid composition profile of n-pentane (case IV)

Stage No.	Composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.062561	0.061663	0.076746	0.076645	18.4830	19.5473
2	0.184829	0.184414	0.217761	0.219128	15.1230	15.8419
3	0.310048	0.311092	0.343572	0.346274	9.7575	10.1602
4	0.389041	0.391349	0.402049	0.404731	3.2354	3.3064
5	0.39796	0.400197	0.385107	0.386263	-3.3375	-3.6074
6	0.467323	0.470091	0.428987	0.429669	-8.9364	-9.4077
7	0.506616	0.509283	0.462422	0.462872	-9.5571	-10.0267
8	0.500143	0.502155	0.467756	0.468138	-6.9239	-7.2664
9	0.438362	0.439302	0.423274	0.423356	-3.5646	-3.7666

Table A-37 Vapor composition profile of propane (case IV)

Stage No.	Composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.741051	0.742745	0.746154	0.747786	0.6839	0.6741
2	0.497316	0.497312	0.497382	0.497397	0.0133	0.0171
3	0.339088	0.338239	0.334941	0.334124	-1.2381	-1.2316
4	0.272878	0.272036	0.268753	0.267950	-1.5349	-1.5249
5	0.251399	0.250697	0.24832	0.247686	-1.2399	-1.2157
6	0.118755	0.117698	0.134678	0.134575	11.8230	12.5410
7	0.049904	0.049188	0.065467	0.065574	23.7723	24.9886
8	0.01899	0.018634	0.028553	0.028676	33.4921	35.0188
9	0.006361	0.006220	0.010635	0.010705	40.1881	41.8963

Table A -38 Liquid composition profile of propane (case IV)

Stage No.	Composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.497224	0.497213	0.497382	0.497397	0.0318	0.0370
2	0.253446	0.252205	0.245584	0.244382	-3.2013	-3.2011
3	0.143679	0.142509	0.134985	0.133883	-6.4407	-6.4429
4	0.101712	0.100788	0.094372	0.093520	-7.7777	-7.7716
5	0.084614	0.083831	0.078575	0.077872	-7.6857	-7.6523
6	0.03578	0.035246	0.039462	0.039240	9.3305	10.1784
7	0.013884	0.013614	0.018006	0.017971	22.8924	24.2446
8	0.004948	0.004835	0.007401	0.007414	33.1442	34.7855
9	0.001559	0.001520	0.002589	0.002601	39.7837	41.5609

Table A-39 The results of case V calculated by simulator using PR method

Stage No	temp	Feed	Interstage (kgmol/hr)		Sidestream (kgmol/hr)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/hr)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentan	propane
1	335 82	0 00	0 000001	57 202225	0 00	22 18	1445485 6	0 033158	0 326262	0 400286	0 019332	0 220962	0 077409	0 298452	0 467179	0 055106	0 101884
2	345 35	0 00	79 382225	55 195175	0 00	0 00	0 0	0 077386	0 298474	0 467137	0 055084	0 101919	0 146421	0 230964	0 455773	0 125850	0 040992
3	352 58	0 00	77 375175	53 779480	0 00	0 00	0 0	0 126580	0 250369	0 459051	0 105507	0 058494	0 206275	0 172024	0 394367	0 205983	0 021351
4	358 13	0 00	75 959480	52 886559	0 00	0 00	0 0	0 168528	0 209059	0 415695	0 161781	0 044938	0 246163	0 131705	0 325391	0 281457	0 015285
5	362 14	0 00	75 066559	52 367195	0 00	0 00	0 0	0 196137	0 181138	0 367420	0 214347	0 040958	0 265486	0 107467	0 269631	0 344145	0 013271
6	364 82	45 36	74 547195	100 017845	0 00	0 00	0 0	0 209351	0 164473	0 328588	0 257865	0 039722	0 269624	0 093841	0 231205	0 392859	0 012472
7	369 85	0 00	76 837845	99 589149	0 00	0 00	0 0	0 255056	0 119954	0 288463	0 320318	0 016210	0 299968	0 063799	0 188104	0 443315	0 004814
8	374 11	0 00	76 409149	99 358971	0 00	0 00	0 0	0 294504	0 080971	0 232664	0 385608	0 006253	0 321584	0 040670	0 142601	0 493366	0 001775
9	377 62	0 00	76 178970	99 273888	0 00	0 00	0 0	0 322675	0 050875	0 173488	0 450667	0 002295	0 332112	0 024425	0 101224	0 541611	0 000629
10	380 40	0 00	76 093887	99 262619	0 00	0 00	0 0	0 336414	0 029692	0 119560	0 513534	0 000800	0 330810	0 013767	0 067166	0 588044	0 000213
11	382 55	0 00	76 082619	23 179998	0 00	0 00	-1524647 4	0 334719	0 015790	0 075134	0 574099	0 000258	0 317980	0 007131	0 041018	0 633804	0 000067

Table A-40 The results of case V calculated by simulator using SRK method

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentan	propane
1	335 25	0 00	0 000001	57 202225	0 00	22 18	1455397 0	0 032627	0 326580	0 400144	0 018765	0 221884	0 077007	0 298724	0 468188	0 054200	0 101881
2	344 79	0 00	79 382225	55 194633	0 00	0 00	0 0	0 076982	0 298747	0 468175	0 054177	0 101919	0 146723	0 230656	0 456899	0 124941	0 040781
3	352 05	0 00	77 374634	53 780380	0 00	0 00	0 0	0 126676	0 250230	0 460154	0 104595	0 058345	0 207368	0 171253	0 394698	0 205511	0 021170
4	357 63	0 00	75 960381	52 893379	0 00	0 00	0 0	0 169176	0 208597	0 416236	0 161175	0 044812	0 247708	0 130733	0 324860	0 281556	0 015143
5	361 66	0 00	75 073380	52 376396	0 00	0 00	0 0	0 197105	0 180535	0 367354	0 214148	0 040858	0 267077	0 106473	0 268568	0 344733	0 013149
6	364 34	45 36	74 556396	99 893089	0 00	0 00	0 0	0 210348	0 163856	0 328151	0 258011	0 039635	0 270999	0 092901	0 229933	0 393808	0 012359
7	369 40	0 00	76 713089	99 455078	0 00	0 00	0 0	0 256701	0 118856	0 287209	0 321164	0 016070	0 301557	0 062772	0 186344	0 444587	0 004739
8	373 66	0 00	76 275078	99 217445	0 00	0 00	0 0	0 296444	0 079747	0 230759	0 386891	0 006159	0 323099	0 039770	0 140679	0 494715	0 001736
9	377 14	0 00	76 037445	99 124229	0 00	0 00	0 0	0 324532	0 049799	0 171350	0 452074	0 002246	0 333341	0 023739	0 099454	0 542854	0 000611
10	379 89	0 00	75 944229	99 103668	0 00	0 00	0 0	0 337905	0 028892	0 117598	0 514827	0 000778	0 331643	0 013306	0 065739	0 589106	0 000206
11	382 00	0 00	75 923668	23 179998	0 00	0 00	-1531771 6	0 335693	0 015276	0 073600	0 575181	0 000249	0 318380	0 006855	0 039997	0 634704	0 000065

Table A-41 a) The results of case V calculated by HYSIM using PR method

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h))	-methyl butan	sobutan	n-butane	-pentan	propane	2-methyl butane	sobutan	n-butane	-pentan	propane
1	335 65	0 00	0 00	27 20	0 00	22 18	-1 429	0 031832	0 326583	0 399541	0 019395	0 222650	0 074645	0 299380	0 468573	0 055219	0 102183
2	345 25	0 00	79 40	55 30	0 00	0 00	0 000	0 074645	0 299380	0 468573	0 055219	0 102183	0 142099	0 232015	0 458923	0 126109	0 040853
3	352 45	0 00	77 50	53 90	0 00	0 00	0 000	0 122793	0 251296	0 461685	0 105819	0 058407	0 201559	0 172842	0 397776	0 206649	0 021173
4	358 05	0 00	76 00	53 00	0 00	0 00	0 000	0 164536	0 209754	0 418428	0 162477	0 044804	0 242079	0 132149	0 328011	0 282643	0 015118
5	362 15	0 00	75 10	52 50	0 00	0 00	0 000	0 192655	0 181514	0 369503	0 215511	0 040818	0 262493	0 107566	0 271148	0 345689	0 013104
6	364 25	45 36	74 70	98 40	0 00	0 00	0 000	0 206694	0 164543	0 329792	0 259406	0 039564	0 267760	0 093677	0 231759	0 394509	0 012295
7	369 85	0 00	75 20	98 80	0 00	0 00	0 000	0 251681	0 120361	0 290570	0 321325	0 016063	0 297995	0 063881	0 189222	0 444180	0 004722
8	374 15	0 00	75 60	99 30	0 00	0 00	0 000	0 291265	0 081295	0 234687	0 386603	0 006149	0 320154	0 040726	0 143529	0 493864	0 001727
9	377 75	0 00	76 10	99 80	0 00	0 00	0 000	0 320213	0 050980	0 174796	0 451778	0 002233	0 331600	0 024389	0 101669	0 541736	0 000605
10	380 55	0 00	76 70	100 30	0 00	0 00	0 000	0 325120	0 029632	0 120062	0 514416	0 000769	0 331438	0 013683	0 067191	0 587486	0 000203
11	382 65	0 00	77 20	23 20	0 00	0 00	1 482	0 334986	0 015676	0 075108	0 574086	0 000244	0 319959	0 007049	0 040835	0 632094	0 000063

Table A-41 b) The results of case V calculated by HYSIM using SRK method

Stage No	temp	Feed	Interstage (kg.nol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	-methyl butan	sobutan	n-butane	-pentan	propane	2-methyl butane	sobutan	n-butane	-pentan	propane
1	335 05	0 00	0 00	57 20	0 00	22 18	-1 442	0 028489	0 327772	0 400573	0 019824	0 223342	0 069577	0 300004	0 471157	0 057052	0 102210
2	344 75	0 00	79 40	55 20	0 00	0 00	0 000	0 069577	0 300004	0 471157	0 057052	0 102100	0 136604	0 231183	0 460683	0 130907	0 040622
3	352 15	0 00	77 40	53 70	0 00	0 00	0 000	0 117398	0 250904	0 463685	0 109744	0 058270	0 197080	0 170902	0 397040	0 214404	0 020934
4	357 95	0 00	75 90	52 90	0 00	0 00	0 000	0 159828	0 208621	0 418694	0 168177	0 044680	0 239066	0 129822	0 325219	0 290980	0 014913
5	362 05	0 00	75 00	52 40	0 00	0 00	0 000	0 188970	0 180123	0 368354	0 221837	0 040715	0 260952	0 105336	0 267526	0 353262	0 012924
6	364 75	45 36	74 60	98 20	0 00	0 00	0 000	0 204061	0 163206	0 328061	0 265205	0 039467	0 267640	0 091712	0 228194	0 400322	0 012132
7	369 85	0 00	75 00	98 70	0 00	0 00	0 000	0 249997	0 118032	0 286809	0 329300	0 015861	0 298463	0 061749	0 184551	0 450629	0 004608
8	374 15	0 00	75 50	99 20	0 00	0 00	0 000	0 290391	0 078706	0 229403	0 395495	0 006004	0 321174	0 038863	0 138587	0 499710	0 001667
9	377 65	0 00	76 10	99 80	0 00	0 00	0 000	0 320083	0 048723	0 169112	0 459926	0 002157	0 333377	0 022996	0 097242	0 545807	0 000578
10	380 35	0 00	76 60	100 30	0 00	0 00	0 000	0 335987	0 027983	0 115032	0 520264	0 000735	0 334426	0 012766	0 063732	0 588884	0 000192
11	382 45	0 00	77 10	23 20	0 00	0 00	1 496	0 337334	0 014645	0 071331	0 576457	0 000232	0 324754	0 006517	0 038456	0 630214	0 000059

Table A-42 The error calculated by PR on case V

Stage No.	2-methyl butane	isobutane	n-butane	n-pentane	propane	Total mass balance
1	-0.0201	0.0257	-0.0294	-0.0110	0.1225	0.0876
2	-0.0296	0.0417	0.0351	-0.0201	0.0378	0.0648
3	-0.0494	0.0647	0.0392	-0.0388	0.0793	0.0950
4	-0.0366	0.0489	0.0443	-0.0387	0.0434	0.0613
5	-0.0093	0.0187	0.0295	-0.0239	-0.0003	0.0148
6	-0.0114	0.0291	0.0419	-0.0351	-0.0035	0.0210
7	-0.0165	0.0295	0.0378	-0.0316	0.0108	0.0300
8	-0.0049	0.0211	0.0256	-0.0227	0.0046	0.0237
9	0.0023	-0.0009	0.0127	-0.0129	-0.0016	-0.0004
10	0.0026	0.0027	0.0038	-0.0050	0.0024	0.0064
11	-0.0001	-0.0014	-0.0010	0.0016	-0.0017	-0.0026
overall	-0.1731	0.2798	0.2396	-0.2383	0.2936	0.4016

Table A- 43 The error calculated by SRK on case V

Stage No.	2-methyl butane	isobutane	n-butane	n-pentane	propane	Total mass balance
1	-0.0219	0.0268	-0.0091	-0.0115	0.1330	0.1173
2	-0.0313	0.0435	0.0220	-0.0214	0.0350	0.0477
3	-0.0534	0.0672	0.0402	-0.0408	0.0827	0.0960
4	-0.0344	0.0501	0.0452	-0.0384	0.0431	0.0657
5	-0.0107	0.0203	0.0315	-0.0244	-0.0017	0.0150
6	-0.0095	0.0265	0.0427	-0.0360	-0.0064	0.0173
7	-0.0164	0.0304	0.0382	-0.0320	0.0115	0.0317
8	-0.0043	0.0146	0.0256	-0.0221	0.0034	0.0173
9	0.0026	0.0053	0.0122	-0.0128	-0.0008	0.0064
10	0.0027	0.0010	0.0037	-0.0055	-0.0013	0.0005
11	-0.0006	-0.0005	-0.0012	0.0017	0.0002	-0.0004
overall	-0.1771	0.2852	0.2510	-0.2431	0.2986	0.4146

Table A-44 Comparison of temperature profile for case V

Stage No.	Temperature (K)				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	335.82	335.25	335.65	335.05	-0.05	-0.06
2	345.35	344.79	345.25	344.75	-0.03	-0.01
3	352.58	352.05	352.45	352.15	-0.04	0.03
4	358.13	357.63	358.05	357.95	-0.02	0.09
5	362.14	361.66	362.15	362.05	0.00	0.11
6	364.82	364.34	364.25	364.75	-0.16	0.11
7	369.85	369.40	369.85	369.85	0.00	0.12
8	374.11	373.66	374.15	374.15	0.01	0.13
9	377.62	377.14	377.75	377.65	0.03	0.14
10	380.4	379.89	380.55	380.35	0.04	0.12
11	382.55	382.00	382.65	382.45	0.03	0.12

Table A-45 Comparison of vapor composition of 2-methyl butane profile for case V

Stage No.	Vapor composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.033158	0.032627	0.031832	0.028489	-4.165620	-14.524904
2	0.077386	0.076982	0.074645	0.069577	-3.672048	-10.642885
3	0.126580	0.126676	0.122793	0.117398	-3.084052	-7.903031
4	0.168528	0.169176	0.164538	0.159828	-2.424972	-5.848787
5	0.196137	0.197105	0.192655	0.188970	-1.807376	-4.304916
6	0.209351	0.210348	0.206694	0.204061	-1.285475	-3.080941
7	0.255056	0.256701	0.251681	0.249997	-1.340983	-2.681632
8	0.294504	0.296444	0.291265	0.290391	-1.112046	-2.084431
9	0.322675	0.324532	0.320213	0.320083	-0.768863	-1.389952
10	0.336414	0.337905	0.325120	0.335987	-3.473794	-0.570855
11	0.334719	0.335693	0.334886	0.337334	0.049868	0.486461

Table A-46 Comparison of liquid composition of 2-methyl butane profile for case V

Stage No.	Liquid composition				Error (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.077409	0.077007	0.074645	0.069577	-3.702860	-10.678816
2	0.146421	0.146723	0.142099	0.136604	-3.041541	-7.407543
3	0.206275	0.207368	0.201559	0.197080	-2.339762	-5.220215
4	0.246163	0.247708	0.242079	0.239066	-1.687053	-3.614901
5	0.265486	0.267077	0.262493	0.260952	-1.140221	-2.347175
6	0.269624	0.270999	0.267760	0.267640	-0.696146	-1.255044
7	0.299968	0.301557	0.297995	0.298463	-0.662092	-1.036644
8	0.321584	0.323099	0.320154	0.321174	-0.446660	-0.599364
9	0.332112	0.333341	0.331600	0.333377	-0.154403	0.010799
10	0.330810	0.331643	0.331438	0.334426	0.189477	0.832172
11	0.317980	0.318380	0.319959	0.324754	0.618517	1.962716

Table A-47 Comparison of vapor composition of i-butane profile for case V

Stage No	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.326262	0.326580	0.326583	0.327772	0.0983	0.3637
2	0.298474	0.298747	0.299380	0.300004	0.3026	0.4190
3	0.250369	0.250230	0.251296	0.250904	0.3689	0.2686
4	0.209059	0.208597	0.209754	0.208621	0.3313	0.0115
5	0.181138	0.180535	0.181514	0.180123	0.2071	-0.2287
6	0.164473	0.163856	0.164543	0.163206	0.0425	-0.3983
7	0.119954	0.118856	0.120361	0.118032	0.3381	-0.6981
8	0.080971	0.079747	0.081295	0.078706	0.3985	-1.3226
9	0.050875	0.049799	0.050980	0.048723	0.2060	-2.2084
10	0.029692	0.028892	0.029632	0.027983	-0.2025	-3.2484
11	0.015790	0.015276	0.015676	0.014645	-0.7272	-4.3086

Table A-48 Comparison of liquid composition of i-butane profile for case V

Stage No	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.298452	0.298724	0.299380	0.300004	0.3100	0.4267
2	0.230964	0.230656	0.232015	0.231183	0.4530	0.2280
3	0.172024	0.171253	0.172842	0.170902	0.4733	-0.2054
4	0.131705	0.130733	0.132149	0.129822	0.3360	-0.7017
5	0.107467	0.106473	0.107566	0.105336	0.0920	-1.0794
6	0.093841	0.092901	0.093677	0.091712	-0.1751	-1.2964
7	0.063799	0.062772	0.063881	0.061749	0.1284	-1.6567
8	0.040670	0.039770	0.040726	0.038863	0.1375	-2.3338
9	0.024425	0.023739	0.024389	0.022996	-0.1476	-3.2310
10	0.013767	0.013306	0.013683	0.012766	-0.6139	-4.2300
11	0.007131	0.006855	0.007049	0.006517	-1.1633	-5.1864

Table A-49 Comparison of vapor composition of n-butane profile for case V

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.400286	0.400144	0.399541	0.400573	-0.186464	0.107097
2	0.467137	0.468175	0.468573	0.471157	0.306462	0.632910
3	0.459051	0.460154	0.461685	0.463685	0.570519	0.761508
4	0.415695	0.416236	0.418428	0.418694	0.653159	0.587064
5	0.367420	0.367354	0.369503	0.368354	0.563730	0.271478
6	0.328588	0.328151	0.329792	0.328061	0.365079	-0.027434
7	0.288463	0.287209	0.290570	0.286809	0.725126	-0.139466
8	0.232664	0.230759	0.234687	0.229403	0.861999	-0.591100
9	0.173488	0.171350	0.174796	0.169112	0.748301	-1.323383
10	0.119560	0.117598	0.120062	0.115032	0.418117	-2.230684
11	0.075134	0.073600	0.075108	0.071331	-0.034617	-3.180945

Table A-50 Comparison of liquid composition of n-butane profile for case V

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.467179	0.468188	0.468573	0.471157	0.297499	0.630151
2	0.455773	0.456899	0.458923	0.460683	0.686390	0.821389
3	0.394367	0.394698	0.397776	0.397040	0.857015	0.589865
4	0.325391	0.324860	0.328011	0.325219	0.798754	0.110387
5	0.269631	0.268568	0.271148	0.267526	0.559473	-0.389495
6	0.231205	0.229933	0.231759	0.228194	0.239041	-0.762071
7	0.188104	0.186344	0.189222	0.184551	0.590840	-0.971547
8	0.142601	0.140679	0.143529	0.138587	0.646559	-1.509521
9	0.101224	0.099454	0.101669	0.097242	0.437695	-2.274737
10	0.067166	0.065739	0.067191	0.063732	0.037207	-3.149124
11	0.041018	0.039997	0.040835	0.038456	-0.448145	-4.007177

Table A-51 Comparison of vapor composition of n-pentane profile for case V

Stage No	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.019332	0.018765	0.019395	0.019824	0.3248	5.3420
2	0.055084	0.054177	0.055219	0.057052	0.2445	5.0393
3	0.105507	0.104595	0.105819	0.109744	0.2948	4.6918
4	0.161781	0.161175	0.162477	0.168177	0.4284	4.1635
5	0.214347	0.214148	0.215511	0.221837	0.5401	3.4661
6	0.257865	0.258011	0.259406	0.265205	0.5940	2.7126
7	0.320318	0.321164	0.321325	0.329300	0.3134	2.4707
8	0.385608	0.386891	0.386603	0.395495	0.2574	2.1755
9	0.450667	0.452074	0.451778	0.459926	0.2459	1.7072
10	0.513534	0.514827	0.514416	0.520264	0.1715	1.0450
11	0.574099	0.575181	0.574086	0.576457	-0.0023	0.2214

Table A-52 Comparison of liquid composition of n-pentane profile for case V

Stage No	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.055106	0.054200	0.055219	0.057052	0.204640	4.998948
2	0.12585	0.124941	0.126109	0.130907	0.205378	4.557434
3	0.205983	0.205511	0.206649	0.214404	0.322286	4.147956
4	0.281457	0.281556	0.282643	0.290980	0.419611	3.238711
5	0.344145	0.344733	0.345689	0.353262	0.446644	2.414355
6	0.392859	0.393808	0.394509	0.400322	0.418241	1.627190
7	0.443315	0.444587	0.44418	0.450629	0.194741	1.340793
8	0.493366	0.494715	0.493864	0.499710	0.100837	0.999580
9	0.541611	0.542854	0.541736	0.545807	0.023074	0.541034
10	0.588044	0.589106	0.587486	0.588884	-0.094981	-0.037698
11	0.633804	0.634704	0.632094	0.630214	-0.270529	-0.712456

Table A-53 Comparison of vapor composition of propane profile for case V

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.220962	0.221884	0.222650	0.223342	0.7581	0.6528
2	0.101919	0.101919	0.102183	0.102100	0.2584	0.1773
3	0.058494	0.058345	0.058407	0.058270	-0.1490	-0.1287
4	0.044938	0.044812	0.044804	0.044680	-0.2991	-0.2954
5	0.040958	0.040858	0.040818	0.040715	-0.3430	-0.3512
6	0.039722	0.039635	0.039564	0.039467	-0.3994	-0.4257
7	0.016210	0.016070	0.016063	0.015861	-0.9151	-1.3177
8	0.006253	0.006159	0.006149	0.006004	-1.6913	-2.5816
9	0.002295	0.002246	0.002233	0.002157	-2.7765	-4.1261
10	0.000800	0.000778	0.000769	0.000735	-4.0312	-5.8503
11	0.000258	0.000249	0.000244	0.000232	-5.7377	-7.3276

Table A-54 Comparison of liquid composition of propane profile for case V

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.101884	0.101881	0.102183	0.10221	0.292612	0.321886
2	0.040992	0.040781	0.040853	0.040622	-0.340244	-0.391414
3	0.021351	0.02117	0.021173	0.020934	-0.840693	-1.127353
4	0.015285	0.015143	0.015118	0.014913	-1.104643	-1.542279
5	0.013271	0.013149	0.013104	0.012924	-1.274420	-1.740947
6	0.012472	0.012359	0.012295	0.012132	-1.439610	-1.871085
7	0.004814	0.004739	0.004722	0.004608	-1.948327	-2.842882
8	0.001775	0.001736	0.001727	0.001667	-2.779386	-4.139172
9	0.000629	0.000611	0.000605	0.000578	-3.966942	-5.709343
10	0.000213	0.000206	0.000203	0.000192	-4.926108	-7.291667
11	0.000067	0.000065	0.000063	0.000059	-6.349206	-10.169492

Table A-55 The results of case VI calculated by simulator using PR model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	329.57	0.00	0.000001	31.412224	0.00	12.18	775538.9	0.014681	0.340464	0.315236	0.009343	0.320276	0.039665	0.350020	0.416760	0.031056	0.162499
2	338.97	0.00	43.592224	30.347158	0.00	0.00	0.0	0.039658	0.350025	0.416745	0.031049	0.162524	0.086173	0.302573	0.457625	0.082050	0.071579
3	345.93	0.00	42.527161	29.455286	0.00	0.00	0.0	0.072834	0.316183	0.445908	0.067423	0.097652	0.136133	0.242295	0.430539	0.152070	0.038963
4	351.78	0.00	41.635288	18.762087	0.00	10.00	0.0	0.107871	0.273855	0.426507	0.116615	0.075152	0.178684	0.190533	0.371433	0.231647	0.027702
5	356.67	0.00	40.942089	18.448126	0.00	0.00	0.0	0.137268	0.238048	0.384940	0.171884	0.067861	0.206338	0.153303	0.308612	0.308262	0.023485
6	359.14	45.36	40.628128	66.612450	0.00	0.00	0.0	0.149501	0.221515	0.356533	0.206197	0.066254	0.214255	0.137362	0.274476	0.351673	0.022235
7	362.39	0.00	43.432449	66.362244	0.00	0.00	0.0	0.171929	0.196114	0.362277	0.235784	0.033896	0.231631	0.115917	0.264799	0.376704	0.010949
8	365.69	0.00	43.182243	66.080803	0.00	0.00	0.0	0.198370	0.163519	0.347928	0.273554	0.016628	0.251397	0.092161	0.241569	0.409701	0.005171
9	369.30	0.00	42.900803	65.809906	0.00	0.00	0.0	0.228576	0.127268	0.312733	0.323653	0.007770	0.271412	0.068192	0.205579	0.452496	0.002321
10	373.25	0.00	42.629910	65.601723	0.00	0.00	0.0	0.259311	0.090515	0.257675	0.389111	0.003388	0.287395	0.045983	0.159886	0.505766	0.000970
11	377.33	0.00	42.421726	23.179998	0.00	0.00	-848934.1	0.283962	0.056293	0.187307	0.471134	0.001305	0.293677	0.027117	0.109706	0.569142	0.000358

Table A-56 The results of case VI calculated by simulator using SRK model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	328.99	0.00	0.000001	31.412224	0.00	12.18	780679.2	0.014146	0.340986	0.314380	0.008881	0.321607	0.038744	0.351145	0.417468	0.030001	0.162642
2	338.36	0.00	43.592224	30.350840	0.00	0.00	0.0	0.038737	0.351150	0.417452	0.029994	0.162668	0.085082	0.303581	0.459660	0.080301	0.071376
3	345.29	0.00	42.530842	29.459326	0.00	0.00	0.0	0.071791	0.317224	0.447563	0.065873	0.097548	0.135368	0.242848	0.432817	0.150203	0.038764
4	351.17	0.00	41.639328	18.764887	0.00	10.00	0.0	0.107061	0.274576	0.428326	0.114985	0.075052	0.178499	0.190570	0.373042	0.230355	0.027533
5	356.10	0.00	40.944889	18.450487	0.00	0.00	0.0	0.136862	0.238411	0.386282	0.170660	0.067786	0.206596	0.152938	0.309220	0.307918	0.023328
6	358.60	45.36	40.630489	66.482765	0.00	0.00	0.0	0.149295	0.221698	0.357417	0.205404	0.066186	0.214602	0.136832	0.274508	0.351981	0.022078
7	361.86	0.00	43.302765	66.222748	0.00	0.00	0.0	0.172027	0.195808	0.363162	0.235306	0.033697	0.232190	0.115121	0.264625	0.377248	0.010817
8	365.18	0.00	43.042747	65.934990	0.00	0.00	0.0	0.198812	0.162783	0.348507	0.273449	0.016449	0.252154	0.091207	0.241064	0.410492	0.005082
9	368.81	0.00	42.754990	65.662918	0.00	0.00	0.0	0.229352	0.126255	0.312782	0.323963	0.007648	0.272284	0.067221	0.204728	0.453497	0.002270
10	372.75	0.00	42.482922	65.452141	0.00	0.00	0.0	0.260300	0.089433	0.257132	0.389816	0.003310	0.288222	0.045133	0.158810	0.506891	0.000944
11	376.82	0.00	42.272144	23.179998	0.00	0.00	-851498.0	0.284913	0.055358	0.186332	0.472127	0.001272	0.294256	0.026490	0.108621	0.570285	0.000347

Table A-57 The results of case VI calculated by HYSIM using PR model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	MMBtu/	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	329.45	0.00	0.00	31.40	0.00	12.18	-0.770	0.014558	0.340061	0.312817	0.009665	0.322900	0.039413	0.350139	0.415342	0.032027	0.163079
2	339.05	0.00	43.60	30.50	0.00	0.00	0.000	0.039413	0.350139	0.415312	0.032027	0.163079	0.085731	0.302268	0.456540	0.084209	0.071252
3	346.05	0.00	42.70	29.60	0.00	0.00	0.000	0.072506	0.315936	0.444773	0.069311	0.097470	0.135644	0.241404	0.429010	0.155433	0.038509
4	351.95	0.00	41.10	18.80	0.00	10.00	0.000	0.107553	0.273144	0.425021	0.119410	0.074872	0.178356	0.189301	0.369240	0.235810	0.027294
5	356.85	0.00	41.00	18.50	0.00	0.00	0.000	0.137041	0.237126	0.382948	0.175215	0.067669	0.206324	0.152039	0.306013	0.312482	0.023142
6	359.35	45.36	40.60	64.50	0.00	0.00	0.000	0.149407	0.220592	0.354346	0.209543	0.066112	0.214548	0.136177	0.271841	0.355514	0.021920
7	362.45	0.00	41.30	64.70	0.00	0.00	0.000	0.170091	0.196986	0.361763	0.237137	0.034023	0.230460	0.116205	0.264200	0.378255	0.010881
8	365.65	0.00	41.50	64.70	0.00	0.00	0.000	0.195091	0.165584	0.349453	0.273110	0.016761	0.249303	0.093294	0.242824	0.409413	0.005167
9	369.15	0.00	41.50	64.80	0.00	0.00	0.000	0.224500	0.129818	0.316027	0.312804	0.007851	0.269174	0.069578	0.208023	0.450900	0.002326
10	373.15	0.00	41.60	64.90	0.00	0.00	0.000	0.255478	0.092835	0.261730	0.386534	0.003423	0.285920	0.047151	0.162512	0.503446	0.000971
11	377.25	0.00	41.80	23.20	0.00	0.00	0.813	0.281572	0.057870	0.190750	0.468496	0.001312	0.293756	0.027834	0.111629	0.566425	0.000357

Table A-58 The results of case VI calculated by HYSIM using SRK model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	MMBtu/	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	328.85	0.00	0.00	31.40	0.00	12.18	-0.775	0.012414	0.341913	0.312640	0.009407	0.323625	0.035230	0.352368	0.417510	0.031638	0.163254
2	338.35	0.00	43.60	30.40	0.00	0.00	0.000	0.035230	0.352368	0.417510	0.031638	0.163254	0.079789	0.304053	0.460774	0.084187	0.071196
3	345.45	0.00	42.60	29.50	0.00	0.00	0.000	0.067055	0.317861	0.448410	0.069170	0.097504	0.129810	0.242216	0.433155	0.156430	0.038390
4	351.45	0.00	41.60	18.70	0.00	10.00	0.000	0.102144	0.274438	0.428578	0.119925	0.074915	0.174181	0.189146	0.371702	0.237813	0.027159
5	356.45	0.00	40.90	18.30	0.00	0.00	0.000	0.132750	0.237813	0.385360	0.176339	0.067738	0.204456	0.151287	0.306612	0.314644	0.023001
6	358.95	45.36	40.50	64.20	0.00	0.00	0.000	0.146122	0.221067	0.356006	0.210623	0.066182	0.214196	0.135301	0.271686	0.357040	0.021777
7	362.05	0.00	41.00	64.40	0.00	0.00	0.000	0.166962	0.196674	0.363419	0.239046	0.033898	0.230308	0.114914	0.263706	0.380321	0.010751
8	365.35	0.00	41.20	64.40	0.00	0.00	0.000	0.192361	0.164529	0.350527	0.275973	0.016610	0.249573	0.091725	0.241717	0.411909	0.005075
9	368.95	0.00	41.20	64.50	0.00	0.00	0.000	0.222517	0.128225	0.316034	0.325490	0.007734	0.270169	0.067951	0.206243	0.453367	0.002270
10	372.85	0.00	41.30	64.70	0.00	0.00	0.000	0.254716	0.091046	0.260523	0.390366	0.003350	0.288076	0.045713	0.160310	0.504959	0.000942
11	377.05	0.00	41.50	23.20	0.00	0.00	0.817	0.282692	0.056287	0.188694	0.471051	0.001276	0.297716	0.026780	0.109483	0.565678	0.000344

Table A-59 The error calculated by PR on case VI

Stage No	2-methyl butane	isobutane	n-butane	n-pentane	propane	Total mass balance
1	-0.0034	0.0032	-0.0058	-0.0019	0.0480	0.0402
2	-0.0055	0.0039	0.0009	-0.0040	0.0139	0.0152
3	-0.0101	0.0151	0.0045	-0.0081	0.0294	0.0308
4	-0.0076	0.0131	0.0085	-0.0088	0.0130	0.0183
5	-0.0017	0.0030	0.0050	-0.0036	-0.0045	-0.0019
6	-0.0016	0.0015	-0.0079	0.0021	0.0237	0.0178
7	-0.0081	0.0134	0.0053	-0.0071	0.0166	0.0200
8	-0.0103	0.0180	0.0156	-0.0135	0.0089	0.0186
9	-0.0085	0.0163	0.0186	-0.0161	0.0022	0.0125
10	-0.0028	0.0080	0.0138	-0.0117	0.0018	0.0091
11	0.0002	-0.0008	-0.0007	0.0006	-0.0011	-0.0018
overall	-0.0594	0.1007	0.0577	-0.0721	0.1518	0.1788

Table A-60 The error calculated by SRK on case VI

Stage No.	2-methyl butane	isobutane	n-butane	n-pentane	propane	Total mass balance
1	-0.0034	0.0032	-0.0062	-0.0019	0.0500	0.0417
2	-0.0063	0.0103	0.0009	-0.0043	0.0161	0.0167
3	-0.0102	0.0170	0.0048	-0.0089	0.0298	0.0326
4	-0.0088	0.0142	0.0093	-0.0094	0.0156	0.0208
5	-0.0017	0.0034	0.0052	-0.0040	-0.0035	-0.0007
6	-0.0024	0.0021	-0.0079	0.0019	0.0269	0.0205
7	-0.0083	0.0138	0.0056	-0.0071	0.0138	0.0177
8	-0.0108	0.0191	0.0171	-0.0148	0.0101	0.0207
9	-0.0091	0.0169	0.0198	-0.0168	-0.0152	-0.0044
10	-0.0027	0.0088	0.0134	-0.0118	0.0185	0.0262
11	0.0006	-0.0013	-0.0003	0.0005	-0.0012	-0.0017
overall	-0.0633	0.1075	0.0616	-0.0766	0.1608	0.1899

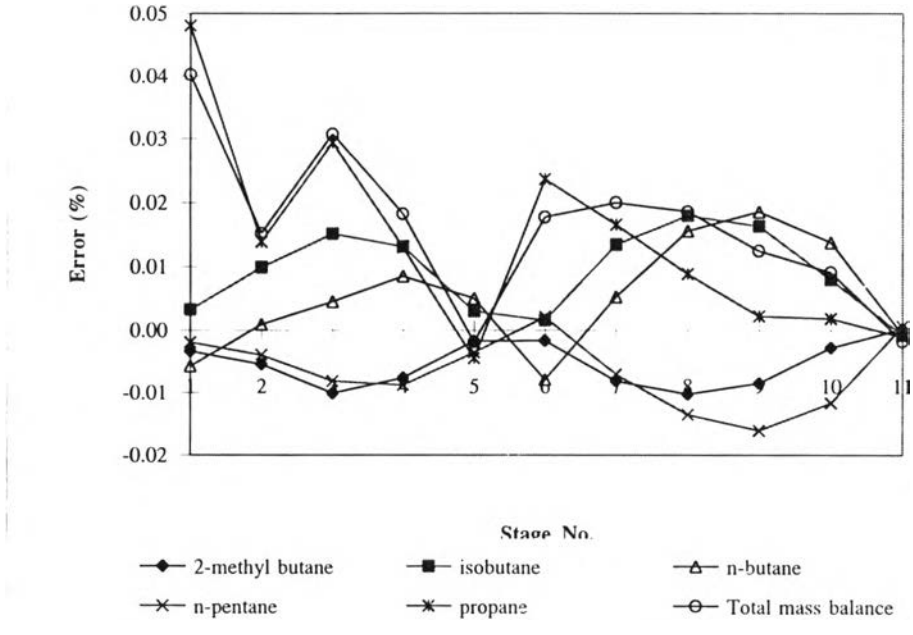

Figure A-1 The materail balance relative error of case VI using PR model

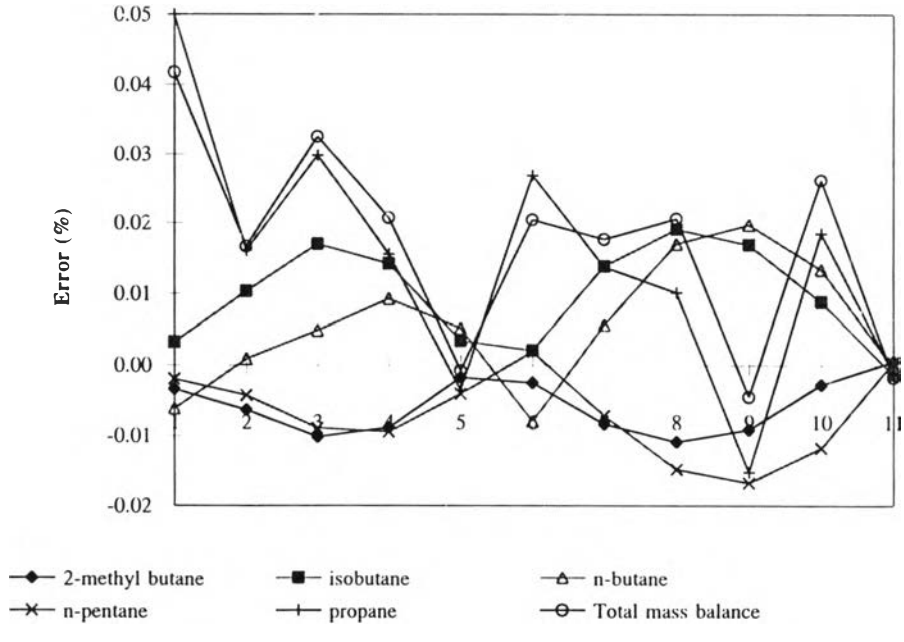

Figure A-2 The materail balance relative error of case VI using SRK model

Table A-61 Comparison of temperature profile for case VI

Stage No.	Temperature (K)				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	329.57	328.99	329.45	328.85	-0.04	-0.04
2	338.97	338.36	339.05	338.35	0.02	0.00
3	345.93	345.29	346.05	345.45	0.03	0.05
4	351.78	351.17	351.95	351.45	0.05	0.08
5	356.67	356.1	356.85	356.45	0.05	0.10
6	359.14	358.6	359.35	358.95	0.06	0.10
7	362.39	361.86	362.45	362.05	0.02	0.05
8	365.69	365.18	365.65	365.35	-0.01	0.05
9	369.3	368.81	369.15	368.95	-0.04	0.04
10	373.25	372.75	373.15	372.85	-0.03	0.03
11	377.33	376.82	377.25	377.05	-0.02	0.06

Table A-62 Comparison of vapor composition of 2-methyl butane profile for case VI

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.014681	0.014146	0.014558	0.012414	-0.8449	-13.9520
2	0.039658	0.038737	0.039413	0.035230	-0.6216	-9.9546
3	0.072834	0.071791	0.072506	0.067055	-0.4524	-7.0629
4	0.107871	0.107061	0.107553	0.102144	-0.2957	-4.8138
5	0.137268	0.136862	0.137041	0.132750	-0.1656	-3.0976
6	0.149501	0.149295	0.149407	0.146122	-0.0629	-2.1715
7	0.171929	0.172027	0.170091	0.166962	-1.0806	-3.0336
8	0.19837	0.198812	0.195091	0.192361	-1.6808	-3.3536
9	0.228576	0.229352	0.224500	0.222517	-1.8156	-3.0717
10	0.259311	0.2603	0.255478	0.254716	-1.5003	-2.1922
11	0.283962	0.284912	0.281572	0.282692	-0.8488	-0.7853

Table A-63 Comparison of liquid composition of 2-methyl butane profile for case VI

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.039665	0.038744	0.039413	0.035230	-0.6394	-9.9745
2	0.086173	0.085082	0.085731	0.079789	-0.5156	-6.6337
3	0.136133	0.135368	0.135644	0.129810	-0.3605	-4.2816
4	0.178684	0.178499	0.178356	0.174181	-0.1839	-2.4790
5	0.206338	0.206596	0.206324	0.204456	-0.0068	-1.0467
6	0.214255	0.214602	0.214548	0.214196	0.1366	-0.1895
7	0.231631	0.232190	0.230460	0.230308	-0.5081	-0.8172
8	0.251397	0.252154	0.249303	0.249573	-0.8399	-1.0342
9	0.271412	0.272284	0.269174	0.270169	-0.8314	-0.7828
10	0.287395	0.288222	0.285920	0.288076	-0.5159	-0.0507
11	0.293677	0.294256	0.293756	0.297716	0.0269	1.1622

Table A-64 Comparison of vapor composition of n-butane profile for case VI

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.315236	0.31438	0.312817	0.31264	-0.7733	-0.5566
2	0.416745	0.417452	0.415342	0.41751	-0.3378	0.0139
3	0.445908	0.447563	0.444778	0.44841	-0.2541	0.1889
4	0.426507	0.428326	0.425021	0.428578	-0.3496	0.0588
5	0.38494	0.386282	0.382948	0.38536	-0.5202	-0.2393
6	0.356533	0.357417	0.354346	0.356006	-0.6172	-0.3963
7	0.362277	0.363162	0.361763	0.363419	-0.1421	0.0707
8	0.347928	0.348507	0.349453	0.350527	0.4364	0.5763
9	0.312733	0.312782	0.316027	0.316034	1.0423	1.0290
10	0.257675	0.257132	0.26173	0.260523	1.5493	1.3016
11	0.187307	0.186332	0.19075	0.188694	1.8050	1.2518

Table A-65 Comparison of liquid composition of n-butane profile for case VI

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.41676	0.417468	0.415342	0.41751	-0.3414	0.0101
2	0.457625	0.45966	0.45654	0.460774	-0.2377	0.2413
3	0.430539	0.432817	0.42901	0.433155	-0.3564	0.0780
4	0.371433	0.373042	0.36924	0.371702	-0.5939	-0.3605
5	0.308612	0.30922	0.306013	0.306612	-0.8493	-0.8506
6	0.274476	0.274508	0.271841	0.271686	-0.9693	-1.0387
7	0.264799	0.264625	0.2642	0.263706	-0.2267	-0.3485
8	0.241569	0.241064	0.242824	0.241717	0.5168	0.2702
9	0.205579	0.204728	0.208023	0.206243	1.1749	0.7346
10	0.159886	0.15881	0.162512	0.16031	1.6159	0.9357
11	0.109706	0.108621	0.111629	0.109483	1.7227	0.7873

Table A-66 Comparison of vapor composition of n-pentane profile for case V

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.009343	0.008881	0.009665	0.009407	3.3316	5.5916
2	0.031049	0.029994	0.032027	0.031638	3.0537	5.1963
3	0.067423	0.065873	0.069311	0.06917	2.7240	4.7665
4	0.116615	0.114985	0.119410	0.119925	2.3407	4.1192
5	0.171884	0.17066	0.175215	0.176339	1.9011	3.2205
6	0.206197	0.205404	0.209543	0.210623	1.5968	2.4779
7	0.235784	0.235306	0.237137	0.239046	0.5706	1.5646
8	0.273554	0.273449	0.273110	0.275973	-0.1626	0.9146
9	0.323653	0.323963	0.312804	0.32549	-3.4683	0.4691
10	0.389111	0.389816	0.386534	0.390366	-0.6667	0.1409
11	0.471134	0.472127	0.468496	0.471051	-0.5631	-0.2284

Table A-67 Comparison of liquid composition of n-pentane profile for case V

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.031056	0.030001	0.032027	0.031638	3.0318	5.1742
2	0.08205	0.080301	0.084209	0.084187	2.5639	4.6159
3	0.15207	0.150203	0.155433	0.15643	2.1636	3.9807
4	0.231647	0.230355	0.23581	0.237813	1.7654	3.1361
5	0.308262	0.307918	0.312482	0.314644	1.3505	2.1377
6	0.351673	0.351981	0.355514	0.35704	1.0804	1.4169
7	0.376704	0.377243	0.378255	0.380321	0.4100	0.8080
8	0.409701	0.410492	0.409413	0.411909	-0.0703	0.3440
9	0.452496	0.453497	0.4509	0.453367	-0.3540	-0.0287
10	0.505766	0.506891	0.503446	0.504959	-0.4608	-0.3826
11	0.569142	0.570285	0.566425	0.565678	-0.4797	-0.8144

Table A-68 Comparison of vapor composition of propane profile for case VI

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.320276	0.321607	0.3229	0.323625	0.8126	0.6236
2	0.162524	0.162668	0 163079	0.163254	0.3403	0.3589
3	0.097652	0.097548	0.09747	0.097504	-0.1867	-0.0451
4	0.075152	0.075052	0.074872	0.074915	-0.3740	-0.1829
5	0.067861	0.067786	0.067669	0.067738	-0.2837	-0.0709
6	0.066254	0.066186	0.066112	0.066182	-0.2148	-0.0060
7	0.033896	0.033697	0.034023	0.033898	0.3733	0.5930
8	0.016628	0.016449	0.016761	0.01661	0.7935	0.9693
9	0.00777	0.007648	0.007851	0.007734	1.0317	1.1120
10	0.003388	0.00331	0.003423	0.00335	1.0225	1.1940
11	0.001305	0.001272	0.001312	0.001276	0.5335	0.3135

Table A-69 Comparison of liquid composition of propane profile for case VI

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.162499	0.162642	0.163079	0.163254	0.3557	0.3749
2	0.071579	0.071376	0.071252	0.071196	-0.4589	-0.2528
3	0.038963	0.038764	0.038509	0.03839	-1.1789	-0.9742
4	0.027702	0.027533	0.027294	0.027159	-1.4948	-1.3771
5	0.023485	0.023328	0.023142	0.023001	-1.4822	-1.4217
6	0.022235	0.022078	0.02192	0.021777	-1.4370	-1.3822
7	0.010949	0.010817	0.010881	0.010751	-0.6249	-0.6139
8	0.005171	0.005082	0.005167	0.005075	-0.0774	-0.1379
9	0.002321	0.00227	0.002326	0.00227	0.2150	0.0000
10	0.00097	0.000944	0.000971	0.000942	0.1030	-0.2123
11	0.000358	0.000347	0.000357	0.000344	-0.2801	-0.8721

Table A-70 The results of case VII calculated by simulator using PR model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	333 89	0 00	0 000001	31 412224	0 00	12.18	792034 4	0 028609	0 328321	0 358077	0 019750	0 265243	0 069863	0 311152	0 434107	0 059033	0 125845
2	344 37	0 00	43 592224	30 227320	0 00	0 00	0 0	0 069849	0 311165	0 434096	0 059017	0 125872	0 134977	0 244756	0 431099	0 137879	0 051289
3	352 21	0 00	42 407322	29 400988	10 00	0 00	0 0	0 116241	0 263863	0 431969	0 115188	0 072739	0 190875	0 182323	0 373420	0 226718	0 026664
4	357 02	0 00	51 580990	28 960482	0 00	0 00	0 0	0 147774	0 228614	0 399136	0 165416	0 059060	0 220579	0 146454	0 318150	0 294461	0 020356
5	359 88	0 00	51 140484	28 728022	0 00	0 00	0 0	0 164209	0 208719	0 368087	0 203214	0 055772	0 232003	0 128022	0 280025	0 341393	0 018557
6	361 51	45 36	50 908024	76 716896	0 00	0 00	0 0	0 170359	0 198604	0 346813	0 229269	0 054915	0 233409	0 118875	0 257003	0 372799	0 017913
7	365 58	0 00	53 536900	76 377701	0 00	0 00	0 0	0 202534	0 163432	0 335993	0 272460	0 025581	0 257193	0 092243	0 233655	0 408946	0 007963
8	369 48	0 00	53 197704	76 087296	0 00	0 00	0 0	0 236458	0 125512	0 303018	0 323661	0 011352	0 279881	0 067085	0 198659	0 450991	0 003384
9	373 28	0 00	52 907299	75 883224	0 00	0 00	0 0	0 268953	0 089541	0 253123	0 383596	0 004787	0 297901	0 045470	0 156987	0 498272	0 001371
10	376 86	0 00	52 703224	75 776718	0 00	0 00	0 0	0 294846	0 058523	0 193377	0 451360	0 001894	0 307329	0 028363	0 114009	0 549776	0 000523
11	380 09	0 00	52 596718	23 179998	0 00	0 00	-1054483 0	0 308424	0 033910	0 131552	0 525440	0 000674	0 304844	0 015781	0 074208	0 604988	0 000180

Table A-71 The results of case VII calculated by simulator using SRK model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	333.30	0.00	0.000001	31.412224	0.00	12.18	79763.9	0.027978	0.328760	0.357767	0.019078	0.266416	0.069158	0.311803	0.435241	0.057861	0.125938
2	343.78	0.00	43.592224	30.227503	0.00	0.00	0.0	0.069143	0.311816	0.435230	0.057844	0.125967	0.134737	0.244908	0.432699	0.136563	0.051093
3	351.64	0.00	42.407505	29.399778	10.00	0.00	0.0	0.115865	0.264160	0.433436	0.113911	0.072627	0.191306	0.181943	0.374400	0.225871	0.026480
4	356.48	0.00	51.579781	28.959494	0.00	0.00	0.0	0.147776	0.228612	0.400249	0.164404	0.058959	0.221371	0.145813	0.318389	0.294227	0.020201
5	359.35	0.00	51.139496	28.727575	0.00	0.00	0.0	0.164410	0.208574	0.368784	0.202545	0.055687	0.232853	0.127287	0.279775	0.341672	0.018413
6	361.00	45.36	50.907578	76.582405	0.00	0.00	0.0	0.170631	0.198409	0.347237	0.228887	0.054837	0.234150	0.118115	0.256498	0.373463	0.017773
7	365.10	0.00	53.402405	76.233452	0.00	0.00	0.0	0.203283	0.162664	0.336007	0.272644	0.025402	0.258230	0.091238	0.232701	0.409976	0.007855
8	369.02	0.00	53.053455	75.936813	0.00	0.00	0.0	0.237654	0.124370	0.302380	0.324390	0.011207	0.281077	0.066024	0.197295	0.452286	0.003318
9	372.82	0.00	52.756817	75.729897	0.00	0.00	0.0	0.270402	0.088292	0.251865	0.384742	0.004699	0.299060	0.044521	0.155412	0.499670	0.001336
10	376.38	0.00	52.549900	75.618607	0.00	0.00	0.0	0.296266	0.057409	0.191766	0.452710	0.001849	0.308257	0.027630	0.112485	0.551121	0.000507
11	379.57	0.00	52.438606	23.179998	0.00	0.00	-1058315.9	0.309523	0.033085	0.129961	0.526776	0.000654	0.305390	0.015294	0.072955	0.606187	0.000174

Table A-72 The results of case VII calculated by HYSIM using PR model

Stage No.	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	333.75	0.00	0.00	31.40	0.00	12.18	-0.787	0.027964	0.328215	0.356301	0.02007	0.26745	0.068523	0.311548	0.433808	0.053872	0.126249
2	344.35	0.00	43.60	30.30	0.00	0.00	0.000	0.068523	0.311548	0.433808	0.059872	0.126249	0.132909	0.244969	0.431572	0.139499	0.051051
3	352.25	0.00	42.50	29.50	10.00	0.00	0.000	0.114457	0.26405	0.432213	0.116679	0.072801	0.188733	0.182187	0.373689	0.229018	0.026373
4	357.15	0.00	51.70	29.10	0.00	0.00	0.000	0.146035	0.228509	0.399178	0.167425	0.058854	0.218892	0.146047	0.317851	0.297129	0.020082
5	359.95	0.00	51.30	28.90	0.00	0.00	0.000	0.162783	0.208398	0.367716	0.205543	0.055559	0.230903	0.127446	0.279216	0.344149	0.018288
6	361.65	45.36	51.00	74.90	0.00	0.00	0.000	0.16933	0.198153	0.34609	0.231729	0.054699	0.232829	0.118205	0.255853	0.375469	0.017644
7	365.55	0.00	51.70	75.10	0.00	0.00	0.000	0.200007	0.164096	0.337066	0.273351	0.02548	0.255629	0.092453	0.234214	0.409805	0.007854
8	369.45	0.00	51.90	75.20	0.00	0.00	0.000	0.233129	0.126648	0.30542	0.323519	0.011284	0.278088	0.067606	0.200159	0.450816	0.003332
9	373.25	0.00	52.10	75.50	0.00	0.00	0.000	0.26566	0.090627	0.255969	0.383006	0.004738	0.29659	0.045946	0.158611	0.49751	0.001343
10	376.85	0.00	52.30	75.80	0.00	0.00	0.000	0.292418	0.059264	0.195755	0.450702	0.001861	0.307055	0.028652	0.115191	0.548593	0.000508
11	380.15	0.00	52.60	23.20	0.00	0.00	1.019	0.307519	0.034269	0.132979	0.524578	0.000656	0.306004	0.015895	0.074794	0.603134	0.000173

Table A-73 The results of case VII calculated by HYSIM using SRK model

Stage No.	temp.	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	333.15	0.00	0.00	31.40	0.00	12.18	-0.794	0.024856	0.329780	0.357100	0.020030	0.268233	0.063601	0.312896	0.436636	0.060515	0.126352
2	343.75	0.00	43.60	30.30	0.00	0.00	0.000	0.063601	0.312896	0.436636	0.060515	0.126352	0.127573	0.245065	0.434498	0.142003	0.050861
3	351.85	0.00	42.40	29.40	10.00	0.00	0.000	0.109215	0.264530	0.435112	0.118619	0.072525	0.184714	0.181152	0.374773	0.233204	0.026157
4	356.75	0.00	51.60	29.00	0.00	0.00	0.000	0.141494	0.228409	0.401069	0.170234	0.058794	0.216483	0.144600	0.317410	0.301617	0.019891
5	359.65	0.00	51.20	28.80	0.00	0.00	0.000	0.159130	0.208096	0.368790	0.208466	0.055517	0.229873	0.125964	0.278073	0.347979	0.018111
6	361.35	45.36	51.00	74.60	0.00	0.00	0.000	0.166460	0.197829	0.346782	0.234272	0.054657	0.232891	0.116803	0.254537	0.378295	0.017474
7	365.35	0.00	51.40	74.80	0.00	0.00	0.000	0.197753	0.162698	0.336794	0.277478	0.025278	0.256207	0.090590	0.231936	0.413551	0.007715
8	369.35	0.00	51.70	75.00	0.00	0.00	0.000	0.231692	0.124513	0.303679	0.329013	0.011103	0.279297	0.065622	0.196993	0.454843	0.003244
9	373.15	0.00	51.90	75.30	0.00	0.00	0.000	0.265199	0.088252	0.252837	0.389091	0.004621	0.298596	0.044164	0.135010	0.500934	0.001296
10	376.75	0.00	52.10	75.70	0.00	0.00	0.000	0.293155	0.057132	0.191889	0.456025	0.001800	0.310191	0.027282	0.111773	0.550267	0.000487
11	379.95	0.00	52.50	23.20	0.00	0.00	1.027	0.309908	0.032704	0.129301	0.527458	0.000629	0.310832	0.015002	0.072080	0.601921	0.000165

Table A-74 Show the error calculated by PR for case VII

Stage No.	2-methyl butane	isobutane	n-butane	n-pentane	propane	Total mass balance
1	-0.0067	0.0083	-0.0042	-0.0044	0.0519	0.0449
2	-0.0093	0.0148	0.0065	-0.0077	0.0162	0.0205
3	-0.0162	0.0239	0.0136	-0.0151	0.0308	0.0370
4	-0.0084	0.0140	0.0128	-0.0117	0.0116	0.0183
5	0.0004	0.0016	0.0056	-0.0041	-0.0079	-0.0045
6	-0.0117	0.0177	0.0049	-0.0088	0.0348	0.0368
7	-0.0156	0.0253	0.0201	-0.0190	0.0179	0.0287
8	-0.0113	0.0208	0.0247	-0.0209	0.0037	0.0169
9	-0.0060	0.0130	0.0201	-0.0170	-0.0002	0.0100
10	0.0007	0.0053	0.0094	-0.0091	0.0015	0.0078
11	0.0001	-0.0015	-0.0010	0.0011	0.0004	-0.0009
overall	-0.0840	0.1431	0.1124	-0.1167	0.1607	0.2155

Table A-75 Show the error calculated by SRK for case VII

Stage No.	2-methyl butane	isobutane	n-butane	n-pentane	propane	Total mass balance
1	-0.0072	0.0083	-0.0042	-0.0047	0.0557	0.0479
2	-0.0100	0.0159	0.0068	-0.0081	0.0144	0.0190
3	-0.0169	0.0245	0.0140	-0.0155	0.0353	0.0413
4	-0.0093	0.0151	0.0138	-0.0125	0.0092	0.0162
5	0.0006	0.0026	0.0061	-0.0045	-0.0060	-0.0011
6	-0.0119	0.0183	0.0054	-0.0096	0.0340	0.0362
7	-0.0158	0.0258	0.0208	-0.0191	0.0144	0.0261
8	-0.0126	0.0218	0.0259	-0.0222	0.0084	0.0213
9	-0.0054	0.0134	0.0203	-0.0170	0.0019	0.0133
10	0.0003	0.0047	0.0094	-0.0095	-0.0015	0.0034
11	0.0008	-0.0015	-0.0010	0.0012	0.0005	-0.0001
overall	-0.0875	0.1488	0.1174	-0.1214	0.1663	0.2236

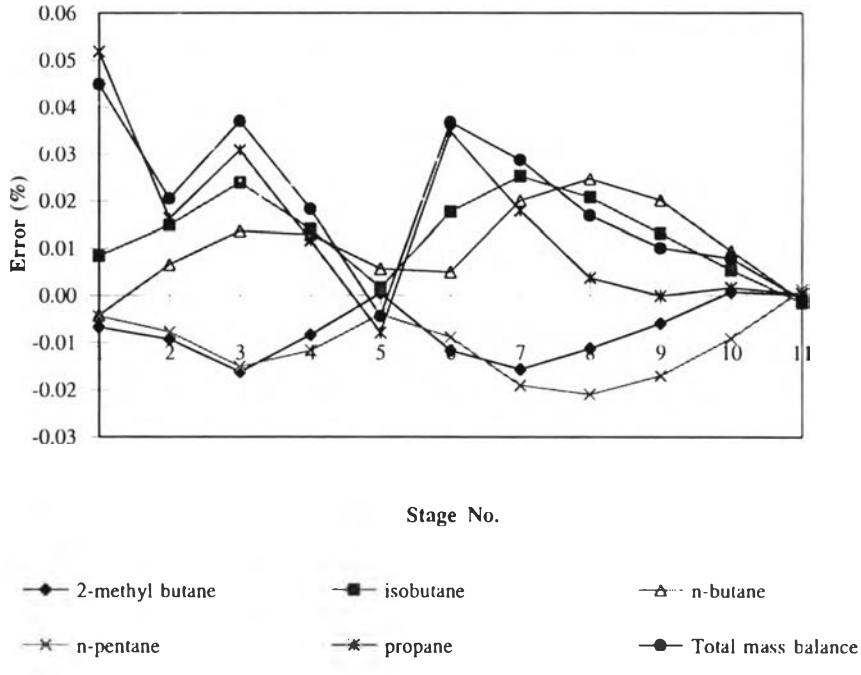

Figure A-3 The material balance relative error of case VII using PR model

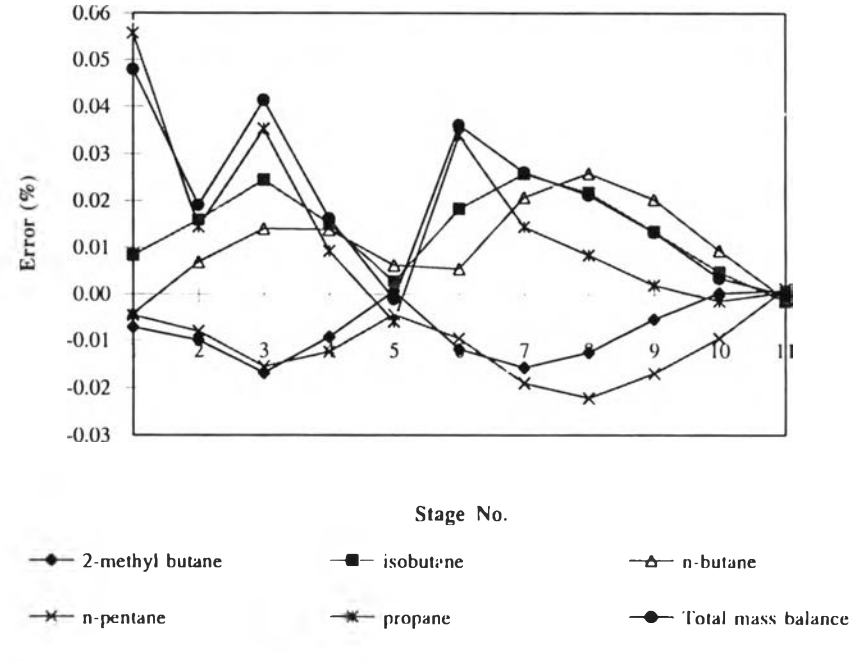

Figure A-4 The material balance relative error of case VII using SRK model

Table A-76 Temperature profile (Case VII)

Stage No.	Temperature				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	333.89	333.30	333.75	333.15	-0.04	-0.05
2	344.37	343.78	344.35	343.75	-0.01	-0.01
3	352.21	351.64	352.25	351.85	0.01	0.06
4	357.02	356.48	357.15	356.75	0.04	0.08
5	359.88	359.35	359.95	359.65	0.02	0.08
6	361.51	361.00	361.65	361.35	0.04	0.10
7	365.58	365.10	365.55	365.35	-0.01	0.07
8	369.48	369.02	369.45	369.35	-0.01	0.09
9	373.28	372.82	373.25	373.15	-0.01	0.09
10	376.86	376.38	376.85	376.75	0.00	0.10
11	380.09	379.57	380.15	379.95	0.02	0.10

Table A-77 Vapor composition of 2-methyl butane for case VII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.028609	0.027978	0.027964	0.024856	-2.3065	-12.5603
2	0.069849	0.069143	0.068523	0.063601	-1.9351	-8.7137
3	0.116241	0.115865	0.114457	0.109215	-1.5587	-6.0889
4	0.147774	0.147776	0.146035	0.141494	-1.1908	-4.4398
5	0.164209	0.164410	0.162783	0.15913	-0.8760	-3.3180
6	0.170399	0.170631	0.16933	0.16646	-0.6313	-2.5057
7	0.202534	0.203283	0.200007	0.197753	-1.2635	-2.7964
8	0.236458	0.237654	0.233129	0.231692	-1.4280	-2.5732
9	0.268953	0.270402	0.26566	0.265199	-1.2396	-1.9619
10	0.294846	0.296266	0.292418	0.293155	-0.8303	-1.0612
11	0.308424	0.309523	0.307519	0.309908	-0.2943	0.1242

Table A-78 Vapor composition of i-butane for case VII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST'	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.328321	0.328760	0.328215	0.32978	-0.0323	0.3093
2	0.311165	0.311816	0.311548	0.312896	0.1229	0.3452
3	0.263863	0.264160	0.26405	0.26453	0.0708	0.1399
4	0.228614	0.228612	0.228509	0.228409	-0.0460	-0.0889
5	0.208719	0.208574	0.208398	0.208096	-0.1540	-0.2297
6	0.198604	0.198409	0.198153	0.197829	-0.2276	-0.2932
7	0.163432	0.162664	0.164096	0.162698	0.4046	0.0209
8	0.125512	0.124370	0.126648	0.124513	0.8970	0.1148
9	0.089541	0.088292	0.090627	0.088252	1.1983	-0.0453
10	0.058523	0.057409	0.059264	0.057132	1.2503	-0.4848
11	0.03391	0.033085	0.034269	0.032704	1.0476	-1.1650

Table A-79 Vapor composition of n-butane for case VII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.358077	0.357767	0.356301	0.3571	-0.4985	-0.1868
2	0.434096	0.435230	0.433808	0.436636	-0.0664	0.3220
3	0.431969	0.433436	0.432213	0.435112	0.0565	0.3852
4	0.399136	0.400249	0.399178	0.401069	0.0105	0.2045
5	0.368087	0.368784	0.367716	0.36879	-0.1009	0.0016
6	0.346813	0.347237	0.34609	0.346782	-0.2089	-0.1312
7	0.335993	0.336007	0.337066	0.336794	0.3183	0.2337
8	0.303018	0.302380	0.30542	0.303679	0.7865	0.4278
9	0.253123	0.251865	0.255969	0.252837	1.1119	0.3844
10	0.193377	0.191766	0.195755	0.191889	1.2148	0.0641
11	0.131552	0.129961	0.132979	0.129301	1.0731	-0.5104

Table A-80 Vapor composition of n-pentane for case VII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.01975	0.019078	0.02007	0.02003	1.5944	4.7529
2	0.059017	0.057844	0.059872	0.060515	1.4280	4.4138
3	0.115188	0.113911	0.116679	0.118619	1.2779	3.9690
4	0.165416	0.164404	0.167425	0.170234	1.1999	3.4247
5	0.203214	0.202545	0.205543	0.208466	1.1331	2.8403
6	0.229269	0.228887	0.231729	0.234272	1.0616	2.2986
7	0.272460	0.272644	0.273351	0.277478	0.3260	1.7421
8	0.323661	0.324390	0.323519	0.329013	-0.0439	1.4051
9	0.383596	0.384742	0.383006	0.389091	-0.1540	1.1177
10	0.451360	0.452710	0.450702	0.456025	-0.1460	0.7269
11	0.525440	0.526776	0.524578	0.527458	-0.1643	0.1293

Table A-81 Vapor composition of propane for case VII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.265243	0.266416	0.26745	0.268233	0.8252	0.6774
2	0.125872	0.125967	0.126249	0.126352	0.2986	0.3047
3	0.072739	0.072627	0.072601	0.072525	-0.1901	-0.1406
4	0.05906	0.058959	0.058854	0.058794	-0.3500	-0.2806
5	0.055772	0.055687	0.055559	0.055517	-0.3834	-0.3062
6	0.054915	0.054837	0.054699	0.054657	-0.3949	-0.3293
7	0.025581	0.025402	0.02548	0.025278	-0.3964	-0.4905
8	0.011352	0.011207	0.011284	0.011103	-0.6026	-0.9367
9	0.004787	0.004699	0.004738	0.004621	-1.0342	-1.6879
10	0.001894	0.001849	0.001861	0.0018	-1.7732	-2.7222
11	0.000674	0.000654	0.000656	0.000629	-2.7439	-3.9746

Table A-82 Liquid composition of propane for case VII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.125845	0.125938	0.126249	0.126352	0.3200	0.3277
2	0.051289	0.051093	0.051051	0.050861	-0.4662	-0.4561
3	0.026664	0.026480	0.026373	0.026157	-1.1034	-1.2349
4	0.020356	0.020201	0.020082	0.019891	-1.3644	-1.5585
5	0.018557	0.018413	0.018288	0.018111	-1.4709	-1.6675
6	0.017913	0.017773	0.017644	0.017474	-1.5246	-1.7111
7	0.007963	0.007855	0.007854	0.007715	-1.3878	-1.8146
8	0.003384	0.003318	0.003332	0.003244	-1.5606	-2.2811
9	0.001371	0.001336	0.001343	0.001296	-2.0849	-3.0864
10	0.000523	0.000507	0.000508	0.000487	-2.9528	-4.1068
11	0.00018	0.000174	0.000173	0.000165	-4.0462	-5.4545

Table A-83 Liquid composition of 2-methyl butane for case VII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.069863	0.069158	0.068523	0.063601	-1.9555	-8.7373
2	0.134977	0.134737	0.132909	0.127573	-1.5560	-5.6156
3	0.190875	0.191306	0.188733	0.184714	-1.1349	-3.5688
4	0.220579	0.221371	0.218892	0.216483	-0.7707	-2.2579
5	0.232003	0.232853	0.230903	0.229873	-0.4764	-1.2964
6	0.233409	0.234150	0.232829	0.232891	-0.2491	-0.5406
7	0.257193	0.258230	0.255629	0.256207	-0.6118	-0.7896
8	0.279881	0.281077	0.278088	0.279297	-0.6448	-0.6373
9	0.297901	0.299060	0.29659	0.298596	-0.4420	-0.1554
10	0.307329	0.308257	0.307055	0.310191	-0.0892	0.6235
11	0.304844	0.305390	0.306004	0.310832	0.3791	1.7508

Table A-84 Liquid composition of iso-butane for case VII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.311152	0.311803	0.311548	0.312896	0.1271	0.3493
2	0.244756	0.244908	0.244969	0.245065	0.0869	0.0641
3	0.182323	0.181943	0.182187	0.181152	-0.0746	-0.4366
4	0.146454	0.145813	0.146047	0.1446	-0.2787	-0.8389
5	0.128022	0.127287	0.127446	0.125964	-0.4520	-1.0503
6	0.118875	0.118115	0.118205	0.116803	-0.5668	-1.1233
7	0.092243	0.091238	0.092453	0.09059	0.2271	-0.7153
8	0.067085	0.066024	0.067606	0.065622	0.7706	-0.6126
9	0.04547	0.044521	0.045946	0.044164	1.0360	-0.8084
10	0.028363	0.027630	0.028652	0.027282	1.0087	-1.2756
11	0.015781	0.015294	0.015895	0.015002	0.7172	-1.9464

Table A-85 Liquid composition of n-butane for case VII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.434107	0.435241	0.433808	0.436636	-0.0689	0.3195
2	0.431099	0.432699	0.431572	0.434498	0.1096	0.4140
3	0.37342	0.374400	0.373689	0.374773	0.0720	0.0995
4	0.31815	0.318389	0.317851	0.31741	-0.0941	-0.3084
5	0.280025	0.279775	0.279216	0.278073	-0.2897	-0.6121
6	0.257003	0.256498	0.255853	0.254537	-0.4495	-0.7704
7	0.233655	0.232701	0.234214	0.231936	0.2387	-0.3298
8	0.198659	0.197295	0.200159	0.196993	0.7494	-0.1533
9	0.156987	0.155412	0.158611	0.15501	1.0239	-0.2593
10	0.114009	0.112485	0.115191	0.111773	1.0261	-0.6370
11	0.074208	0.072955	0.074794	0.07208	0.7835	-1.2139

Table A-86 Liquid composition of n-pentane for case VII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.059033	0.057861	0.053872	0.060515	-9.5801	4.3857
2	0.137879	0.136563	0.139499	0.142003	1.1613	3.8309
3	0.226718	0.225871	0.229018	0.233204	1.0043	3.1445
4	0.294461	0.294227	0.297129	0.301617	0.8979	2.4501
5	0.341393	0.341672	0.344149	0.347979	0.8008	1.8125
6	0.372799	0.373463	0.375469	0.378295	0.7111	1.2773
7	0.408946	0.409976	0.409805	0.413551	0.2096	0.8645
8	0.450991	0.452286	0.450816	0.454843	-0.0388	0.5622
9	0.498272	0.499670	0.49751	0.500934	-0.1532	0.2523
10	0.549776	0.551121	0.548593	0.550267	-0.2156	-0.1552
11	0.604988	0.606187	0.603134	0.601921	-0.3074	-0.7087

Table A-87 The results of case VIII calculated by simulator using PR model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	335 80	0 00	0 000001	57 202225	0 00	22 18	1445303 8	0 033085	0 326271	0 400502	0 019230	0 220912	0 077259	0 298526	0 467507	0 054829	0 101880
2	345 32	0 00	79 382225	55 197952	0 00	0 00	0 0	0 077235	0 298548	0 467495	0 054806	0 101916	0 146220	0 231130	0 456351	0 125292	0 041007
3	352 54	0 00	77 377953	54 298470	0 00	0 00	10000 0	0 126393	0 250509	0 459566	0 105028	0 058504	0 206128	0 172225	0 395067	0 205215	0 021365
4	358 12	0 00	76 478470	53 393074	0 00	0 00	0 0	0 168634	0 208974	0 416153	0 161452	0 044788	0 246360	0 131670	0 325798	0 280936	0 015236
5	362 16	0 00	75 573074	52 864677	0 00	0 00	0 0	0 196564	0 180807	0 367534	0 214343	0 040752	0 265954	0 107236	0 269621	0 343988	0 013201
6	364 86	45 36	75 044678	100 508942	0 00	0 00	0 0	0 210903	0 163959	0 328301	0 258239	0 039498	0 270226	0 093484	0 230833	0 393062	0 012394
7	369 90	0 00	77 328941	100 080574	0 00	0 00	0 0	0 255885	0 119349	0 287725	0 320955	0 016086	0 300629	0 063427	0 187460	0 443709	0 004774
8	374 17	0 00	76 900574	99 851593	0 00	0 00	0 0	0 295352	0 080403	0 231652	0 386401	0 006192	0 322180	0 040357	0 141860	0 493846	0 001757
9	377 68	0 00	76 671593	99 766922	0 00	0 00	0 0	0 323397	0 050423	0 172435	0 451477	0 002268	0 332566	0 024191	0 100537	0 542084	0 000621
10	380 44	0 00	76 586922	99 757004	0 00	0 00	0 0	0 336930	0 029380	0 118658	0 514242	0 000789	0 331102	0 013616	0 066623	0 588449	0 000216
11	382 57	0 00	76 577003	23 179998	0 00	0 00	-1534513 9	0 335027	0 015605	0 074488	0 574626	0 000254	0 318138	0 007046	0 040651	0 634100	0 000066

Table A-88 The results of case VIII calculated by simulator using SRK model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	335 24	0 00	0 000001	57 202225	0 00	22 18	1455229 1	0 032557	0 326587	0 400355	0 018666	0 221835	0 076860	0 298794	0 468538	0 053930	0 101877
2	344 76	0 00	79 382225	55 196152	0 00	0 00	0 0	0 076836	0 298817	0 468525	0 053907	0 101915	0 146529	0 230817	0 457466	0 124394	0 040795
3	352 01	0 00	77 376152	54 295761	0 00	0 00	10000 0	0 126495	0 250365	0 460658	0 104127	0 058354	0 207229	0 171449	0 395385	0 204755	0 021184
4	357 63	0 00	76 475761	53 394669	0 00	0 00	0 0	0 169293	0 208506	0 416681	0 160858	0 044662	0 247914	0 130693	0 325252	0 281047	0 015094
5	361 68	0 00	75 574669	52 870537	0 00	0 00	0 0	0 197539	0 180201	0 367456	0 214151	0 040653	0 267551	0 106241	0 268546	0 344582	0 013080
6	364 39	45 36	75 050537	100 382454	0 00	0 00	0 0	0 211007	0 163340	0 327852	0 258388	0 039413	0 271606	0 092545	0 229553	0 394013	0 012283
7	369 45	0 00	77 202454	99 942207	0 00	0 00	0 0	0 257535	0 118253	0 206459	0 321805	0 015948	0 302220	0 062404	0 185696	0 444981	0 004700
8	373 72	0 00	76 762207	99 705849	0 00	0 00	0 0	0 297293	0 079184	0 229741	0 387683	0 006099	0 323692	0 039459	0 139940	0 495190	0 001719
9	377 20	0 00	76 525848	99 614731	0 00	0 00	0 0	0 325249	0 049355	0 170300	0 452876	0 002220	0 333790	0 023512	0 098774	0 543319	0 000604
10	379 93	0 00	76 434731	99 594460	0 00	0 00	0 0	0 338414	0 028588	0 116705	0 515525	0 000768	0 331929	0 013160	0 065205	0 569503	0 000203
11	382 02	0 00	76 414459	23 179998	0 00	0 00	-1541649 0	0 335994	0 015098	0 072963	0 575700	0 000246	0 318532	0 006773	0 039637	0 634994	0 000064

Table A-89 The results of case VIII calculated by HYSIM using PR model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	335.65	0.00	0.00	57.20	0.00	22.18	-1.429	0.031751	0.326585	0.399800	0.019274	0.222584	0.074479	0.299452	0.469007	0.054893	0.102170
2	345.15	0.00	79.40	55.40	0.00	0.00	0.000	0.074479	0.299452	0.469007	0.054893	0.102170	0.141880	0.232189	0.459609	0.125457	0.040864
3	352.45	0.00	77.60	54.50	0.00	0.00	-0.009	0.122603	0.251427	0.462297	0.105275	0.058398	0.201422	0.173039	0.398581	0.205779	0.021179
4	358.05	0.00	76.60	53.60	0.00	0.00	0.000	0.164675	0.209633	0.418968	0.162101	0.044624	0.242329	0.132084	0.328474	0.282056	0.015057
5	362.15	0.00	75.70	53.10	0.00	0.00	0.000	0.193165	0.181107	0.369637	0.215519	0.040573	0.263057	0.107277	0.271123	0.345523	0.013020
6	364.95	45.36	75.30	99.10	0.00	0.00	0.000	0.207472	0.163922	0.329450	0.259858	0.039297	0.268486	0.093244	0.231309	0.394757	0.012204
7	369.95	0.00	75.90	99.50	0.00	0.00	0.000	0.252708	0.119601	0.289624	0.322155	0.015912	0.298816	0.063414	0.188397	0.444700	0.004674
8	374.25	0.00	76.30	100.00	0.00	0.00	0.000	0.292336	0.080565	0.233356	0.387669	0.006074	0.320901	0.040321	0.142559	0.494514	0.001705
9	377.75	0.00	76.80	100.50	0.00	0.00	0.000	0.321127	0.050395	0.173404	0.452874	0.002200	0.332167	0.024090	0.100767	0.542380	0.000596
10	380.55	0.00	77.30	100.90	0.00	0.00	0.000	0.335770	0.029232	0.118878	0.515366	0.000756	0.331799	0.013490	0.066484	0.588028	0.000199
11	382.75	0.00	77.80	23.20	0.00	0.00	1.493	0.335270	0.015442	0.074268	0.574780	0.000240	0.320152	0.006941	0.040361	0.632484	0.000062

Table A-90 The results of case VIII calculated by HYSIM using SRK model

Stage No	temp	Feed	Interstage (kgmol/h)		Sidestream (kgmol/h)		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/h)	Vapor	Liquid	Vapor	Liquid	(MMBtu/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	335.05	0.00	0.00	57.20	0.00	22.18	-1.442	0.028417	0.327783	0.400777	0.019724	0.223299	0.069419	0.300082	0.471510	0.056779	0.102210
2	344.25	0.00	79.40	55.20	0.00	0.00	0.000	0.069419	0.300082	0.471510	0.056779	0.102210	0.136376	0.231335	0.461268	0.130361	0.040639
3	352.15	0.00	77.40	54.20	0.00	0.00	-0.009	0.117190	0.251049	0.464203	0.109277	0.058282	0.196886	0.171108	0.397750	0.213307	0.020949
4	357.95	0.00	76.40	53.30	0.00	0.00	0.000	0.159884	0.208547	0.419162	0.167869	0.044538	0.239196	0.129796	0.325636	0.290504	0.014867
5	362.05	0.00	75.50	52.90	0.00	0.00	0.000	0.189332	0.179809	0.368479	0.221859	0.040520	0.261347	0.105120	0.267528	0.353146	0.012859
6	364.75	45.36	75.10	98.70	0.00	0.00	0.000	0.204650	0.162714	0.327786	0.265596	0.039254	0.268179	0.091375	0.227838	0.400548	0.012060
7	369.95	0.00	75.50	99.20	0.00	0.00	0.000	0.250764	0.117450	0.286082	0.329960	0.015744	0.299068	0.061396	0.183925	0.451039	0.004571
8	374.25	0.00	76.00	99.70	0.00	0.00	0.000	0.291186	0.078163	0.228410	0.396294	0.005948	0.321725	0.038565	0.137871	0.500188	0.001650
9	377.75	0.00	76.50	100.30	0.00	0.00	0.000	0.320762	0.048297	0.168090	0.460719	0.002132	0.333800	0.022780	0.096587	0.546262	0.000571
10	380.45	0.00	77.10	100.80	0.00	0.00	0.000	0.336474	0.027694	0.114170	0.520936	0.000725	0.334702	0.012629	0.063222	0.589258	0.000189
11	382.45	0.00	77.60	23.20	0.00	0.00	1.505	0.337629	0.014477	0.070723	0.576942	0.000228	0.324906	0.006440	0.038116	0.630479	0.000058

Table A-91 The error calculated by PR on case VIII.

Stage No.	2-methyl butane	isobutane	n-butane	n-pentane	propane	Total mass balance
1	-0.0210	0.0257	-0.0084	-0.0115	0.1260	0.1108
2	-0.0299	0.0429	0.0201	-0.0207	0.0380	0.0504
3	-0.0502	0.0659	0.0403	-0.0394	0.0800	0.0967
4	-0.0376	0.0502	0.0450	-0.0392	0.0452	0.0638
5	-0.0109	0.0203	0.0308	-0.0244	-0.0004	0.0154
6	-0.0094	0.0279	0.0430	-0.0364	-0.0019	0.0232
7	-0.0173	0.0305	0.0386	-0.0319	0.0079	0.0278
8	-0.0048	0.0158	0.0251	-0.0230	0.0030	0.0161
9	0.0019	0.0053	0.0129	-0.0125	0.0009	0.0084
10	0.0030	0.0004	0.0051	-0.0059	-0.0251	-0.0224
11	-0.0006	-0.0003	-0.0022	0.0021	0.0250	0.0240
overall	-0.1768	0.2846	0.2505	-0.2428	0.2986	0.4141

Table A-92 The error calculated by SRK on case VIII.

Stage No.	2-methyl butane	isobutane	n-butane	n-pentane	propane	Total mass balance
1	-0.0210	0.0268	-0.0091	-0.0115	0.1330	0.1182
2	-0.0330	0.0440	0.0215	-0.0218	0.0367	0.0474
3	-0.0519	0.0681	0.0413	-0.0407	0.0828	0.0996
4	-0.0385	0.0532	0.0474	-0.0405	0.0458	0.0674
5	-0.0114	0.0208	0.0322	-0.0256	0.0010	0.0170
6	-0.0084	0.0263	0.0436	-0.0364	-0.0085	0.0166
7	-0.0168	0.0297	0.0380	-0.0323	0.0096	0.0282
8	-0.0040	0.0161	0.0261	-0.0229	0.0021	0.0174
9	0.0023	0.0049	0.0128	-0.0122	0.0018	0.0097
10	0.0036	0.0010	0.0035	-0.0055	0.0020	0.0047
11	-0.0009	-0.0006	-0.0014	0.0017	-0.0028	-0.0040
overall	-0.1800	0.2903	0.2561	-0.2477	0.3035	0.4222

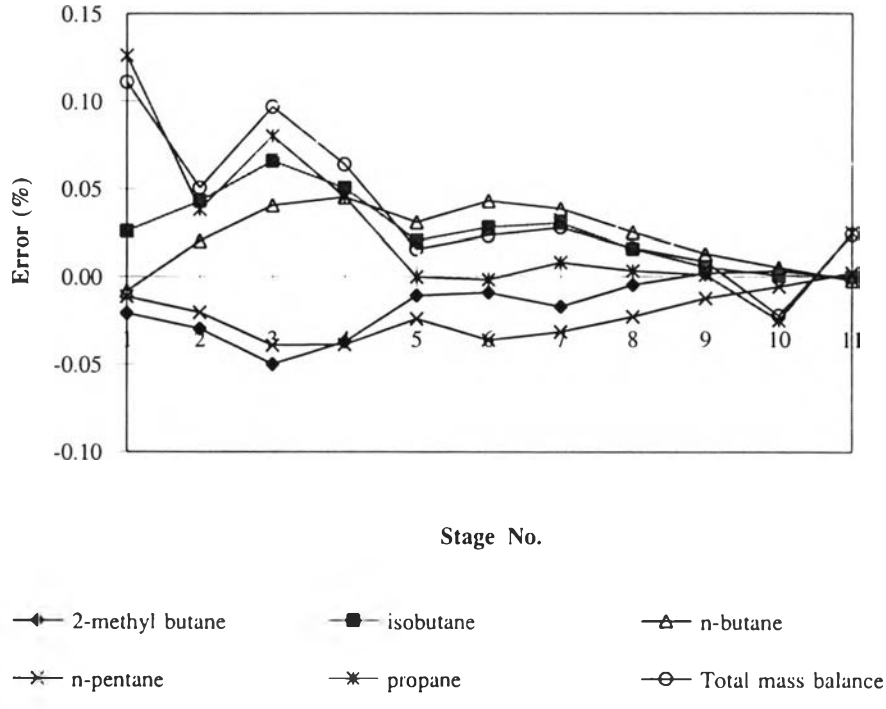

Figure A-5 The material balance relative error of case VIII using PR model

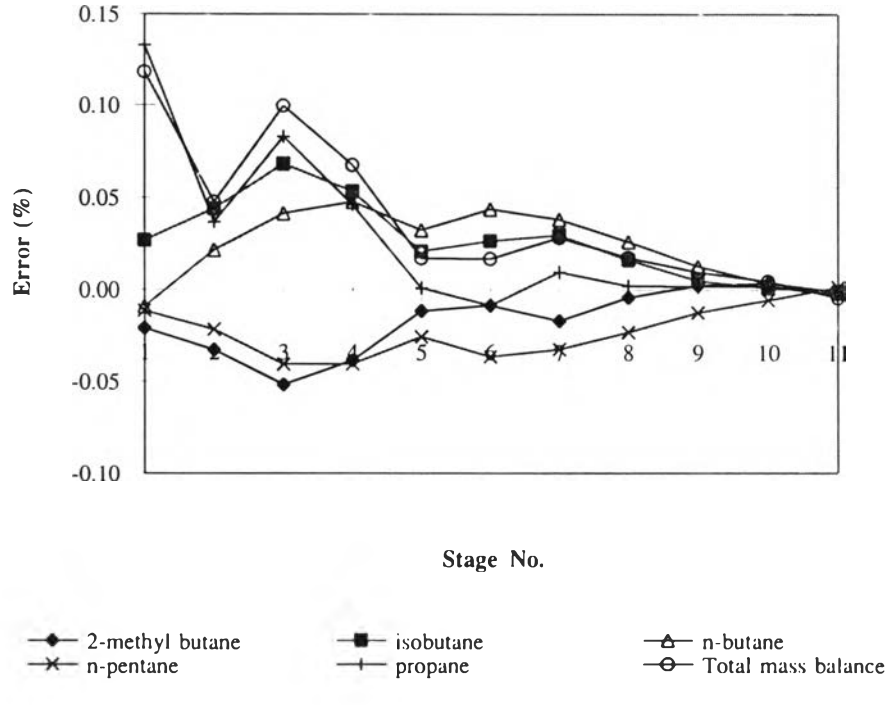

Figure A-6 The material balance relative error of case VIII using SRK model

Table A-93 Temperature profile (Case VIII)

Stage No.	Temperature				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	335.8	335.24	335.65	335.05	-0.04	-0.06
2	345.32	344.76	345.15	344.25	-0.05	-0.15
3	352.54	352.01	352.45	352.15	-0.03	0.04
4	358.12	357.63	358.05	357.95	-0.02	0.09
5	362.16	361.68	362.15	362.05	0.00	0.10
6	364.86	364.39	364.95	364.75	0.02	0.10
7	369.9	369.45	369.95	369.95	0.01	0.14
8	374.17	373.72	374.25	374.25	0.02	0.14
9	377.68	377.2	377.75	377.75	0.02	0.15
10	380.44	379.93	380.55	380.45	0.03	0.14
11	382.57	382.02	382.75	382.45	0.05	0.11

Table A-94 Vapor composition of 2-methyl butane for case VIII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.033085	0.032557	0.031751	0.028417	-4.2014	-14.5687
2	0.077235	0.076836	0.074479	0.069419	-3.7004	-10.6844
3	0.126393	0.126495	0.122603	0.11719	-3.0913	-7.9401
4	0.168634	0.169293	0.164675	0.159884	-2.4041	-5.8849
5	0.196564	0.197539	0.193165	0.189332	-1.7596	-4.3347
6	0.210003	0.211007	0.207472	0.20465	-1.2199	-3.1063
7	0.255885	0.257535	0.252708	0.250764	-1.2572	-2.7001
8	0.295352	0.297293	0.292336	0.291186	-1.0317	-2.0973
9	0.323397	0.325249	0.321127	0.320762	-0.7069	-1.3989
10	0.336930	0.338414	0.33577	0.336474	-0.3455	-0.5766
11	0.335027	0.335394	0.33527	0.337629	0.0725	0.4843

Table A-95 Vapor composition of iso-butane for case VIII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.326271	0.326587	0.326585	0.327783	0.0961	0.3649
2	0.298548	0.298817	0.299452	0.300082	0.3019	0.4216
3	0.250509	0.250365	0.251427	0.251049	0.3651	0.2725
4	0.208974	0.208506	0.209633	0.208547	0.3144	0.0197
5	0.180807	0.180201	0.181107	0.179809	0.1656	-0.2180
6	0.163959	0.16334	0.163922	0.162714	-0.0226	-0.3847
7	0.119349	0.118253	0.119601	0.11745	0.2107	-0.6837
8	0.080403	0.079184	0.080565	0.078163	0.2011	-1.3062
9	0.050423	0.049355	0.050395	0.048297	-0.0556	-2.1906
10	0.02938	0.028588	0.029232	0.027694	-0.5063	-3.2281
11	0.015605	0.015098	0.015442	0.014477	-1.0556	-4.2896

Table A-96 Vapor composition of n-butane for case VIII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.400502	0.400355	0.399806	0.400777	-0.1741	0.1053
2	0.467495	0.468525	0.469007	0.471510	0.3224	0.6331
3	0.459566	0.460658	0.462297	0.464203	0.5907	0.7637
4	0.416153	0.416681	0.418968	0.419162	0.6719	0.5919
5	0.367534	0.367456	0.369637	0.368479	0.5689	0.2776
6	0.328301	0.327852	0.329450	0.327786	0.3488	-0.0201
7	0.287725	0.286459	0.289624	0.286082	0.6557	-0.1318
8	0.231652	0.229741	0.233356	0.228410	0.7302	-0.5827
9	0.172435	0.170300	0.173404	0.168090	0.5588	-1.3148
10	0.118658	0.116705	0.118878	0.114170	0.1851	-2.2204
11	0.074488	0.072963	0.074268	0.070723	-0.2962	-3.1673

Table A-97 Vapor composition of n-pentane for case VIII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.01923	0.01867	0.01927	0.01972	0.2283	5.3640
2	0.05481	0.05391	0.05489	0.05678	0.1585	5.0582
3	0.10503	0.10413	0.10528	0.10928	0.2346	4.7128
4	0.16145	0.16086	0.16210	0.16787	0.4004	4.1765
5	0.21434	0.21415	0.21552	0.22186	0.5457	3.4743
6	0.25824	0.25839	0.25986	0.26560	0.6230	2.7139
7	0.32096	0.32181	0.32216	0.32996	0.3725	2.4715
8	0.38640	0.38768	0.38767	0.39629	0.3271	2.1729
9	0.45148	0.45288	0.45287	0.46072	0.3085	1.7023
10	0.51424	0.51553	0.51537	0.52094	0.2181	1.0387
11	0.57463	0.57570	0.57478	0.57694	0.0268	0.2153

Table A-98 Vapor composition of propane for case VIII

Stage No.	Vapor composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.220912	0.221835	0.222584	0.223299	0.7512	0.6556
2	0.101916	0.101915	0.102170	0.102210	0.2486	0.2886
3	0.058504	0.058354	0.058398	0.058282	-0.1815	-0.1235
4	0.044788	0.044662	0.044624	0.044538	-0.3675	-0.2784
5	0.040752	0.040653	0.040573	0.040520	-0.4412	-0.3282
6	0.039498	0.039413	0.039297	0.039254	-0.5115	-0.4051
7	0.016086	0.015948	0.015912	0.015744	-1.0935	-1.2957
8	0.006192	0.006099	0.006074	0.005948	-1.9427	-2.5387
9	0.002268	0.002220	0.002200	0.002132	-3.0909	-4.1276
10	0.000789	0.000768	0.000756	0.000725	-4.3651	-5.9310
11	0.000254	0.000246	0.000240	0.000228	-5.8333	-7.8947

Table A-99 Liquid composition of propane for case VIII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.101880	0.101877	0.102170	0.102210	0.2838	0.3258
2	0.041007	0.040795	0.040864	0.040639	-0.3499	-0.3839
3	0.021365	0.021184	0.021179	0.020949	-0.8782	-1.1218
4	0.015236	0.015094	0.015057	0.014867	-1.1888	-1.5269
5	0.013201	0.013080	0.013020	0.012859	-1.3902	-1.7186
6	0.012394	0.012283	0.012204	0.012060	-1.5569	-1.8491
7	0.004774	0.004700	0.004674	0.004571	-2.1395	-2.8221
8	0.001757	0.001719	0.001705	0.001650	-3.0499	-4.1818
9	0.000621	0.000604	0.000596	0.000571	-4.1946	-5.7793
10	0.000216	0.000203	0.000199	0.000189	-8.5427	-7.4074
11	0.000066	0.000064	0.000062	0.000058	-6.4516	-10.3448

Table A-100 Liquid composition of 2-methyl butane for case VIII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.077259	0.076860	0.074479	0.069419	-3.7326	-10.7190
2	0.146220	0.146529	0.141880	0.136376	-3.0589	-7.4449
3	0.206128	0.207229	0.201422	0.196886	-2.3364	-5.2533
4	0.246360	0.247914	0.242329	0.239196	-1.6634	-3.6447
5	0.265954	0.267551	0.263057	0.261347	-1.1013	-2.3739
6	0.270226	0.271606	0.268486	0.268179	-0.6481	-1.2779
7	0.300629	0.302220	0.298816	0.299068	-0.6067	-1.0539
8	0.322180	0.323692	0.320901	0.321725	-0.3986	-0.6114
9	0.332566	0.333790	0.332167	0.333800	-0.1201	0.0030
10	0.331102	0.331929	0.331799	0.334702	0.2101	0.8285
11	0.318138	0.318532	0.320152	0.324906	0.6291	1.9618

Table A-101 Liquid composition of iso-butane for case VIII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.298526	0.298794	0.299452	0.300082	0.3092	0.4292
2	0.23113	0.230817	0.232189	0.231335	0.4561	0.2239
3	0.172225	0.171449	0.173039	0.171108	0.4704	-0.1993
4	0.13167	0.130693	0.132084	0.129796	0.3134	-0.6911
5	0.107236	0.106241	0.107277	0.10512	0.0382	-1.0664
6	0.093484	0.092545	0.093244	0.091375	-0.2574	-1.2804
7	0.063427	0.062404	0.063414	0.061396	-0.0205	-1.6418
8	0.040357	0.039459	0.040321	0.038565	-0.0893	-2.3182
9	0.024191	0.023512	0.02409	0.02278	-0.4193	-3.2133
10	0.013616	0.013160	0.01349	0.012629	-0.9340	-4.2046
11	0.007046	0.006773	0.006941	0.00644	-1.5128	-5.1708

Table A-102 Liquid composition of n-butane for case VIII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.467507	0.468538	0.469007	0.471510	0.3198	0.6303
2	0.456351	0.457466	0.459609	0.461268	0.7089	0.8242
3	0.395067	0.395385	0.398581	0.397750	0.8816	0.5946
4	0.325798	0.325252	0.328474	0.325636	0.8147	0.1179
5	0.269621	0.268546	0.271123	0.267528	0.5540	-0.3805
6	0.230833	0.229553	0.231309	0.227838	0.2058	-0.7527
7	0.187460	0.185696	0.188397	0.183925	0.4974	-0.9629
8	0.141860	0.139940	0.142559	0.137871	0.4903	-1.5007
9	0.100537	0.098774	0.100767	0.096587	0.2282	-2.2643
10	0.066623	0.065205	0.066484	0.063222	-0.2091	-3.1366
11	0.040651	0.039637	0.040361	0.038116	-0.7185	-3.9905

Table A-103 Liquid composition of n-pentane for case VIII

Stage No.	Liquid composition				difference (%)	
	PR_DIST	SRK_DIST	PR_HYSIM	SRK_HYSIM	PR	SRK
1	0.054829	0.053930	0.054893	0.056779	0.1166	5.0177
2	0.125292	0.124394	0.125457	0.130361	0.1315	4.5773
3	0.205215	0.204755	0.205779	0.213307	0.2741	4.0092
4	0.280936	0.281047	0.282056	0.290504	0.3971	3.2554
5	0.343988	0.344582	0.345523	0.353146	0.4443	2.4251
6	0.393062	0.394013	0.394757	0.400548	0.4294	1.6315
7	0.443709	0.444981	0.444700	0.451039	0.2228	1.3431
8	0.493846	0.495190	0.494514	0.500188	0.1351	0.9992
9	0.542084	0.543319	0.542380	0.546262	0.0546	0.5388
10	0.588449	0.589503	0.588028	0.589258	-0.0716	-0.0416
11	0.634100	0.634994	0.632484	0.630479	-0.2555	-0.7161

Table A-104 The results of case V calculated by simulator using PR method (Tolerance : 0.001N)

Stage N	temp	Feed	Interstage (kgmol/hr)		Sidestream (kgmol/hr		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/hr)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	335 76	0 00	0 000001	57 202225	0 00	22 18	1444631 4	0 032836	0 326515	0 400336	0 019100	0 221213	0 076748	0 298972	0 467685	0 054513	0 102082
2	345 26	0 00	79 382225	55 197670	0 00	0 00	0 0	0 076741	0 298980	0 467631	0 054505	0 102093	0 145455	0 231683	0 456993	0 124756	0 041110
3	352 48	0 00	77 377670	53 770500	0 00	0 00	0 0	0 125741	0 250991	0 460064	0 104601	0 058603	0 205314	0 172723	0 395904	0 204642	0 021418
4	358 04	0 00	75 950500	52 863602	0 00	0 00	0 0	0 167729	0 209631	0 416892	0 160750	0 044998	0 245427	0 132250	0 328817	0 280184	0 015323
5	362 06	0 00	75 043602	52 332794	0 00	0 00	0 0	0 195517	0 181582	0 368500	0 213407	0 040994	0 265004	0 107844	0 270733	0 343124	0 013294
6	364 76	45 36	74 512794	99 981415	0 00	0 00	0 0	0 208907	0 164799	0 329423	0 257119	0 039752	0 269312	0 094090	0 231901	0 392121	0 012409
7	369 79	0 00	76 801414	99 546059	0 00	0 00	0 0	0 254574	0 120317	0 289492	0 319381	0 016236	0 299704	0 064043	0 188936	0 442492	0 004825
8	374 06	0 00	76 366058	99 308311	0 00	0 00	0 0	0 294101	0 081297	0 233729	0 384004	0 006268	0 321436	0 040867	0 143362	0 492555	0 001780
9	377 58	0 00	76 128311	99 218765	0 00	0 00	0 0	0 322430	0 051123	0 174431	0 449713	0 002302	0 332100	0 024557	0 101835	0 540877	0 000631
10	380 37	0 00	76 038765	99 206017	0 00	0 00	0 0	0 336346	0 029856	0 120289	0 512707	0 000803	0 330914	0 013848	0 067604	0 587419	0 000214
11	382 53	0 00	76 026016	23 179990	0 00	0 00	-1523497 9	0 334801	0 015883	0 075625	0 573433	0 000259	0 318166	0 007175	0 041290	0 633294	0 000068

Table A-105 The results of case V calculated by simulator using PR method (Tolerance : 0.0001N)

Stage N	temp	Feed	Interstage (kgmol/hr)		Sidestream (kgmol/hr		Duty	Vapor Composition					Liquid Composition				
	(K)	(kgmol/hr)	Vapor	Liquid	Vapor	Liquid	(J/h)	2-methyl butane	isobutane	n-butane	n-pentane	propane	2-methyl butane	isobutane	n-butane	n-pentane	propane
1	335 75	0 00	0 000001	57 202225	0 00	22 18	1444356 8	0 032727	0 326601	0 400353	0 019022	0 221297	0 076525	0 299149	0 467866	0 054312	0 102149
2	345 24	0 00	79 382225	55 198563	0 00	0 00	0 0	0 076522	0 299151	0 467864	0 054310	0 102153	0 145127	0 231927	0 457406	0 124389	0 041151
3	352 45	0 00	77 378563	53 768341	0 00	0 00	0 0	0 125458	0 251202	0 460406	0 104295	0 058641	0 204986	0 172961	0 396426	0 204187	0 021441
4	356 01	0 00	75 948341	52 855553	0 00	0 00	0 0	0 167457	0 209826	0 417297	0 160401	0 045019	0 245176	0 132435	0 327301	0 279752	0 015336
5	362 04	0 00	75 035553	52 321442	0 00	0 00	0 0	0 195306	0 181731	0 368966	0 213090	0 041006	0 264839	0 107973	0 271108	0 342778	0 013302
6	364 75	45 36	74 501442	99 969498	0 00	0 00	0 0	0 208755	0 164909	0 329707	0 256867	0 039762	0 269205	0 094185	0 232240	0 391870	0 012494
7	369 77	0 00	76 789497	99 531662	0 00	0 00	0 0	0 254409	0 120440	0 289842	0 319064	0 016245	0 299613	0 064125	0 189220	0 442213	0 004828
8	374 04	0 00	76 351662	99 288895	0 00	0 00	0 0	0 293962	0 081408	0 234091	0 384265	0 006273	0 321383	0 040932	0 143622	0 492281	0 001782
9	377 57	0 00	76 108894	99 203659	0 00	0 00	0 0	0 322344	0 051208	0 174753	0 449391	0 002304	0 332093	0 024603	0 102046	0 540627	0 000632
10	380 36	0 00	76 023659	99 187492	0 00	0 00	0 0	0 336320	0 029912	0 120538	0 512425	0 000804	0 330947	0 013877	0 067755	0 587207	0 000214
11	382 52	0 00	76 007492	23 179998	0 00	0 00	-1523129 8	0 334827	0 015916	0 075795	0 573204	0 000259	0 318228	0 007190	0 041394	0 633120	0 000068

APPENDIX B

THE ERROR CALCULATION

The material balance relative error

Basis: molar flow in feed stream of each component which is the specified by user.

$$L_{j-1}\, x_{i,j-1} + V_{j+1}\, y_{i,j+1} + F_j\, z_{i,j} - (L_j + U_j)\, x_{i,j} - (V_j + W_j)\, y_{i,j} = E_{i,j} \quad (5\text{-}1)$$

The material balance relative error, $\%E_{i,j}$ is discussed in equation (B-1).

$$\%E_{i,j} = \frac{E_{i,j}}{\sum_{j=1}^{m}(F_j \times z_{i,j})} \times 100 \quad (B\text{-}1)$$

where $E_{i,j}$ is the error of component i on stage j.

m is the number of feed streams

The relative difference

$$\%E = \frac{(T_{ref} - T_{cal})}{T_{ref}} \times 100 \quad (B\text{-}2)$$

where %E is the relative error

subscript ref is reference data

subscript cal is result from the simulator

The relative errors of liquid and vapor are the same as temperature.

VITA

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