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APPENDICES

Appendix A Kinetic of Adsorption Data (Batch System)

Table A1 Amount of mercury adsorbed on Beta zeolite with Si/Al ratio of 10 as a function of time

Time (min)	Weight of Adsorbent (g)	1st reading	2nd reading	Results (ppb)	Adsorption (mg/g adsorbent)	%Adsorption
0	0.1	3.57	3.54	370.4	0.0000	0.0
5	0.1	3.17	3.19	330.2	0.0080	10.9
20	0.1	2.57	2.55	263.7	0.0213	28.8
50	0.1	2.51	2.57	261.5	0.0217	29.4
110	0.1	2.55	2.56	263.1	0.0214	29.0
170	0.1	2.53	2.53	260.5	0.0219	29.7
240	0.1	2.52	2.52	259.4	0.0221	30.0

Table A2 Amount of mercury adsorbed on Beta zeolite with Si/Al ratio of 30 as a function of time

Time (min)	Weight of Adsorbent (g)	1st reading	2nd reading	Results (ppb)	Adsorption (mg/g adsorbent)	%Adsorption
0	0.1	3.57	3.59	373.1	0.0000	0.0
5	0.1	3.24	3.29	339.3	0.0067	9.1
20	0.1	2.90	2.90	300.2	0.0145	19.6
50	0.1	2.88	2.92	300.2	0.0145	19.6
110	0.1	2.91	2.86	298.5	0.0149	20.0
170	0.1	2.87	2.85	295.9	0.0154	20.7
240	0.1	2.85	2.86	295.3	0.0155	20.8

Table A3 Amount of mercury adsorbed on Beta zeolite with Si/Al ratio of 100 as a function of time

Time (min)	Weight of Adsorbent(g)	1st reading	2nd reading	Results (ppb)	Adsorption (mg/g adsorbent)	%Adsorption
0	0.1	3.56	3.52	368.8	0.0000	0.0
5	0.1	3.31	3.27	342.0	0.0053	7.3
20	0.1	3.17	3.15	328.0	0.0081	11.1
50	0.1	3.10	3.09	321.1	0.0095	12.9
110	0.1	3.04	3.08	317.3	0.0103	14.0
170	0.1	3.05	3.05	316.2	0.0105	14.3
240	0.1	3.04	3.02	314.1	0.0109	14.8

Table A4 Amount of mercury adsorbed on X zeolite as a function of time

Time (min)	Weight of Adsorbent(g)	1st reading	2nd reading	Results (ppb)	Adsorption (mg/g adsorbent)	%Adsorption
0	0.1	3.59	3.56	372.6	0.0000	0.0
5	0.1	3.23	3.26	337.2	0.0071	9.5
20	0.1	2.93	2.92	302.8	0.0139	18.7
50	0.1	2.81	2.79	289.4	0.0166	22.3
110	0.1	2.76	2.78	286.2	0.0172	23.2
170	0.1	2.74	2.78	285.1	0.0174	23.5
240	0.1	2.72	2.75	282.4	0.0180	24.2

Table A5 Amount of mercury adsorbed on Y zeolite as a function of time

Time (min)	Weight of Adsorbent(g)	1st reading	2nd reading	Results (ppb)	Adsorption (mg/g adsorbent)	%Adsorption
0	0.1	3.54	3.57	370.4	0.0000	0.0
5	0.1	3.26	3.29	340.4	0.0060	8.1
20	0.1	2.98	2.96	307.7	0.0125	16.9
50	0.1	2.86	2.87	296.4	0.0148	20.0
110	0.1	2.85	2.87	295.9	0.0149	20.1
170	0.1	2.83	2.83	292.6	0.0155	21.0
240	0.1	2.82	2.83	292.1	0.0156	21.1

Table A6 Amount of mercury adsorbed on ZSM-5 zeolite as a function of time

Time (min)	Weight of Adsorbent(g)	1st reading	2nd reading	Results (ppb)	Adsorption (mg/g adsorbent)	%Adsorption
0	0.1	3.60	3.58	374.2	0.0000	0.0
5	0.1	3.51	3.53	366.7	0.0015	2.0
20	0.1	3.41	3.45	357.0	0.0034	4.6
50	0.1	3.40	3.38	352.7	0.0043	5.7
110	0.1	3.35	3.36	349.0	0.0050	6.7
170	0.1	3.38	3.36	350.6	0.0047	6.3
240	0.1	3.34	3.31	345.8	0.0057	7.6

Figure A1 Fitting of three kinetic models with experimental data of Beta zeolite with Si/Al ratio of 10

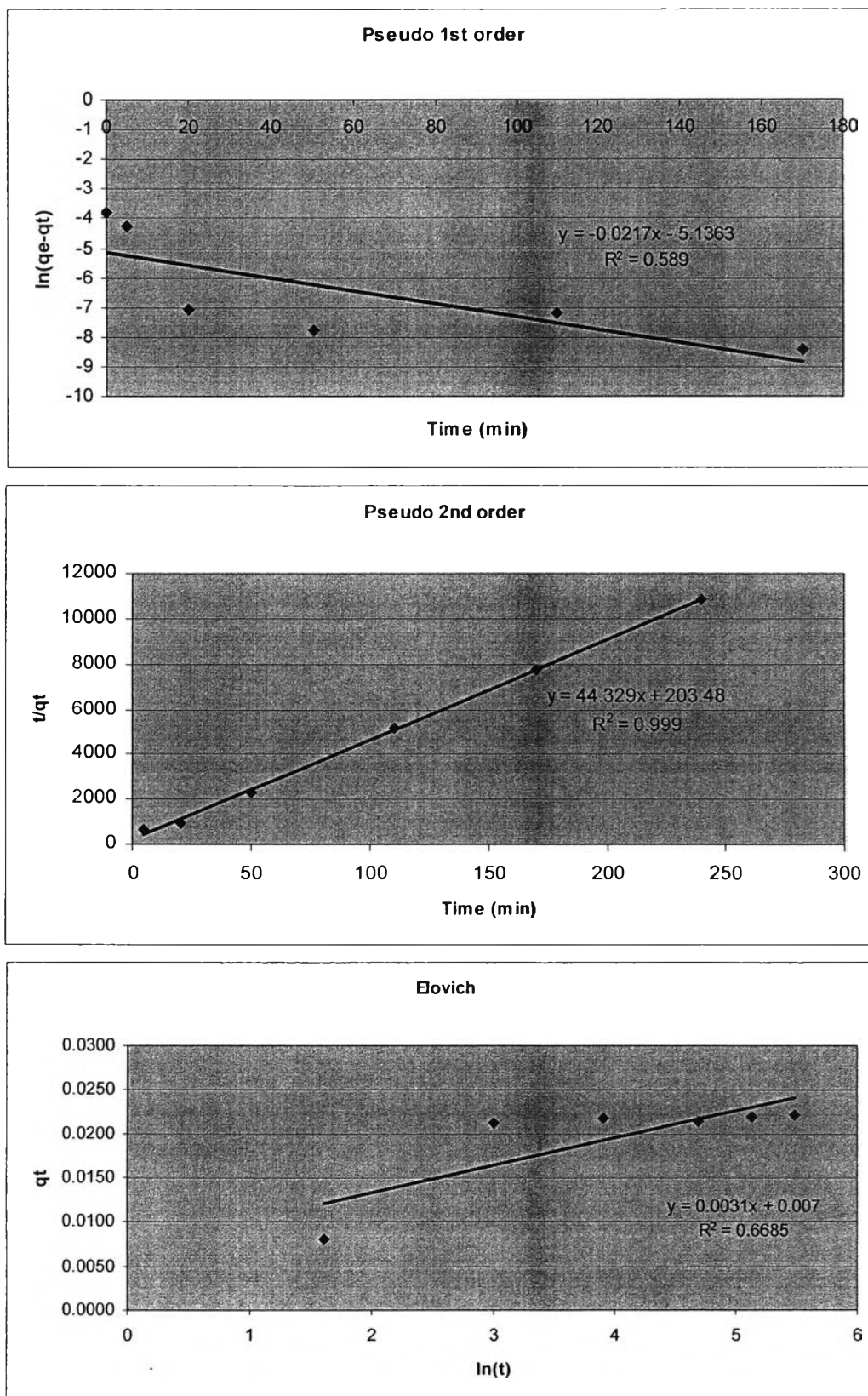


Figure A2 Fitting of three kinetic models with experimental data of Beta zeolite with Si/Al ratio of 30

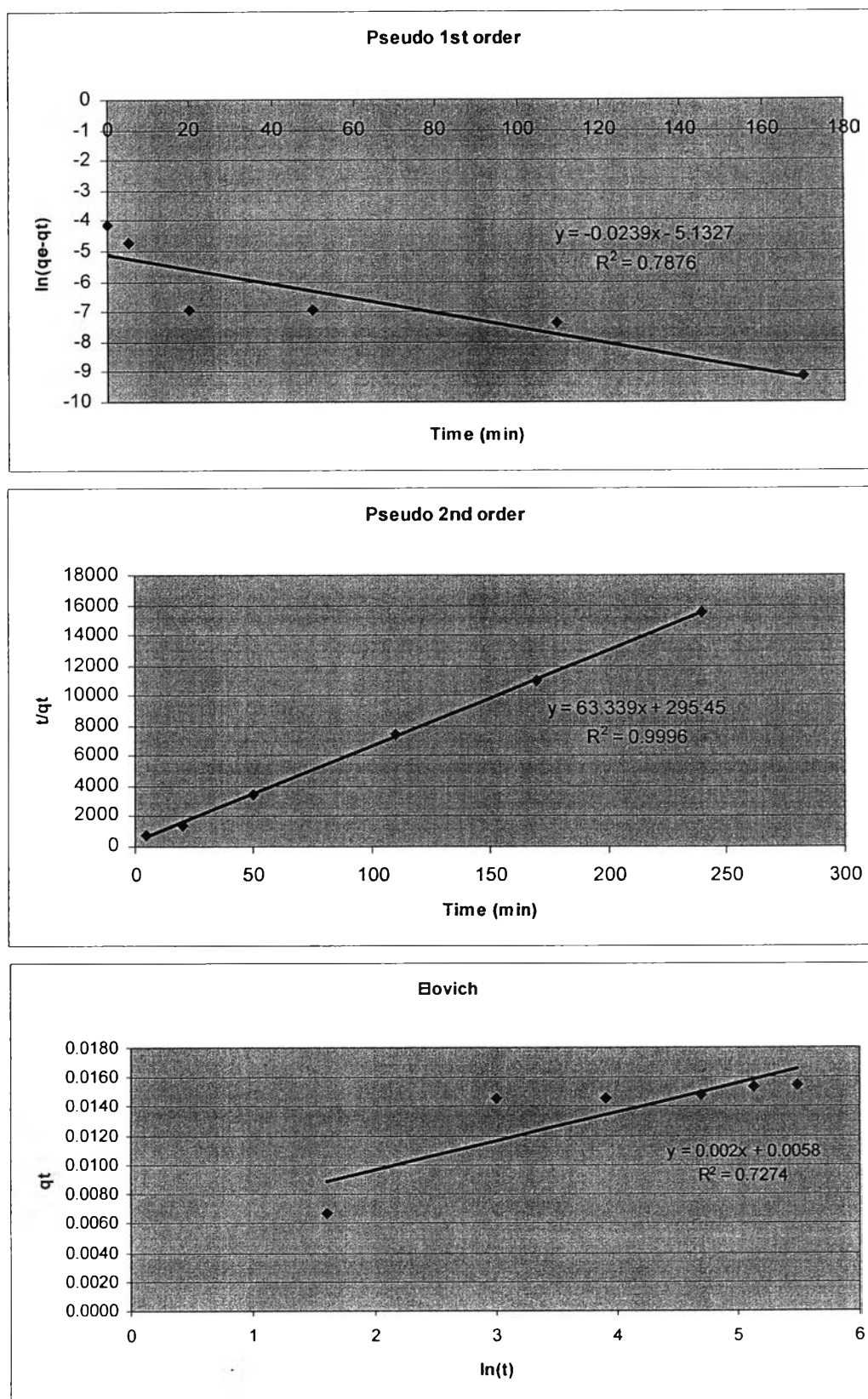


Figure A3 Fitting of three kinetic models with experimental data of Beta zeolite with Si/Al ratio of 100

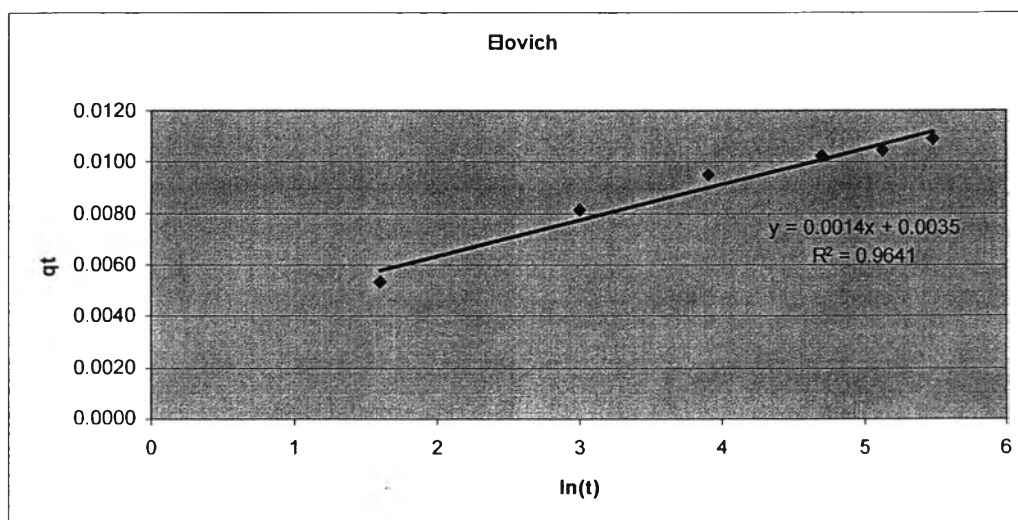
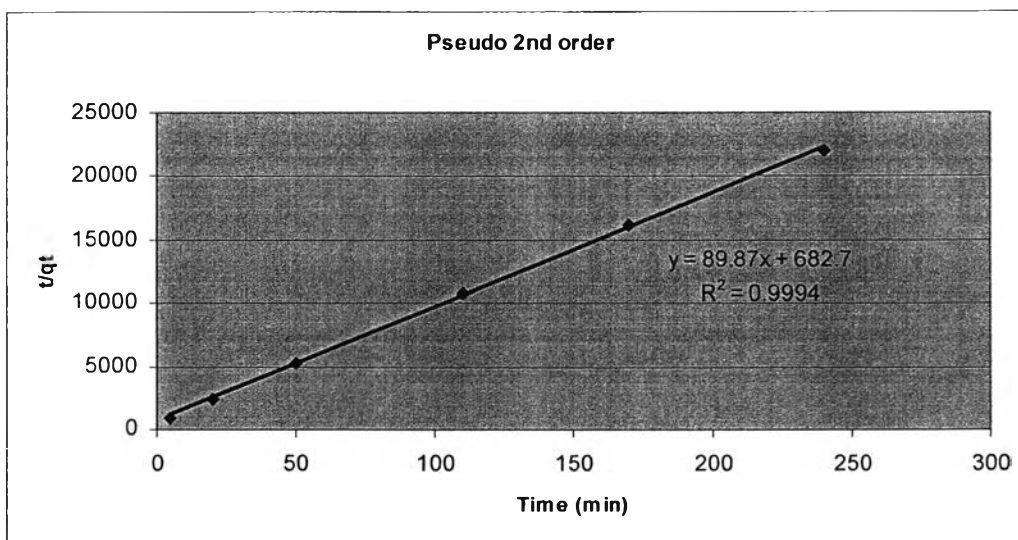
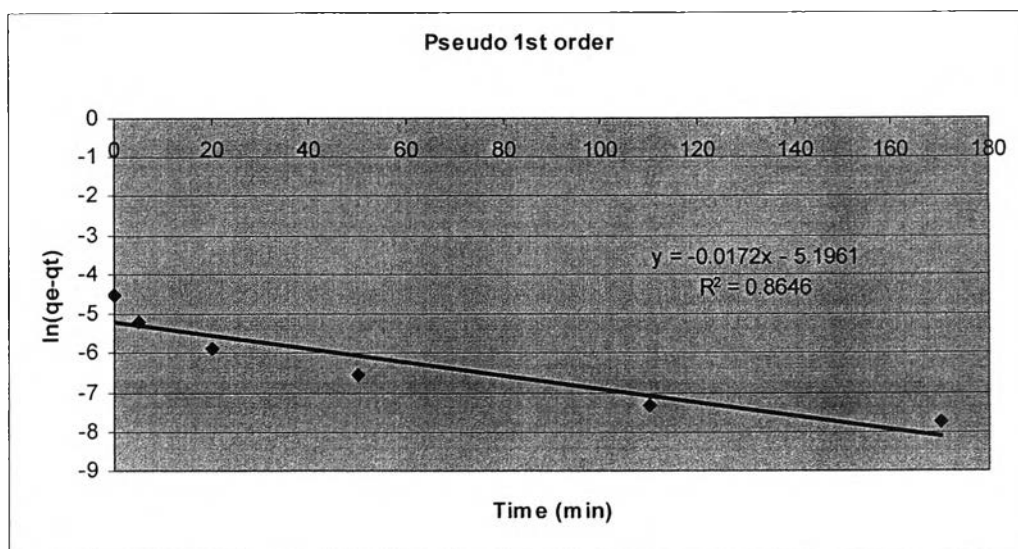


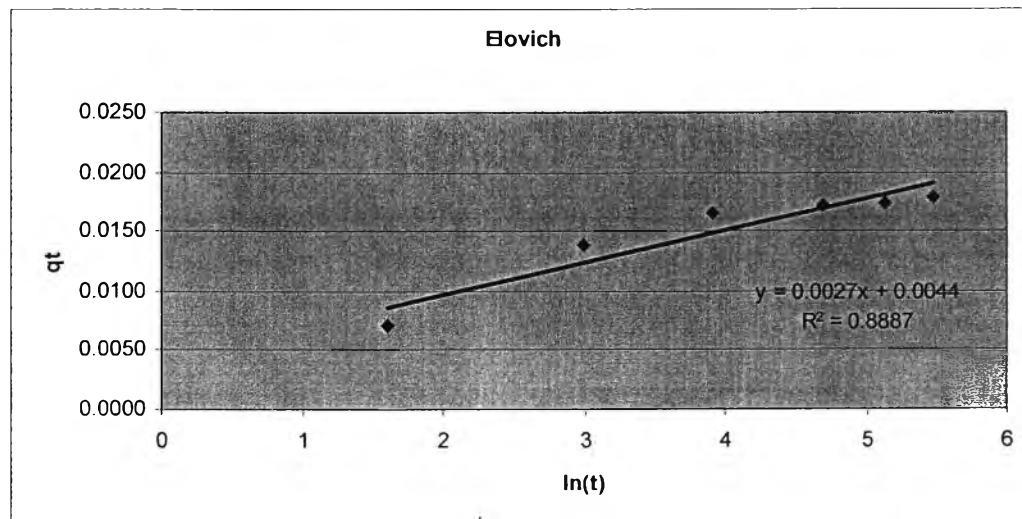
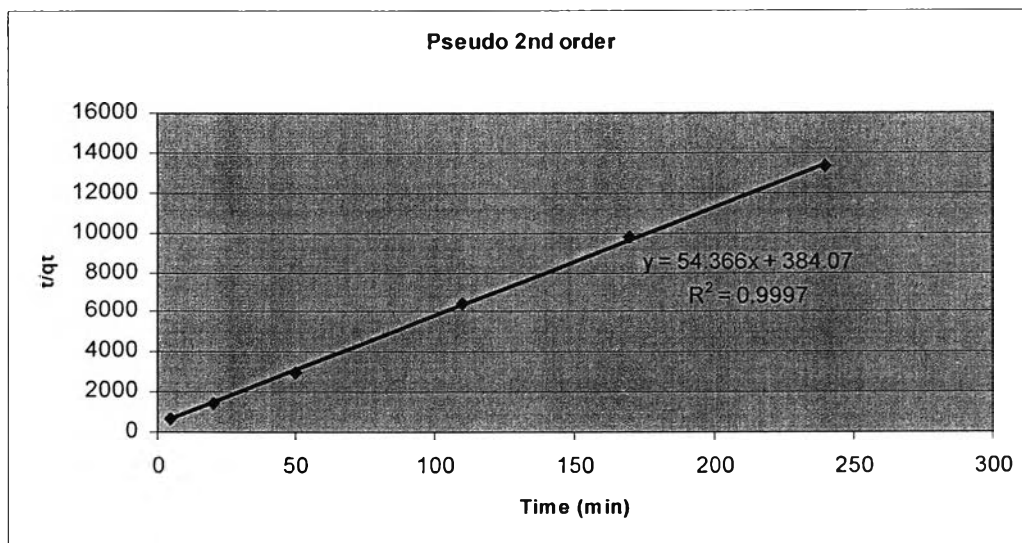
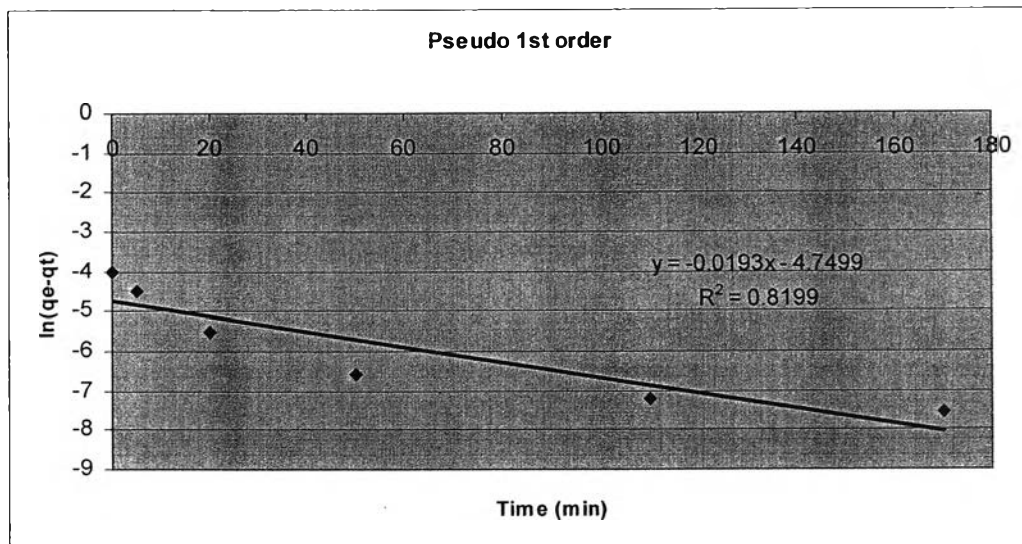
Figure A4 Fitting of three kinetic models with experimental data of X zeolite

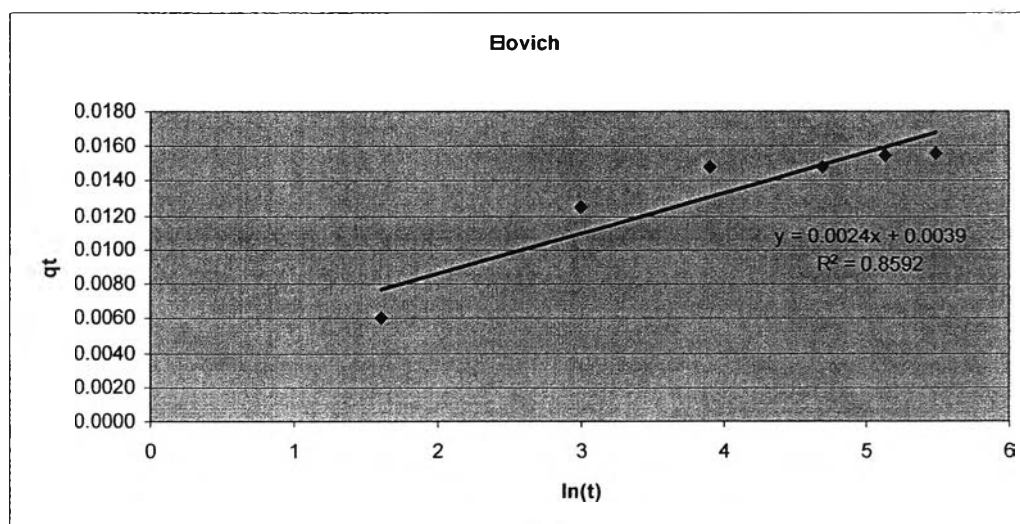
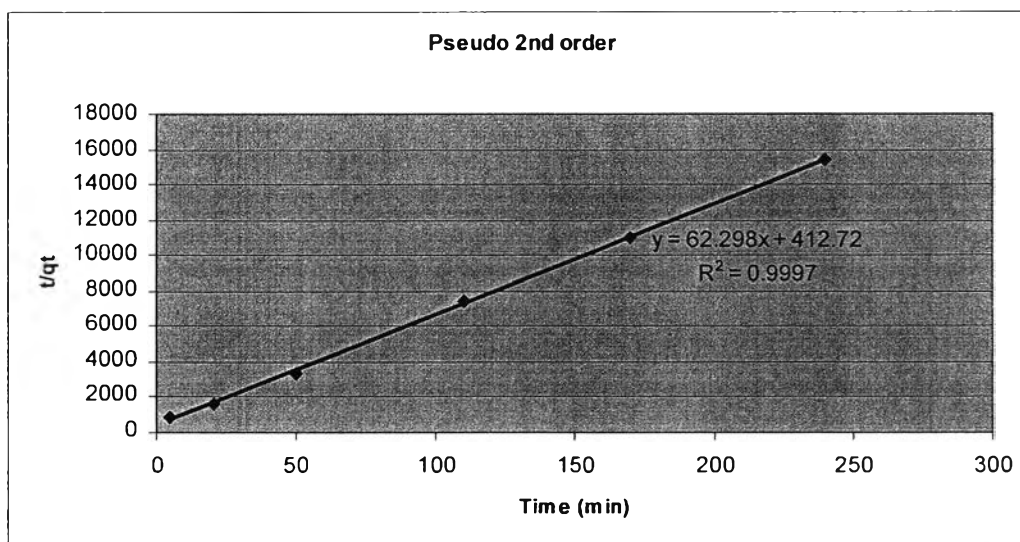
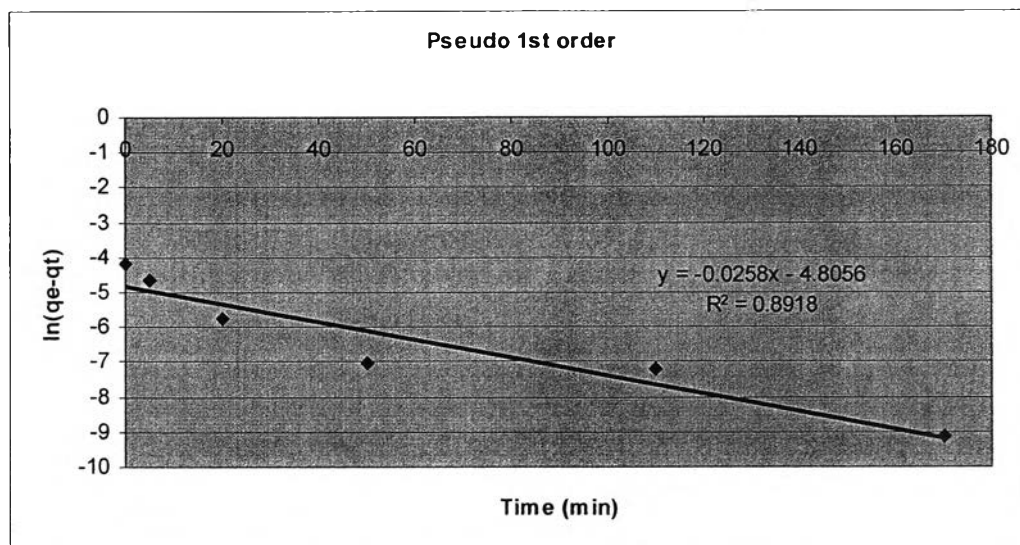
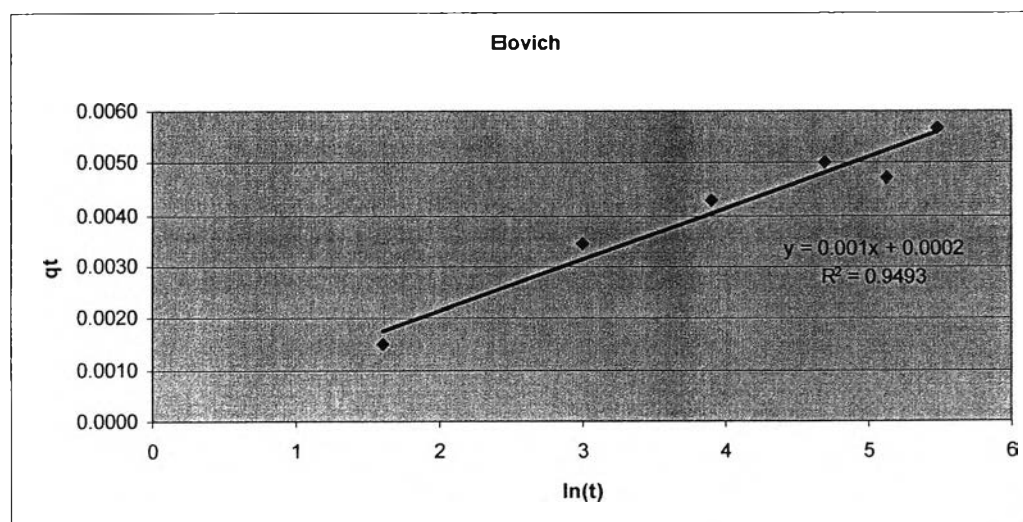
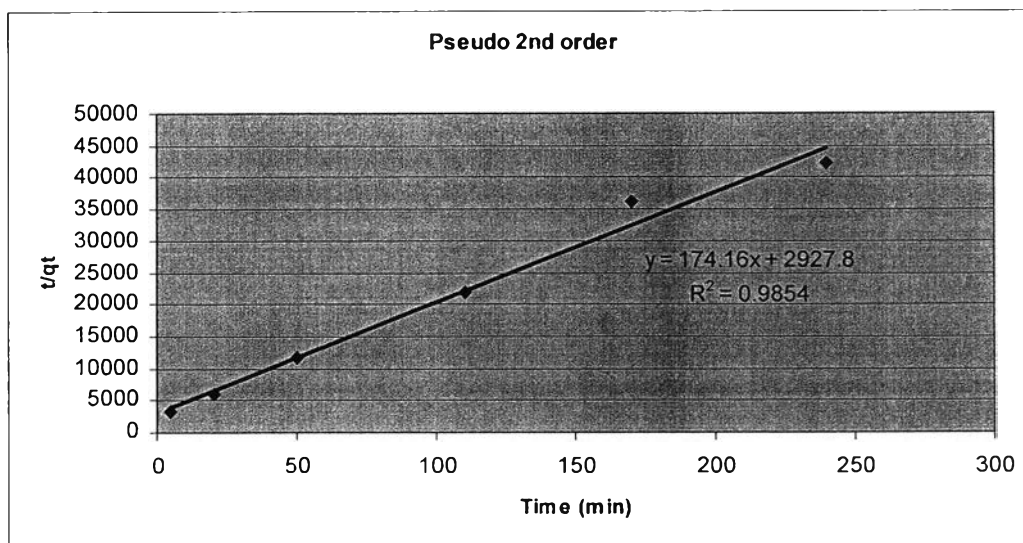
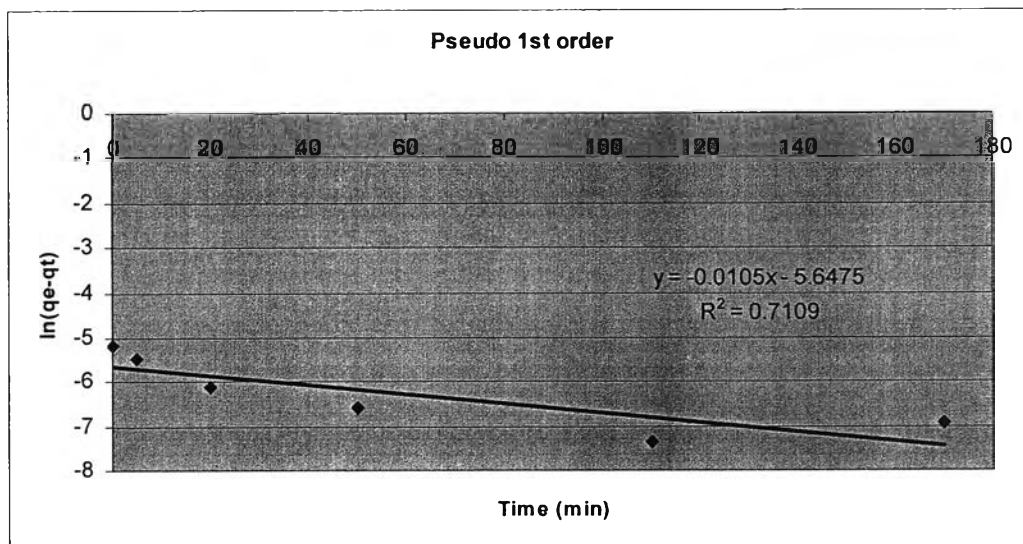
Figure A5 Fitting of three kinetic models with experimental data of Y zeolite

Figure A6 Fitting of three kinetic models with experimental data of ZSM-5 zeolite

Appendix B Adsorption Isotherms Data (Batch System)

Table B1 Adsorption isotherms of mercury in heavy naphtha on Bata zeolite with Si/Al ratio of 10

RUN 1

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc.(ppb)	Remaining Conc.($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1001	311.25	213.750	1.066	0.097
0.1000	196.00	121.900	0.608	0.074
0.1001	101.60	53.900	0.269	0.048
0.1002	51.40	20.700	0.103	0.031

RUN 2

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc.(ppb)	Remaining Conc.($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1003	303.75	202.500	1.010	0.101
0.1002	194.50	122.600	0.611	0.072
0.1000	100.90	54.500	0.272	0.046
0.1000	52.00	21.200	0.106	0.031

Table B2 Adsorption isotherms of mercury in heavy naphtha on Bata zeolite with Si/Al ratio of 30

RUN 1

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc.(ppb)	Remaining Conc.($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1001	315.00	243.750	1.215	0.071
0.1001	195.80	138.000	0.688	0.058
0.1000	102.10	60.100	0.300	0.042
0.1000	49.70	22.600	0.113	0.027

RUN 2

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc.(ppb)	Remaining Conc.($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1003	311.25	236.250	1.178	0.075
0.1000	197.20	139.000	0.693	0.058
0.1001	99.40	62.300	0.311	0.037
0.1001	51.70	22.800	0.114	0.029

Table B3 Adsorption isotherms of mercury in heavy naphtha on Bata zeolite with Si/Al ratio of 100

RUN 1

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc. (ppb)	Remaining Conc. ($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1001	311.25	266.250	1.327	0.045
0.1003	194.00	155.800	0.777	0.038
0.1001	100.40	73.400	0.366	0.027
0.1000	52.40	27.900	0.139	0.024

RUN 2

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc. (ppb)	Remaining Conc. ($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1000	311.25	270.000	1.346	0.041
0.1000	196.10	156.500	0.780	0.039
0.1001	101.70	69.100	0.344	0.032
0.1001	49.40	27.600	0.138	0.022

Table B4 Adsorption isotherms of mercury in heavy naphtha on X zeolite

RUN 1

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc. (ppb)	Remaining Conc. ($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1003	307.50	225.000	1.122	0.082
0.1002	196.20	124.100	0.619	0.072
0.1001	98.00	54.800	0.273	0.043
0.1001	49.90	20.600	0.103	0.029

RUN 2

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc. (ppb)	Remaining Conc. ($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1003	303.75	225.000	1.122	0.078
0.1001	197.40	122.900	0.613	0.074
0.1001	98.30	57.100	0.285	0.041
0.1001	51.90	21.000	0.105	0.031

Table B5 Adsorption isotherms of mercury in heavy naphtha on Y zeolite

RUN 1

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc.(ppb)	Remaining Conc.($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1002	296.25	221.250	1.103	0.075
0.1002	196.70	128.900	0.643	0.067
0.1001	99.30	58.300	0.291	0.041
0.1002	52.20	21.700	0.108	0.030

RUN 2

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc.(ppb)	Remaining Conc.($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1003	315.00	236.250	1.178	0.078
0.1003	198.90	130.000	0.648	0.068
0.1002	102.00	56.800	0.283	0.045
0.1002	50.70	22.100	0.110	0.028

Table B6 Adsorption isotherms of mercury in heavy naphtha on ZSM-5 zeolite

RUN 1

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc.(ppb)	Remaining Conc.($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1000	303.75	281.250	1.402	0.022
0.1000	194.20	174.600	0.870	0.020
0.1001	102.50	86.500	0.431	0.016
0.1000	51.40	42.300	0.211	0.009

RUN 2

Weight of adsorbent (g)	Initial concentration (ppb)	Remaining Conc.(ppb)	Remaining Conc.($\mu\text{mol/l}$)	Amount of absorbed ($\mu\text{mol/g}$)
0.1000	296.25	277.500	1.383	0.019
0.1001	191.70	172.700	0.861	0.019
0.1000	101.90	84.700	0.422	0.017
0.1000	51.40	42.500	0.212	0.009

Appendix C Continuous System

Table C1 Adsorption of mercury in heavy naphtha on Beta zeolite with Si/Al ratio of 10 in continuous system

Condition

Feed: Heavy naphtha
 Adsorbent: Beta zeolite 0.5 ml + SiC 2ml
 Flow rate: 2 ml/min
 Temperature: 50°C
 Pressure: 7 barg

Time (h)	Feed weight (g)	Sample weight(g)	Outlet conc.(µg/l)	C/C_0
0	Feed	-	423.75	-
2	185	15.92	170.76	0.403
4	374	17.52	192.00	0.453
6	546	17.18	195.87	0.462
11	1033	16.82	221.62	0.523
14	1241	16.49	252.52	0.596
18	1600	16.38	302.73	0.714
21	1906	16.21	319.04	0.753
23	2090	17.45	314.32	0.742
25	2256	16.9	317.54	0.749
27	2455	17.26	295.87	0.698
29	2626	17.42	311.75	0.736

Table C2 Adsorption of mercury in heavy naphtha on Beta zeolite with Si/Al ratio of 10 in continuous system

Condition

Feed: Heavy naphtha
 Adsorbent: Beta zeolite 1 ml + SiC 4 ml
 Flow rate: 4 ml/min
 Temperature: 50°C
 Pressure: 7 barg

Time (h)	Feed weight (g)	Sample weight (g)	Outlet conc. (µg/l)	C/C ₀
0	Feed	-	404.97	-
0.5	82	17.19	8.13	0.020
1	172	16.52	10.59	0.026
1.5	262	17.47	26.47	0.065
2.5	474	17.37	105.52	0.261
3.5	605	16.93	117.97	0.291
5.5	984	17.39	142.86	0.353
6.5	1325	17.41	176.77	0.436
7.5	1521	17.04	205.31	0.507
11.5	2187	13.8	214.97	0.531
14.5	2746	15.8	254.88	0.629
19.5	3651	16.77	296.94	0.733
24	4288	17.18	305.52	0.754
26	4607	16.7	309.60	0.764
27	4820	17.03	304.45	0.752

Table C3 Adsorption of mercury in heavy naphtha on X zeolite in continuous system

Condition

Feed: Heavy naphtha
 Adsorbent: Beta zeolite 0.5 ml + SiC 2ml
 Flow rate: 2 ml/min
 Temperature: 50°C
 Pressure: 7 barg

Time (h)	Feed weight [g]	Sample weight(g)	Outlet conc. (µg/l)	C/C_0
0	Feed	-	407.66	-
0.5	44	7.81	6.17	0.015
1	90	17.17	10.03	0.025
1.5	136	16.99	37.93	0.093
2.5	244	17.33	126.98	0.311
4	356	17.33	167.11	0.410
5.5	490	16.67	186.21	0.457
7	632	17.31	218.83	0.537
8.5	766	17.15	251.02	0.616
12	1069	16.71	287.50	0.705
15.5	1386	16.44	326.12	0.800
19.5	1742	14.81	319.69	0.784
23	2065	17.24	317.54	0.779
25	2242	17.23	326.12	0.800
26	2340	16.87	313.25	0.768

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