THOMAS MODEL EQUATION

$$\frac{C_t}{C_0} = \frac{1}{1 + \exp[K_T q_0 m/Q - K_T C_0 t]}$$

Q = 8 cm   C0 = 100

BH	K_T	T	R2
4	0.0004	21265.04	0.9857
8	0.0003	20135.92	0.9923
12	0.0004	2116.63	0.9997

BH = 4 cm C0 = 100

Q	K_T	T	R2
4	0.0003	24331.61	0.998
8	0.0004	21265.04	0.9857
12	0.0008	13296.16	0.9856

BH=4 cm   Q= 8 mg/L

C0	K_T	T	R2
50	0.0007	16336.79	0.9873
100	0.0004	21265.04	0.9857
150	0.0006	12646.08	0.9834

YOON-NELSON MODEL EQUATION

$$q = \frac{C0 * EXP[Kyn * (t - \tau)}{1 + EXP[Kyn * (t - \tau) * C0}$$

Q= 8 mL/min C0 =100mg/l

BH	Kyn	T
4	0.0352738	236.88009
8	0.0299557	355.09164
12	0.0367358	442.1088

BH= 4 cm, Co = 100mg/l

Q	kyn	T
4	0.0275173	410.67131
8	0.0352738	236.88009
12	0.0725263	107.69923

BH=4 cm, Q = 8 ml/min

C0	Kyn	T
50	0.0203881	404.89838
100	0.0352738	236.88009
150	0.0891755	98.342058

DOSE-RESPONSE MODEL EQUATION

$$q = 1 - [\frac{1}{1 + (\frac{C_0 Q t}{q_0 m})^\wedge \alpha}$$

Q= 8 mL/min C0 =100mg/l

BH	α	q0 or No	R2
4	3.4077957	20143.275	#REF!
8	5.8835702	19802.404	#REF!
12	11.761802	21020.969	#DIV/0!

BH= 4 cm, Co = 100mg/l

Q	α	q0 or No	R2
4	6.9259379	24068.914	#DIV/0!
8	3.4077957	20143.275	#REF!
12	2.6444962	12377.18	#VALUE!

BH=4 cm, Q = 8 ml/min

C0	α	q0 or No	R2
50	3.9674517	20251.858	#DIV/0!
100	3.4077957	20143.275	#REF!
150	3.3466101	11897.86	0.9961

pollutant	sorbent	bed hieght	C_0 (mg/L)	C_t (mg/L)	bed mass	t (min)	pH	V_{eff}
Cd2+	NCF	2	25	0		0		0
		2	25	0.3		5		15
		2	25	0.6		10		30
		2	25	1.1		15		45
		2	25	1.8		20		60
		2	25	2.3		30		90
		2	25	3.3		40		120
		2	25	3.9		50		150
		2	25	5.1		60		180
		2	25	6.3		70		210
		2	25	6.5		80		240
		2	25	6.6		90		270
		2	25	6.6		100		300
		2	25	6.7		140		420

Ni2+

PH EFFECT BASED ON TIME

Pb2+

Cr2+

CR VS t

0   20   40   60   80   100   120   140   160

Ct/ C0	Q (ml/min)	CR
0	3	25
0.012	3	24.7
0.024	3	24.4
0.044	3	23.9
0.072	3	23.2
0.092	3	22.7
0.132	3	21.7
0.156	3	21.1
0.204	3	19.9
0.252	3	18.7
0.26	3	18.5
0.264	3	18.4
0.264	3	18.4
0.268	3	18.3

pH effect based on

Veff

400   450
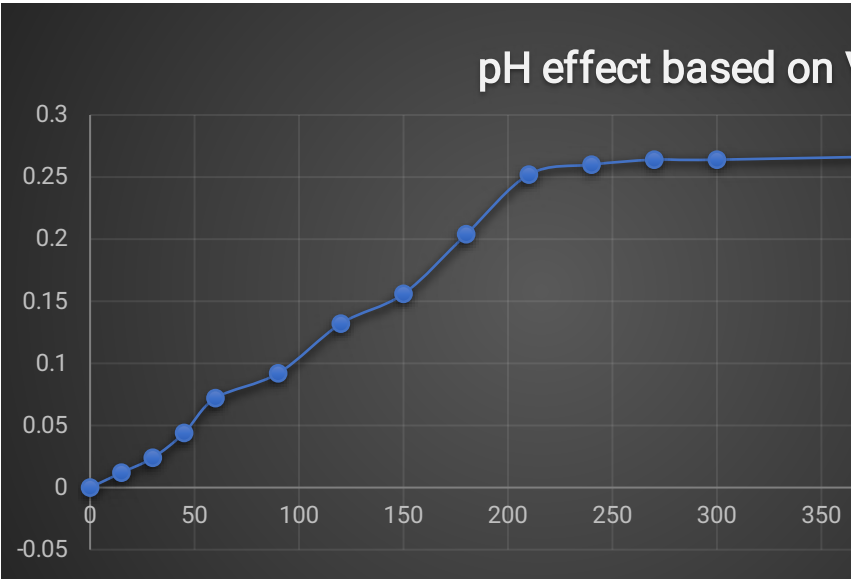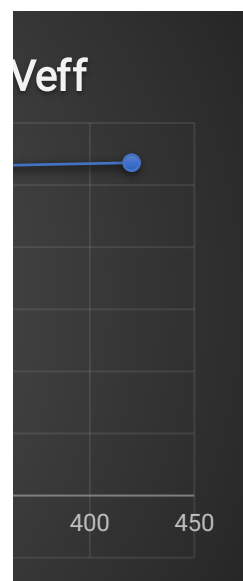
Effect of bed height variations on Co(II) ions adsorption by the synthesized nanocellulosic adsorbents

BH=12 cm

t (min)	qexp	AUC
0	0	0
20	0	0
30	0	0
40	0	0
50	0	0
60	0	0
80	0	0
100	0	0
140	0	0
180	0	0.5
230	0.02	1.25
255	0.08	3.625
280	0.21	3.315
293	0.3	2.275
300	0.35	6.3
315	0.49	12.87
337	0.68	12.58
354	0.8	6.56
362	0.84	6.84
370	0.87	4.4
375	0.89	4.475
380	0.9	18.1
400	0.91	

83.09
AOC=258.9, qt=2.0712, qe=0.2589, mt=2.949; R=70.23%

BH=8 cm

t (min)	qexp	AUC
0	0	0
20	0	0
30	0	0
40	0	0
50	0	0
60	0	0
70	0	0
80	0	0.175
115	0.01	1.125
140	0.08	5.7
170	0.3	9.875
195	0.49	8.175
210	0.6	13.1
230	0.71	15.1
250	0.8	16.5
270	0.85	12.9
285	0.87	13.275
300	0.9	18.1
320	0.91	

114.025
AOC=155.98, qt=1.248
qe=0.1560; mt=2.328
R=53.61%

BH=4 cm

t (min)	qexp	AUC
0	0	0
10	0	0
15	0	0
20	0	0
25	0	0.075
40	0.01	3.75
70	0.24	7.37
92	0.43	8.91
110	0.56	12.6
130	0.7	23.25
160	0.85	17.3
180	0.88	8.85
190	0.89	8.95
200	0.9	18.1
220	0.91	

109.155
AOC=70.845; qt=0.5668;
qe=0.14169; mt=1.552; R=36.52%

Effect of different flow rates on Co(II) ion adsorption

fr4ml/min

t (min)	qexp	AUC
0	0	0
20	0	0
30	0	0
40	0	0
50	0	0
60	0	0
90	0	0.6
150	0.02	9.3
210	0.29	9.25

fr8ml/min

t (min)	qexp	AUC
0	0	0
10	0	0
15	0	0
20	0	0
25	0	0.075
40	0.01	3.75
70	0.24	7.37
92	0.43	8.91
110	0.56	12.6

fr12ml/min

t (min)	qexp	AUC
0	0	0
10	0	0.4
20	0.08	2
30	0.32	8.46
48	0.62	8.16
60	0.74	20
85	0.86	13.125
100	0.89	17.9
120	0.9	9.05

t	qexp	AUC	t	qexp	AUC	t	qexp
235	0.45	13.5	130	0.7	23.25	130	0.91
260	0.63	13.7	160	0.85	17.3		
280	0.74	7.65	180	0.88	8.85		79.095
290	0.79	8.1	190	0.89	8.95	AOC=28.905; qt=0.3467; qe=0.087	
300	0.83	12.75	200	0.9	18.1	mt=1.397; R=28.84%	
315	0.87	4.375	220	0.91			
320	0.88	8.85					
330	0.89	8.95			109.155		
340	0.9	18.1					
360	0.91				AOC=70.845; qt=0.5668;		
					qe=0.14169; mt=1.552;		
		115.125			R=36.52%		

AOC=190.875; qt=0.7635; qe=0.1909;
mt=1.3192; R=58%

Effect of different initial concentrations for Co(II) ion adsorption

BH=4g	50mg/l			100mg/l			150mg/l	
t (min)	qexp	AUC	t (min)	qexp	AUC	t (min)	qexp	AUC
0	0	0	0	0	0	0	0	0
10	0	0	10	0	0	10	0	0.025
22	0	0	15	0	0	15	0.01	1.05
30	0	0	20	0	0	25	0.2	5.1
41	0	0	25	0	0.075	40	0.48	5.85
50	0	0	40	0.01	3.75	50	0.69	7.6
60	0	0.1	70	0.24	7.37	60	0.83	8.55
80	0.01	0.6	92	0.43	8.91	70	0.88	4.425
100	0.05	8.525	110	0.56	12.6	75	0.89	17.9
155	0.26	22	130	0.7	23.25	95	0.9	13.575
210	0.54	18	160	0.85	17.3	110	0.91	
240	0.66	29	180	0.88	8.85			64.075
280	0.79	16.2	190	0.89	8.95	AOC=21.425; qt=0.1714; qe=0.042		
300	0.83	16.9	200	0.9	18.1	mt=0.988; R=17.34		
320	0.86	17.4	220	0.91				
340	0.88	26.7						
370	0.9	18.1			109.155			
390	0.91							
		173.525			AOC=70.845; qt=0.5668;			

AOC=159.475; qt=1.2758; qe=0.3190;
mt=2.2792; R=56%

qe=0.14169; mt=1.552;
R=36.52%

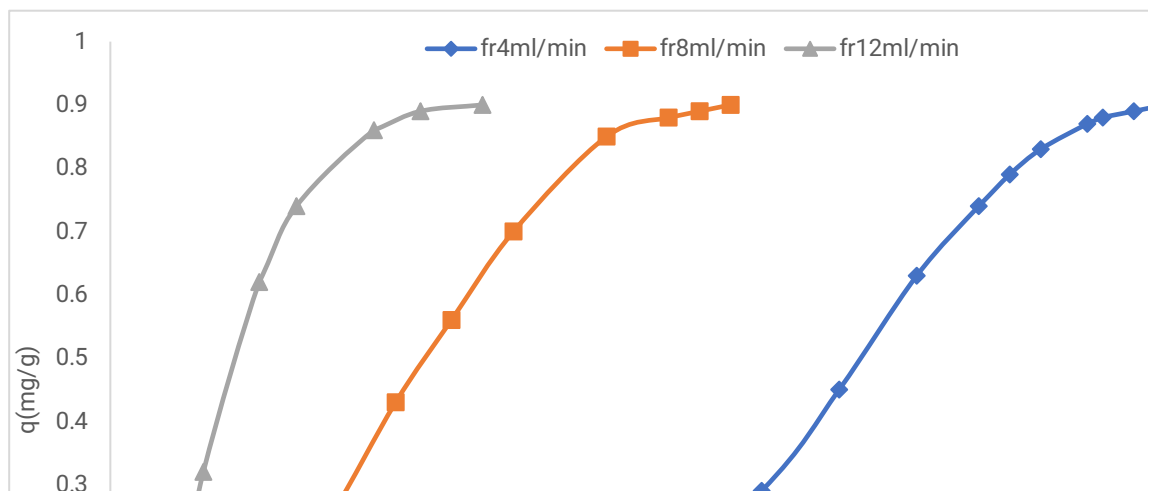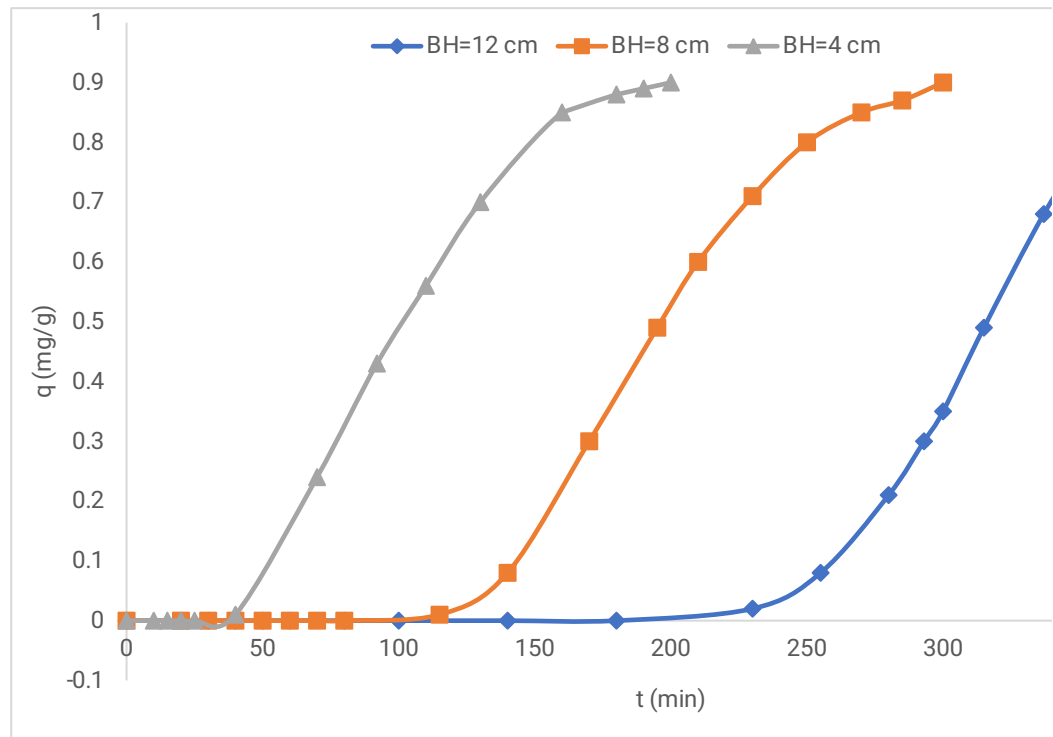Effect of magnetically modified nanocellulosic adsorbents (MNFC and MF-MNFC) on Ni(II) adsorption

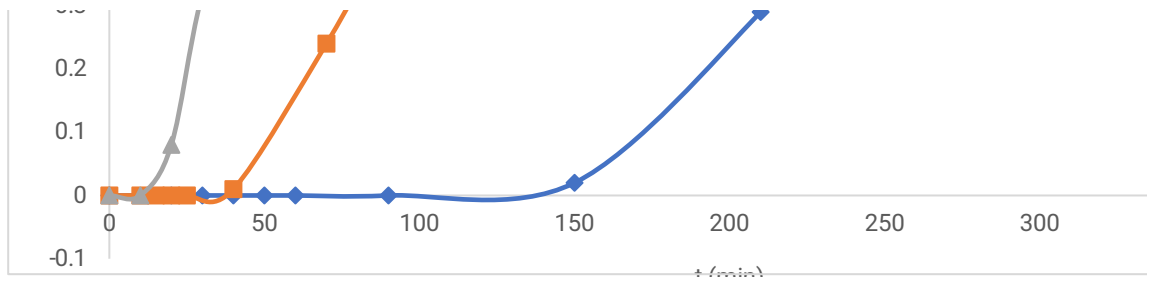MF-MNFC   C-MNFC   C-NFC

t (min)	qexp	AUC	t (min)	qexp	AUC	t (min)	qexp	AUC
0	0	0	0	0	0	0	0	0
20	0	0	20	0	0	10	0	0.4
40	0	0	30	0	0	20	0.08	2
50	0	0	40	0	0.05	30	0.32	8.46
60	0	0	50	0.01	0.6	48	0.62	8.16
70	0	0.05	60	0.11	4.3	60	0.74	20
80	0.01	1	80	0.32	6.72	85	0.86	13.125
100	0.09	2.25	96	0.52	5.13	100	0.89	17.9
115	0.21	4.275	105	0.62	12.155	120	0.9	9.05
130	0.36	4.1	122	0.81	8.35	130	0.91	
140	0.46	14.75	132	0.86	5.22			79.095
165	0.72	12	138	0.88	4.425			
180	0.88	4.425	143	0.89	6.265	AOC=28.905; q_t=0.3467; q_e=0.087		
185	0.89	4.475	150	0.9	22.625	m_t=1.397; R=24.82%		
190	0.9	4.525	175	0.91				
195	0.91	51.85			75.84			

AOC=119.1;

AOC=59.16
q_t=0.71, q_e=0.1775, m_t= 1.746, R=41%

q_t= 1.43, q_e=0.3573, m_t=2.1534; R= 66.41%

Summary of fixed bed adsorption parameters for Co(II) ion removal by raw NFC, MNFC and MF/MNFC @

Adsorbent type	m (g)	H (cm)	Q (ml/min)	C0 (mg/L)	tb (min)	te (min)	q_{total}(mg)	q_e(mg/g)
C-NFC	4	4	8	100	40	200	0.5668	0.1416
C-NFC	8	8	8	100	115	300	1.248	0.156
C-NFC	12	12	8	100	220	380	2.0712	0.2589
C-NFC	4	4	4	100	135	340	0.7635	0.1909
C-NFC	4	4	12	100	15	120	0.3467	0.0872
C-NFC	4	4	8	150	15	95	0.1714	0.0426
C-NFC	4	4	8	50	80	370	1.2758	0.319
MF-NFC	4	4	12	100	20	130	0.4764	0.1191
CMNFC	4	4	12	100	50	150	0.71	0.1775
MF-MNFC	4	4	12	100	80	185	1.43	0.3573
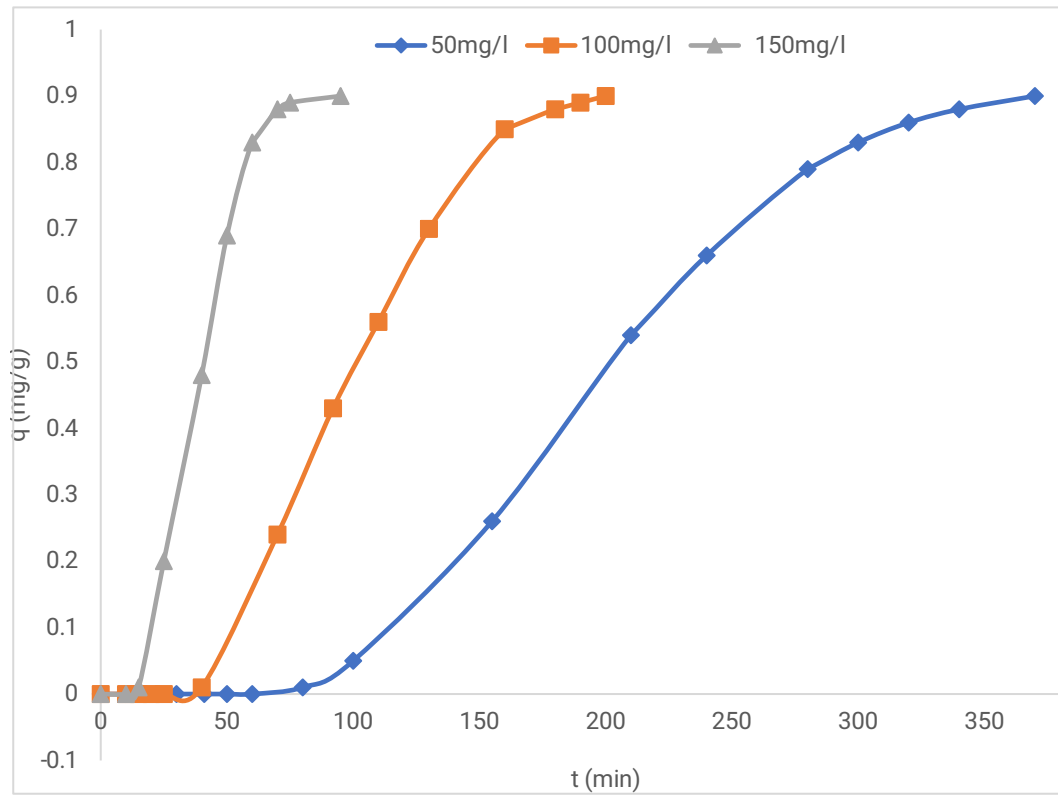
MF-NFC

t (min)	qexp	AUC
0	0	0
10	0	0.15
25	0.02	6.25
50	0.48	15.375
75	0.75	15.9
95	0.84	12.825
110	0.87	8.8
120	0.89	8.95
130	0.9	9.05
140	0.91	
		77.3
	qt=0.4764; qe=0.1191	
'2	R=31.16%	mt=1.5288
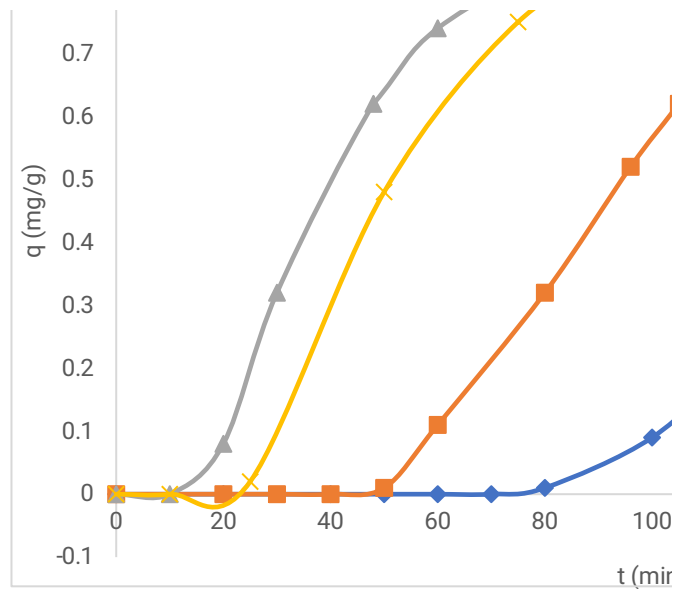
different operating conditions

m_{total} (mg)	%R (mass%)
1.522	36.52
2.328	53.61
2.949	70.23
1.3192	58
1.397	28.84
0.988	17.34
2.279	56
1.5288	31.16
1.746	41
2.1534	66.41

350   400

400
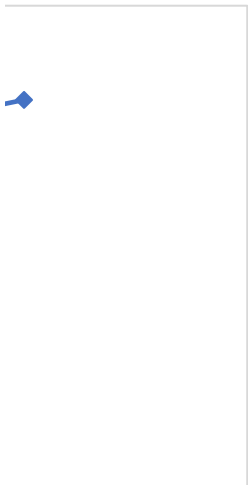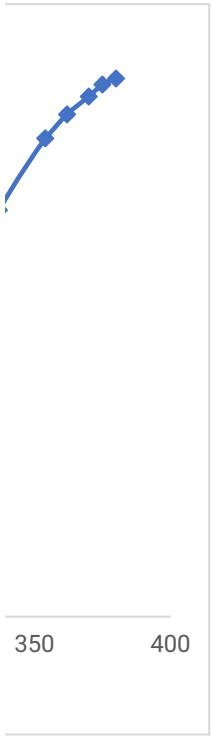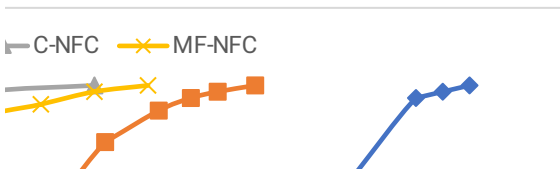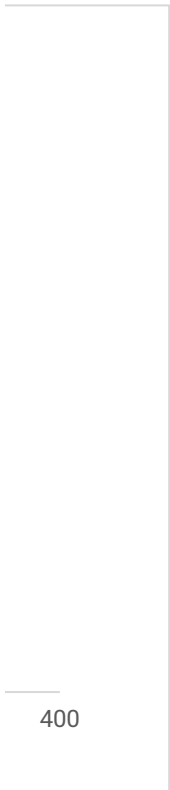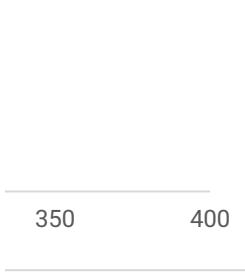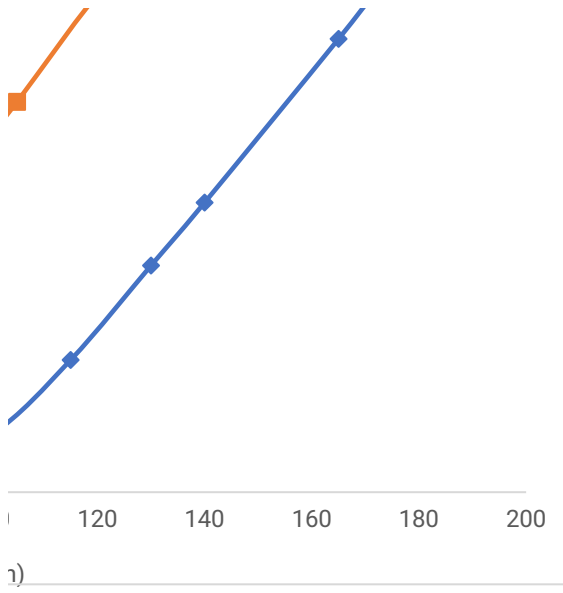
THOMAS MODEL PARAMETERS FOR Co(II) ION ADSORPTION AT DIFFERENT BED HEIGHTS

BH=4g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.022966334	0.000527453	0.172759
10	0	0.032365735	0.001047541	0.172759
15	0	0.038368852	0.001472169	0.172759
20	0	0.045433133	0.00206417	0.172759
25	0	0.053725388	0.002886417	0.172759
40	0.01	0.087900754	0.006068528	0.1645461
70	0.24	0.217324429	0.000514182	0.0308504
92	0.43	0.376295075	0.002884219	0.0002061
110	0.56	0.532360777	0.000763927	0.020839
130	0.7	0.697432204	6.59358E-06	0.080859
160	0.85	0.86913286	0.000366066	0.1886662
180	0.88	0.930783603	0.002578974	0.2156276
190	0.89	0.950335602	0.003640385	0.2250147
200	0.9	0.964574824	0.004169908	0.2346019
		0.415642827	0.028990531	2.0250058

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.00239556	5.73871E-06	0.1063609
20	0	0.004352523	1.89445E-05	0.1063609
30	0	0.005863742	3.43835E-05	0.1063609
40	0	0.007895504	6.2339E-05	0.1063609
50	0	0.010623738	0.000112864	0.1063609
60	0	0.014281125	0.000203951	0.1063609
70	0	0.019173223	0.000367612	0.1063609
80	0	0.025697454	0.000660359	0.1063609
115	0.01	0.06998625	0.00359835	0.0999383
140	0.08	0.137285343	0.003281611	0.0605801
170	0.3	0.281027885	0.000359941	0.0006828
195	0.49	0.45252085	0.001404687	0.0268533
210	0.6	0.564350218	0.001270907	0.0750047
230	0.71	0.702229842	6.03754E-05	0.147356
250	0.8	0.811079742	0.000122761	0.2245526
270	0.85	0.886566952	0.001337142	0.2744395
285	0.87	0.924524451	0.002972916	0.2957943
300	0.9	0.950489749	0.002549215	0.3293265
		0.326130231	0.018424096	2.3854155

	BH=12 cm			
t (min)	qexp	qcalc	SSE	SSEA
0	0	8.84121E-06	7.8167E-11	0.086618
20	0	1.84328E-05	3.39768E-10	0.086618
30	0	2.66152E-05	7.0837E-10	0.086618
40	0	3.84297E-05	1.47684E-09	0.086618
50	0	5.54883E-05	3.07895E-09	0.086618
60	0	8.01185E-05	6.41897E-09	0.086618
80	0	0.000167024	2.7897E-08	0.086618
100	0	0.000348164	1.21218E-07	0.086618
140	0	0.001511633	2.28503E-06	0.086618
180	0	0.006537665	4.27411E-05	0.086618
230	0.02	0.039664688	0.0003867	0.0752456
255	0.08	0.093772077	0.00018967	0.0459285
280	0.21	0.205866082	1.70893E-05	0.0071081
293	0.3	0.294742778	2.76384E-05	3.238E-05
300	0.35	0.350849266	7.21252E-07	0.0031015
315	0.49	0.483938085	3.67468E-05	0.0382949
337	0.68	0.677852458	4.61194E-06	0.1487573
354	0.8	0.797126425	8.25743E-06	0.2557231
362	0.84	0.840548852	3.01239E-07	0.2977784
370	0.87	0.876121624	3.74743E-05	0.3314198
375	0.89	0.8947197	2.22756E-05	0.3548474
380	0.9	0.91080986	0.000116853	0.3668612
		0.294309287	0.000893527	2.7912776

THOMAS MODEL PARAMETERS FOR Co(II) ADSORPTION AT DIFFERENT FLOW RATES

Sum of the sfr4ml/min

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.001235154	1.52561E-06	0.1695126
20	0	0.002139623	4.57798E-06	0.1695126
30	0	0.002815449	7.92675E-06	0.1695126
40	0	0.00370395	1.37192E-05	0.1695126
50	0	0.004871477	2.37313E-05	0.1695126
60	0	0.006404654	4.10196E-05	0.1695126
90	0	0.014502923	0.000210335	0.1695126
150	0.02	0.071241205	0.002625661	0.1534439
210	0.29	0.285618646	1.91963E-05	0.0148155
235	0.45	0.443039564	4.84477E-05	0.0014654
260	0.63	0.612798074	0.000295906	0.0476466

t (min)	qexp	qcalc	SSE	SSEA
280	0.74	0.732908305	5.02921E-05	0.1077684
290	0.79	0.78323149	4.58127E-05	0.1430964
300	0.83	0.826320059	1.3542E-05	0.1749589
315	0.87	0.877881804	6.21228E-05	0.2100214
320	0.88	0.891881692	0.000141175	0.219287
330	0.89	0.915697699	0.000660372	0.2287526
340	0.9	0.934651964	0.001200759	0.2384182
		0.411719096	0.005466121	2.7262626

fr12ml/min

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.034695062	0.001203747	0.0012037
10	0	0.070735885	0.005003565	0.0012037
20	0.08	0.138831013	0.003461088	0.0020525
30	0.32	0.254524227	0.004287077	0.0813989
48	0.62	0.56859116	0.002642869	0.3425819
60	0.74	0.764334744	0.00059218	0.4974551
85	0.86	0.954895081	0.009005076	0.6811282
100	0.89	0.984905573	0.009007068	0.7315465
120	0.9	0.996594776	0.009330551	0.7487526
		0.529789725	0.044533221	3.0873233

50mg/l

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.012148493	0.000147586	0.6462267
10	0	0.014907654	0.000222238	0.6462267
22	0	0.019041662	0.000362585	0.6462267
30	0	0.022402458	0.00050187	0.6462267
41	0	0.027984686	0.000783143	0.6462267
50	0	0.033536985	0.001124729	0.6462267
60	0	0.040952507	0.001677108	0.6462267
80	0.01	0.060734039	0.002573943	0.6302491
100	0.05	0.089182222	0.001535247	0.5683385
155	0.26	0.23458597	0.000645873	0.295808
210	0.54	0.489619387	0.002538206	0.0696339
240	0.66	0.641267894	0.000350892	0.0207021
280	0.79	0.803882297	0.000192718	0.0001927
300	0.83	0.861245221	0.000976264	0.0006821
320	0.86	0.903836994	0.001921682	0.0031492
340	0.88	0.934351473	0.002954083	0.0057939

t (min)	qexp	qcalc	SSE	SSEA
370	0.9	0.963664128	0.004053121	0.0092386
		0.361961416	0.001327135	0.3604338

150mg/l

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.022776533	0.00051877	0.2652827
10	0	0.053796489	0.002894062	0.2652827
15	0.01	0.081556686	0.005120359	0.2550816
25	0.2	0.178045381	0.000482005	0.0992603
40	0.48	0.45213602	0.000776401	0.0012289
50	0.69	0.668119299	0.000478765	0.0306054
60	0.83	0.830816684	6.66973E-07	0.0991897
70	0.88	0.922952915	0.001844953	0.1331841
75	0.89	0.949262933	0.003512095	0.140583
95	0.9	0.991097664	0.008298784	0.1481818
		0.51505606	0.023926863	1.4378803

THOMAS MODEL PARAMETERS FOR Co(II) ADSORPTION WITH MODIFIED NANOCELLULOSE ADSOR

MNFC

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.005307722	2.81719E-05	0.1917853
20	0	0.015532577	0.000241261	0.1917853
30	0	0.026413624	0.00069768	0.1917853
40	0	0.044572068	0.001986669	0.1917853
50	0.01	0.074261629	0.004129557	0.1831267
60	0.11	0.121218391	0.000125852	0.1075401
80	0.32	0.289701695	0.000917987	0.0139082
96	0.52	0.492614085	0.000749988	0.006735
105	0.62	0.612611616	5.45882E-05	0.0331484
122	0.81	0.798958287	0.000121919	0.1384339
132	0.86	0.872344701	0.000152392	0.1781406
138	0.88	0.904398692	0.000595296	0.1954232
143	0.89	0.925401764	0.001253285	0.2043646
150	0.9	0.947725162	0.002277691	0.2135059
		0.437933001	0.013332338	2.0414677

MF-MNFC

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.000773343	5.98059E-07	0.0942707

20	0	0.00209887	4.40526E-06	0.0942707
40	0	0.00568346	3.23017E-05	0.0942707
50	0	0.009334906	8.71405E-05	0.0942707
60	0	0.015296206	0.000233974	0.0942707
70	0	0.02496846	0.000623424	0.0942707
80	0.01	0.040505194	0.000930567	0.08823
100	0.09	0.102917763	0.000166869	0.0471044
115	0.21	0.195384086	0.000213625	0.0094159
130	0.36	0.339487663	0.000420756	0.0028052
140	0.46	0.458669896	1.76918E-06	0.0233982
165	0.72	0.747250341	0.000742581	0.1705398
180	0.88	0.862216204	0.000316263	0.3282884
185	0.89	0.889314702	4.69634E-07	0.3398477
190	0.9	0.911629866	0.000135254	0.351607
		0.307035397	0.003909997	1.926861

KTH	0.000353
q0	21265.04
R^2	**0.985684**

m	4
C0	100
n	14
p	2
Q	8
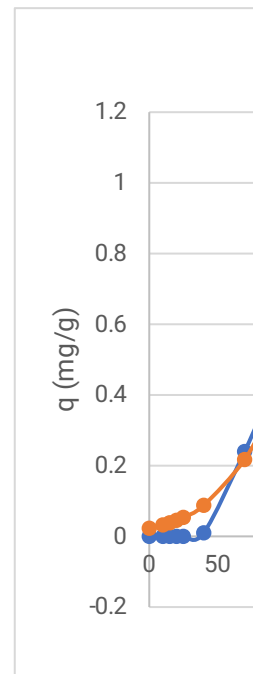
KTH	0.0003
q0	20135.92
R^2	**0.992276**

m	8
C0	100
n	18
Q	8
p	2

Chart Tit
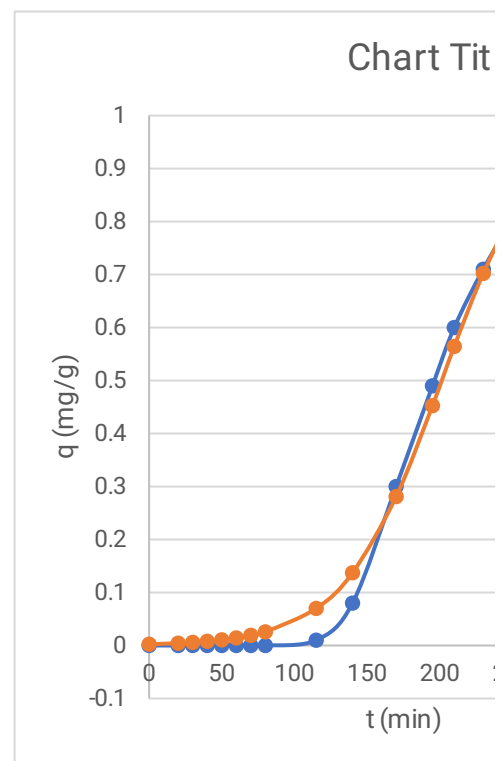
KTH	0.000367
q0	21116.63

R^2	0.99968

m	12
C0	100
Q	8
n	23
p	2

Chart
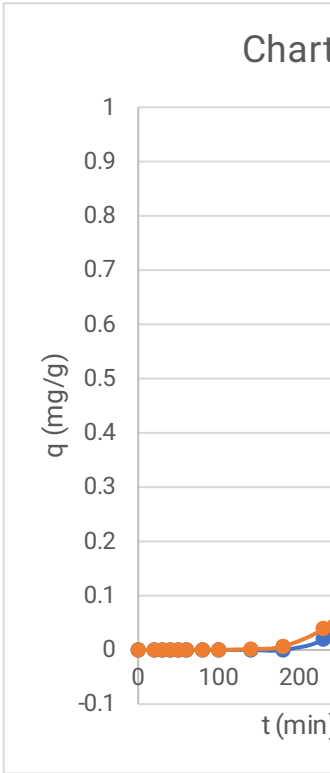
KTH	0.000275
q0	24331.61
R^2	0.997995

m	4
C0	100
Q	4
p	2
n	18

Chart Tit
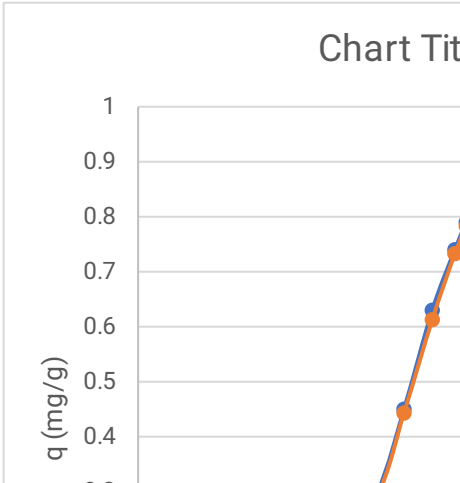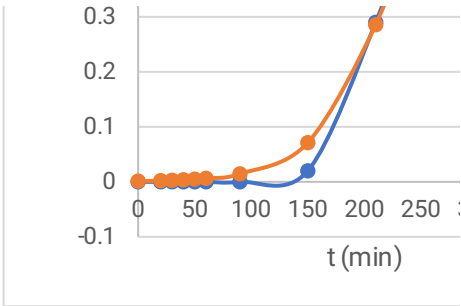
| KTH | 0.00075 |
| q0 | 13296.18 |

| R^2 | 0.985575 |

m	4
C0	100
Q	12
n	9
p	2

KTH	0.000415
q0	21200.17
	0
R^2	0.996318

m	4
C0	50
Q	8
n	12
p	2
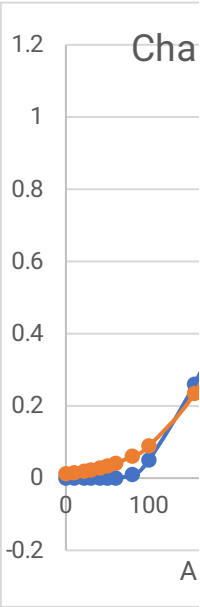
KTH	0.000594
q0	12646.08
R^2	0.98336
m	4
Q	8
C0	150
n	10
p	2

Chart Titl[e]
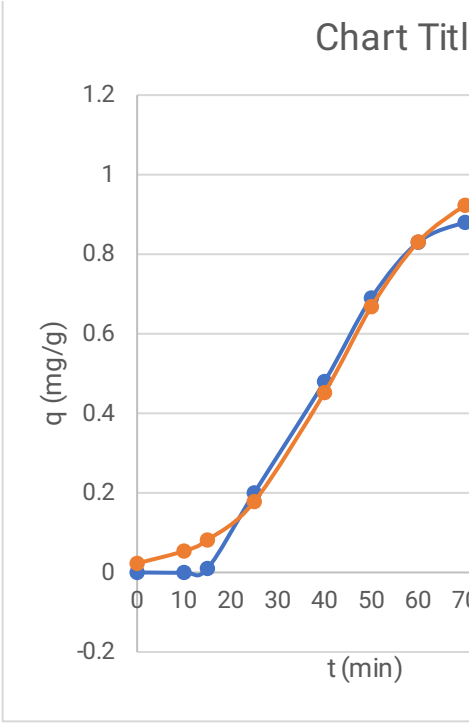
RBENTS

KTH	0.000542
q0	28963.52
R^2	0.993469
m	4
Q	12
C0	100
n	14
p	2

KTH	0.0005

q0	42994.43

R^2	0.997971

m	4
C0	100
Q	12
n	15
p	2

Chart Title

t (min)

Chart Title

Title

rt Title

qexp

qcalc

200   300   400

xis Title

e
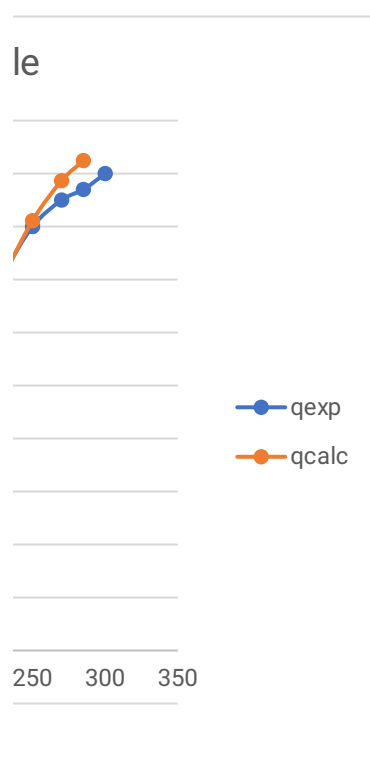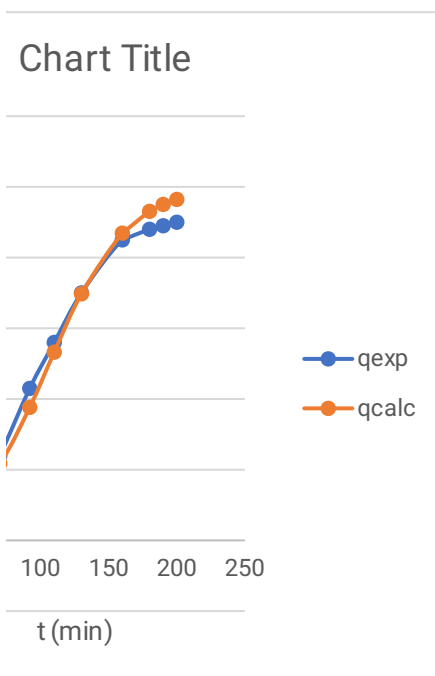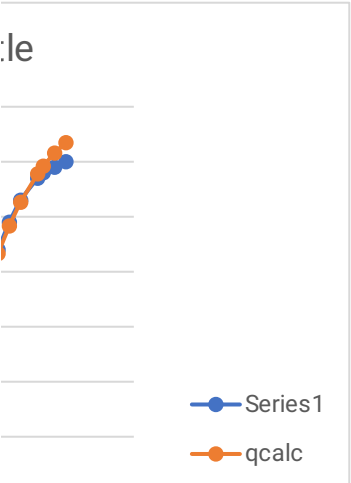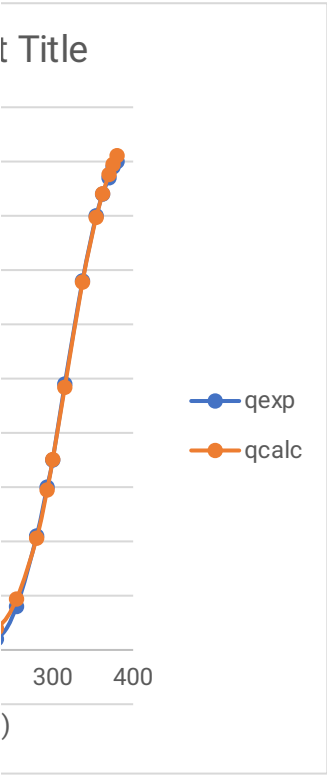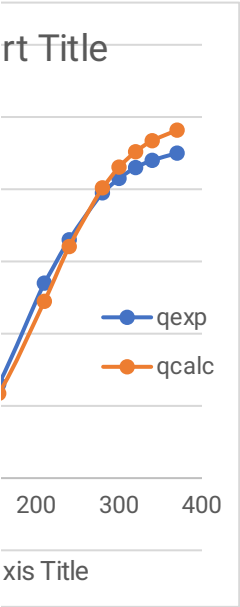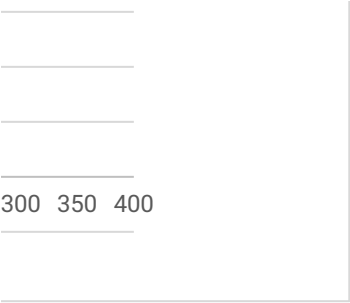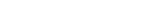
qexp

qcalc

0 80 90 100
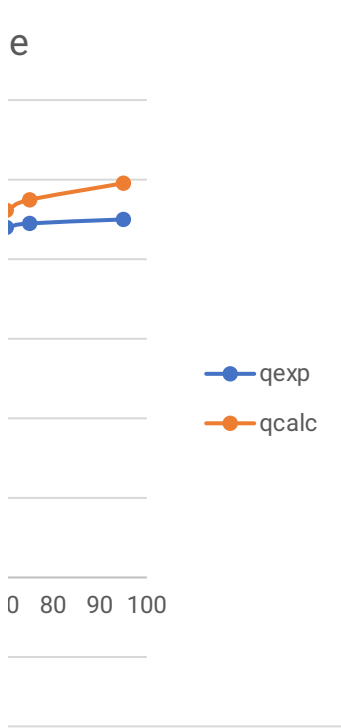
THOMAS MODEL EQUATION

$$\frac{C_t}{C_0} = \frac{1}{1 + \exp[K_T q_0 m/Q - K_T C_0 t]}$$

Q = 8 cm   C0 = 100

BH	K_T	q0	R2
4	0.0004	21265.04	0.9857
8	0.0003	20135.92	0.9923
12	0.0004	2116.63	0.9997

BH = 4 cm C0 = 100

Q	K_T	q0	R2
4	0.0003	24331.61	0.998
8	0.0004	21265.04	0.9857
12	0.0008	13296.16	0.9856

BH=4 cm   Q= 8 mg/L

C0	K_T	q0	R2
50	0.0007	16336.79	0.9873
100	0.0004	21265.04	0.9857
150	0.0006	12646.08	0.9834

C-MNFC   AND   MF-MNFC

C-MNFC
BH = 4 cm, C0 = 100mg/L, Flow rate = 12 mL/min

K_T	q0
0.0005421	28963.521

MF-MNFC
BH = 4 cm, C0 =100mg/L, Flow rate = 12 mL/min

K_T	q0
0.0005	42994.43

ERROR FUNCTIONS

Sum of the Squares of the Errors (ERRSQ /SSE)

t (min)	qexp	qcalc	SSE	SSEA		
0	0	0.0229277	0.000525678	0.000525678		
10	0	0.03231	0.001043935	0.000525678		
15	0	0.0383021	0.001467052	0.000525678		
20	0	0.0453535	0.002056936	0.000525678		
25	0	0.0536305	0.002876234	0.000525678	SSE	
40	0.01	0.0877443	0.006044172	0.000167125		
70	0.24	0.2169632	0.000530696	0.047120393		
92	0.43	0.3757669	0.002941231	0.165707876		
110	0.56	0.5317746	0.000796672	0.28844668		
130	0.7	0.696911	9.54207E-06	0.45842693		
160	0.85	0.8688322	0.000354652	0.684048627		
180	0.88	0.9306059	0.002560956	0.734572966		
190	0.89	0.9502027	0.003624364	0.751814413		
200	0.9	0.9644766	0.004157236	0.769255859		
		0.4154144	0.028989356	3.90218926		

Marquardt's Percent Standard Deviation (MPSD)

t (min)	qexp	qcalc	qex-qca/qex	error		
0	0	0.0229277	0	0.000525678		
10	0	0.03231	0	0.001043935		
15	0	0.0383021	0	0.001467052		
20	0	0.0453535	0	0.002056936	MPSD	0.9001938
25	0	0.0536305	0	0.002876234		
40	0.01	0.0877443	60.44172404	0.006044172		
70	0.24	0.2169632	0.009213464	0.000530696		
92	0.43	0.3757669	0.015907146	0.002941231		
110	0.56	0.5317746	0.002540407	0.000796672		
130	0.7	0.696911	1.94736E-05	9.54207E-06	0.0009724	
160	0.85	0.8688322	0.000490868	0.000354652		
180	0.88	0.9306059	0.003307019	0.002560956		
190	0.89	0.9502027	0.004575639	0.003624364		
200	0.9	0.9644766	0.00513239	0.004157236		
	5.46		60.48291044	0.028989356		

The Sum of Absolute Errors (SAE)

t (min)	qexp	qcalc	abs(qex-qca)	error
0	0	0.0293675	0.029367464	0.000862448
10	0	0.0405509	0.040550863	0.001644373
15	0	0.0475764	0.0475764	0.002263514
20	0	0.0557484	0.055748403	0.003107884
25	0	0.0652279	0.065227945	0.004254685
40	0.01	0.1033053	0.093305259	0.008705871
70	0.24	0.238985	0.001014981	1.03019E-06
92	0.43	0.3958269	0.034173117	0.001167802
110	0.56	0.5445766	0.015423371	0.00023788
130	0.7	0.7	3.43781E-09	1.18185E-17
160	0.85	0.8641357	0.014135663	0.000199817
180	0.88	0.9254348	0.045434787	0.00206432
190	0.89	0.9454657	0.055465709	0.003076445
200	0.9	0.9603462	0.06034617	0.00364166
			0.557770137	

SAE (ObF

Hybrid Fractional Error Function (HYBRID)

t (min)	qexp	qcalc	qex-qca/qex	error
0	0	0.0033817	0	1.14356E-05
10	0	0.0058293	0	3.39804E-05
15	0	0.0076488	0	5.85046E-05
20	0	0.0100306	0	0.000100613
25	0	0.0131442	0	0.000172771
40	0.01	0.0293674	0.037509587	0.000375096
70	0.24	0.1350403	0.045902223	0.011016534
92	0.43	0.3421465	0.017949408	0.007718246
110	0.56	0.581961	0.000861224	0.000482286
130	0.7	0.8060895	0.016078534	0.011254973
160	0.85	0.9554577	0.013083916	0.011121329
180	0.88	0.9846281	0.012439809	0.010947032
190	0.89	0.9910464	0.01147233	0.010210374
200	0.9	0.994799	0.009985389	0.00898685
			0.165282421	

HYBDRID   1.3773535

Average Relative Error (ARE)

t (min)	qexp	qcalc	qex-qca/qex	errors		
0	0	0.0345143	0	0.00119124		
10	0	0.0469067	0	0.00220024		
15	0	0.0545935	0	0.002980454	ARE	0.1095318
20	0	0.0634561	0	0.004026683		
25	0	0.0736454	0	0.005423649		
40	0.01	0.1138063	0	0.010775739		
70	0.24	0.2509928	0.002097946	0.000120842		
92	0.43	0.4037235	0.003734205	0.000690455		
110	0.56	0.546241	0.000603669	0.00018931		
130	0.7	0.6952762	4.55403E-05	2.23147E-05		
160	0.85	0.8561922	5.30698E-05	3.83429E-05		
180	0.88	0.9185963	0.00192365	0.001489675		
190	0.89	0.9395242	0.003096387	0.002452648		
200	0.9	0.9553334	0.003779987	0.003061789		
				0.015334454		

BH=8g

Sum of the Squares of the Errors (ERRSQ /SSE)

t (min)	qexp	qcalc	SSE		
0	0	0.0023941	5.7318E-06		
20	0	0.0043499	1.89215E-05		
30	0	0.0058602	3.43417E-05		
40	0	0.0078907	6.22631E-05	SSE	0.018424
50	0	0.0106173	0.000112726		
60	0	0.0142724	0.000203702		
70	0	0.0191615	0.000367165		
80	0	0.0256818	0.000659557		
115	0.01	0.0699451	0.003593416		
140	0.08	0.1372098	0.003272956		
170	0.3	0.2808974	0.000364909		
195	0.49	0.4523593	0.00141682		
210	0.6	0.564189	0.001282427		
230	0.71	0.7020917	6.25414E-05		
250	0.8	0.8109777	0.000120511		
270	0.85	0.8864995	0.001332214		

t			
285	0.87	0.9244774	0.002967786
300	0.9	0.9504578	0.002545993
			0.018423982

The Sum of Absolute Errors (SAE)

t (min)	qexp	qcalc	abs-errors
0	0	0.0030371	0.003037085
20	0	0.0054204	0.005420424
30	0	0.0072368	0.007236813
40	0	0.009656	0.009655966
50	0	0.0128733	0.012873317
60	0	0.0171441	0.017144126
70	0	0.0227991	0.02279908
80	0	0.0302619	0.030261877
115	0.01	0.0794959	0.069495931
140	0.08	0.1515972	0.071597185
170	0.3	0.2995117	0.000488324
195	0.49	0.4694039	0.020596061
210	0.6	0.5777917	0.022208252
230	0.71	0.7100001	7.0192E-08
250	0.8	0.8141272	0.014127185
270	0.85	0.8868261	0.036826117
285	0.87	0.9237888	0.053788845
300	0.9	0.9493687	0.049368728
			0.446925385

SAE   0.4469254

Hybrid Fractional Error Function (HYBRID)

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	0.0002229	4.96905E-08	0
20	0	0.000515	2.65188E-07	0
30	0	0.0007826	6.12475E-07	0
40	0	0.0011892	1.41417E-06	0
50	0	0.0018066	3.26386E-06	0
60	0	0.0027437	7.52806E-06	0
70	0	0.0041649	1.73465E-05	0
80	0	0.0063176	3.99116E-05	0
115	0.01	0.0267977	0.000282162	0.028216243

HYBRID   0.9324437

140	0.08	0.0727449	5.2637E-05	0.000657963
170	0.3	0.2160452	0.007048404	0.023494679
195	0.49	0.4398286	0.002517171	0.005137084
210	0.6	0.5954027	2.11353E-05	3.52255E-05
230	0.71	0.772758	0.003938564	0.005547273
250	0.8	0.88711	0.007588149	0.009485186
270	0.85	0.9478049	0.009565793	0.011253875
285	0.87	0.9714564	0.010293397	0.011831491
300	0.9	0.9845651	0.00715125	0.007945833
				0.103604853

Marquardt's Percent Standard Deviation (MPSD)

t (min)	qexp	qcalc	qex-qca/qex	error	
0	0	1.926E-05	0	3.71054E-10	
20	0	5.917E-05	0	3.50096E-09	
30	0	0.0001037	0	1.07533E-08	
40	0	0.0001817	0	3.30266E-08	MPSD 0.3914455
50	0	0.0003185	0	1.01423E-07	
60	0	0.000558	0	3.11402E-07	
70	0	0.0009776	0	9.5576E-07	
80	0	0.0017122	0	2.93158E-06	
115	0.01	0.0120769	0.043134103	4.31341E-06	
140	0.08	0.0473588	0.16647603	0.001065447	
170	0.3	0.2111358	0.087742718	0.007896845	0.0039227
195	0.49	0.521171	0.004046771	0.00097163	
210	0.6	0.7163506	0.037604079	0.013537468	
230	0.71	0.8858154	0.061319326	0.030911072	
250	0.8	0.9597265	0.039863361	0.025512551	
270	0.85	0.9865232	0.025797343	0.01863858	
285	0.87	0.9941469	0.020362599	0.015412451	
300	0.9	0.997469	0.011728651	0.009500207	
	5.61		0.49807498	0.123454912	

FLOW RATES

Average Relative Error (ARE)

fr4ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.5	0.25	0		
20	0	0.5	0.25	0		
30	0	0.5	0.25	0	ARE	154.8353
40	0	0.5	0.25	0		
50	0	0.5	0.25	0		
60	0	0.5	0.25	0		
90	0	0.5	0.25	0		
150	0.02	0.5	0.2304	24		
210	0.29	0.5	0.0441	0.724137931		
235	0.45	0.5	0.0025	0.111111111		
260	0.63	0.5	0.0169	0.206349206		
280	0.74	0.5	0.0576	0.324324324		
290	0.79	0.5	0.0841	0.367088608		
300	0.83	0.5	0.1089	0.397590361		
315	0.87	0.5	0.1369	0.425287356		
320	0.88	0.5	0.1444	0.431818182		
330	0.89	0.5	0.1521	0.438202247		
340	0.9	0.5	0.16	0.444444444		
				27.87035377		

Sum of the Squares of the Errors (ERRSQ /SSE)

fr4ml/min

t (min)	qexp	qcalc	SSE	SSEA		
0	0	0.0012351	1.52554E-06	0.004026683		
20	0	0.0021396	4.57774E-06	0.004026683		
30	0	0.0028154	7.92629E-06	0.004026683	SSE	0.0054661
40	0	0.0037038	1.37184E-05	0.004026683		
50	0	0.0048713	2.37297E-05	0.004026683		
60	0	0.0064044	4.10167E-05	0.004026683		
90	0	0.0145023	0.000210317	0.004026683		
150	0.02	0.0712376	0.002625289	0.001888437		
210	0.29	0.2856048	1.93176E-05	0.051322117		
235	0.45	0.4430215	4.86992E-05	0.149416149		
260	0.63	0.6127795	0.000296547	0.320971936		
280	0.74	0.7328921	5.05222E-05	0.457711583		
290	0.79	0.7832171	4.60081E-05	0.527865968		

300	0.83	0.8263076	1.36341E-05	0.587589477
315	0.87	0.8778721	6.19703E-05	0.650512985
320	0.88	0.8918729	0.000140965	0.666743862
330	0.89	0.9156905	0.000660001	0.683174739
340	0.9	0.9346461	0.001200354	0.699805616
			0.005466119	

The Sum of Absolute Errors (SAE)

Sum of the :fr4ml/min

t (min)	qexp	qcalc	error	qex-qca			
0	0	0.0012213	1.49157E-06	0.0012213			
20	0	0.0021227	4.50605E-06	0.002122746			
30	0	0.0027979	7.82845E-06	0.002797937		SAE	0.1950069
40	0	0.0036871	1.35947E-05	0.003687095			
50	0	0.0048574	2.35948E-05	0.004857443			
60	0	0.0063969	4.09203E-05	0.006396894			
90	0	0.0145576	0.000211923	0.014557574			
150	0.02	0.0721658	0.002721267	0.052165763			
210	0.29	0.2905333	2.84388E-07	0.000533281			
235	0.45	0.4499992	6.00863E-13	7.75154E-07			
260	0.63	0.6204474	9.12514E-05	0.009552562			
280	0.74	0.7398415	2.51107E-08	0.000158464			
290	0.79	0.7895132	2.36951E-07	0.000486776			
300	0.83	0.8318565	3.44671E-06	0.001856533			
315	0.87	0.8822712	0.000150581	0.012271155			
320	0.88	0.8959059	0.000252997	0.015905864			
330	0.89	0.919041	0.000843382	0.029041035			
340	0.9	0.9373937	0.001398287	0.037393674			
				0.195006871			

Marquardt's Percent Standard Deviation (MPSD)

Sum of the :fr4ml/min

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.0259356	0.000672656	0			
20	0	0.0259356	0.000672657	0			
30	0	0.0259356	0.000672658	0			
40	0	0.0259357	0.000672658	0		MPSD	7.9037989
50	0	0.0259357	0.000672659	0			
60	0	0.0259357	0.000672659	0			

t	qexp	qcalc	error	qex-qca/qex	
90	0	0.0259357	0.000672661	0	
150	0.02	0.0259358	3.52333E-05	0.088083372	
210	0.29	0.0259358	0.069729886	0.829130624	
235	0.45	0.0259359	0.179830398	0.888051347	
260	0.63	0.0259359	0.364893458	0.919358675	
280	0.74	0.0259359	0.509887534	0.931131363	
290	0.79	0.0259359	0.583793928	0.935417286	0.0999521
300	0.83	0.0259359	0.646519039	0.938480242	
315	0.87	0.0259359	0.712444138	0.941265872	
320	0.88	0.0259359	0.729425411	0.941923309	
330	0.89	0.025936	0.746606674	0.942566184	
340	0.9	0.025936	0.763987937	0.943194984	
	7.29		5.311862244	9.298603258	

Hybrid Fractional Error Function (HYBRID)

Sum of the :fr4ml/min

t (min)	qexp	qcalc	err0r	qex-qca/qex
0	0	0.0002496	6.22826E-08	0
20	0	0.0004902	2.40336E-07	0
30	0	0.0006871	4.72041E-07	0
40	0	0.0009628	9.26981E-07	0
50	0	0.0013491	1.81998E-06	0
60	0	0.00189	3.57212E-06	0
90	0	0.0051883	2.69181E-05	0
150	0.02	0.0380561	0.000326024	0.016301182
210	0.29	0.2308293	0.003501176	0.012073022
235	0.45	0.4111145	0.00151208	0.003360178
260	0.63	0.6189078	0.000123038	0.000195298
280	0.74	0.7613935	0.000457683	0.00061849
290	0.79	0.8172826	0.000744343	0.000942206
300	0.83	0.8624458	0.001052731	0.001268351
315	0.87	0.9123218	0.001791134	0.002058774
320	0.88	0.9249215	0.002017939	0.002293112
330	0.89	0.945261	0.003053775	0.003431208
340	0.9	0.9603267	0.003639306	0.004043673
			0.01825324	0.046585495

HYBRID   0.2911593

flow rate = 12ml/l
Sum of the Squares of the Errors (ERRSQ /SSE)

t (min)	qexp	fr12ml/min qcalc	error		
0	0	0.0387664	0.001502834		
10	0	0.0768157	0.005900657		
20	0.08	0.1465181	0.00442466		
30	0.32	0.2615494	0.003416472	SSE	0.0443
48	0.62	0.5660391	0.002911784		
60	0.74	0.7567239	0.00027969		
85	0.86	0.9500462	0.008108318		
100	0.89	0.9825666	0.008568569		
120	0.9	0.9958491	0.009187047		
			0.044300031		

The Sum of Absolute Errors (SAE)

t (min)	qexp	fr12ml/min qcalc	error	qex-qca		
0	0	0.0338707	0.001147224	0.033870701		
10	0	0.0679914	0.004622826	0.067991368		
20	0.08	0.1317956	0.002682779	0.051795554	SAE	0.5860851
30	0.32	0.2400529	0.006391534	0.079947068		
48	0.62	0.5415603	0.006152794	0.078439748		
60	0.74	0.74	3.40901E-16	1.84635E-08		
85	0.86	0.9467448	0.007524656	0.086744776		
100	0.89	0.981605	0.008391484	0.091605046		
120	0.9	0.9956908	0.009156729	0.095690801		
			0.046070028	0.58608508		

Marquardt's Percent Standard Deviation (MPSD)

t (min)	qexp	fr12ml/min qcalc	error	qex-qca/qex		
0	0	0.0120172	0.000144413	0		
10	0	0.0334539	0.001119162	0		
20	0.08	0.0896597	9.33103E-05	0.014579733	MPSD	2.207333
30	0.32	0.2189096	0.010219271	0.099797568		

48	0.62	0.6480194	0.000785084	0.002042362
60	0.74	0.8659091	0.015853101	0.028950148
85	0.86	0.98879	0.016586858	0.022426796
100	0.89	0.9976437	0.011587175	0.014628424	0.0034106
120	0.9	0.9997084	0.009941766	0.012273785
	4.41		0.06633014	0.194698816

Hybrid Fractional Error Function (HYBRID)

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0227118	0.000515828	0		
10	0	0.0519378	0.002697537	0		
20	0.08	0.114371	0.001181366	0.014767072		
30	0.32	0.2333791	0.007503179	0.023447433	<mark>HYBRID</mark>	<mark>1.1656911</mark>
48	0.62	0.5876386	0.001047259	0.001689127		
60	0.74	0.7995107	0.003541521	0.004785839		
85	0.86	0.9714476	0.012420558	0.014442509		
100	0.89	0.9919446	0.010392708	0.0116772		
120	0.9	0.9985408	0.00971028	0.0107892		
			0.049010234	0.08159838		

Marquardt's Percent Standard Deviation (MPSD

50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0001338	1.78966E-08	0		
10	0	0.0002311	5.33974E-08	0		
20	0	0.0003991	1.59297E-07	0		
35	0	0.0009058	8.2039E-07	0	<mark>MPSD</mark>	<mark>1.7744145</mark>
55	0	0.0026981	7.27998E-06	0		
80	0	0.0105002	0.000110254	0		
100	0.03	0.0306956	4.83903E-07	0.00053767		
160	0.53	0.4570023	0.005328666	0.018969974		
180	0.66	0.7152317	0.003050537	0.007003069		
210	0.8	0.9283058	0.016462377	0.025722465	0.0031485	
240	0.88	0.9852401	0.011075481	0.014302016		
270	0.9	0.9971025	0.009428889	0.011640603		
	3.8		<mark>0.045465019</mark>	0.078175797		

The sum of the squares of the errors (SSE)

t (min)	qexp	qcalc	error
		50mg/l	
0	0	0.0032216	1.03786E-05
10	0	0.0045697	2.08822E-05
20	0	0.0064783	4.19682E-05
35	0	0.0109175	0.000119192
55	0	0.021784	0.000474543
80	0	0.0508235	0.002583028
100	0.03	0.0974943	0.004555478
160	0.53	0.4700813	0.003590245
180	0.66	0.6415359	0.000340922
210	0.8	0.8368287	0.001356351
240	0.88	0.936291	0.003168676
270	0.9	0.9768057	0.005899119
			0.022160783

SSE	0.0221608

Sum of Absolute Errors (EABS/SAE)

t (min)	qexp	qcalc	error	qex-qca
		50mg/l		
0	0	0.0006807	4.6342E-07	0.000680749
10	0	0.0010587	1.12075E-06	0.001058657
20	0	0.001646	2.70935E-06	0.001646009

35	0	0.003189	1.01699E-05	0.003189032	SAE	0.4005954
55	0	0.0076835	5.90367E-05	0.007683534		
80	0	0.0228406	0.000521692	0.022840577		
100	0.03	0.0535435	0.000554298	0.023543528		
160	0.53	0.4450758	0.007212112	0.084924157		
180	0.66	0.66	8.68279E-16	2.94666E-08		
210	0.8	0.8796496	0.006344056	0.079649583		
240	0.88	0.9649377	0.007214416	0.08493772		
270	0.9	0.9904419	0.008179732	0.090441872		
			0.030099807	0.400595448		

Hybrid Fractional Error Function (HYBRID)

50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0003419	1.16909E-07	0		
10	0	0.0005557	3.08756E-07	0		
20	0	0.0009029	8.15206E-07	0		
35	0	0.0018693	3.49428E-06	0	HYBRID	0.5153213
55	0	0.0049238	2.4244E-05	0		
80	0	0.0163949	0.000268793	0		
100	0.03	0.0421819	0.000148398	0.004946597		
160	0.53	0.4482087	0.006689821	0.012622304		
180	0.66	0.682151	0.000490665	0.000743432		
210	0.8	0.9021242	0.010429348	0.013036685		
240	0.88	0.9753599	0.009093508	0.010333532		
270	0.9	0.9941521	0.00886462	0.009849577		
			0.036014133	0.051532128		

Sum of the Squares of the Errors (ERRSQ /SSE)

150mg/l

t (min)	qexp	qcalc	error		
0	0	0.0227378	0.000517009		
10	0	0.0536953	0.002883184		
15	0.01	0.0813984	0.005097734	SSE	0.0239256

t (min)	qexp	qcalc	error	
25	0.2	0.1776996	0.000497307	
40	0.48	0.4514577	0.000814665	
50	0.69	0.6674563	0.000508218	
60	0.83	0.830361	1.30347E-07	
70	0.88	0.9227045	0.001823677	
75	0.89	0.9490887	0.003491469	
95	0.9	0.9910613	0.008292162	
		0.0227378	0.023925556	

Sum of Absolute Errors (EABS/SAE)

150mg/l

t (min)	qexp	qcalc	error	qex-qca		
0	0	0.0277961	0.000772621	0.027796062		
10	0	0.0637257	0.004060965	0.063725704		
15	0.01	0.0950355	0.007231038	0.085035509	SAE	0.3869956
25	0.2	0.2	1.90237E-17	4.36162E-09		
40	0.48	0.4786959	1.70078E-06	0.001304139		
50	0.69	0.6861288	1.49863E-05	0.003871214		
60	0.83	0.8388145	7.76946E-05	0.008814452		
70	0.88	0.9253101	0.002053006	0.045310105		
75	0.89	0.9502852	0.003634306	0.060285202		
95	0.9	0.9908532	0.008254302	0.090853189		
		0.0277961	0.026100619	0.38699558		

Hybrid Fractional Error Function (HYBRID)

150mg/l

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0037797	1.42859E-05	0		
10	0	0.0140601	0.000197686	0		
15	0.01	0.0269038	0.000285737	0.028573725		
25	0.2	0.0941367	0.011207041	0.056035205	HYBRID	1.3382706

40	0.48 0.4309377	0.002407108	0.005014807
50	0.69 0.7400156	0.002501565	0.003625456
60	0.83 0.9145207	0.007143751	0.008606929
70	0.88 0.9757361	0.0091654	0.010415227
75	0.89 0.9873359	0.00947428	0.010645259
95	0.9 0.9990929	0.00981941	0.010910456
		0.052216264	0.133827065

Marquardt's Percent Standard Deviation (MPSD)

150mg/l

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.000804	6.46417E-07	0			
10	0	0.0046949	2.20418E-05	0		MPSD	0.0006024
15	0.01	0.0112919	1.66893E-06	0.016689266			
25	0.2	0.0627501	0.018837532	0.470938296			
40	0.48	0.4872529	5.2604E-05	0.000228316			
50	0.69	0.84781	0.024904005	0.05230835			
60	0.83	0.9702883	0.019680818	0.028568469			
70	0.88	0.9948036	0.013179868	0.017019457	0.0041277		
75	0.89	0.9978472	0.011631024	0.014683783			
95	0.9	0.9999372	0.009987449	0.012330184			
	4.88		0.098297658	0.612766121			

Sum of the Squares of the Errors (ERRSQ /SSE)

MNFC

t (min)	qexp	qcalc	error			
0	0	0.0053056	2.81494E-05			
20	0	0.0155258	0.00024105			
30	0	0.0264016	0.000697046			
40	0	0.0445513	0.001984817		SSE	0.0133323
50	0.01	0.0742266	0.004125055			
60	0.11	0.1211618	0.000124586			
80	0.32	0.2895835	0.000925163			
96	0.52	0.4924619	0.000758348			
105	0.62	0.6124625	5.68141E-05			
122	0.81	0.7988515	0.00012429			
132	0.86	0.8722682	0.000150509			

138	0.88	0.9043382	0.000592348	
143	0.89	0.9253527	0.001249815	
150	0.9	0.9476892	0.002274261	
			0.013332251	

Sum of Absolute Errors (EABS/SAE)

MNFC

t (min)	qexp	qcalc	error	qex-qca		
0	0	0.0050511	2.55132E-05	0.005051062		
20	0	0.0150155	0.000225466	0.015015511		
30	0	0.0257366	0.000662374	0.02573662		
40	0	0.0437724	0.001916027	0.043772443	SAE	0.354675
50	0.01	0.073494	0.004031494	0.063494044		
60	0.11	0.1208462	0.000117641	0.010846245		
80	0.32	0.2921655	0.000774762	0.02783454		
96	0.52	0.4986876	0.000454218	0.02131238		
105	0.62	0.62	1.54794E-16	1.24416E-08		
122	0.81	0.8059907	1.60742E-05	0.00400926		
132	0.86	0.8780339	0.00032522	0.018033861		
138	0.88	0.9091918	0.000852163	0.029191835		
143	0.89	0.9294777	0.001558493	0.039477749		
150	0.9	0.9508994	0.00259075	0.050899414		
			0.013550194	0.354674977		

Marquardt's Percent Standard Deviation (MPSD)

MNFC

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	7.251E-05	5.25708E-09	0		
20	0	0.0005631	3.17109E-07	0		
30	0	0.0015682	2.45912E-06	0		
40	0	0.0043591	1.90017E-05	0	MPSD	1.6362988
50	0.01	0.0120572	4.23222E-06	0.042322243		
60	0.11	0.032901	0.005944252	0.491260514		
80	0.32	0.2090813	0.012302953	0.120146021		
96	0.52	0.5768336	0.003230057	0.011945477		
105	0.62	0.7742444	0.023791339	0.061892142		
122	0.81	0.9514416	0.020005726	0.030491886	0.003213	
132	0.86	0.9820204	0.014888976	0.020131119		

138	0.88	0.9901995	0.012143926	0.015681723
143	0.89	0.9941068	0.010838234	0.013682912
150	0.9	0.9971159	0.009431505	0.011643833
	5.92		0.112602984	0.81919787

Hybrid Fractional Error Function (HYBRID)

MNFC

t (min)	qexp	qcalc	error	qex-qac/qex			
0	0	0.0007236	5.23598E-07	0			
20	0	0.0032307	1.04376E-05	0			
30	0	0.0068106	4.63843E-05	0			
40	0	0.0143003	0.000204498	0		HYBRID	1.0436266
50	0.01	0.0297795	0.000391228	0.039122831			
60	0.11	0.0609775	0.002403206	0.021847331			
80	0.32	0.2252033	0.008986417	0.028082553			
96	0.52	0.4908492	0.000849768	0.00163417			
105	0.62	0.6542615	0.001173854	0.001893312			
122	0.81	0.8712158	0.003747373	0.004626386			
132	0.86	0.9346931	0.005579056	0.006487274			
138	0.88	0.9573337	0.005980493	0.006796015			
143	0.89	0.9702702	0.00644331	0.007239674			
150	0.9	0.9821893	0.006755079	0.007505643			
			0.042571629	0.125235192			

Sum of the Squares of the Errors (ERRSQ /SSE)

MF-MNFC

t (min)	qexp	qcalc	error			
0	0	0.0007733	5.97924E-07			
20	0	0.0020986	4.40431E-06			
40	0	0.0056829	3.22951E-05			
50	0	0.009334	8.71233E-05		SSE	0.00391
60	0	0.0152947	0.000233929			
70	0	0.0249662	0.00062331			
80	0.01	0.0405016	0.00093035			
100	0.09	0.1029098	0.000166664			
115	0.21	0.1953712	0.000214001			
130	0.36	0.3394703	0.00042147			
140	0.46	0.4586513	1.81896E-06			
165	0.72	0.7472375	0.000741882			

t (min)	qexp	qcalc		
180	0.88	0.8622086	0.000316533	
185	0.89	0.8893086	4.78096E-07	
190	0.9	0.9116249	0.000135139	
			0.003909996	

Sum of Absolute Errors (EABS/SAE)

MF-MNFC

t (min)	qexp	qcalc	error	qex-qca
0	0	0.0007736	5.98417E-07	0.000773574
20	0	0.002101	4.41425E-06	0.002101011
40	0	0.0056933	3.24139E-05	0.005693324
50	0	0.0093544	8.75047E-05	0.009354395
60	0	0.0153334	0.000235113	0.0153334
70	0	0.0250374	0.000626871	0.025037391
80	0.01	0.0406293	0.000938154	0.030629307
100	0.09	0.1032794	0.000176343	0.013279429
115	0.21	0.1960851	0.000193625	0.013914911
130	0.36	0.3406086	0.000376028	0.019391429
140	0.46	0.46	1.31493E-15	3.6262E-08
165	0.72	0.7484306	0.000808301	0.028430628
180	0.88	0.8630221	0.000288248	0.016977855
185	0.89	0.89	1.75012E-15	4.18344E-08
190	0.9	0.9122051	0.000148966	0.012205142
				0.193121876

<mark>SAE   0.1931219</mark>

<mark>SSE   =   0.003916579</mark>

Marquardt's Percent Standard Deviation (MPSD

MF-MNFC

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	2.561E-05	6.55901E-10	0
20	0	0.0001195	1.42916E-08	0
40	0	0.0005578	3.11187E-07	0
50	0	0.0012045	1.45085E-06	0
60	0	0.0025989	6.75413E-06	0
70	0	0.0055983	3.13412E-05	0
80	0.01	0.0120178	4.07158E-06	0.040715818
100	0.09	0.0537342	0.001315205	0.16237101
115	0.21	0.1527916	0.003272803	0.074213212
130	0.36	0.3641792	1.74655E-05	0.000134764

<mark>MPSD   1.5657952</mark>

t (min)	qexp	qcalc	error	qex-qca/qex	
140	0.46	0.5530817	0.008664201	0.04094613	
165	0.72	0.8946488	0.030502203	0.058839126	0.0031872
180	0.88	0.9642477	0.00709767	0.00916538	
185	0.89	0.975396	0.007292471	0.009206503	
190	0.9	0.9831288	0.006910401	0.00853136	
	4.52			0.404123302	
		SUM	=	0.065116363	

Hybrid Fractional Error Function (HYBRID)

MF-MNFC

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.0002275	5.17775E-08	0			
20	0	0.0007386	5.45501E-07	0			
40	0	0.0023946	5.73393E-06	0		HYBRID	0.3947974
50	0	0.0043069	1.85496E-05	0			
60	0	0.0077347	5.98258E-05	0			
70	0	0.0138527	0.000191896	0			
80	0.01	0.0246893	0.000215775	0.021577515			
100	0.09	0.0759633	0.000197029	0.002189213			
115	0.21	0.1658834	0.00194627	0.009267954			
130	0.36	0.3248275	0.001237104	0.003436401			
140	0.46	0.4643776	1.91635E-05	4.16598E-05		SUM ERR	
165	0.72	0.7907786	0.00500961	0.006957792			
180	0.88	0.9014143	0.000458573	0.000521105			
185	0.89	0.9246666	0.001201775	0.00135031			
190	0.9	0.9427828	0.001830368	0.002033742			
				0.047375693			
			0.012392272				

Summary of Thomas parameters for Co (II) ion adsorption at Bed height of 4 cm.

rror functic	/(mg.min)	N0 (mg/L)	bjective function
SSE	0.000353	21278.27	0.028989
HYB	0.000547	20790.35	1.377354
MPSD	0.000353	21265.04	4.915058
ARE	0.00032	20839.59	0.109532
SAE	0.000334	20930.28	0.55777
R2	0.0004	21265.04	0.9857

at bed height of 8 cm

Error function	/(mg.min)	N0 (mg/L)	Objective function
SSE	0.0003	20138.1	0.018424
HYB	0.000419	20077.5	0.932444
MPSD	0.000561	19348.99	17.64361
ARE	0.00042	20077.5	2.9071
SAE	0.000291	19921.33	0.446925
R2	0.0003	20135.92	0.9923
R2/12cm	0.0004	2116.63	0.9997

at flow rate of 4 mL/min

Error function	/(mg.min)	N0 (mg/L)	Objective function
SSE	0.000275	24331.89	0.005466
HYB	0.000338	24564.11	0.291159
MPSD	0.000202	17913.63	70.23403
ARE	0.00034	24564.1	15.8353
SAE	0.000277	24224.85	0.195007
R2	0.0003	24331.61	0.998

at flow rate of 12 mL/min

Error function	/(mg.min)	N0 (mg/L)	Objective function
SSE	0.000724	13299.37	0.0443
HYB	0.000858	13160.81	1.165691
MPSD	0.001046	12649.1	16.67756
ARE	0.00086	13160.8	0.9769
SAE	0.000733	13717.84	0.586085
R2	0.0008	13296.16	0.9856

at 50 mg/L initial concentration

Error function	/(mg.min)	N0 (mg/L)	Objective function
SSE	0.000702	16341.43	0.022161
HYB	0.000972	16427.98	0.515321
MPSD	0.001093	16315.39	8.841708
ARE	0.00097	16428	3.9134
SAE	0.000884	16499.13	0.400595
R2	0.0007	16336.79	0.9873

at 150 mg/L initial concentration

Error function	/(mg.min)	N0 (mg/L)	objective function
SSE	0.000594	12655.48	0.023926
HYB	0.000883	12629.93	1.338271
MPSD	0.001179	12086.51	13.2753
ARE	0.00088	12629.9	4.2009
SAE	0.000578	12294.93	0.387
R2	0.0006	12646.08	0.9834

For C-MNFC adsorbent [4 cm, 12 mL/min, 100mg/L]

Error function	/(mg.min)	N0 (mg/L)	objective function
SSE	0.000542	28966.9	0.013332
HYB	0.000749	28946.55	1.043627
MPSD	0.001025	27893.45	26.12786
ARE	0.00075	28946.6	8.9811
SAE	0.00055	28828.65	0.354675
R	0.000542	28963.52	

for MF-MNFC adsorbent [4 cm, 12 mL/min, 100mg/L]

Error function	/(mg.min)	N0 (mg/L)	objective function
SSE	0.0005	42994.87	0.00391
HYB	0.000589	42727.06	0.394797
MPSD	0.00077	41170.06	17.63134
ARE	0.00059	42727.1	0.8768
SAE	0.0005	42961.59	0.193122

KTH	0.0003527
q0	21278.27

0.0289894

m	4
C0	100
n	14
p	2
Q	8

KTH	0.0003527
q0	21265.039

m	4
C0	100
n	14
p	2
Q	8

KTH	0.0003343
q0	20930.281

0.5577701

m	4
C0	100
n	14
p	2
Q	8

KTH	0.000547
q0	20790.354

m	4
C0	100
n	14
p	2
Q	8

KTH	0.0003197
q0	20839.591

m	4
C0	100
n	14
p	2
Q	8

KTH	0.0002995
q0	20138.101

m	8
C0	100
n	18
Q	8
p	2

KTH	0.0002908
q0	19921.33

m	8
C0	100
n	18
Q	8
p	2

KTH	0.0004188
q0	20077.499

m	8
C0	100
n	18
Q	8

p   2

<mark>KTH 0.0005611</mark>
<mark>q0   19348.993</mark>

m   8
C0   100
n   18
Q   8
p   2

KTH	0
q0	40582.466

m	4
C0	100
Q	4
p	2
n	18

KTH	0.0002752
q0	24331.887

m	4
C0	100
Q	4
p	2
n	18

KTH	0.0002768
q0	24224.85

m	4
C0	100
Q	4
p	2
n	18

KTH	0.0002024
q0	17913.626

m	4
C0	100

Q	4
p	2
n	18

KTH	0.0003377
q0	24564.108

m	4
C0	100
Q	4
p	2
n	18

KTH	0.0007242
q0	13299.369

m	4
C0	100
Q	12
n	9
p	2

KTH	0.0007328
q0	13717.841

R^2	0.9213936

m	4
C0	100
Q	12
n	9
p	2

KTH	0.0010458
q0	12649.096

R^2	0.6593192

m	4
C0	100
Q	12
n	9
p	2

KTH	0.0008575
q0	13160.806

m	4
C0	100
Q	12
n	9
p	2

KTH	0.0010933
q0	16315.392

m	4
C0	50
Q	8
n	12
p	2

| KTH | 0.0007019 |
| q0 | 16341.432 |

m	4
C0	50
Q	8
n	12
p	2

| KTH | 0.0008839 |
| q0 | 16499.132 |

m	4
C0	50
Q	8
n	12
p	2

KTH	0.0009716
q0	16427.983

m	4
C0	50
Q	8
n	12
p	2

KTH	0.0005943
q0	12655.477

m	4
Q	8
C0	150
n	10
p	2

KTH	0.0005782
q0	12294.926

R^2	0.9325558

m	4
Q	8
C0	150
n	10
p	2

KTH	0.0008827
q0	12629.933

m	4
Q	8
C0	150
n	10
p	2

KTH	0.001179
q0	12086.512

m	4
Q	8
C0	150
n	10
p	2

KTH	0.000542
q0	28966.898

m	4
Q	12
C0	100
n	14
p	2

KTH	0.0005498
q0	28828.646

m	4
Q	12
C0	100
n	14
p	2

KTH	0.0010252
q0	27893.446

m	4
Q	12
C0	100
n	14
p	2

KTH	0.0007494
q0	28946.552

m	4
Q	12
C0	100
n	14
p	2

KTH	0.0004999
q0	42994.874

m	4
C0	100
Q	12
n	15
p	2

KTH	0.0005002
q0	42961.592

R^2	1

m	4
C0	100
Q	12
n	15
p	2

KTH	0.0007704
q0	41170.056

m	4
C0	100
Q	12
n	15
p	2

KTH	0.0005889
q0	42727.056

R^2	1

m	4
C0	100
Q	12
n	15
p	2

0.0123923

BH=4g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.02296639	0.000527455	0.1727593
10	0	0.03236582	0.001047546	0.1727593
15	0	0.03836895	0.001472176	0.1727593
20	0	0.04543325	0.00206418	0.1727593
25	0	0.05372553	0.002886432	0.1727593
40	0.01	0.08790099	0.006068564	0.1645464
70	0.24	0.21732499	0.000514156	0.0308505
92	0.43	0.37629591	0.00288413	0.0002061
110	0.56	0.53236171	0.000763875	0.0208389
130	0.7	0.69743305	6.58924E-06	0.0808588
160	0.85	0.86913336	0.000366085	0.1886658
180	0.88	0.9307839	0.002579004	0.2156272
190	0.89	0.95033582	0.003640412	0.2250144
200	0.9	0.96457499	0.004169929	0.2346015
		0.41564319	0.028990534	2.025006

BH=8g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.00239529	5.73743E-06	0.1063612
20	0	0.00435209	1.89407E-05	0.1063612
30	0	0.00586319	3.4377E-05	0.1063612
40	0	0.00789481	6.23281E-05	0.1063612
50	0	0.01062287	0.000112845	0.1063612
60	0	0.01428005	0.00020392	0.1063612
70	0	0.01917189	0.000367561	0.1063612
80	0	0.02569583	0.000660276	0.1063612
115	0.01	0.06998335	0.003598002	0.0999386
140	0.08	0.1372818	0.003281204	0.0605803
170	0.3	0.28102537	0.000360036	0.0006828
195	0.49	0.45252139	0.001404646	0.0268531
210	0.6	0.5643529	0.001270716	0.0750044
230	0.71	0.70223457	6.03019E-05	0.1473556
250	0.8	0.81108499	0.000122877	0.2245521
270	0.85	0.88657157	0.00133748	0.274439
285	0.87	0.92452827	0.002973332	0.2957938
300	0.9	0.95049274	0.002549516	0.3293259
		0.32613072	0.018424098	2.3854158

	BH=12g			
t (min)	qexp	qcalc	SSE	SSEA
0	0	8.8413E-06	7.81694E-11	0.0866176
20	0	1.8433E-05	3.39778E-10	0.0866176
30	0	2.6616E-05	7.08388E-10	0.0866176
40	0	3.843E-05	1.47688E-09	0.0866176
50	0	5.5489E-05	3.07902E-09	0.0866176
60	0	8.0119E-05	6.41911E-09	0.0866176
80	0	0.00016703	2.78975E-08	0.0866176
100	0	0.00034817	1.2122E-07	0.0866176
140	0	0.00151164	2.28506E-06	0.0866176
180	0	0.00653768	4.27413E-05	0.0866176
230	0.02	0.03966464	0.000386698	0.0752452
255	0.08	0.09377183	0.000189663	0.0459282
280	0.21	0.20586532	1.70956E-05	0.007108
293	0.3	0.29474161	2.76506E-05	3.239E-05
300	0.35	0.35084788	7.18894E-07	0.0031015
315	0.49	0.4839363	3.67685E-05	0.0382951
337	0.68	0.67785055	4.62012E-06	0.1487578
354	0.8	0.79712482	8.26666E-06	0.2557237
362	0.84	0.84054745	2.99697E-07	0.297779
370	0.87	0.87612042	3.74596E-05	0.3314205
375	0.89	0.89471863	2.22654E-05	0.3548482
380	0.9	0.9108089	0.000116832	0.366862
		0.29430867	0.000893527	2.7912776

YOON NELSON KINETIC MODEL PARAMETER FOR Co(II) ION ADSORPTION AT DIFFERENT FLOW I FLOW RATES

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.00123507	1.52541E-06	0.1695139
20	0	0.0021395	4.57745E-06	0.1695139
30	0	0.00281529	7.92587E-06	0.1695139
40	0	0.00370376	1.37178E-05	0.1695139
50	0	0.00487124	2.37289E-05	0.1695139
60	0	0.00640436	4.10158E-05	0.1695139
90	0	0.01450239	0.000210319	0.1695139
150	0.02	0.07123998	0.002625536	0.1534451
210	0.29	0.2856187	1.91958E-05	0.0148159
235	0.45	0.44304156	4.84199E-05	0.0014653
260	0.63	0.61280184	0.000295777	0.0476459
280	0.74	0.73291264	5.02307E-05	0.1077673
290	0.79	0.78323577	4.57547E-05	0.1430953
300	0.83	0.82632413	1.3512E-05	0.1749576

t (min)	qexp	qcalc	SSE	SSEA
315	0.87	0.87788535	6.21787E-05	0.21002
320	0.88	0.89188503	0.000141254	0.2192856
330	0.89	0.91570061	0.000660521	0.2287511
340	0.9	0.93465446	0.001200932	0.2384167
		0.41172065	0.005466122	2.726263

fr12ml/min

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.03894574	0.001516771	0.2824557
10	0	0.07722958	0.005964409	0.2824557
20	0.08	0.14737564	0.004539477	0.2038212
30	0.32	0.26307036	0.003240984	0.0447177
48	0.62	0.56841894	0.002660606	0.0078383
60	0.74	0.75872821	0.000350746	0.0434866
85	0.86	0.95068143	0.008223121	0.1079349
100	0.89	0.98282158	0.008615845	0.1285469
120	0.9	0.9959189	0.009200436	0.1358176
		0.5314656	0.044312394	1.2370746

YOON NELSON KINETIC MODEL PARAMETERS FOR Co(II) ION ADSORPTION AT DIFFERENT INITIA

BH=4g   50mg/l

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.01282938	0.000164593	0.1298294
10	0	0.01568527	0.000246028	0.1298294
22	0	0.01994626	0.000397853	0.1298294
30	0	0.02339727	0.000547432	0.1298294
41	0	0.02910832	0.000847294	0.1298294
50	0	0.03476711	0.001208752	0.1298294
60	0	0.04229722	0.001789055	0.1298294
80	0.01	0.06226587	0.002731721	0.122723
100	0.05	0.09076828	0.001662053	0.0962976
155	0.26	0.23452363	0.000649045	0.0100638
210	0.54	0.4846064	0.003068451	0.0322855
240	0.66	0.63414732	0.000668361	0.089809
280	0.79	0.79666453	4.44159E-05	0.1846262
300	0.83	0.85487247	0.00061864	0.2206007
320	0.86	0.89853962	0.001485302	0.2496816
340	0.88	0.93014152	0.002514172	0.2700689
370	0.9	0.96085346	0.003703143	0.2912562
		0.36031847	0.022346312	2.4762183

	150mg/l			
t (min)	qexp	qcalc	SSE	SSEA
0	0	0.02277462	0.000518683	0.2652828
10	0	0.05379315	0.002893703	0.2652828
15	0.01	0.08155253	0.005119764	0.2550817
25	0.2	0.17804021	0.000482232	0.0992604
40	0.48	0.45213477	0.000776471	0.0012289
50	0.69	0.66812266	0.000478618	0.0306054
60	0.83	0.83082166	6.75119E-07	0.0991896
70	0.88	0.92295687	0.001845292	0.133184
75	0.89	0.9492661	0.00351247	0.1405829
95	0.9	0.9910986	0.008298955	0.1481818
		0.51505612	0.023926864	1.4378803

YOON-NELSON MODEL PARAMETERS FOR Co(II) ION ADSORPTION FOR THE MODIFIED NANOCE

	MNFC			
t (min)	qexp	qcalc	SSE	SSEA
0	0	0.00530721	2.81665E-05	0.1917847
20	0	0.01553137	0.000241223	0.1917847
30	0	0.02641183	0.000697585	0.1917847
40	0	0.04456949	0.001986439	0.1917847
50	0.01	0.07425809	0.004129102	0.183126
60	0.11	0.12121388	0.000125751	0.1075396
80	0.32	0.28969672	0.000918289	0.013908
96	0.52	0.49261169	0.00075012	0.0067351
105	0.62	0.61261129	5.45931E-05	0.0331487
122	0.81	0.79896055	0.000121869	0.1384344
132	0.86	0.87234729	0.000152455	0.1781412
138	0.88	0.90440117	0.000595417	0.1954239
143	0.89	0.92540406	0.001253447	0.2043652
150	0.9	0.94772712	0.002277878	0.2135066
		0.43793227	0.013332336	2.0414673

	MF+MNFC			
t (min)	qexp	qcalc	SSE	SSEA

0	0	0.00077321	5.97847E-07	0.0942713
20	0	0.00209855	4.40393E-06	0.0942713
40	0	0.00568276	3.22937E-05	0.0942713
50	0	0.00933388	8.71214E-05	0.0942713
60	0	0.01529474	0.000233929	0.0942713
70	0	0.02496641	0.000623322	0.0942713
80	0.01	0.04050244	0.000930399	0.0882306
100	0.09	0.10291369	0.000166763	0.0471048
115	0.21	0.1953803	0.000213736	0.009416
130	0.36	0.33948674	0.000420794	0.0028052
140	0.46	0.45867219	1.76308E-06	0.0233979
165	0.72	0.74725838	0.000743019	0.170539
180	0.88	0.86222364	0.000315999	0.3282874
185	0.89	0.88932152	4.60341E-07	0.3398467
190	0.9	0.91163598	0.000135396	0.351606
		0.3070363	0.003909997	1.9268612

KYN	0.0352738
τ	236.88009
R^2	0.9856837
C0	100
m	4
Q	8
n	14
p	2

KYN	0.0299557
τ	355.09164
R^2	0.9922764
C0	100
m	8
Q	8
n	18
p	2

KYN	0.0367358
τ	442.1088
R^2	0.9996799
C0	100
m	12
Q	8
n	23
p	2

Cha

q (mg/g)

t (m
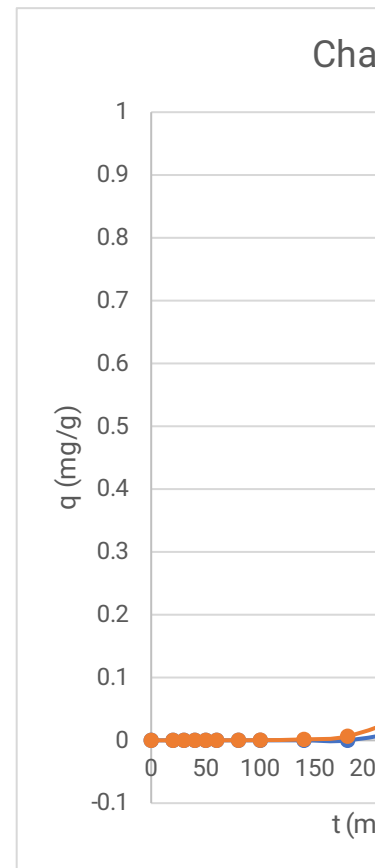
RATES

KYN	0.027517
τ	410.6713
R^2	0.997995
m	4
Q	4
C0	100
n	19
p	2

C

q (mg/g)
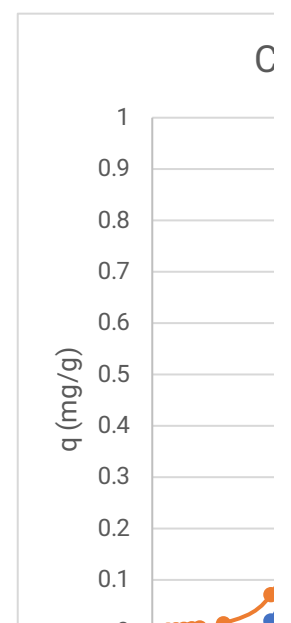
KYN	0.072526
τ	107.6992
R^2	0.9641797
C0	100
Q	12
m	4

AL SOLUTE CONCENTRATION

KYN	0.020388
τ	404.8984
R^2	0.9909756
C0	50
Q	8
m	4
p	2
n	17

KYN	0.089176
τ	98.34206
R^2	0.9833596
C0	150
Q	8
m	4
p	2
n	10

LLULOSIC ADSORBENTS

KYN	0.054206
τ	181.5015
R^2	0.9934692
C0	100
Q	12
m	4
n	14
p	2

C

C
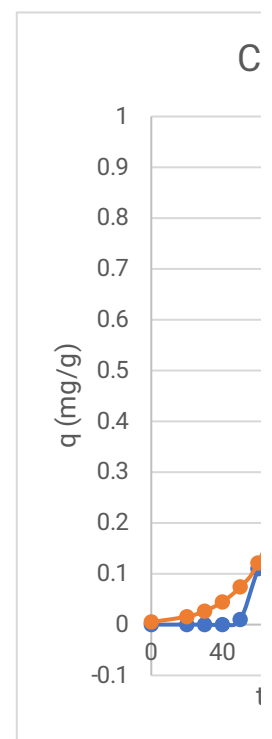
KYN	0.049989
τ	235.4376
R^2	0.9979708
C0	100
Q	12
m	4
n	15
p	2
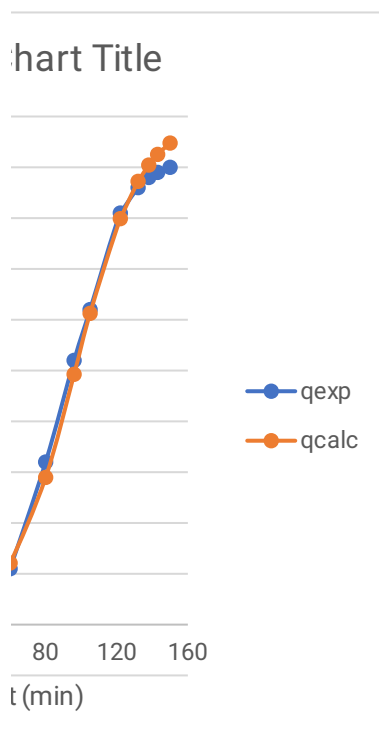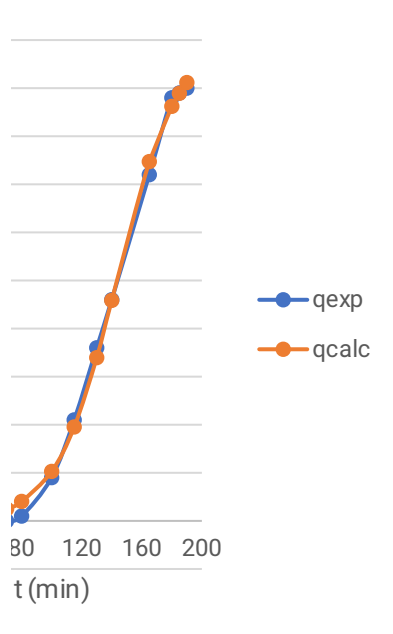
ττττττ

Chart Title

Chart Title

200   300   400

t (min)

τ

τ

Chart Title

qexp
qcalc

80   120   160

t (min)

Chart Title

t (min)

YOON-NELSON MODEL EQUATION

$$q = \frac{C0 * EXP[Kyn * (t - \tau)}{1 + EXP[Kyn * (t - \tau) * C0}$$

Q= 8 mL/min C0 =100mg/l

BH	Kyn	T
4	0.0352738	236.88009
8	0.0299557	355.09164
12	0.0367358	442.1088

BH= 4 cm, Co = 100mg/l

Q	kyn	T
4	0.0275173	410.67131
8	0.0352738	236.88009
12	0.0725263	107.69923

BH=4 cm, Q = 8 ml/min

C0	Kyn	T
50	0.0203881	404.89838
100	0.0352738	236.88009
150	0.0891755	98.342058

YOON-NELSON ERROR FUNCTIONS

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=4g

t (min)	qexp	qcalc	error			
0	0	0.022966389	0.0005275			
10	0	0.032365816	0.0010475			
15	0	0.038368949	0.0014722		SSE	0.0289905
20	0	0.04543325	0.0020642			
25	0	0.053725528	0.0028864			
40	0.01	0.087900989	0.0060686			
70	0.24	0.217324988	0.0005142			
92	0.43	0.376295908	0.0028841			
110	0.56	0.532361713	0.0007639			
130	0.7	0.697433048	6.589E-06			
160	0.85	0.869133356	0.0003661		SUM	0.0289905
180	0.88	0.930783899	0.002579			
190	0.89	0.950335824	0.0036404			
200	0.9	0.96457499	0.0041699			
		0.415643189	0.0289905			

Sum of Absolute Errors (EABS/SAE)

BH=4g

t (min)	qexp	qcalc	error	qex-qca		
0	0	0.022966389	0.0005275	0.022966389		
10	0	0.032365816	0.0010475	0.032365816		
15	0	0.038368949	0.0014722	0.038368949	SAE	0.5721733
20	0	0.04543325	0.0020642	0.04543325		
25	0	0.053725528	0.0028864	0.053725528		
40	0.01	0.087900989	0.0060686	0.077900989		
70	0.24	0.217324988	0.0005142	0.022675012		
92	0.43	0.376295908	0.0028841	0.053704092		
110	0.56	0.532361713	0.0007639	0.027638287		
130	0.7	0.697433048	6.589E-06	0.002566952		
160	0.85	0.869133356	0.0003661	0.019133356		
180	0.88	0.930783899	0.002579	0.050783899		
190	0.89	0.950335824	0.0036404	0.060335824		
200	0.9	0.96457499	0.0041699	0.06457499		
			0.0289905	0.572173332		

Marquardt's Percent Standard Deviation (MPSD

BH=4g

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.000544503	2.965E-07	0			
10	0	0.001166414	1.361E-06	0			
15	0	0.001706786	2.913E-06	0		MPSD	2.0162675
20	0	0.002496874	6.234E-06	0			
25	0	0.003651364	1.333E-05	0			
40	0.01	0.011370032	1.877E-06	0.018769877			
70	0.24	0.101741361	0.0191155	0.331865475			
92	0.43	0.377385602	0.0027683	0.014971741			
110	0.56	0.705105343	0.0210556	0.067141456			
130	0.7	0.916568096	0.0469017	0.095717837	0.0048784		
160	0.85	0.990841938	0.0198365	0.027455296			
180	0.88	0.997992383	0.0139222	0.017978051			
190	0.89	0.999062387	0.0118946	0.015016544			
200	0.9	0.999562359	0.0099127	0.012237856			
	5.46		0.145433	0.601154132			

Hybrid Fractional Error Function (HYBRID)

BH=4g

t (min)	qexp	qcalc	error	qex-qeca/qex			
0	0	0.022966389	0.0005275	0			
10	0	0.032365816	0.0010475	0			
15	0	0.038368949	0.0014722	0		HYBRID	0.0081038
20	0	0.04543325	0.0020642	0			
25	0	0.053725528	0.0028864	0			
40	0.01	0.087900989	0.0060686	0.606856408			
70	0.24	0.217324988	0.0005142	0.002142317			
92	0.43	0.376295908	0.0028841	0.006707278			
110	0.56	0.532361713	0.0007639	0.001364062			
130	0.7	0.697433048	6.589E-06	9.4132E-06			
160	0.85	0.869133356	0.0003661	0.000430689	0.0009725		
180	0.88	0.930783899	0.002579	0.002930687			
190	0.89	0.950335824	0.0036404	0.00409035			
200	0.9	0.96457499	0.0041699	0.004633255			
	5.46	SUM ERR=	0.0289905	0.629164459			

AVERAGE RELATIVE ERROR

BH=4 cm

t (min)	qexp	qcalc	qex-qcal/qex			
0	0	0.022966389	0			
10	0	0.032365816	0			
15	0	0.038368949	0			
20	0	0.04543325	0			
25	0	0.053725528	0	ARE	0.5124999	
40	0.01	0.087900989	7.7900989			
70	0.24	0.217324988	0.0944792			
92	0.43	0.376295908	0.1248932			
110	0.56	0.532361713	0.0493541			
130	0.7	0.697433048	0.0036671			
160	0.85	0.869133356	0.0225098			
180	0.88	0.930783899	0.057709			
190	0.89	0.950335824	0.0677931			
200	0.9	0.96457499	0.07175			

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=8g

t (min)	qexp	qcalc	error			
0	0	0.002395293	5.737E-06			
20	0	0.00435209	1.894E-05			
30	0	0.005863194	3.438E-05	SSE	0.0184241	
40	0	0.007894812	6.233E-05			
50	0	0.010622872	0.0001128			
60	0	0.014280046	0.0002039			
70	0	0.019171891	0.0003676			
80	0	0.025695827	0.0006603			
115	0.01	0.069983351	0.003598			
140	0.08	0.137281797	0.0032812			
170	0.3	0.281025374	0.00036			
195	0.49	0.452521387	0.0014046			
210	0.6	0.564352903	0.0012707			
230	0.71	0.702234567	6.03E-05			

250	0.8	0.811084993	0.0001229
270	0.85	0.886571573	0.0013375
285	0.87	0.924528269	0.0029733
300	0.9	0.950492735	0.0025495
		SUM ERR=	0.0184241

Sum of Absolute Errors (EABS/SAE)

BH=8g

t (min)	qexp	qcalc	error	qex-qca
0	0	0.00306178	9.374E-06	0.00306178
20	0	0.005460558	2.982E-05	0.005460558
30	0	0.007287744	5.311E-05	0.007287744
40	0	0.009720358	9.449E-05	0.009720358
50	0	0.012954371	0.0001678	0.012954371
60	0	0.017245618	0.0002974	0.017245618
70	0	0.022925362	0.0005256	0.022925362
80	0	0.030417799	0.0009252	0.030417799
115	0.01	0.079793893	0.0048712	0.069793893
140	0.08	0.152006979	0.005185	0.072006979
170	0.3	0.299957494	1.807E-09	4.25064E-05
195	0.49	0.469713239	0.0004116	0.020286761
210	0.6	0.577965546	0.0004855	0.022034454
230	0.71	0.710001451	2.106E-12	1.45134E-06
250	0.8	0.814021377	0.0001966	0.014021377
270	0.85	0.886685044	0.0013458	0.036685044
285	0.87	0.923652563	0.0028786	0.053652563
300	0.9	0.949250182	0.0024256	0.049250182
			0.0199027	0.4468488

<mark>SAE   0.4468488</mark>

Marquardt's Percent Standard Deviation (MPSD)

BH=8g

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	1.92589E-05	3.709E-10	0
20	0	5.91589E-05	3.5E-09	0
30	0	0.000103682	1.075E-08	0
40	0	0.000181708	3.302E-08	0

<mark>MPSD   1.5658928</mark>

50	0	0.000318433	1.014E-07	0
60	0	0.000557978	3.113E-07	0
70	0	0.000977548	9.556E-07	0
80	0	0.001712073	2.931E-06	0
115	0.01	0.012076788	4.313E-06	0.043130486
140	0.08	0.047360397	0.0010653	0.166459948
170	0.3	0.211150072	0.0078943	0.087714552
195	0.49	0.521202889	0.0009736	0.004055062	0.0039232
210	0.6	0.716381761	0.0135447	0.037624206
230	0.71	0.885834364	0.0309177	0.06133252
250	0.8	0.959735023	0.0255153	0.039867621
270	0.85	0.986526571	0.0186395	0.025798622
285	0.87	0.994148522	0.0154129	0.020363133
300	0.9	0.997469776	0.0095004	0.011728836
	5.61	SUM ERR=	0.1234724	0.498074987

Hybrid Fractional Error Function (HYBRID)

BH=8g

t (min)	qexp	qcalc	error	qex-qca/qex	
0	0	0.000222908	4.969E-08	0	
20	0	0.000514954	2.652E-07	0	
30	0	0.000782594	6.125E-07	0	HYBID 0.6475303
40	0	0.001189172	1.414E-06	0	
50	0	0.001806595	3.264E-06	0	
60	0	0.002743707	7.528E-06	0	
70	0	0.004164886	1.735E-05	0	
80	0	0.006317542	3.991E-05	0	
115	0.01	0.026797872	0.0002822	0.02821685	
140	0.08	0.072745816	5.262E-05	0.00065779	
170	0.3	0.21604909	0.0070478	0.023492518	
195	0.49	0.439835975	0.0025164	0.00513557	
210	0.6	0.59541096	2.106E-05	3.50988E-05	
230	0.71	0.772765025	0.0039394	0.005548519	
250	0.8	0.887114577	0.0075889	0.009486187	
270	0.85	0.947807429	0.0095663	0.011254463	
285	0.87	0.971457934	0.0102937	0.011831853	
300	0.9	0.98456598	0.0071514	0.007946006	
		SUM ERR=	0.0485302	0.103604854	

BH=8g

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.000222908	4.969E-08	0			
20	0	0.000514954	2.652E-07	0			
30	0	0.000782594	6.125E-07	0	ARE	0.5906783	
40	0	0.001189172	1.414E-06	0			
50	0	0.001806595	3.264E-06	0			
60	0	0.002743707	7.528E-06	0			
70	0	0.004164886	1.735E-05	0			
80	0	0.006317542	3.991E-05	0			
115	0.01	0.026797872	0.0002822	0.016797872			
140	0.08	0.072745816	5.262E-05	0.007254184			
170	0.3	0.21604909	0.0070478	0.08395091			
195	0.49	0.439835975	0.0025164	0.050164025	0.1063221		
210	0.6	0.59541096	2.106E-05	0.00458904			
230	0.71	0.772765025	0.0039394	0.062765025			
250	0.8	0.887114577	0.0075889	0.087114577			
270	0.85	0.947807429	0.0095663	0.097807429			
285	0.87	0.971457934	0.0102937	0.101457934			
300	0.9	0.98456598	0.0071514	0.08456598			
	5.61			0.596466977			

Sum of Absolute Errors (EABS/SAE)

t (min)	qexp	qcalc	error	qex-qca		
0	0	1.00013E-05	1E-10	1.00013E-05		
20	0	2.07057E-05	4.287E-10	2.07057E-05		
30	0	2.97924E-05	8.876E-10	2.97924E-05		
40	0	4.28666E-05	1.838E-09	4.28666E-05	SAE	0.0796647
50	0	6.16779E-05	3.804E-09	6.16779E-05		
60	0	8.87435E-05	7.875E-09	8.87435E-05		
80	0	0.00018371	3.375E-08	0.00018371		
100	0	0.000380265	1.446E-07	0.000380265		
140	0	0.00162787	2.65E-06	0.00162787		
180	0	0.006940306	4.817E-05	0.006940306		
230	0.02	0.041321055	0.0004546	0.021321055		
255	0.08	0.096690193	0.0002786	0.016690193		

280	0.21	0.210000376	1.413E-13	3.7596E-07
293	0.3	0.299031232	9.385E-07	0.000968768
300	0.35	0.35498025	2.48E-05	0.00498025
315	0.49	0.487142708	8.164E-06	0.002857292
337	0.68	0.67896824	1.065E-06	0.00103176
354	0.8	0.79698937	9.064E-06	0.00301063
362	0.84	0.84005868	3.443E-09	5.86799E-05
370	0.87	0.875418997	2.937E-05	0.005418997
375	0.89	0.893943688	1.555E-05	0.003943688
380	0.9	0.909997031	9.994E-05	0.009997031
		SUM ERR =	0.0009731	0.079664657

Marquardt's Percent Standard Deviation (MPSD)

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	7.38404E-07	5.452E-13	0		
20	0	1.8182E-06	3.306E-12	0		
30	0	2.8531E-06	8.14E-12	0	MPSD	0.5052398
40	0	4.47703E-06	2.004E-11	0		
50	0	7.02528E-06	4.935E-11	0		
60	0	1.10239E-05	1.215E-10	0		
80	0	2.71443E-05	7.368E-10	0		
100	0	6.6836E-05	4.467E-09	0		
140	0	0.000405099	1.641E-07	0		
180	0	0.002451149	6.008E-06	0		
230	0.02	0.022844001	8.088E-06	0.020220851		
255	0.08	0.067259758	0.0001623	0.025361527		
280	0.21	0.18195298	0.0007866	0.017837536		
293	0.3	0.285478353	0.0002109	0.002343091	0.0005361	
300	0.35	0.353873223	1.5E-05	0.000122464		
315	0.49	0.518436355	0.0008086	0.003367873		
337	0.68	0.743645811	0.0040508	0.008760358		
354	0.8	0.861875116	0.0038285	0.005982078		
362	0.84	0.89947438	0.0035372	0.005013041		
370	0.87	0.927697282	0.003329	0.004398172		
375	0.89	0.941426968	0.0026447	0.003338888		
380	0.9	0.952682479	0.0027754	0.003426474		
	6.43	SUM ERROR=	0.0221634	0.100172352		

Hybrid Fractional Error Function (HYBRID)

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	3.61713E-06	1.308E-11	0		
20	0	7.98362E-06	6.374E-11	0		
30	0	1.18609E-05	1.407E-10	0		
40	0	1.76211E-05	3.105E-10	0	HYBRID	0.0585091
50	0	2.61787E-05	6.853E-10	0		
60	0	3.88921E-05	1.513E-09	0		
80	0	8.58379E-05	7.368E-09	0		
100	0	0.00018944	3.589E-08	0		
140	0	0.000922208	8.505E-07	0		
180	0	0.004476687	2.004E-05	0		
230	0.02	0.03152029	0.0001327	0.006635854		
255	0.08	0.080508989	2.591E-07	3.23838E-06		
280	0.21	0.190647748	0.0003745	0.001783379		
293	0.3	0.282683038	0.0002999	0.000999591		
300	0.35	0.342068224	6.291E-05	0.000179752		
315	0.49	0.484928505	2.572E-05	5.24899E-05		
337	0.68	0.692233734	0.0001497	0.000220094		
354	0.8	0.815106894	0.0002282	0.000285273		
362	0.84	0.858176651	0.0003304	0.000393322		
370	0.87	0.892536293	0.0005079	0.000583775		
375	0.89	0.910098886	0.000404	0.000453893		
380	0.9	0.925032338	0.0006266	0.000696242		
		SUM ERROR=	0.0031637	0.012286904		

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	3.61713E-06	1.308E-11	0		
20	0	7.98362E-06	6.374E-11	0		
30	0	1.18609E-05	1.407E-10	0		
40	0	1.76211E-05	3.105E-10	0	ARE	0.7603764
50	0	2.61787E-05	6.853E-10	0		
60	0	3.88921E-05	1.513E-09	0		
80	0	8.58379E-05	7.368E-09	0 0.0271985		
100	0	0.00018944	3.589E-08	0		
140	0	0.000922208	8.505E-07	0		
180	0	0.004476687	2.004E-05	0		
230	0.02	0.03152029	0.0001327	0.01152029		

255	0.08	0.080508989	2.591E-07	0.000508989
280	0.21	0.190647748	0.0003745	0.019352252
293	0.3	0.282683038	0.0002999	0.017316962
300	0.35	0.342068224	6.291E-05	0.007931776
315	0.49	0.484928505	2.572E-05	0.005071495
337	0.68	0.692233734	0.0001497	0.012233734
354	0.8	0.815106894	0.0002282	0.015106894
362	0.84	0.858176651	0.0003304	0.018176651
370	0.87	0.892536293	0.0005079	0.022536293
375	0.89	0.910098886	0.000404	0.020098886
380	0.9	0.925032338	0.0006266	0.025032338
	6.43			0.174886561

Sum of Absolute Errors (EABS/SAE)

FLOW RATES

t (min)	qexp	qcalc	error	qex-qca
0	0	0.001270499	1.614E-06	0.001270499
20	0	0.002200776	4.843E-06	0.002200776
30	0	0.002895852	8.386E-06	0.002895852
40	0	0.003809616	1.451E-05	0.003809616
50	0	0.005010264	2.51E-05	0.005010264
60	0	0.006586809	4.339E-05	0.006586809
90	0	0.014911784	0.0002224	0.014911784
150	0.02	0.073129445	0.0028227	0.053129445
210	0.29	0.29140166	1.965E-06	0.00140166
235	0.45	0.449999919	6.562E-15	8.10071E-08
260	0.63	0.619457025	0.0001112	0.010542975
280	0.74	0.738382101	2.618E-06	0.001617899
290	0.79	0.787971714	4.114E-06	0.002028286
300	0.83	0.830321654	1.035E-07	0.000321654
315	0.87	0.880866119	0.0001181	0.010866119
320	0.88	0.894564799	0.0002121	0.014564799
330	0.89	0.917843949	0.0007753	0.027843949
340	0.9	0.936348985	0.0013212	0.036348985
		SUM ERROR=	0.0056896	0.195351451

SAE   0.1953515

Marquardt's Percent Standard Deviation (MPSD)

FLOW RATES

t (min)	qexp	qcalc	error	qex-qca/qex

0	0	0.000249542	6.227E-08	0			
20	0	0.000490201	2.403E-07	0			
30	0	0.000686998	4.72E-07	0		MPSD	0.449504
40	0	0.000962726	9.268E-07	0			
50	0	0.001348969	1.82E-06	0			
60	0	0.001889878	3.572E-06	0			
90	0	0.005187973	2.692E-05	0			
150	0.02	0.038054823	0.000326	0.016298832			
210	0.29	0.230826799	0.0035015	0.012074026			
235	0.45	0.411113354	0.0015122	0.003360381	0.0003435		
260	0.63	0.618908763	0.000123	0.000195263			
280	0.74	0.761395595	0.0004578	0.00061861			
290	0.79	0.817284895	0.0007445	0.000942361			
300	0.83	0.862448035	0.0010529	0.001268524			
315	0.87	0.912323713	0.0017913	0.002058962			
320	0.88	0.924923272	0.0020181	0.002293296			
330	0.89	0.945262502	0.0030539	0.003431398			
340	0.9	0.960327922	0.0036395	0.004043842			
	7.29	SSE = 0.0182546		0.046585495			

Hybrid Fractional Error Function (HYBRID)

FLOW RATES

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.000249547	6.227E-08	0			
20	0	0.000490209	2.403E-07	0			
30	0	0.000687009	4.72E-07	0			
40	0	0.000962741	9.269E-07	0		HYBRID	0.2740323
50	0	0.001348988	1.82E-06				
60	0	0.001889903	3.572E-06	0			
90	0	0.005188029	2.692E-05	0			
150	0.02	0.03805503	0.000326	0.016299205			
210	0.29	0.23082689	0.0035015	0.012073989			
235	0.45	0.411112959	0.0015122	0.003360449			
260	0.63	0.618907873	0.000123	0.000195294			
280	0.74	0.761394598	0.0004577	0.000618552			
290	0.79	0.817283948	0.0007444	0.000942296			
300	0.83	0.862447181	0.0010528	0.001268457			
315	0.87	0.912323034	0.0017912	0.002058896			
320	0.88	0.924922653	0.002018	0.002293233			

330	0.89	0.945261996	0.0030539	0.003431335
340	0.9	0.960327517	0.0036394	0.004043788
			0.0182542	0.046585495

FLOW RATES

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.000249547	6.227E-08	0		
20	0	0.000490209	2.403E-07	0		
30	0	0.000687009	4.72E-07	0		
40	0	0.000962741	9.269E-07	0	ARE	0.2451868
50	0	0.001348988	1.82E-06	0		
60	0	0.001889903	3.572E-06	0		
90	0	0.005188029	2.692E-05	0		
150	0.02	0.03805503	0.000326	0.016299205		
210	0.29	0.23082689	0.0035015	0.012073989		
235	0.45	0.411112959	0.0015122	0.003360449		
260	0.63	0.618907873	0.000123	0.000195294		
280	0.74	0.761394598	0.0004577	0.000618552		
290	0.79	0.817283948	0.0007444	0.000942296		
300	0.83	0.862447181	0.0010528	0.001268457		
315	0.87	0.912323034	0.0017912	0.002058896		
320	0.88	0.924922653	0.002018	0.002293233		
330	0.89	0.945261996	0.0030539	0.003431335		
340	0.9	0.960327517	0.0036394	0.004043788		
				0.046585495		

t (min)	qexp	qcalc	error	qex-qca		
0	0	0.034815264	0.0012121	0.034815264		
10	0	0.069511072	0.0048318	0.069511072		
20	0.08	0.13398381	0.0029143	0.05398381		
30	0.32	0.242661077	0.0059813	0.077338923	SAE	0.5856444
48	0.62	0.542975187	0.0059328	0.077024813		
60	0.74	0.740000918	8.429E-13	9.18095E-07		
85	0.86	0.946143546	0.0074207	0.086143546		
100	0.89	0.981259156	0.0083282	0.091259156		
120	0.9	0.995566887	0.009133	0.095566887		
			0.0457542	0.585644388		

Marquardt's Percent Standard Deviation (MPSD

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.012017322	0.0001444	0			
10	0	0.033454199	0.0011192	0			
20	0.08	0.089660547	9.333E-05	0.014582214			
30	0.32	0.218911309	0.0102189	0.099794175		MPSD	2.2073354
48	0.62	0.648021636	0.0007852	0.002042695			
60	0.74	0.865910259	0.0158534	0.028950682			
85	0.86	0.988790088	0.0165869	0.022426834	0.0034106		
100	0.89	0.997643764	0.0115872	0.014628431			
120	0.9	0.999708407	0.0099418	0.012273786			
	4.41		0.0663303	0.194698816			

Hybrid Fractional Error Function (HYBRID)

fr12ml/min

t (min)	qexp	qcalc	error	SSEA		
0	0	0.02271128	0.0005158	0		
10	0	0.051936883	0.0026974	0		
20	0.08	0.114369705	0.0011813	0.014765958		
30	0.32	0.233377919	0.0075034	0.023448078		
48	0.62	0.587639691	0.0010472	0.001689016	HYBRID	1.1656911
60	0.74	0.79951257	0.0035417	0.004786143		
85	0.86	0.971448312	0.0124207	0.014442705		
100	0.89	0.991944921	0.0103928	0.011677266		
120	0.9	0.998540822	0.0097103	0.010789215		
			0.0490106	0.08159838		

fr12ml/min

t (min)	qexp	qcalc	error	SSEA
0	0	0.02271128	0.0005158	0
10	0	0.051936883	0.0026974	0
20	0.08	0.114369705	0.0011813	0.429621311

30	0.32	0.233377919	0.0075034	0.270694003
48	0.62	0.587639691	0.0010472	0.052194047
60	0.74	0.79951257	0.0035417	0.080422392
85	0.86	0.971448312	0.0124207	0.12959106
100	0.89	0.991944921	0.0103928	0.114544855
120	0.9	0.998540822	0.0097103	0.109489802
			0.0490106	1.186557471

<mark>ARE</mark> <mark>13.183972</mark>

<mark>SUM ERROR=</mark> <mark>0.094808</mark> 2.373114942

Marquardt's Percent Standard Deviation (MPSD)

BH=4g 50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex	
0	0	0.000672188	4.518E-07	0	
10	0	0.000970065	9.41E-07	0	
22	0	0.001506243	2.269E-06	0	
30	0	0.002019404	4.078E-06	0	
41	0	0.003021136	9.127E-06	0	
50	0	0.004199062	1.763E-05	0	
60	0	0.006050392	3.661E-05	0	
80	0.01	0.012526316	6.382E-06	0.063822704	
100	0.05	0.025754026	0.0005879	0.23514691	
155	0.26	0.166048093	0.008827	0.130576345	
210	0.54	0.599954689	0.0035946	0.012327039	0.0037365
240	0.66	0.818563356	0.0251423	0.057718865	
280	0.79	0.951438078	0.0260623	0.041759739	
300	0.83	0.976092851	0.0213431	0.03098145	
320	0.86	0.988383284	0.0164823	0.022285381	
340	0.88	0.994391629	0.0130854	0.016897527	
370	0.9	0.998128681	0.0096292	0.011887948	
	5.78		0.1248315	0.623403909	

<mark>MPSD</mark> <mark>1.5782969</mark>

Hybrid Fractional Error Function (HYBRID)

BH=4g   50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	0.00319652	1.022E-05	0
10	0	0.004183097	1.75E-05	0
22	0	0.005774362	3.334E-05	0
30	0	0.007156494	5.122E-05	0
41	0	0.009607327	9.23E-05	0
50	0	0.01221749	0.0001493	0
60	0	0.015943775	0.0002542	0
80	0.01	0.027049735	0.0002907	0.029069345
100	0.05	0.045533816	1.995E-05	0.000398936
155	0.26	0.17396109	0.0074027	0.0284719
210	0.54	0.4817772	0.0033899	0.006277582
240	0.66	0.676342712	0.0002671	0.000404673
280	0.79	0.860197625	0.0049277	0.006237603
300	0.83	0.913480416	0.006969	0.008396361
320	0.86	0.947690499	0.0076896	0.008941423
340	0.88	0.968835306	0.0078917	0.008967854
370	0.9	0.985891196	0.0073773	0.008196997
			0.0468337	0.105362676

HYBRID   0.7024178

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=4g   50mg/l

t (min)	qexp	qcalc	SSE	qex-qcal/qex
0	0	0.012829382	0.0001646	0
10	0	0.015685274	0.000246	0
22	0	0.019946263	0.0003979	0
30	0	0.023397274	0.0005474	0
41	0	0.029108322	0.0008473	0
50	0	0.034767114	0.0012088	0
60	0	0.042297225	0.0017891	0
80	0.01	0.062265869	0.0027317	5.226586877
100	0.05	0.09076828	0.0016621	0.815365602
155	0.26	0.234523633	0.000649	0.097986025

ARE

t (min)	qexp	qcalc	SSE	qex-qca
210	0.54	0.484606401	0.0030685	0.102580739
240	0.66	0.634147323	0.0006684	0.039170723
280	0.79	0.796664525	4.442E-05	0.008436108
300	0.83	0.854872469	0.0006186	0.02996683
320	0.86	0.898539615	0.0014853	0.044813506
340	0.88	0.930141524	0.0025142	0.056979004
370	0.9	0.960853455	0.0037031	0.067614951
			0.0223463	6.489500365

BH=4g   50mg/l

t (min)	qexp	qcalc	SSE
0	0	0.012829382	0.0001646
10	0	0.015685274	0.000246
22	0	0.019946263	0.0003979
30	0	0.023397274	0.0005474
41	0	0.029108322	0.0008473
50	0	0.034767114	0.0012088
60	0	0.042297225	0.0017891
80	0.01	0.062265869	0.0027317
100	0.05	0.09076828	0.0016621
155	0.26	0.234523633	0.000649
210	0.54	0.484606401	0.0030685
240	0.66	0.634147323	0.0006684
280	0.79	0.796664525	4.442E-05
300	0.83	0.854872469	0.0006186
320	0.86	0.898539615	0.0014853
340	0.88	0.930141524	0.0025142
370	0.9	0.960853455	0.0037031

SSE   0

Sum of Absolute Errors (EABS/SAE)

150mg/l

t (min)	qexp	qcalc	SSE	qex-qca
0	0	0.027565091	0.0007598	0.027565091
10	0	0.063420312	0.0040221	0.063420312
15	0.01	0.094743153	0.0071814	0.084743153
25	0.2	0.200007647	5.848E-11	7.64736E-06
40	0.48	0.48	3.055E-21	5.52726E-11
50	0.69	0.687994465	4.022E-06	0.002005535
60	0.83	0.84044763	0.0001092	0.01044763
70	0.88	0.92637981	0.0021511	0.04637981

SAE   0.3867357

t (min)	qexp	qcalc	error	qex-qca/qex
75	0.89	0.951096488	0.0037328	0.061096488
95	0.9	0.991070024	0.0082937	0.091070024
			0.0262542	0.38673569

Marquardt's Percent Standard Deviation (MPSD)

150mg/l

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.000803964	6.464E-07	0		
10	0	0.004694834	2.204E-05	0		
15	0.01	0.011292001	1.669E-06	0.01669266	MPSD	2.2715533
25	0.2	0.062753032	0.0188367	0.470918256		
40	0.48	0.487279463	5.299E-05	0.000229994		
50	0.69	0.847828655	0.0249099	0.052320698		
60	0.83	0.970293592	0.0196823	0.028570608		
70	0.88	0.994804743	0.0131801	0.017019795		
75	0.89	0.997847741	0.0116311	0.014683923	0.004128	
95	0.9	0.999937245	0.0099875	0.012330189		
	4.88		0.098305	0.612766124		

150mg/l

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.000803964	6.464E-07	0		
10	0	0.004694834	2.204E-05	0		
15	0.01	0.011292001	1.669E-06	0.001292001	ARE	1.570759
25	0.2	0.062753032	0.0188367	0.137246968		
40	0.48	0.487279463	5.299E-05	0.007279463		
50	0.69	0.847828655	0.0249099	0.157828655		
60	0.83	0.970293592	0.0196823	0.140293592	0.1570759	
70	0.88	0.994804743	0.0131801	0.114804743		
75	0.89	0.997847741	0.0116311	0.107847741		
95	0.9	0.999937245	0.0099875	0.099937245		
	4.88			0.766530409		

MNFC AND MF-MNFC

Sum of the Squares of the Errors (ERRSQ /SSE)

MNFC

t (min)	qexp	qcalc	SSE
0	0	0.00530721	2.817E-05
20	0	0.015531371	0.0002412
30	0	0.026411831	0.0006976
40	0	0.044569487	0.0019864
50	0.01	0.074258088	0.0041291
60	0.11	0.121213875	0.0001258
80	0.32	0.289696721	0.0009183
96	0.52	0.492611688	0.0007501
105	0.62	0.612611287	5.459E-05
122	0.81	0.798960553	0.0001219
132	0.86	0.872347287	0.0001525
138	0.88	0.904401172	0.0005954
143	0.89	0.925404059	0.0012534
150	0.9	0.947727124	0.0022779
			0.0133323

SSE   0.0133323

Sum of Absolute Errors (EABS/SAE)

MNFC

t (min)	qexp	qcalc	error	qex-qca
0	0	0.005249576	2.756E-05	0.005249576
20	0	0.015486569	0.0002398	0.015486569
30	0	0.026439796	0.0006991	0.026439796
40	0	0.044787518	0.0020059	0.044787518
50	0.01	0.07488813	0.0042105	0.06488813
60	0.11	0.122621704	0.0001593	0.012621704
80	0.32	0.294077085	0.000672	0.025922915
96	0.52	0.49951799	0.0004195	0.02048201
105	0.62	0.620000065	4.224E-15	6.49922E-08
122	0.81	0.805007906	2.492E-05	0.004992094
132	0.86	0.876962833	0.0002877	0.016962833
138	0.88	0.908181393	0.0007942	0.028181393

SAE   0.3546859

143	0.89	0.928553009	0.0014863	0.038553009	
150	0.9	0.950118249	0.0025118	0.050118249	
			0.0135387	0.354685863	

Marquardt's Percent Standard Deviation (MPSD)

MNFC

t (min)	qexp	qcalc	error	qex-qca/qex	
0	0	7.24988E-05	5.256E-09	0	
20	0	0.000563089	3.171E-07	0	
30	0	0.001568086	2.459E-06	0	
40	0	0.004358971	1.9E-05	0	**MPSD** 1.6363518
50	0.01	0.0120571	4.232E-06	0.042316602	
60	0.11	0.032901194	0.0059442	0.491258341	
80	0.32	0.20908779	0.0123015	0.120132016	
96	0.52	0.576849722	0.0032319	0.011952259	
105	0.62	0.774258619	0.0237957	0.061903542	0.0032132
122	0.81	0.951446679	0.0200072	0.030494076	
132	0.86	0.982022629	0.0148895	0.020131858	
138	0.88	0.990200812	0.0121442	0.015682101	
143	0.89	0.994107693	0.0108384	0.013683136	
150	0.9	0.997116387	0.0094316	0.011643942	
	5.92		0.1126103	0.819197871	

Hybrid Fractional Error Function (HYBRID)

MNFC

t (min)	qexp	qcalc	error	qex-qca/qex	
0	0	0.00072354	5.235E-07	0	
20	0	0.003230539	1.044E-05	0	
30	0	0.006810271	4.638E-05	0	**HYBRID** 1.0436266
40	0	0.014299764	0.0002045	0	
50	0.01	0.029778762	0.0003912	0.039119944	
60	0.11	0.060976722	0.0024033	0.021848017	
80	0.32	0.225205074	0.0089861	0.028081494	
96	0.52	0.490856507	0.0008493	0.001633352	
105	0.62	0.654270559	0.0011745	0.001894308	
122	0.81	0.871222515	0.0037482	0.004627403	
132	0.86	0.934697461	0.0055797	0.006488036	
138	0.88	0.957336873	0.005981	0.006796582	
143	0.89	0.970272679	0.0064437	0.007240116	

t (min)	150	0.9	0.982190916	0.0067553	0.007505941
				0.0425741	0.125235192

MNFC

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.00072354	5.235E-07	0		
20	0	0.003230539	1.044E-05	0		
30	0	0.006810271	4.638E-05	0	ARE	1.9778762
40	0	0.014299764	0.0002045	0		
50	0.01	0.029778762	0.0003912	1.977876231		
60	0.11	0.060976722	0.0024033	0.445666168		
80	0.32	0.225205074	0.0089861	0.296234145		
96	0.52	0.490856507	0.0008493	0.056045179		
105	0.62	0.654270559	0.0011745	0.055275096		
122	0.81	0.871222515	0.0037482	0.075583352		
132	0.86	0.934697461	0.0055797	0.086857513		
138	0.88	0.957336873	0.005981	0.08788281		
143	0.89	0.970272679	0.0064437	0.090194021		
150	0.9	0.982190916	0.0067553	0.091323239		
				3.262937756		

MF+MNFC

t (min)	qexp	qcalc	error	qex-qex		
0	0	0.000773489	5.983E-07	0.000773489		
20	0	0.002100812	4.413E-06	0.002100812		
40	0	0.005692875	3.241E-05	0.005692875		
50	0	0.009353734	8.749E-05	0.009353734	SAE	0.1931249
60	0	0.015332443	0.0002351	0.015332443		
70	0	0.025036036	0.0006268	0.025036036		
80	0.01	0.040627453	0.000938	0.030627453		
100	0.09	0.103276486	0.0001763	0.013276486		
115	0.21	0.19608195	0.0001937	0.01391805		
130	0.36	0.340606763	0.0003761	0.019393237		
140	0.46	0.460000001	3.109E-19	5.57562E-10		

t (min)	qexp	qcalc	error	qex-qca/qex
165	0.72	0.748434323	0.0008085	0.028434323
180	0.88	0.863025866	0.0002881	0.016974134
185	0.89	0.890003511	1.233E-11	3.51121E-06
190	0.9	0.912208297	0.000149	0.012208297
			0.0039166	0.193124881

Marquardt's Percent Standard Deviation (MPSD)

MF+MNFC

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	2.56075E-05	6.557E-10	0			
20	0	0.000119536	1.429E-08	0			
40	0	0.000557799	3.111E-07	0	MPSD	1.5658493	
50	0	0.001204432	1.451E-06	0			
60	0	0.00259873	6.753E-06	0			
70	0	0.005598075	3.134E-05	0			
80	0.01	0.012017428	4.07E-06	0.040700162	0.0031874		
100	0.09	0.053733689	0.0013152	0.162375961			
115	0.21	0.152792295	0.0032727	0.074211373			
130	0.36	0.364184224	1.751E-05	0.000135091			
140	0.46	0.553089779	0.0086657	0.040953247			
165	0.72	0.894654451	0.0305042	0.058842935			
180	0.88	0.964250302	0.0070981	0.009165952			
185	0.89	0.975397929	0.0072928	0.009206926			
190	0.9	0.98313027	0.0069106	0.008531656			
	4.52		0.0651209	0.404123304			

MF+MNFC

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	2.56075E-05	6.557E-10	0			
20	0	0.000119536	1.429E-08	0			
40	0	0.000557799	3.111E-07	0	ARE	0.8330366	
50	0	0.001204432	1.451E-06	0			
60	0	0.00259873	6.753E-06	0			
70	0	0.005598075	3.134E-05	0			
80	0.01	0.012017428	4.07E-06	0.002017428			
100	0.09	0.053733689	0.0013152	0.036266311			
115	0.21	0.152792295	0.0032727	0.057207705	0.1249555		

130	0.36	0.364184224	1.751E-05	0.004184224
140	0.46	0.553089779	0.0086657	0.093089779
165	0.72	0.894654451	0.0305042	0.174654451
180	0.88	0.964250302	0.0070981	0.084250302
185	0.89	0.975397929	0.0072928	0.085397929
190	0.9	0.98313027	0.0069106	0.08313027
		4.963354547	0.0651209	0.6201984

Summary of Yoo-Nelson model parameters for Co (II) ion adsorption
 at Bed height of 4 cm.

Error Func	KYN(L/miⅈ	τ (min)	Objective function
SSE	0.0353	236.8801	0.022899
HYB	0.0353	236.8801	5.243037
MPSD	0.0762	158.9671	22.38218
ARE	0.0353	236.8801	0.5125
SAE	0.0353	236.8801	0.5722
R2	0.0353	236.8801	0.9857

 at Bed height of 8 cm.

Error Func	KYN(L/miⅈ	τ (min)	Objective function
SSE	0.03	355.0916	0.018424
HYB	0.0419	310.734	0.64753
MPSD	0.0561	275.5547	17.64361
ARE	0.0419	310.734	14.907
SAE	0.0291	357.7112	0.446849
R2	0.029956	355.091638	0.9923

 at Bed height of 12 cm.

Error Func	KYN(L/miⅈ	τ (min)	Objective function
SSE	0.036736	442.1088	0.000894
HYB	0.039586	432.8573	0.058509
MPSD	0.045056	415.573	6.9066
ARE	0.03959	432.8573	3.9134
SAE	0.036385	442.9808	0.079665
	0.036736	442.1088021	0.9997

at the flow rate of 4 mL/min

Error Func	K_{YN}(L/min)	τ (min)	Objective function
SSE	0.027517	410.6713	0.0055
HYB	0.033771	382.0048	0.274
MPSD	0.033771	382.0043	5.2348
ARE	0.03377	382.0048	0.2452
SAE	0.027517	409.6524	0.1954
R2	0.027517	410.6713	0.998

at the flow rate of 12 mL/min

Error Func	K_{YN}(L/min)	τ (min)	Objective function
SSE	0.072526	107.0992	0.044312
HYB	0.085753	97.5722	1.165691
MPSD	0.104576	86.2	16.67756
ARE	0.08575	97.5722	13.184
SAE	0.072804	108.8874	0.585644
R2	0.072526	107.6992	0.9642

at the initial adsobate concentration of 50mg/L

Error Func	K_{YN}(L/min)	τ (min)	Objective function
SSE	0.020388	404.8984	0.022346
HYB	0.026998	357.6019	0.702418
MPSD	0.036712	305.5198	20.38633
ARE	0.027	357.6019	0.7024
SAE	0.020692	405.0316	0.552907
R2	0.020388	404.8983768	0.991

at the initial adsobate concentration of 150mg/L

Error Func	K_{YN}(L/min)	τ (min)	Objective function
SSE	0.089176	98.34206	0.023927
HYB	0.132409	79.94181	1.672838
MPSD	0.1769	68.61942	27.67594
ARE	0.1769	68.6194	15.9104
SAE	0.08708	98.45961	0.386736
R2	0.089176	98.34205808	0.9834

Yoon-Nelson Parameters for C-MNFC adsorbent [4 cm, 12 mL/min, 100mg/L]

Error Func	K_{YN}(L/min)	τ (min)	Objective function
SSE	0.054206	181.5015	0.013332
HYB	0.074938	157.9411	1.043627

MPSD	0.102518	137.8982	26.12786
ARE	0.07494	157.4911	1.9779
SAE	0.054609	180.3659	0.354686
R2	0.054206	181.5014808	0.9935

Yoon-Nelson Parameters for MF-MNFC adsorbent [4 cm, 12 mL/min, 100mg/L]

Error Func	KYN(L/min)	τ (min)	Objective function
SSE	0.049989	235.4376	0.00391
HYB	0.058895	220.6157	0.364428
MPSD	0.077041	197.0086	17.63134
ARE	0.07704	197.0086	10.785
SAE	0.050025	235.2629	0.193125
R2	0.049989	235.4376069	0.998

KYN	0.0352738
τ	236.88009

C0	100
m	4
Q	8
n	14
p	2

C0	100
m	4
Q	8
n	14
p	2

KYN	0.0762438
τ	158.96713

C0	100
m	4
Q	8
n	14
p	2

KYN	0.0352738
τ	236.88009

R^2	0.9539222

C0	100
m	4
Q	8
n	14
p	2

KYN	0.0352738
τ	236.88009

R^2	#DIV/0!

C0	100
m	4
Q	8
n	14
p	2

KYN	0.0299557
τ	355.09164

C0	100
m	8
Q	8
n	18
p	2

KYN	0.0290482
τ	357.7112

C0	100
m	8
Q	8
n	18
p	2

KYN	0.0561148
τ	275.55468

R^2	0.7521008

C0	100
m	8
Q	8
n	18
p	2

KYN	0.0418805
τ	310.73395

C0	100
m	8
Q	8
n	18
p	2

KYN	0.0418805
τ	310.73395

C0	100
m	8
Q	8
n	18
p	2

KYN	0.0363852
τ	442.98084

C0	100
m	12
Q	8
n	23
p	2

KYN	0.0450557
τ	415.57304

C0	100
m	12
Q	8
n	23
p	2

KYN	0.0395858
τ	432.85731

C0	100
m	12
Q	8
n	23
p	2

KYN	0.0275166
τ	409.65238

m	4
Q	4
C0	100
n	19
p	2

KYN	0.0337714
τ	382.00433

m	4
Q	4
C0	100
n	19
p	2

KYN	0.0337713
τ	382.00475

m	4
Q	4
C0	100
n	19
p	2

KYN	0.0337713
τ	382.00475

m	4
Q	4
C0	100
n	19
p	2

KYN	0.0728039
τ	108.88741

C0	100
Q	12
m	4

KYN	0.1045765
τ	86.19995

C0	100
Q	12
m	4

KYN	0.0857529
τ	97.572156

C0	100
Q	12
m	4
SSE	0.0490106

KYN	0.0857529
τ	97.572156

C0	100
Q	12
m	4
SSE	0.0490106

KYN	0.0367123
τ	305.51976

C0	50
Q	8
m	4
p	2
n	17

KYN	0.0269979
τ	357.60187

C0	50
Q	8
m	4
p	2
n	17

KYN	0.0203881
τ	404.89838

38.173532

C0	50
Q	8
m	4
p	2
n	17

KYN	0.0203881
τ	404.89838

C0	50
Q	8
m	4
p	2
n	17

KYN	0.0870803
τ	98.459611

C0	150
Q	8
m	4

p 2
n 10

KYN 0.1768565
τ 68.619416

C0 150
Q 8
m 4
p 2
n 10

KYN 0.1768565
τ 68.619416

C0 150
Q 8
m 4
p 2
n 10

KYN	0.0542064
τ	181.50148

C0	100
Q	12
m	4
n	14
p	2

KYN	0.0546085
τ	180.36595

C0	100
Q	12
m	4
n	14
p	2

KYN	0.1025179
τ	137.89818

C0	100
Q	12
m	4
n	14
p	2

KYN	0.0749381
τ	157.94113

C0	100
Q	12
m	4
n	14
p	2

KYN	0.0749381
τ	157.94113

C0	100
Q	12
m	4
n	14
p	2

KYN	0.0500249
τ	235.26285

C0	100
Q	12
m	4
n	15
p	2

KYN	0.0770412
τ	197.00858

C0	100
Q	12
m	4
n	15
p	2

p   2

WOLBORSKA KINETIC MODEL PARAMETERS FOR Co(II) ION ADSORPTION AT DIFFERENT BED-HEIGH

BH=4g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.116166222	0.013494591	0.1760125
10	0	0.129773102	0.016841058	0.1760125
15	0	0.137163038	0.018813699	0.1760125
20	0	0.144973794	0.021017401	0.1760125
25	0	0.153229335	0.023479229	0.1760125
40	0.01	0.180925235	0.029215436	0.1677218
70	0.24	0.252239794	0.000149813	0.0322341
92	0.43	0.321843102	0.011697915	0.0001094
110	0.56	0.392855539	0.027937271	0.0197294
130	0.7	0.490278129	0.043983263	0.0786587
160	0.85	0.683529052	0.027712577	0.1852971
180	0.88	0.853034541	0.000727136	0.2120248
190	0.89	0.952952901	0.003963068	0.221334
200	0.9	1.064574982	0.027084925	0.2308433
		0.419538483	0.26611738	2.0280153

BH=8g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.052731121	0.002780571	0.1170648
20	0	0.064491262	0.004159123	0.1170648
30	0	0.071321064	0.005086694	0.1170648
40	0	0.078874161	0.006221133	0.1170648
50	0	0.087227151	0.007608576	0.1170648
60	0	0.096464746	0.009305447	0.1170648
70	0	0.106680627	0.011380756	0.1170648
80	0	0.117978398	0.013918902	0.1170648
115	0.01	0.167807657	0.024903256	0.1103219
140	0.08	0.215826174	0.01844875	0.0687213
170	0.3	0.291913998	6.53834E-05	0.0017764
195	0.49	0.37544581	0.013122662	0.0218604
210	0.6	0.436639143	0.02668677	0.066488
230	0.71	0.53401879	0.030969386	0.1353155
250	0.8	0.653116132	0.021574871	0.209629
270	0.85	0.798774668	0.002624035	0.2579143
285	0.87	0.928965718	0.003476956	0.2786284
300	0.9	1.080376407	0.032535648	0.3111995
		0.34214739	0.234868921	2.3983733

	BH=12g			
t (min)	qexp	qcalc	SSE	SSEA
0	0	0.00566285	3.20679E-05	0.0928226
20	0	0.007437421	5.53152E-05	0.0928226
30	0	0.008523463	7.26494E-05	0.0928226
40	0	0.009768092	9.54156E-05	0.0928226
50	0	0.011194467	0.000125316	0.0928226
60	0	0.012829126	0.000164586	0.0928226
80	0	0.016849399	0.000283902	0.0928226
100	0	0.022129509	0.000489715	0.0928226
140	0	0.038172137	0.001457112	0.0928226
180	0	0.065844752	0.004335531	0.0928226
230	0.02	0.130163595	0.012136018	0.0810359
255	0.08	0.183009536	0.010610964	0.0504757
280	0.21	0.257310735	0.002238306	0.008962
293	0.3	0.307191844	5.17226E-05	2.179E-05
300	0.35	0.337944399	0.000145338	0.002055
315	0.49	0.414606173	0.005684229	0.034348
337	0.68	0.559579565	0.014501081	0.1408741
354	0.8	0.705490374	0.008932069	0.2453538
362	0.84	0.786766811	0.002833772	0.2865803
370	0.87	0.877406749	5.48599E-05	0.3196003
375	0.89	0.93928591	0.002429101	0.3426135
380	0.9	1.005529102	0.011136391	0.3544202
		0.304668	0.077865464	2.7945665

WOLBORSKA MODEL PARAMETERS FOR C0(II) ION ADSORPTION AT DIFFERENT FLOW RATES

	fr4ml/min			
t (min)	qexp	qcalc	SSE	SSEA
0	0	0.047589732	0.002264783	0.1837986
20	0	0.057127656	0.003263569	0.1837986
30	0	0.062591157	0.003917653	0.1837986
40	0	0.068577168	0.004702828	0.1837986
50	0	0.075135663	0.005645368	0.1837986
60	0	0.08232139	0.006776811	0.1837986
90	0	0.108271065	0.011722624	0.1837986
150	0.02	0.187288814	0.027985547	0.1670499
210	0.29	0.32397483	0.001154289	0.0192425
235	0.45	0.407078064	0.001842293	0.0004529
260	0.63	0.511498224	0.014042671	0.0405147

t (min)	qexp	qcalc	SSE	SSEA
280	0.74	0.614012587	0.015872828	0.0968969
290	0.79	0.672734726	0.013751145	0.1305251
300	0.83	0.737072856	0.008635454	0.1610277
315	0.87	0.845298845	0.000610147	0.1947303
320	0.88	0.884796837	2.30096E-05	0.203656
330	0.89	0.969415888	0.006306883	0.2127816
340	0.9	1.062127626	0.026285367	0.2221073
		0.428717396	0.154803269	2.7355753

fr12ml/min

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.223763482	0.050070096	0.2667423
10	0	0.255443456	0.065251359	0.2667423
20	0.08	0.291608615	0.044778206	0.190507
30	0.32	0.332893963	0.000166254	0.0386009
48	0.62	0.422489524	0.039010388	0.0107182
60	0.74	0.495247883	0.059903599	0.0499652
85	0.86	0.689583007	0.029041952	0.1180121
100	0.89	0.841094716	0.002391727	0.1395239
120	0.9	1.096114803	0.038461016	0.1470945
		0.51647105	0.329074597	1.2279064

WOLBORSKA PARAMETERS FOR Co(II) ION ADSORPTION AT DIFFERENT INITIAL SOLUTE CONCENTR

BH=4g   50mg/l

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.089617797	0.00803135	0.1404082
10	0	0.095968511	0.009209955	0.1404082
22	0	0.104186188	0.010854762	0.1404082
30	0	0.11005195	0.012111432	0.1404082
41	0	0.118660365	0.014080282	0.1404082
50	0	0.126202141	0.01592698	0.1404082
60	0	0.135145384	0.018264275	0.1404082
80	0.01	0.154978052	0.021018636	0.133014
100	0.05	0.177721177	0.016312699	0.1054372
155	0.26	0.258987549	1.02506E-06	0.0131586

t (min)	qexp	qcalc	SSE	SSEA
210	0.54	0.377414506	0.026434043	0.0273205
240	0.66	0.463470465	0.038623858	0.0813899
280	0.79	0.609480801	0.032587181	0.172465
300	0.83	0.698922486	0.017181315	0.2072882
320	0.86	0.801489793	0.003423444	0.2355055
340	0.88	0.919108916	0.001529507	0.2553171
370	0.9	1.128679023	0.052294096	0.2759287
		0.374710888	0.29788484	2.4896824

150mg/l

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.197976608	0.039194737	0.2707415
10	0	0.238308065	0.056790734	0.2707415
15	0.01	0.26145754	0.063230895	0.260435
25	0.2	0.314721225	0.01316096	0.1026102
40	0.48	0.415636163	0.004142704	0.0016264
50	0.69	0.500308854	0.035982731	0.0287885
60	0.83	0.602230922	0.051878753	0.0958966
70	0.88	0.72491638	0.024050929	0.1293637
75	0.89	0.795335457	0.008961376	0.1366572
95	0.9	1.152391559	0.063701499	0.1441506
		0.520328277	0.361095316	1.4410112

WOLBORSKA MODEL PARAMETERS FOR MODIFIED NANOCELLULOSE ADSORBENTS IN Co(II) ADSOF

MNFC

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.069721464	0.004861083	0.2009647
20	0	0.100355458	0.010071218	0.2009647
30	0	0.120400489	0.014496278	0.2009647
40	0	0.14444932	0.020865606	0.2009647
50	0.01	0.173301672	0.026667436	0.1920988
60	0.11	0.207917002	0.009587739	0.1144407
80	0.32	0.299270911	0.000429695	0.0164585
96	0.52	0.400501464	0.0142799	0.0051422
105	0.62	0.47182683	0.021955288	0.029484
122	0.81	0.643029593	0.027879117	0.1308335
132	0.86	0.771468524	0.007837822	0.1695045
138	0.88	0.860539009	0.00037873	0.1863728

t (min)	qexp	qcalc	SSE	SSEA
143	0.89	0.942571247	0.002763736	0.195107
150	0.9	1.070718394	0.02914477	0.2040412
		0.448290813	0.191218418	2.0473419

MF+MNFC

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.021233266	0.000450852	0.1032918
20	0	0.031878492	0.001016238	0.1032918
40	0	0.047860667	0.002290643	0.1032918
50	0	0.058643413	0.00343905	0.1032918
60	0	0.071855452	0.005163206	0.1032918
70	0	0.088044092	0.007751762	0.1032918
80	0.01	0.107879943	0.009580483	0.096964
100	0.09	0.16196519	0.005178989	0.0535415
115	0.21	0.219675902	9.36231E-05	0.0124078
130	0.36	0.297949837	0.003850223	0.0014907
140	0.46	0.365076301	0.009010509	0.0192126
165	0.72	0.606715184	0.012833449	0.1588896
180	0.88	0.822897225	0.003260727	0.3120447
185	0.89	0.910889808	0.000436384	0.3233169
190	0.9	1.008291456	0.011727039	0.3347891
		0.321390415	0.076083177	1.9324076

β	0.1553735
N0	1402.7256
R^2	0.8687794
H	4
v	0.2887
C0	100
Q	8
n	15
p	2

β	0.106189
N0	1054.909
R^2	0.902072
H	8
v	0.2887
C0	100
Q	8
n	19
p	2

β	0.124474
N0	913.2434
R^2	0.972137
H	12
v	0.2887
Q	8
C0	100
n	23
p	2

β	0.109853
N0	1202.743
R^2	0.943411
H	4
v	0.1443
Q	4
C0	100
n	18

p	2

β	0.162143
N0	1224.539
R^2	0.732004
v	0.4332
H	4
Q	12
C0	100
n	9
p	2

β	0.174101
N0	1271.435
R^2	0.880352
C0	50
H	4
v	0.2887
n	17

p	2
Q	8

β	0.116895
N0	945.6749
R^2	0.749415
H	4
C0	150
v	0.2887
n	10
p	2

v

β	0.28843
N0	1583.863
R^2	0.906602
v	0.4332
H	4
C0	100
n	14
p	2
Q	12

β	0.417192
N0	2053.299
R^2	0.960628
Q	12
H	4
n	
v	0.4332
p	2
C0	100

ββββββ
vvvvv

β

ν

β

WOLBOSKA ERROR FUNCTIONS
 Sum of the Squares of the Errors (ERRSQ /SSE)
BED-HIEIGHTS

BH=4g

t (min)	qexp	qcalc	error		
0	0	0.116166222	0.0134946		
10	0	0.129773102	0.0168411		
15	0	0.137163038	0.0188137		
20	0	0.144973794	0.0210174	SSE	0.2661174
25	0	0.153229335	0.0234792		
40	0.01	0.180925235	0.0292154		
70	0.24	0.252239794	0.0001498		
92	0.43	0.321843102	0.0116979		
110	0.56	0.392855539	0.0279373		
130	0.7	0.490278129	0.0439833		
160	0.85	0.683529052	0.0277126		
180	0.88	0.853034541	0.0007271		
190	0.89	0.952952901	0.0039631		
200	0.9	1.064574982	0.0270849		
		0.419538483	0.2661174		

Sum of Absolute Errors (EABS/SAE)

BH=4g

t (min)	qexp	qcalc	error	qex-qca		
0	0	0.110645055	0.0122423	0.1106451		
10	0	0.123586746	0.0152737	0.1235867		
15	0	0.130614636	0.0170602	0.1306146		
20	0	0.138042173	0.0190556	0.1380422	SAE	1.7514823
25	0	0.145892086	0.0212845	0.1458921		
40	0.01	0.172223166	0.0263164	0.1622232		
70	0.24	0.239999997	6.345E-18	2.519E-09		
92	0.43	0.306125138	0.015345	0.1238749		
110	0.56	0.373568971	0.0347565	0.186431		
130	0.7	0.466069385	0.0547235	0.2339306		
160	0.85	0.649486674	0.0402056	0.2005133		
180	0.88	0.810307809	0.004857	0.0696922		
190	0.89	0.905086139	0.0002276	0.0150861		
200	0.9	1.010950296	0.01231	0.1109503		
			0.2736579	1.7514823		

Marquardt's Percent Standard Deviation (MPSD)

BH=4g

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.004210456	1.773E-05	0			
10	0	0.005593543	3.129E-05	0			
15	0	0.006447123	4.157E-05	0			
20	0	0.00743096	5.522E-05	0	MPSD	50.668063
25	0	0.008564932	7.336E-05	0			
40	0.01	0.013114773	9.702E-06	0.0970181			
70	0.24	0.030749251	0.0437859	0.7601715			
92	0.43	0.057440998	0.1388002	0.7506772			
110	0.56	0.095778104	0.215502	0.6871874			
130	0.7	0.169037117	0.2819216	0.5753502			
160	0.85	0.396328992	0.2058174	0.2848684			
180	0.88	0.699474177	0.0325896	0.0420836			
190	0.89	0.929243663	0.0015401	0.0019443			
200	0.9	1.234489867	0.1118835	0.1381277			
			1.032069	3.3374283			

BH=4g

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.0296666	0.0008801	0			
10	0	0.035631338	0.0012696	0			
15	0	0.039049394	0.0015249	0			
20	0	0.042795339	0.0018314	0	HYBRID	8.5189786
25	0	0.046900627	0.0021997	0			
40	0.01	0.061734106	0.0026764	0.2676418			
70	0.24	0.106959214	0.0176999	0.0737494			
92	0.43	0.160051505	0.0728722	0.1694702			
110	0.56	0.222574592	0.1138559	0.2033141			
130	0.7	0.321073363	0.1435854	0.205122			
160	0.85	0.556284955	0.0862685	0.1014924			
180	0.88	0.802464828	0.0060117	0.0068315			
190	0.89	0.963807612	0.0054476	0.0061209			
200	0.9	1.157589818	0.0663525	0.073725			

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=8g

t (min)	qexp	qcalc	error
0	0	0.052731121	0.0027806
20	0	0.064491262	0.0041591
30	0	0.071321064	0.0050867
40	0	0.078874161	0.0062211
50	0	0.087227151	0.0076086
60	0	0.096464746	0.0093054
70	0	0.106680627	0.0113808
80	0	0.117978398	0.0139189
115	0.01	0.167807657	0.0249033
140	0.08	0.215826174	0.0184487
170	0.3	0.291913998	6.538E-05
195	0.49	0.37544581	0.0131227
210	0.6	0.436639143	0.0266868
230	0.71	0.53401879	0.0309694
250	0.8	0.653116132	0.0215749
270	0.85	0.798774668	0.002624
285	0.87	0.928965718	0.003477
300	0.9	1.080376407	0.0325356
			0.2348689

SSE   0.2348689

Sum of Absolute Errors (EABS/SAE)

BH=8g

t (min)	qexp	qcalc	SSE	qex-qca
0	0	0.050812122	0.0025819	0.0508121
20	0	0.062602745	0.0039191	0.0626027
30	0	0.069487453	0.0048285	0.0694875
40	0	0.077129305	0.0059489	0.0771293
50	0	0.085611566	0.0073293	0.0856116
60	0	0.095026659	0.0090301	0.0950267
70	0	0.105477174	0.0111254	0.1054772
80	0	0.117076979	0.013707	0.117077
115	0.01	0.168681356	0.0251798	0.1586814
140	0.08	0.218952364	0.0193078	0.1389524

SAE   1.8547916

170	0.3	0.299425445	3.301E-07	0.0005746
195	0.49	0.388661265	0.0102695	0.1013387
210	0.6	0.454507226	0.0211681	0.1454928
230	0.71	0.559972677	0.0225082	0.1500273
250	0.8	0.6899107	0.0121197	0.1100893
270	0.85	0.849999998	5.213E-18	2.283E-09
285	0.87	0.994004745	0.0153772	0.1240047
300	0.9	1.162406395	0.0688571	0.2624064
			0.253258	1.8547916

Marquardt's Percent Standard Deviation (MPSD)

BH=8g

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	0.000884166	7.818E-07	0
20	0	0.001438897	2.07E-06	0
30	0	0.001835598	3.369E-06	0
40	0	0.002341669	5.483E-06	0
50	0	0.002987262	8.924E-06	0
60	0	0.003810845	1.452E-05	0
70	0	0.004861487	2.363E-05	0
80	0	0.006201789	3.846E-05	0
115	0.01	0.014542347	2.063E-05	0.2063292
140	0.08	0.026730321	0.0028377	0.4433842
170	0.3	0.055494222	0.0597831	0.6642564
195	0.49	0.102004055	0.1505409	0.6269923
210	0.6	0.146973567	0.2052329	0.5700915
230	0.71	0.239185566	0.2216662	0.4397267
250	0.8	0.389251863	0.168714	0.2636157
270	0.85	0.633470553	0.046885	0.0648927
285	0.87	0.912742411	0.0018269	0.0024137
300	0.9	1.315134073	0.1723363	0.2127609
			1.0299409	3.4944632

MPSD   45.338357

Hybrid Fractional Error Function (HYBRID)

BH=8g

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	0.009494437	9.014E-05	0

20	0	0.013108681	0.0001718	0
30	0	0.015402949	0.0002373	0
40	0	0.018098757	0.0003276	0
50	0	0.021266383	0.0004523	0
60	0	0.024988404	0.0006244	0
70	0	0.02936185	0.0008621	0
80	0	0.034500731	0.0011903	0
115	0.01	0.060671592	0.0025676	0.256761
140	0.08	0.090802457	0.0001167	0.0014587
170	0.3	0.147310009	0.0233142	0.0777141
195	0.49	0.220467445	0.0726478	0.1482608
210	0.6	0.2808095	0.1018826	0.1698043
230	0.71	0.387705146	0.103874	0.1463014
250	0.8	0.535292718	0.0700699	0.0875874
270	0.85	0.739062394	0.0123072	0.014479
285	0.87	0.941344158	0.00509	0.0058506
300	0.9	1.198990547	0.0893953	0.0993282
			0.4852212	1.0075454

HYBRID   5.9267378

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=12g

t (min)	qexp	qcalc	error		
0	0	0.00566285	3.207E-05		
20	0	0.007437421	5.532E-05		
30	0	0.008523463	7.265E-05		
40	0	0.009768092	9.542E-05	SSE	0.0778655
50	0	0.011194467	0.0001253		
60	0	0.012829126	0.0001646		
80	0	0.016849399	0.0002839		
100	0	0.022129509	0.0004897		
140	0	0.038172137	0.0014571		
180	0	0.065844752	0.0043355		
230	0.02	0.130163595	0.012136		
255	0.08	0.183009536	0.010611		
280	0.21	0.257310735	0.0022383		
293	0.3	0.307191844	5.172E-05		
300	0.35	0.337944399	0.0001453		
315	0.49	0.414606173	0.0056842		
337	0.68	0.559579565	0.0145011		

t (min)	qexp	qcalc	error
354	0.8	0.705490374	0.0089321
362	0.84	0.786766811	0.0028338
370	0.87	0.877406749	5.486E-05
375	0.89	0.93928591	0.0024291
380	0.9	1.005529102	0.0111364
			0.0778655

Sum of Absolute Errors (EABS/SAE)

BH=12g

t (min)	qexp	qcalc	error	qex-qca		
0	0	0.005219099	2.724E-05	0.0052191		
20	0	0.00688176	4.736E-05	0.0068818		
30	0	0.007902264	6.245E-05	0.0079023		
40	0	0.009074099	8.234E-05	0.0090741		
50	0	0.010419707	0.0001086	0.0104197	SAE	0.9673366
60	0	0.011964857	0.0001432	0.0119649		
80	0	0.01577653	0.0002489	0.0157765		
100	0	0.020802497	0.0004327	0.0208025		
140	0	0.036167913	0.0013081	0.0361679		
180	0	0.062882734	0.0039542	0.0628827		
230	0.02	0.125542674	0.0111393	0.1055427		
255	0.08	0.177386823	0.0094842	0.0973868		
280	0.21	0.250640551	0.0016517	0.0406406		
293	0.3	0.299998391	2.589E-12	1.609E-06		
300	0.35	0.330487715	0.0003807	0.0195123		
315	0.49	0.406661734	0.0069453	0.0833383		
337	0.68	0.551248843	0.0165769	0.1287512		
354	0.8	0.697326353	0.0105419	0.1026736		
362	0.84	0.778892769	0.0037341	0.0611072		
370	0.87	0.870000026	6.644E-16	2.578E-08		
375	0.89	0.932277626	0.0017874	0.0422776		
380	0.9	0.999013271	0.0098036	0.0990133		
			0.0784601	0.9673366		

Marquardt's Percent Standard Deviation (MPSD

BH=12g

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.000107489	1.155E-08	0			
20	0	0.000175709	3.087E-08	0			
30	0	0.000224652	5.047E-08	0			
40	0	0.000287228	8.25E-08	0		MPSD	28.970374
50	0	0.000367234	1.349E-07	0			
60	0	0.000469525	2.205E-07	0			
80	0	0.000767522	5.891E-07	0			
100	0	0.00125465	1.574E-06	0			
140	0	0.003352636	1.124E-05	0			
180	0	0.008958806	8.026E-05	0			
230	0.02	0.030607645	0.0001125	0.2813053			
255	0.08	0.056574379	0.0005488	0.0857437			
280	0.21	0.104570618	0.0111154	0.2520489			
293	0.3	0.143926384	0.024359	0.2706553			
300	0.35	0.170939166	0.0320628	0.261737			
315	0.49	0.247124332	0.0589886	0.2456834			
337	0.68	0.424317167	0.0653737	0.1413791			
354	0.8	0.644329064	0.0242334	0.0378648			
362	0.84	0.784296873	0.0031028	0.0043974			
370	0.87	0.954669934	0.007169	0.0094715			
375	0.89	1.079471601	0.0358995	0.0453219			
380	0.9	1.220588285	0.1027768	0.126885			
			0.3658365	1.7624933			

Hybrid Fractional Error Function (HYBRID)

BH=12g

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.000995036	9.901E-07	0			
20	0	0.001437807	2.067E-06	0			
30	0	0.00172835	2.987E-06	0			
40	0	0.002077604	4.316E-06	0			
50	0	0.002497433	6.237E-06	0		HYBRID	1.7493928
60	0	0.003002098	9.013E-06	0			

80	0	0.004337973	1.882E-05	0
100	0	0.006268287	3.929E-05	0
140	0	0.013087991	0.0001713	0
180	0	0.027327323	0.0007468	0
230	0.02	0.068588644	0.0023609	0.1180428
255	0.08	0.108662521	0.0008215	0.0102693
280	0.21	0.172150122	0.0014326	0.006822
293	0.3	0.218684331	0.0066122	0.0220408
300	0.35	0.248753605	0.0102508	0.0292881
315	0.49	0.327843003	0.0262949	0.053663
337	0.68	0.491489419	0.0355362	0.0522592
354	0.8	0.67204277	0.0163731	0.0204663
362	0.84	0.778649003	0.0037639	0.0044809
370	0.87	0.902166198	0.0010347	0.0011893
375	0.89	0.989127014	0.0098262	0.0110406
380	0.9	1.084470082	0.0340292	0.0378102
			0.149338	0.3673725

Sum of the Squares of the Errors (ERRSQ /SSE)

fr4ml/min

t (min)	qexp	qcalc	error
0	0	0.047589732	0.0022648
20	0	0.057127656	0.0032636
30	0	0.062591157	0.0039177
40	0	0.068577168	0.0047028
50	0	0.075135663	0.0056454
60	0	0.08232139	0.0067768
90	0	0.108271065	0.0117226
150	0.02	0.187288814	0.0279855
210	0.29	0.32397483	0.0011543
235	0.45	0.407078064	0.0018423
260	0.63	0.511498224	0.0140427
280	0.74	0.614012587	0.0158728
290	0.79	0.672734726	0.0137511
300	0.83	0.737072856	0.0086355
315	0.87	0.845298845	0.0006101
320	0.88	0.884796837	2.301E-05
330	0.89	0.969415888	0.0063069

SSE   0.1548033

340	0.9 1.062127626 0.0262854
	==0.1548033==

Sum of Absolute Errors (EABS/SAE)

fr4ml/min

t (min)	qexp	qcalc	error	qex-qca			
0	0	0.034771901	0.0012091	0.0347719			
20	0	0.042555813	0.001811	0.0425558			
30	0	0.047078663	0.0022164	0.0470787			
40	0	0.052082203	0.0027126	0.0520822	SAE	1.4459888	
50	0	0.057617522	0.0033198	0.0576175			
60	0	0.063741136	0.0040629	0.0637411			
90	0	0.086300932	0.0074479	0.0863009			
150	0.02	0.158200134	0.0190993	0.1382001			
210	0.29	0.290000143	2.046E-14	1.43E-07			
235	0.45	0.373302828	0.0058825	0.0766972			
260	0.63	0.480534252	0.02234	0.1494657			
280	0.74	0.588104907	0.0230721	0.1518951			
290	0.79	0.650608946	0.0194299	0.1393911			
300	0.83	0.719755941	0.0121538	0.1102441			
315	0.87	0.83749669	0.0010565	0.0325033			
320	0.88	0.880877897	7.707E-07	0.0008779			
330	0.89	0.974497973	0.0071399	0.084498			
340	0.9	1.07806803	0.0317082	0.178068			
			0.1646624	1.4459888			

Marquardt's Percent Standard Deviation (MPSD)

fr4ml/min

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.001344982	1.809E-06	0			
20	0	0.002016277	4.065E-06	0			
30	0	0.002468692	6.094E-06	0			
40	0	0.003022621	9.136E-06	0	==MPSD==	==83.348941==	

50	0	0.003700842	1.37E-05	0
60	0	0.004531243	2.053E-05	9
90	0	0.008317021	6.917E-05	0
150	0.02	0.028020034	6.432E-05	0.1608024
210	0.29	0.094399464	0.0382596	0.4549295
235	0.45	0.156589111	0.0860899	0.4251356
260	0.63	0.259748822	0.1370859	0.3453916
280	0.74	0.389392165	0.1229259	0.2244811
290	0.79	0.47676462	0.0981164	0.1572126
300	0.83	0.583741851	0.0606431	0.0880289
315	0.87	0.790853513	0.0062642	0.0082761
320	0.88	0.875093491	2.407E-05	3.109E-05
330	0.89	1.07144841	0.0329235	0.0415649
340	0.9	1.311861769	0.1696301	0.2094199
			0.7521515	11.115274

Hybrid Fractional Error Function (HYBRID)

fr4ml/min

t (min)	qexp	qcalc	error	qex-qca/qca
0	0	0.010746662	0.0001155	0
20	0	0.014162477	0.0002006	0
30	0	0.016258184	0.0002643	0
40	0	0.018664006	0.0003483	0
50	0	0.021425831	0.0004591	0
60	0	0.02459634	0.000605	0
90	0	0.037210795	0.0013846	0
150	0.02	0.085165921	0.0042466	0.2123299
210	0.29	0.194922848	0.0090397	0.0311713
235	0.45	0.275229379	0.0305448	0.0678773
260	0.63	0.388621508	0.0582636	0.0924819
280	0.74	0.512144445	0.0519182	0.0701597
290	0.79	0.587929543	0.0408325	0.0516867
300	0.83	0.674929018	0.024047	0.0289723
315	0.87	0.830151441	0.0015879	0.0018252
320	0.88	0.889454496	8.939E-05	0.0001016
330	0.89	1.021072434	0.01718	0.0193034
340	0.9	1.172166671	0.0740747	0.0823052
			0.3152016	0.6582142

Sum of the Squares of the Errors (ERRSQ /SSE)

fr12ml/min

t (min)	qexp	qcalc	error
0	0	0.223763482	0.0500701
10	0	0.255443456	0.0652514
20	0.08	0.291608615	0.0447782
30	0.32	0.332893963	0.0001663
48	0.62	0.422489524	0.0390104
60	0.74	0.495247883	0.0599036
85	0.86	0.689583007	0.029042
100	0.89	0.841094716	0.0023917
120	0.9	1.096114803	0.038461
			0.3290746

SSE   0.3290746

Sum of Absolute Errors (EABS/SAE)

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca
0	0	0.219214669	0.0480551	0.2192147
10	0	0.252186394	0.063598	0.2521864
20	0.08	0.290117344	0.0441493	0.2101173
30	0.32	0.333753426	0.0001892	0.0137534
48	0.62	0.429496278	0.0362917	0.1905037
60	0.74	0.508138208	0.0537599	0.2318618
85	0.86	0.721293389	0.0192395	0.1387066
100	0.89	0.890000011	1.105E-16	1.051E-08
120	0.9	1.177861134	0.0772068	0.2778611
			0.3424894	1.5342051

SAE   1.5342051

Marquardt's Percent Standard Deviation (MPSD)

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.072361569	0.0052362	0		
10	0	0.09144147	0.0083615	0		
20	0.08	0.115552254	0.001264	0.1974942		
30	0.32	0.146020438	0.0302689	0.2955946		
48	0.62	0.222513851	0.1579952	0.4110178	MPSD	47.052239
60	0.74	0.294658734	0.1983288	0.3621783		
85	0.86	0.528941177	0.1095999	0.1481881		
100	0.89	0.751381007	0.0192152	0.0242586		
120	0.9	1.199860236	0.0899162	0.1110076		
			0.620186	1.5497392		

Hybrid Fractional Error Function (HYBRID)

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.150494804	0.0226487	0		
10	0	0.178045417	0.0317002	0		
20	0.08	0.210639634	0.0170667	0.2133339		
30	0.32	0.249200772	0.0050125	0.0156642		
48	0.62	0.33726099	0.0799413	0.1289377	HYBRID	9.0318226
60	0.74	0.412645642	0.1071609	0.144812		
85	0.86	0.628203707	0.0537295	0.0624762		
100	0.89	0.808377905	0.0066622	0.0074856		
120	0.9	1.131443887	0.0535663	0.0595181		
			0.3774883	0.6322276		

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=4g   50mg/l

t (min)	qexp	qcalc	error		
0	0	0.089617797	0.0080313		
10	0	0.095968511	0.00921		
22	0	0.104186188	0.0108548		
30	0	0.11005195	0.0121114		
41	0	0.118660365	0.0140803	SSE	0.2978848
50	0	0.126202141	0.015927		
60	0	0.135145384	0.0182643		
80	0.01	0.154978052	0.0210186		
100	0.05	0.177721177	0.0163127		
155	0.26	0.258987549	1.025E-06		
210	0.54	0.377414506	0.026434		
240	0.66	0.463470465	0.0386239		
280	0.79	0.609480801	0.0325872		
300	0.83	0.698922486	0.0171813		
320	0.86	0.801489793	0.0034234		
340	0.88	0.919108916	0.0015295		
370	0.9	1.128679023	0.0522941		
			0.2978848		

Sum of Absolute Errors (EABS/SAE)

BH=4g   50mg/l

t (min)	qexp	qcalc	error	qex-qca		
0	0	0.084558623	0.0071502	0.0845586		
10	0	0.090915367	0.0082656	0.0909154		
22	0	0.099177365	0.0098361	0.0991774		
30	0	0.105098394	0.0110457	0.1050984		
41	0	0.113821266	0.0129553	0.1138213	SAE	2.0246181
50	0	0.121494009	0.0147608	0.121494		
60	0	0.130627392	0.0170635	0.1306274		
80	0.01	0.151005595	0.0198826	0.1410056		
100	0.05	0.17456285	0.0155159	0.1245628		
155	0.26	0.260068935	4.752E-09	6.894E-05		
210	0.54	0.387458449	0.0232689	0.1525416		
240	0.66	0.481574311	0.0318357	0.1784257		
280	0.79	0.643547903	0.0214482	0.1464521		
300	0.83	0.743943003	0.0074058	0.086057		
320	0.86	0.859999993	4.857E-17	6.97E-09		
340	0.88	0.994162167	0.013033	0.1141622		
370	0.9	1.235649813	0.1126608	0.3356498		
			0.3261281	2.0246181		

BH=4g 50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.004202746	1.766E-05	0		
10	0	0.004913774	2.415E-05	0		
22	0	0.005927529	3.514E-05	0		
30	0	0.006717062	4.512E-05	0		
41	0	0.007977185	6.364E-05	0	MPSD	46.780452
50	0	0.009182132	8.431E-05	0		
60	0	0.010735583	0.0001153	0		
80	0.01	0.014675395	2.186E-05	0.2185931		
100	0.05	0.020061063	0.0008963	0.358536		
155	0.26	0.047392039	0.0452021	0.6686708		
210	0.54	0.111958439	0.1832196	0.628325		
240	0.66	0.178938205	0.2314205	0.5312683		
280	0.79	0.334373153	0.2075958	0.3326323		
300	0.83	0.457083518	0.1390667	0.2018678		
320	0.86	0.624826907	0.0553064	0.0747788		
340	0.88	0.85412982	0.0006693	0.0008642		
370	0.9	1.365117791	0.2163346	0.2670797		
			1.0801184	3.282616		

BH=4g 50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.02494736	0.0006224	0		
10	0	0.027730119	0.000769	0		
22	0	0.031482145	0.0009911	0		
30	0	0.034261473	0.0011738	0		
41	0	0.038488048	0.0014813	0	HYBRID	6.7041046
50	0	0.042331174	0.0017919	0		
60	0	0.047053015	0.002214	0		
80	0.01	0.058135545	0.002317	0.2317031		
100	0.05	0.071828374	0.0004765	0.0095296		
155	0.26	0.128497691	0.0172929	0.066511		
210	0.54	0.229876521	0.0961766	0.1781048		
240	0.66	0.315701066	0.1185418	0.1796087		

280	0.79	0.481930734	0.0949067	0.120135
300	0.83	0.595441241	0.0550178	0.0662865
320	0.86	0.735687199	0.0154537	0.0179694
340	0.88	0.908965683	0.000839	0.0009534
370	0.9	1.248328595	0.1213328	0.1348142
			0.5313982	1.0056157

Sum of the Squares of the Errors (ERRSQ /SSE)

150mg/l

t (min)	qexp	qcalc	error
0	0	0.192831367	0.0371839
10	0	0.232575151	0.0540912
15	0.01	0.255420721	0.0602313
25	0.2	0.308064573	0.011678
40	0.48	0.408056409	0.0051759
50	0.69	0.492159456	0.0391409
60	0.83	0.593596682	0.0558865
70	0.88	0.715940771	0.0269154
75	0.89	0.78626675	0.0107606
95	0.9	1.143776507	0.059427
			0.3604907

SSE   0.3604907

Sum of Absolute Errors (EABS/SAE)

150mg/l

t (min)	qexp	qcalc	error	qex-qca
0	0	0.225934916	0.0510466	0.2259349
10	0	0.271250725	0.073577	0.2712507
15	0.01	0.297210867	0.0824901	0.2872109
25	0.2	0.356822506	0.0245933	0.1568225
40	0.48	0.469389717	0.0001126	0.0106103
50	0.69	0.5635353	0.0159933	0.1264647
60	0.83	0.676563681	0.0235427	0.1534363
70	0.88	0.812262185	0.0045884	0.0677378
75	0.89	0.890000012	1.532E-16	1.238E-08
95	0.9	1.282818228	0.1465498	0.3828182

SAE   1.6822864

0.4224937 1.6822864

Marquardt's Percent Standard Deviation (MPSD

150mg/l

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	0.005655533	3.199E-05	0
10	0	0.009978289	9.957E-05	0
15	0.01	0.013254012	1.059E-05	0.1058859
25	0.2	0.023384597	0.031193	0.779825
40	0.48	0.054802917	0.1807926	0.7846899
50	0.69	0.096691034	0.3520155	0.7393731
60	0.83	0.170595955	0.4348137	0.631171
70	0.88	0.300989439	0.3352532	0.43292
75	0.89	0.399799753	0.2402963	0.3033661
95	0.9	1.244536324	0.1187053	0.1465497
			1.6932117	3.9237808

MPSD   70.033749

Hybrid Fractional Error Function (HYBRID)

150mg/l

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	0.197976608	0.0391947	0
10	0	0.238308065	0.0567907	0
15	0.01	0.26145754	0.0632309	5.2526023
25	0.2	0.314721225	0.013161	0.0076775
40	0.48	0.415636163	0.0041427	0.1208158
50	0.69	0.500308854	0.0359827	0.2945415
60	0.83	0.602230922	0.0518788	0.4205563
70	0.88	0.72491638	0.0240509	0.4666399
75	0.89	0.795335457	0.0089614	0.4759095
95	0.9	1.152391559	0.0637015	0.4851952
			0.3610953	7.5239381

HYBRID   94.049227

FOR THE MODIFIED NANOCELLULOSE ADSORBENTS

Sum of the Squares of the Errors (ERRSQ /SSE)

	MNFC			
t (min)	qexp	qcalc	error	
0	0	0.068759874	0.0047279	
20	0	0.099127653	0.0098263	
30	0	0.119021304	0.0141661	
40	0	0.142907355	0.0204225	SSE 0.19115
50	0.01	0.17158703	0.0261104	
60	0.11	0.206022349	0.0092203	
80	0.32	0.297012064	0.0005284	
96	0.52	0.397980593	0.0148887	
105	0.62	0.46919004	0.0227436	
122	0.81	0.640294213	0.0288001	
132	0.86	0.76879306	0.0083187	
138	0.88	0.857960672	0.0004857	
143	0.89	0.940117895	0.0025118	
150	0.9	1.068521424	0.0283995	
			0.19115	

Sum of Absolute Errors (EABS/SAE)

	MNFC				
t (min)	qexp	qcalc	error	qex-qca	
0	0	0.075491147	0.0056989	0.0754911	
20	0	0.107764024	0.0116131	0.107764	
30	0	0.12875458	0.0165777	0.1287546	
40	0	0.153833731	0.0236648	0.1538337	SAE 1.4684607
50	0.01	0.183797865	0.0302057	0.1737979	
60	0.11	0.21959849	0.0120118	0.1095985	
80	0.32	0.313478041	4.254E-05	0.006522	
96	0.52	0.416743989	0.0106618	0.103256	
105	0.62	0.48913568	0.0171255	0.1308643	
122	0.81	0.661942784	0.0219209	0.1480572	
132	0.86	0.790877717	0.0047779	0.0691223	
138	0.88	0.88	9.786E-21	9.892E-11	
143	0.89	0.961893779	0.0051687	0.0718938	
150	0.9	1.089505275	0.0359122	0.1895053	
			0.1953817	1.4684607	

Marquardt's Percent Standard Deviation (MPSD

t (min)	qexp	MNFC qcalc	error	qex-qca/qex
0	0	0.001435323	2.06E-06	0
20	0	0.003559018	1.267E-05	0
30	0	0.00560429	3.141E-05	0
40	0	0.008824924	7.788E-05	0
50	0.01	0.013896368	1.518E-05	0.1518169
60	0.11	0.021882235	0.0077647	0.6417141
80	0.32	0.054259077	0.0706182	0.6896312
96	0.52	0.112195898	0.1663042	0.6150303
105	0.62	0.168829488	0.2035548	0.5295391
122	0.81	0.36531871	0.1977414	0.3013892
132	0.86	0.575257483	0.0810783	0.1096245
138	0.88	0.755399152	0.0155254	0.0200483
143	0.89	0.947919971	0.0033547	0.0042352
150	0.9	1.30258156	0.1620719	0.2000888
			0.9081529	3.2631176

MPSD	57.123704

Hybrid Fractional Error Function (HYBRID)

t (min)	qexp	MNFC qcalc	error	qex-qca/qex
0	0	0.013210386	0.0001745	0
20	0	0.024072099	0.0005795	0
30	0	0.03249475	0.0010559	0
40	0	0.043864424	0.0019241	0
50	0.01	0.059212263	0.0024218	0.2421847
60	0.11	0.079930199	0.0009042	0.0082199
80	0.32	0.145649622	0.0303981	0.0949939
96	0.52	0.235390069	0.0810028	0.1557746
105	0.62	0.308359581	0.0971198	0.1566448
122	0.81	0.513530383	0.0878942	0.1085114
132	0.86	0.69321089	0.0278186	0.0323472

HYBRID	9.0091315

138	0.88	0.829936599	0.0025063	0.0028481
143	0.89	0.964260849	0.0055147	0.0061963
150	0.9	1.189608331	0.083873	0.0931922
			==0.4231875==	0.9009131

Sum of the Squares of the Errors (ERRSQ /SSE)

==MF+MNFC==

t (min)	qexp	qcalc	error
0	0	0.021233266	0.0004509
20	0	0.031878492	0.0010162
40	0	0.047860667	0.0022906
50	0	0.058643413	0.003439
60	0	0.071855452	0.0051632
70	0	0.088044092	0.0077518
80	0.01	0.107879943	0.0095805
100	0.09	0.16196519	0.005179
115	0.21	0.219675902	9.362E-05
130	0.36	0.297949837	0.0038502
140	0.46	0.365076301	0.0090105
165	0.72	0.606715184	0.0128334
180	0.88	0.822897225	0.0032607
185	0.89	0.910889808	0.0004364
190	0.9	1.008291456	0.011727
			0.0760832

==SSE   0.0760832==

Sum of Absolute Errors (EABS/SAE)

MF+MNFC

t (min)	qexp	qcalc	error	qex-qca
0	0	0.018936225	0.0003586	0.0189362
20	0	0.028775286	0.000828	0.0287753
40	0	0.043726618	0.001912	0.0437266
50	0	0.053902513	0.0029055	0.0539025
60	0	0.066446503	0.0044151	0.0664465
70	0	0.081909683	0.0067092	0.0819097
80	0.01	0.100971397	0.0082758	0.0909714

==SAE   0.9373712==

100	0.09	0.153435058	0.004024	0.0634351
115	0.21	0.209999993	4.508E-17	6.715E-09
130	0.36	0.287417997	0.0052681	0.072582
140	0.46	0.354304834	0.0111715	0.1056952
165	0.72	0.597771044	0.0149399	0.122229
180	0.88	0.818143627	0.0038262	0.0618564
185	0.89	0.908366504	0.0003373	0.0183665
190	0.9	1.008538939	0.0117807	0.1085389
			0.076752	0.9373712

Marquardt's Percent Standard Deviation (MPSD)

MF+MNFC

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	0.000560603	3.143E-07	0
20	0	0.00125768	1.582E-06	0
40	0	0.00282153	7.961E-06	0
50	0	0.00422612	1.786E-05	0
60	0	0.006329933	4.007E-05	0
70	0	0.009481047	8.989E-05	0
80	0.01	0.014200824	1.765E-05	0.1764692
100	0.09	0.031858694	0.0033804	0.4173347
115	0.21	0.058400129	0.0229825	0.5211456
130	0.36	0.107053196	0.0639821	0.4936889
140	0.46	0.16034553	0.0897928	0.4243516
165	0.72	0.440250555	0.0782598	0.150964
180	0.88	0.807022687	0.0053257	0.0068772
185	0.89	0.987675667	0.0095405	0.0120446
190	0.9	1.20876803	0.0953377	0.1177009
			0.3687768	2.3205767

MPSD   42.249959

Hybrid Fractional Error Function (HYBRID)

MF+MNFC

t (min)	qexp	qcalc	error	qex-qca/qex

					HYBRID	33.659241
0	0	0.021233266	0.0004509	0		
20	0	0.031878492	0.0010162	0		
40	0	0.047860667	0.0022906	0		
50	0	0.058643413	0.003439	0		
60	0	0.071855452	0.0051632	0		
70	0	0.088044092	0.0077518	0		
80	0.01	0.107879943	0.0095805	0.000218		
100	0.09	0.16196519	0.005179	0.0737603		
115	0.21	0.219675902	9.362E-05	0.193299		
130	0.36	0.297949837	0.0038502	0.3431549		
140	0.46	0.365076301	0.0090105	0.443111		
165	0.72	0.606715184	0.0128334	0.703054		
180	0.88	0.822897225	0.0032607	0.8630356		
185	0.89	0.910889808	0.0004364	0.8730347		
190	0.9	1.008291456	0.011727	0.8830338		
			0.0760832	4.3757013		

Summary of Wolborska model parameters for Co(II) ion adsorption

Wolborska parameters at BH=4cm

Error Func	β (min-1)	N0 (mg/L)	Objective function
SSE	0.155374	1402.726	0.2661
HYB	0.253892	1385.848	8.519
MPSD	0.394811	1389.972	50.66806
ARE	0.25367	1387.978	2.0676
SAE	0.158888	1436.394	1.7515
R2	0.1557	1402.73	0.8688

Wolborska parameters at BH= 8 cm

Error Func	β (min-1)	N0 (mg/L)	Objective function
SSE	0.1062	1054.909	0.2347
HYB	0.1681	1042.019	5.926738
MPSD	0.2537	1042.025	45.33836
ARE	0.1681	1042.019	2.7832
SAE	0.1075	1030.574	1.8548
R2	0.106189	1054.9094	0.9021

Wolborska parameters a BH= 12 cm

Error Func	β (min-1)	N0 (mg/L)	Objective function
SSE	0.124474	913.2434	0.077865
HYB	0.166309	903.6166	1.749393
MPSD	0.129848	894.7003	28.97037
ARE	0.12593	913.4037	0.7592
SAE	0.126437	914.3884	0.967337
R2	0.124474	913.243401	0.9721

Wolborska parameters at flow rate of 4 mL/min

Error Func	β (min-1)	N0 (mg/L)	Objective function
SSE	0.1098	1202.743	0.154803
HYB	0.1635	1185.024	4.1138
MPSD	0.2385	1178.177	83.34894
ARE	0.1635	1178.177	9.6103
SAE	0.1211	1199.702	1.446
R2	0.109853	1202.74344	0.9434

Wolborska parameters at flow rate of 12 mL/min

Error Func	β (min-1)	N0 (mg/L)	Objective function
SSE	0.162143	1224.539	0.3295
HYB	0.205101	1220.042	9.0313
MPSD	0.284404	1215.28	47.0224
ARE	0.2051	1220.042	3.3007
SAE	0.164367	1173.072	1.5345
R2	0.162143	1224.53928	0.732

Wolborska parameters at initial concentration of 50 mg/L

Error Func	β (min-1)	N0 (mg/L)	Objective function
SSE	0.174101	1271.435	0.2978
HYB	0.266397	1259.547	0.704105
MPSD	0.3949	1263.378	46.78045
ARE	0.1789	1259.547	0.9874
SAE	0.178295	1229.89	2.0248
R2	0.174101	1271.43495	0.8804

Wolborska parameters at initial concentration of 150 mg/L

Error Func	β (min-1)	N0 (mg/L)	Objective function
SSE	0.118796	950.8859	0.3604
HYB	0.116895	945.6749	94.04923
MPSD	0.373514	986.7805	70.03375
ARE	0.1171	945.6747	8.5613
SAE	0.107361	880.9867	1.6822
R2	0.116895	945.674889	0.7494

Wolborska parameters for C-MNFC
[at 4 cm, 12 mL/min and 100 mg/L]

Error Func	β (min-1)	N0 (mg/L)	Objective function
SSE	0.2899	1585.255	0.19115
HYB	0.4685	1561.827	9.009131
MPSD	0.709	1561.447	57.1237
ARE	0.709	1561.447	7.0673
SAE	0.2798	1572.333	1.468461
R2	0.28843	1583.86348	0.9066

Wolborska parameters for MF-MNFC
[at 4 cm, 12 mL/min and 100 mg/L]

Error Func	β (min-1)	N0 (mg/L)	Objective function
SSE	0.417192	2053.299	0.076083
HYB	0.417192	2053.299	33.65924
MPSD	0.81079	2006.874	42.24996
ARE	0.41719	2006.874	0.7957
SAE	0.429591	2053.299	0.937371
R2	0.417192	2053.2987	0.9606

β	0.1553735
N0	1402.7256

H	4
v	0.2887
C0	100
Q	8
n	15
p	2

β	0.1588881
N0	1436.394

H	4
v	0.2887
C0	100
Q	8
n	15
p	2

β	0.3948106
N0	1389.9719

H	4
v	0.2887
C0	100
Q	8
n	15
p	2

β	0.2538924
N0	1385.8478

H	4
v	0.2887
C0	100
Q	8
n	15
p	2

β	0.1061893
N0	1054.9094

H	8
v	0.2887
C0	100
Q	8
n	19
p	2

β	0.107527
N0	1030.5736

H	8
v	0.2887
C0	100
Q	8
n	19

p   2

β	0.2537263
N0	1042.0253

H	8
v	0.2887
C0	100
Q	8
n	19
p	2

β	0.1680613

N0	1042.0187

R^2	0.5184126

H	8
v	0.2887
C0	100
Q	8
n	19
p	2

β	0.1244737
N0	913.2434

H	12
v	0.2887
Q	8
C0	100
n	23
p	2

β	0.1264369
N0	914.38843
H	12
v	0.2887
Q	8
C0	100
n	23
p	2

β	0.219848
N0	894.70027

H	12
v	0.2887
Q	8
C0	100
n	23
p	2

β	0.1663088
N0	903.61658

| R^2 | 0.5934969 |

H	12

v	0.2887
Q	8
C0	100
n	23
p	2

β	0.1098534
N0	1202.7434

H	4
v	0.1443
Q	4
C0	100
n	18
p	2

β	0.121174
N0	1199.7016

R^2	0.8861247

H	4
v	0.1443
Q	4
C0	100
n	18
p	2

β	0.2385053
N0	1178.1769

H	4
v	0.1443
Q	4
C0	100
n	18
p	2

β	0.1635338
N0	1185.0236

R^2	0.521126

H	4
v	0.1443
Q	4
C0	100
n	18
p	2

β	0.162143
N0	1224.5393

v	0.4332
H	4
Q	12
C0	100
n	9
p	2

β	0.1643673
N0	1173.0719

v	0.4332
H	4
Q	12
C0	100
n	9
p	2

β	0.2844045
N0	1215.2803

v	0.4332
H	4
Q	12
C0	100
n	9
p	2

β	0.2051014
N0	1220.0422

v	0.4332
H	4
Q	12
C0	100
n	9
p	2

β	0.1741006
N0	1271.435

C0	50
H	4
v	0.2887
n	17
p	2
Q	8

β	0.1782946
N0	1229.89

C0	50
H	4
v	0.2887
n	17
p	2
Q	8

β	0.3949428
N0	1263.3783

C0	50
H	4
v	0.2887
n	17
p	2
Q	8

β	0.266397
N0	1259.5465

C0	50
H	4
v	0.2887
n	17
p	2
Q	8

β	0.1187957
N0	950.88593

H	4
C0	150
v	0.2887
n	10
p	2

β	0.1073609
N0	880.98667

H	4
C0	150
v	0.2887
n	10
p	2

β	0.3735143
N0	986.7805

H	4
C0	150
v	0.2887
n	10
p	2

β	0.1168951
N0	945.67489

H	4
C0	150
v	0.2887
n	10
p	2

β	0.2899337
N0	1585.255

v	0.4332
H	4
C0	100
n	14
p	2
Q	12

β	0.279819
N0	1572.3329

v	0.4332
H	4
C0	100
n	14
p	2
Q	12

β	0.7089714
N0	1561.4474

v	0.4332
H	4
C0	100
n	14
p	2
Q	12

β	0.4685872
N0	1561.8269

R^2	0.5302683

v	0.4332
H	4
C0	100
n	14
p	2
Q	12

β	0.4171918
N0	2053.2987

Q	12
H	4
n	
v	0.4332
p	2
C0	100

β	0.4295913
N0	2053.2987

Q	12
H	4

n
v   0.4332
p   2
C0   100

β   0.8107876
N0   2006.8743

Q   12
H   4
n
v   0.4332
p   2
C0   100

β	0.4171918
N0	2053.2987

Q	12
H	4
n	
v	0.4332
p	2
C0	100

)

BOHART-ADAMS PARAMETERS FOR Co(II) ION BASED ON ADSORPTION BED HEIGHT VARIATIONS

BH=4g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.11616678	0.013494721	0.176013156
10	0	0.129773697	0.016841212	0.176013156
15	0	0.137163652	0.018813867	0.176013156
20	0	0.144974427	0.021017585	0.176013156
25	0	0.153229987	0.023479429	0.176013156
40	0.01	0.180925946	0.029215679	0.167722372
70	0.24	0.252240623	0.000149833	0.032234331
92	0.43	0.321844007	0.011697719	0.000109428
110	0.56	0.392856491	0.027936953	0.019729231
130	0.7	0.490279105	0.043982854	0.07865825
160	0.85	0.683529971	0.027712271	0.185296484
180	0.88	0.853035319	0.000727094	0.212024131
190	0.89	0.952953565	0.003963151	0.221333347
200	0.9	1.064575494	0.027085093	0.230842562
		0.419539219	0.26611746	2.028015916

BH=8g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.052730955	0.002780554	0.117064748
20	0	0.064491075	0.004159099	0.117064748
30	0	0.071320865	0.005086666	0.117064748
40	0	0.07887395	0.0062211	0.117064748
50	0	0.087226929	0.007608537	0.117064748
60	0	0.096464512	0.009305402	0.117064748
70	0	0.106680382	0.011380704	0.117064748
80	0	0.117978142	0.013918842	0.117064748
115	0.01	0.167807364	0.024903164	0.110321802
140	0.08	0.215825865	0.018448666	0.068721186
170	0.3	0.291913688	6.53884E-05	0.001776392
195	0.49	0.375445526	0.013122727	0.021860433
210	0.6	0.436638894	0.026686851	0.066488035
230	0.71	0.534018617	0.030969447	0.135315638
250	0.8	0.653116081	0.021574886	0.209629131
270	0.85	0.798774803	0.002624021	0.257914405
285	0.87	0.928966047	0.003476995	0.278628515
300	0.9	1.08037699	0.032535858	0.311199679

		0.34214726	0.234868907	2.398373198

BH=12g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.005662753	3.20668E-05	0.092822357
20	0	0.007437301	5.53134E-05	0.092822357
30	0	0.008523329	7.26471E-05	0.092822357
40	0	0.009767943	9.54127E-05	0.092822357
50	0	0.011194301	0.000125312	0.092822357
60	0	0.012828943	0.000164582	0.092822357
80	0	0.016849174	0.000283895	0.092822357
100	0	0.022129234	0.000489703	0.092822357
140	0	0.038171733	0.001457081	0.092822357
180	0	0.065844179	0.004335456	0.092822357
230	0.02	0.130162766	0.012135835	0.081035652
255	0.08	0.183008584	0.010610768	0.050475538
280	0.21	0.257309697	0.002238207	0.008961958
293	0.3	0.307190791	5.17075E-05	2.17866E-05
300	0.35	0.337943351	0.000145363	0.002055025
315	0.49	0.414605177	0.005684379	0.034348092
337	0.68	0.559578796	0.014501266	0.140874398
354	0.8	0.705489963	0.008932147	0.24535417
362	0.84	0.786766647	0.00283379	0.28658076
370	0.87	0.877406893	5.48621E-05	0.319600703
375	0.89	0.939286284	0.002429138	0.342613998
380	0.9	1.005529737	0.011136525	0.354420646
		0.304667617	0.077865458	2.794566296

BOHART-ADAMS KINETIC MODEL PARAMETERS FOR Co(II) ION ADSORPTION BASED ON FLOW RATE VA

fr4ml/min

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.047589792	0.002264788	0.18379867
20	0	0.057127724	0.003263577	0.18379867
30	0	0.062591229	0.003917662	0.18379867
40	0	0.068577245	0.004702838	0.18379867
50	0	0.075135743	0.00564538	0.18379867
60	0	0.082321475	0.006776825	0.18379867
90	0	0.108271164	0.011722645	0.18379867

150	0.02	0.187288942	0.02798559	0.167049971
210	0.29	0.323974976	0.001154299	0.019242537
235	0.45	0.407078207	0.00184228	0.000452946
260	0.63	0.511498355	0.01404264	0.040514657
280	0.74	0.614012696	0.015872801	0.096896813
290	0.79	0.672734819	0.013751123	0.130525066
300	0.83	0.737072929	0.00863544	0.161027668
315	0.87	0.84529888	0.000610145	0.194730271
320	0.88	0.884796856	2.30098E-05	0.203655921
330	0.89	0.969415872	0.006306881	0.212781572
340	0.9	1.062127567	0.026285348	0.222107223
		0.42871747	0.154803273	2.735575331

fr12ml/min

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.223763968	0.050070313	0.266742836
10	0	0.255443967	0.06525162	0.266742836
20	0.08	0.291609149	0.044778432	0.190507392
30	0.32	0.332894517	0.000166269	0.03860106
48	0.62	0.422490097	0.039010162	0.010718145
60	0.74	0.495248454	0.059903319	0.049964979
85	0.86	0.689583509	0.02904178	0.118011813
100	0.89	0.841095115	0.002391688	0.139523521
120	0.9	1.096114952	0.038461074	0.147094091
		0.516471525	0.329074658	1.227906675

BOHART-ADAMS KINETIC PARAMETERS FOR Co(II) BASED ON INITIAL SOLUTE CONCENTRATION VARIA

BH=4g   50mg/l

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.089618087	0.008031402	0.140408494
10	0	0.095968813	0.009210013	0.140408494
22	0	0.104186504	0.010854828	0.140408494
30	0	0.110052275	0.012111503	0.140408494
41	0	0.118660705	0.014080363	0.140408494

50	0	0.126202492	0.015927069	0.140408494
60	0	0.135145747	0.018264373	0.140408494
80	0.01	0.15497844	0.021018748	0.13301427
100	0.05	0.17772159	0.016312805	0.105437372
155	0.26	0.25898802	1.0241E-06	0.013158663
210	0.54	0.377415005	0.026433881	0.027320383
240	0.66	0.46347095	0.038623667	0.081389691
280	0.79	0.609481217	0.032587031	0.172464776
300	0.83	0.698922835	0.017181223	0.207287879
320	0.86	0.801490048	0.003423414	0.235505206
340	0.88	0.919109041	0.001529517	0.255316757
370	0.9	1.128678869	0.052294025	0.275928309
		0.374711214	0.297884886	2.489682762

150mg/l

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.1979771	0.039194932	0.270742049
10	0	0.238308598	0.056790988	0.270742049
15	0.01	0.261458092	0.063231172	0.260435474
25	0.2	0.314721811	0.013161094	0.102610534
40	0.48	0.41563678	0.004142624	0.001626411
50	0.69	0.500309471	0.035982497	0.02878832
60	0.83	0.602231514	0.051878483	0.095896258
70	0.88	0.724916911	0.024050765	0.12936338
75	0.89	0.795335939	0.008961284	0.136656804
95	0.9	1.15239168	0.06370156	0.144150228
		0.52032879	0.361095399	1.441011506

BOHART-ADAMS KINETIC PARAMETERS Pb(II) ION ADSORPTION USING MNFC

MNFC

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.069721373	0.00486107	0.200965572
20	0	0.100355389	0.010071204	0.200965572
30	0	0.120400442	0.014496266	0.200965572

t (min)	qexp	qcalc	SSE	SSEA
40	0	0.144449308	0.020865603	0.200965572
50	0.01	0.17330171	0.026667449	0.192099735
60	0.11	0.207917111	0.009587761	0.114441367
80	0.32	0.299271251	0.000429681	0.016458796
96	0.52	0.400502114	0.014279745	0.005142061
105	0.62	0.471827726	0.021955023	0.029483693
122	0.81	0.643031147	0.027878598	0.130832795
132	0.86	0.771470623	0.007837451	0.169503611
138	0.88	0.860541508	0.000378633	0.186371937
143	0.89	0.942574129	0.002764039	0.195106101
150	0.9	1.070721895	0.029145966	0.204040264
		0.448291838	0.191218486	2.047342646

MNFC

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.06972182	0.004861132	0.200965234
20	0	0.100355909	0.010071308	0.200965234
30	0	0.120400992	0.014496399	0.200965234
40	0	0.144449879	0.020865767	0.200965234
50	0.01	0.173302288	0.026667637	0.192099405
60	0.11	0.207917676	0.009587871	0.114441113
80	0.32	0.299271696	0.000429663	0.016458699
96	0.52	0.400502314	0.014279697	0.005142114
105	0.62	0.471827701	0.02195503	0.029483822
122	0.81	0.643030439	0.027878834	0.130833067
132	0.86	0.771469298	0.007837685	0.169503921
138	0.88	0.860539712	0.000378703	0.186372262
143	0.89	0.94257187	0.002763802	0.195106433
150	0.9	1.070718868	0.029144932	0.204040604
		0.448291462	0.191218461	2.047342378

MF-MNFC

t (min)	qexp	qcalc	SSE	SSEA
0	0	0.017235106	0.000297049	0.077462075
20	0	0.026675012	0.000711556	0.077462075

40	0	0.041285285	0.001704475	0.077462075
50	0	0.051361845	0.002638039	0.077462075
60	0	0.063897807	0.00408293	0.077462075
70	0	0.079493439	0.006319207	0.077462075
80	0.01	0.09889552	0.007902413	0.071995673
100	0.09	0.153061965	0.003976811	0.035464458
115	0.21	0.212390596	5.71495E-06	0.004667635
130	0.36	0.294715707	0.004262039	0.006671607
140	0.46	0.366647405	0.008714707	0.033007588
165	0.72	0.632939134	0.007579594	0.195081139
180	0.88	0.878273842	2.97962E-06	0.362018709
185	0.9	0.979608657	0.006337538	0.386485905
		0.278320094	0.054535053	1.560165164

KBA	0.000110765
N0	701.1196538
R^2	0.868779403

C0	100
H	4
v	0.1443
n	14
p	2

KBA	0.000100662
N0	1054.909241
R^2	0.902071576

C0	100
H	8
v	0.2887
n	18
p	2

KBA	0.0001363
N0	913.24329
R^2	0.9721368

C0	100
H	12
v	0.2887
n	23
p	2

ARIATIONS

KBA	9.13356E-05
N0	2406.320405
R^2	0.943411073

C0	100
H	4

v	0.2887
n	18
p	2

KBA	0.000132411
N0	816.0767088
R^2	0.732003527

C0	100
H	4
v	0.2887
n	9
p	2

ATIONS

KBA	0.000136932
N0	1271.434942
R^2	0.880352272

1.2

1

0.8
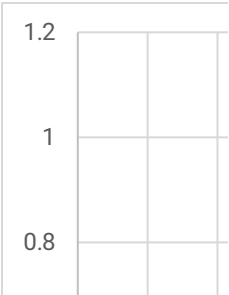
C0	50
H	4
v	0.2887
n	18
p	2
Q	8
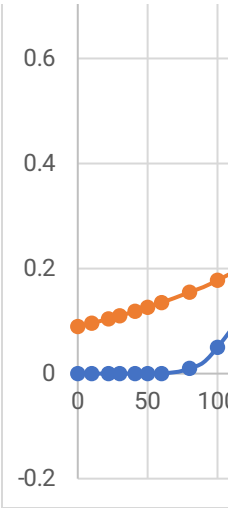
KBA	0.00012361
N0	945.674715

R^2	0.749415326

C0	150
H	4
v	0.2887
n	10
p	2
Q	8

KBA	0.000182105
N0	1055.542113

R^2   0.90660162

C0	100
H	4
v	0.2887
n	14
p	2

KBA   0.000182105
N0   1583.863143

R^2   0.90660162

C0	100
H	4
v	0.4332
n	17
p	2

KBA   0.000218389
N0   2013.766653

R^2	0.965045333
C0	100
H	4
v	0.4332
n	17
p	2
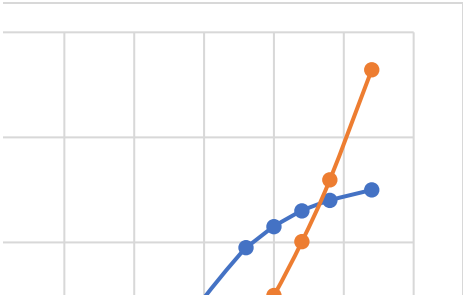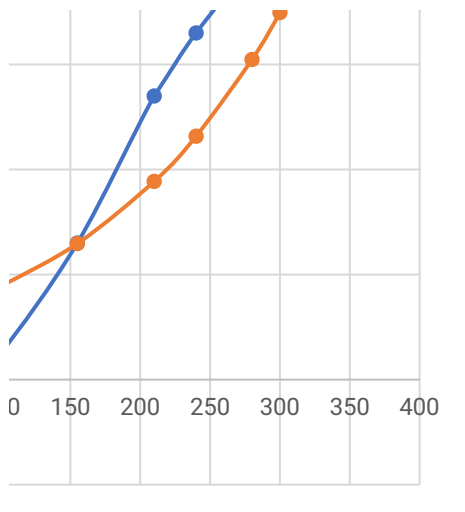
Sum of the Squares of the Errors (ERRSQ /SSE)

BH=4g

t (min)	qexp	qcalc	SSE
0	0	0.1161668	0.0134947
10	0	0.1297737	0.0168412
15	0	0.1371637	0.0188139
20	0	0.1449744	0.0210176
25	0	0.15323	0.0234794
40	0.01	0.1809259	0.0292157
70	0.24	0.2522406	0.0001498
92	0.43	0.321844	0.0116977
110	0.56	0.3928565	0.027937
130	0.7	0.4902791	0.0439829
160	0.85	0.68353	0.0277123
180	0.88	0.8530353	0.0007271
190	0.89	0.9529536	0.0039632
200	0.9	1.0645755	0.0270851
			0.2661175

SSE   0.2661175

Sum of Absolute Errors (EABS/SAE)

BH=4g

t (min)	qexp	qcalc	error	qex-qex
0	0	0.1113514	0.0123991	0.1113514
10	0	0.1242627	0.0154412	0.1242627
15	0	0.1312694	0.0172316	0.1312694
20	0	0.1386711	0.0192297	0.1386711
25	0	0.1464902	0.0214594	0.1464902
40	0.01	0.1726935	0.0264692	0.1626935
70	0.24	0.24	3.275E-20	1.81E-10
92	0.43	0.3055135	0.0154969	0.1244865
110	0.56	0.372213	0.035264	0.187787
130	0.7	0.463534	0.0559161	0.236466
160	0.85	0.6441942	0.042356	0.2058058
180	0.88	0.8022449	0.0060459	0.0777551
190	0.89	0.8952659	2.773E-05	0.0052659
200	0.9	0.9990727	0.0098154	0.0990727
			0.2771522	1.7513772

SAE   1.7513772

Hybrid Fractional Error Function (HYBRID)

BH=4g

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0296663	0.0008801	0		
10	0	0.035631	0.0012696	0		
15	0	0.0390491	0.0015248	0		
20	0	0.042795	0.0018314	0	HYBRID	9.2288934
25	0	0.0469003	0.0021996	0		
40	0.01	0.0617337	0.0026764	0.2676372		
70	0.24	0.1069586	0.0177	0.0737501		
92	0.43	0.1600507	0.0728726	0.1694712		
110	0.56	0.2225737	0.1138565	0.2033152		
130	0.7	0.3210724	0.1435861	0.2051231		
160	0.85	0.556284	0.0862691	0.101493		
180	0.88	0.8024642	0.0060118	0.0068316		
190	0.89	0.9638073	0.0054475	0.0061208		
200	0.9	1.1575899	0.0663526	0.0737251		
			0.5224781	1.1074672		

Marquardt's Percent Standard Deviation (MPSD

BH=4g

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0042105	1.773E-05	0		
10	0	0.0055936	3.129E-05	0		
15	0	0.0064472	4.157E-05	0		
20	0	0.007431	5.522E-05	0	MPSD	52.736992
25	0	0.008565	7.336E-05	0		
40	0.01	0.0131148	9.702E-06	0.0970223		
70	0.24	0.0307494	0.0437858	0.7601705		
92	0.43	0.0574412	0.1388	0.7506763		
110	0.56	0.0957785	0.2155016	0.6871864		
130	0.7	0.1690377	0.281921	0.575349		
160	0.85	0.39633	0.2058165	0.2848671		
180	0.88	0.6994757	0.032589	0.0420829		
190	0.89	0.9292455	0.0015402	0.0019445		
200	0.9	1.234492	0.1118849	0.1381295		
			1.032068	3.3374283		

BH=8g

t (min)	qexp	qcalc	error	qex-qca

0	0	0.0417991	0.0017472	0.0417991
20	0	0.0522486	0.0027299	0.0522486
30	0	0.0584156	0.0034124	0.0584156
40	0	0.0653104	0.0042655	0.0653104
50	0	0.0730191	0.0053318	0.0730191
60	0	0.0816376	0.0066647	0.0816376
70	0	0.0912733	0.0083308	0.0912733
80	0	0.1020464	0.0104135	0.1020464
115	0.01	0.1507946	0.0198231	0.1407946
140	0.08	0.1993058	0.0142339	0.1193058
170	0.3	0.278536	0.0004607	0.021464
195	0.49	0.3681423	0.0148493	0.1218577
210	0.6	0.4352075	0.0271566	0.1647925
230	0.71	0.5440062	0.0275539	0.1659938
250	0.8	0.6800039	0.0143991	0.1199961
270	0.85	0.8499999	3.017E-15	5.493E-08
285	0.87	1.0048461	0.0181835	0.1348461
300	0.9	1.1879008	0.0828869	0.2879008
			0.2624426	1.8427015

SAE   1.8427015

Marquardt's Percent Standard Deviation (MPSD

BH=8g

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	0.0008842	7.818E-07	0
20	0	0.0014389	2.07E-06	0
30	0	0.0018356	3.369E-06	0
40	0	0.0023417	5.483E-06	0
50	0	0.0029873	8.924E-06	0
60	0	0.0038109	1.452E-05	0
70	0	0.0048615	2.363E-05	0
80	0	0.0062018	3.846E-05	0
115	0.01	0.0145424	2.063E-05	0.2063312
140	0.08	0.0267304	0.0028377	0.4433835
170	0.3	0.0554943	0.059783	0.6642559
195	0.49	0.1020042	0.1505407	0.6269918
210	0.6	0.1469738	0.2052327	0.5700909
230	0.71	0.239186	0.2216659	0.439726
250	0.8	0.3892525	0.1687135	0.2636148
270	0.85	0.6334716	0.0468845	0.0648921
285	0.87	0.912744	0.001827	0.0024139
300	0.9	1.3151364	0.1723382	0.2127632
			1.0299412	3.4944632

MPSD   46.733709

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=8g

t (min)	qexp	qcalc	error		
0	0	0.052731	0.0027806		
20	0	0.0644911	0.0041591		
30	0	0.0713209	0.0050867		
40	0	0.078874	0.0062211	SSE	0.2348689
50	0	0.0872269	0.0076085		
60	0	0.0964645	0.0093054		
70	0	0.1066804	0.0113807		
80	0	0.1179781	0.0139188		
115	0.01	0.1678074	0.0249032		
140	0.08	0.2158259	0.0184487		
170	0.3	0.2919137	6.539E-05		
195	0.49	0.3754455	0.0131227		
210	0.6	0.4366389	0.0266869		
230	0.71	0.5340186	0.0309694		
250	0.8	0.6531161	0.0215749		
270	0.85	0.7987748	0.002624		
285	0.87	0.928966	0.003477		
300	0.9	1.080377	0.0325359		
			0.2348689		

Hybrid Fractional Error Function (HYBRID)

BH=8g

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0094945	9.015E-05	0		
20	0	0.0131088	0.0001718	0		
30	0	0.015403	0.0002373	0		
40	0	0.0180989	0.0003276	0	HYBRID	1.0075454
50	0	0.0212665	0.0004523	0		
60	0	0.0249885	0.0006244	0		
70	0	0.029362	0.0008621	0		
80	0	0.0345009	0.0011903	0		
115	0.01	0.0606719	0.0025676	0.256764		
140	0.08	0.0908029	0.0001167	0.0014588		

t			
170	0.3	0.1473106	0.023314	0.0777135
195	0.49	0.2204683	0.0726473	0.1482598
210	0.6	0.2808106	0.1018819	0.1698031
230	0.71	0.3877066	0.103873	0.1463
250	0.8	0.5352947	0.0700689	0.0875861
270	0.85	0.7390649	0.0123066	0.0144783
285	0.87	0.9413473	0.0050904	0.0058511
300	0.9	1.1989944	0.0893976	0.0993307
			0.4852201	1.0075454

check Turkey ournal

BH=12g			
t (min)	qexp	qcalc	error
0	0	0.0056375	3.178E-05
20	0	0.0074058	5.485E-05
30	0	0.0084881	7.205E-05
40	0	0.0097287	9.465E-05	SSE	0.0717284
50	0	0.0111506	0.0001243
60	0	0.0127802	0.0001633
80	0	0.0167889	0.0002819
100	0	0.0220549	0.0004864
140	0	0.0380603	0.0014486
180	0	0.0656808	0.004314
230	0.02	0.1299114	0.0120805
255	0.08	0.1827055	0.0105484
280	0.21	0.2569543	0.0022047
293	0.3	0.3068105	4.638E-05
300	0.35	0.337551	0.000155
315	0.49	0.4141923	0.0057468
337	0.68	0.559157	0.014603
354	0.8	0.7050902	0.0090079
362	0.84	0.7863901	0.002874
370	0.87	0.8770643	4.99E-05
375	0.89	0.9389713	0.0023982
380	0.9	1.0052479	0.0110771
	6.43	6.6978215	0.0778638

BH=12g			
t (min)	qexp	qcalc	error	qex-qca
0	0	0.0052193	2.724E-05	0.0052193
20	0	0.006882	4.736E-05	0.006882

t (min)	qexp	qcalc	SSE	qex-qca/qex		
30	0	0.0079026	6.245E-05	0.0079026		
40	0	0.0090744	8.235E-05	0.0090744	SAE	0.0311747
50	0	0.0104201	0.0001086	0.0104201		
60	0	0.0119653	0.0001432	0.0119653		
80	0	0.015777	0.0002489	0.015777		
100	0	0.0208031	0.0004328	0.0208031		
140	0	0.0361688	0.0013082	0.0361688		
180	0	0.062884	0.0039544	0.062884		
230	0.02	0.1255444	0.0111396	0.1055444		
255	0.08	0.1773886	0.0094845	0.0973886		
280	0.21	0.2506423	0.0016518	0.0406423		
293	0.3	0.3	1.446E-19	3.802E-10		
300	0.35	0.3304892	0.0003807	0.0195108		
315	0.49	0.4066628	0.0069451	0.0833372		
337	0.68	0.5512487	0.0165769	0.1287513		
354	0.8	0.6973246	0.0105422	0.1026754		
362	0.84	0.77889	0.0037344	0.06111		
370	0.87	0.869996	1.571E-11	3.963E-06		
375	0.89	0.9322727	0.001787	0.0422727		
380	0.9	0.9990074	0.0098025	0.0990074		
	6.43	6.6065635	0.0784602	0.967341		

BH=12g

t (min)	qexp	qcalc	SSE	qex-qca/qex		
0	0	0.0001075	1.155E-08	0		
20	0	0.0001757	3.087E-08	0		
30	0	0.0002247	5.047E-08	0		
40	0	0.0002872	8.25E-08	0	MPSD	1.9216595
50	0	0.0003672	1.349E-07	0		
60	0	0.0004695	2.205E-07	0		
80	0	0.0007675	5.891E-07	0		
100	0	0.0012546	1.574E-06	0		
140	0	0.0033526	1.124E-05	0		
180	0	0.0089588	8.026E-05	0		
230	0.02	0.0306076	0.0001125	0.2813053		
255	0.08	0.0565744	0.0005488	0.0857433		
280	0.21	0.1045708	0.0111153	0.2520479		
293	0.3	0.1439267	0.0243589	0.270654		

300	0.35	0.1709396	0.0320626	0.2617356
315	0.49	0.2471252	0.0589882	0.2456817
337	0.68	0.424319	0.0653728	0.1413771
354	0.8	0.6443322	0.0242324	0.0378632
362	0.84	0.784301	0.0031024	0.0043968
370	0.87	0.9546753	0.0071699	0.0094727
375	0.89	1.0794778	0.0359019	0.0453249
380	0.9	1.2205956	0.1027815	0.1268908
	6.43	5.8774108	0.3658413	1.7624933

BH=12g

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.000995	9.901E-07	0		
20	0	0.0014378	2.067E-06	0		
30	0	0.0017284	2.987E-06	0		
40	0	0.0020776	4.316E-06	0	HYBRID	0.0721327
50	0	0.0024974	6.237E-06	0		
60	0	0.0030021	9.013E-06	0		
80	0	0.004338	1.882E-05	0		
100	0	0.0062683	3.929E-05	0		
140	0	0.0130881	0.0001713	0		
180	0	0.0273275	0.0007468	0		
230	0.02	0.068589	0.0023609	0.1180447		
255	0.08	0.1086632	0.0008216	0.0102697		
280	0.21	0.1721512	0.0014325	0.0068216		
293	0.3	0.2186858	0.006612	0.02204		
300	0.35	0.2487552	0.0102505	0.0292871		
315	0.49	0.3278452	0.0262942	0.0536616		
337	0.68	0.4914929	0.0355349	0.0522573		
354	0.8	0.6720476	0.0163718	0.0204648		
362	0.84	0.7786547	0.0037632	0.0044801		
370	0.87	0.9021729	0.0010351	0.0011898		
375	0.89	0.9891344	0.0098276	0.0110423		
380	0.9	1.0844782	0.0340322	0.0378136		
	6.43	6.1254305	0.1493384	0.3673725		

	fr4ml/min		
t (min)	qexp	qcalc	error
0	0	0.0475898	0.0022648
20	0	0.0571277	0.0032636
30	0	0.0625912	0.0039177
40	0	0.0685772	0.0047028
50	0	0.0751357	0.0056454
60	0	0.0823215	0.0067768
90	0	0.1082712	0.0117226
150	0.02	0.1872889	0.0279856
210	0.29	0.323975	0.0011543
235	0.45	0.4070782	0.0018423
260	0.63	0.5114984	0.0140426
280	0.74	0.6140127	0.0158728
290	0.79	0.6727348	0.0137511
300	0.83	0.7370729	0.0086354
315	0.87	0.8452989	0.0006101
320	0.88	0.8847969	2.301E-05
330	0.89	0.9694159	0.0063069
340	0.9	1.0621276	0.0262853
			0.1548033

SSE   0.1548033

	fr4ml/min			
t (min)	qexp	qcalc	error	qex-qca
0	0	0.0346719	0.0012021	0.0346719
20	0	0.0424451	0.0018016	0.0424451
30	0	0.0469626	0.0022055	0.0469626
40	0	0.0519609	0.0026999	0.0519609
50	0	0.0574912	0.0033052	0.0574912
60	0	0.0636101	0.0040462	0.0636101
90	0	0.086159	0.0074234	0.086159
150	0.02	0.15807	0.0190633	0.13807
210	0.29	0.2900001	7.385E-15	8.594E-08
235	0.45	0.3734308	0.0058628	0.0765692
260	0.63	0.4808638	0.0222416	0.1491362
280	0.74	0.5886696	0.0229009	0.1513304
290	0.79	0.651323	0.0192313	0.138677
300	0.83	0.7206447	0.0119586	0.1093553
315	0.87	0.8387033	0.0009795	0.0312967

SAE   1.4460376

320	0.88	0.8822075	4.873E-06	0.0022075
330	0.89	0.9761028	0.0074137	0.0861028
340	0.9	1.0799915	0.0323969	0.1799915
			0.1647376	1.4460376

fr4ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0475898	0.0022648	0		
20	0	0.0571277	0.0032636	0		
30	0	0.0625912	0.0039177	0		
40	0	0.0685772	0.0047028	0	MPSD	170.44129
50	0	0.0751357	0.0056454	0		
60	0	0.0823215	0.0067768	0		
90	0	0.1082712	0.0117226	0		
150	0.02	0.1872889	0.0279856	42.768036		
210	0.29	0.323975	0.0011543	0.0193782		
235	0.45	0.4070782	0.0018423	0.0895239		
260	0.63	0.5114984	0.0140426	0.2296379		
280	0.74	0.6140127	0.0158728	0.3471631		
290	0.79	0.6727348	0.0137511	0.4085836		
300	0.83	0.7370729	0.0086354	0.46132		
315	0.87	0.8452989	0.0006101	0.5172565		
320	0.88	0.8847969	2.301E-05	0.5317406		
330	0.89	0.9694159	0.0063069	0.5464247		
340	0.9	1.0621276	0.0262853	0.5613088		
			0.1548033	46.480374		

fr4ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0475898	0.0022648	0		
20	0	0.0571277	0.0032636	0		
30	0	0.0625912	0.0039177	0		
40	0	0.0685772	0.0047028	0	HYBRID	34.151279

50	0	0.0751357	0.0056454	0
60	0	0.0823215	0.0067768	0
90	0	0.1082712	0.0117226	0
150	0.02	0.1872889	0.0279856	0.8553607
210	0.29	0.323975	0.0011543	0.0668212
235	0.45	0.4070782	0.0018423	0.198942
260	0.63	0.5114984	0.0140426	0.3645045
280	0.74	0.6140127	0.0158728	0.4691393
290	0.79	0.6727348	0.0137511	0.5171944
300	0.83	0.7370729	0.0086354	0.5558073
315	0.87	0.8452989	0.0006101	0.5945477
320	0.88	0.8847969	2.301E-05	0.6042507
330	0.89	0.9694159	0.0063069	0.6139603
340	0.9	1.0621276	0.0262853	0.6236764
			0.1548033	5.4642046

Sum of the Squares of the Errors (ERRSQ /SSE)

fr12ml/min

t (min)	qexp	qcalc	error		
0	0	0.223764	0.0500703		
10	0	0.255444	0.0652516		
20	0.08	0.2916091	0.0447784	SSE	0.3290747
30	0.32	0.3328945	0.0001663		
48	0.62	0.4224901	0.0390102		
60	0.74	0.4952485	0.0599033		
85	0.86	0.6895835	0.0290418		
100	0.89	0.8410951	0.0023917		
120	0.9	1.096115	0.0384611		
			0.3290747		

Sum of Absolute Errors (EABS/SAE)

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca		
0	0	0.2305366	0.0531471	0.2305366		
10	0	0.263879	0.0696321	0.263879		
20	0.08	0.3020438	0.0493034	0.2220438	SAE	1.5421136

30	0.32	0.3457283	0.0006619	0.0257283
48	0.62	0.4408917	0.0320798	0.1791083
60	0.74	0.5184775	0.0490722	0.2215225
85	0.86	0.7267624	0.0177522	0.1332376
100	0.89	0.89	4.195E-22	2.048E-11
120	0.9	1.1660577	0.0707867	0.2660577
			0.3424356	1.5421136

Marquardt's Percent Standard Deviation (MPSD)

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0723617	0.0052362	0		
10	0	0.0914416	0.0083616	0		
20	0.08	0.1155524	0.001264	0.1974956	MPSD	47.052239
30	0.32	0.1460206	0.0302688	0.2955941		
48	0.62	0.222514	0.1579951	0.4110174		
60	0.74	0.2946589	0.1983287	0.362178		
85	0.86	0.5289413	0.1095998	0.148188		
100	0.89	0.7513811	0.0192152	0.0242586		
120	0.9	1.1998601	0.0899161	0.1110075		
			0.6201855	1.5497392		

Hybrid Fractional Error Function (HYBRID)

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.223764	0.0500703	0		
10	0	0.255444	0.0652516	0		
20	0.08	0.2916091	0.0447784	0.0771481	HYBRID	62.71287
30	0.32	0.3328945	0.0001663	0.3171287		
48	0.62	0.4224901	0.0390102	0.6171255		
60	0.74	0.4952485	0.0599033	0.737125		
85	0.86	0.6895835	0.0290418	0.8571246		
100	0.89	0.8410951	0.0023917	0.8871245		

| | 120 | 0.9 | 1.096115 | 0.0384611 | 0.8971245 |
| | | | | 0.3290747 | 4.3899009 |

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=4g   50mg/l

t (min)	qexp	qcalc	error
0	0	0.0896181	0.0080314
10	0	0.0959688	0.00921
22	0	0.1041865	0.0108548
30	0	0.1100523	0.0121115
41	0	0.1186607	0.0140804
50	0	0.1262025	0.0159271
60	0	0.1351457	0.0182644
80	0.01	0.1549784	0.0210187
100	0.05	0.1777216	0.0163128
155	0.26	0.258988	1.024E-06
210	0.54	0.377415	0.0264339
240	0.66	0.4634709	0.0386237
280	0.79	0.6094812	0.032587
300	0.83	0.6989228	0.0171812
320	0.86	0.80149	0.0034234
340	0.88	0.919109	0.0015295
370	0.9	1.1286789	0.052294
			0.2978849

SSE   0.2978849

Sum of Absolute Errors (EABS/SAE)

BH=4g   50mg/l

t (min)	qexp	qcalc	error	qex-qca
0	0	0.0762847	0.0058194	0.0762847
10	0	0.0822838	0.0067706	0.0822838
22	0	0.0901086	0.0081196	0.0901086
30	0	0.0957344	0.0091651	0.0957344
41	0	0.1040477	0.0108259	0.1040477
50	0	0.1113837	0.0124063	0.1113837
60	0	0.1201431	0.0144344	0.1201431
80	0.01	0.1397824	0.0168435	0.1297824
100	0.05	0.1626321	0.012686	0.1126321
155	0.26	0.2466206	0.000179	0.0133794
210	0.54	0.3739834	0.0275615	0.1660166

SAE   2.0142461

240	0.66	0.4693351	0.0363531	0.1906649
280	0.79	0.6353173	0.0239267	0.1546827
300	0.83	0.7391703	0.00825	0.0908297
320	0.86	0.8599997	9.136E-14	3.023E-07
340	0.88	1.0005807	0.0145397	0.1205807
370	0.9	1.2556912	0.1265162	0.3556912
			0.334397	2.0142461

Marquardt's Percent Standard Deviation (MPSD)

BH=4g   50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.0042027	1.766E-05	0			
10	0	0.0049138	2.414E-05	0			
22	0	0.0059275	3.514E-05	0			
30	0	0.006717	4.512E-05	0		MPSD	45.294977
41	0	0.0079772	6.363E-05	0			
50	0	0.0091821	8.431E-05	0			
60	0	0.0107355	0.0001153	0			
80	0.01	0.0146753	2.186E-05	0.2185886			
100	0.05	0.020061	0.0008963	0.3585374			
155	0.26	0.0473919	0.0452022	0.6686715			
210	0.54	0.1119583	0.1832197	0.6283255			
240	0.66	0.178938	0.2314206	0.5312687			
280	0.79	0.334373	0.207596	0.3326326			
300	0.83	0.4570834	0.1390668	0.2018679			
320	0.86	0.6248269	0.0553064	0.0747788			
340	0.88	0.8541301	0.0006693	0.0008642			
370	0.9	1.3651188	0.2163355	0.2670809			
			1.0801199	3.282616			

Hybrid Fractional Error Function (HYBRID)

BH=4g   50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0.0249471	0.0006224	0			
10	0	0.0277299	0.0007689	0			
22	0	0.0314819	0.0009911	0			
30	0	0.0342612	0.0011738	0		HYBRID	2.5070098

41	0	0.0384877	0.0014813	0
50	0	0.0423308	0.0017919	0
60	0	0.0470527	0.002214	0
80	0.01	0.0581351	0.002317	0.2316991
100	0.05	0.0718279	0.0004765	0.0095291
155	0.26	0.128497	0.017293	0.0665117
210	0.54	0.2298756	0.0961771	0.1781058
240	0.66	0.3157	0.1185425	0.1796098
280	0.79	0.4819296	0.0949074	0.1201359
300	0.83	0.5954401	0.0550183	0.0662872
320	0.86	0.7356861	0.0154539	0.0179697
340	0.88	0.9089648	0.000839	0.0009534
370	0.9	1.2483283	0.1213326	0.134814
			==0.5314007==	1.0056157

Sum of the Squares of the Errors (ERRSQ /SSE)

150mg/l

t (min)	qexp	qcalc	error		
0	0	0.1979771	0.0391949		
10	0	0.2383086	0.056791		
15	0.01	0.2614581	0.0632312		
25	0.2	0.3147218	0.0131611	==SSE==	==0.3610954==
40	0.48	0.4156368	0.0041426		
50	0.69	0.5003095	0.0359825		
60	0.83	0.6022315	0.0518785		
70	0.88	0.7249169	0.0240508		
75	0.89	0.7953359	0.0089613		
95	0.9	1.1523917	0.0637016		
			==0.3610954==		

Sum of Absolute Errors (EABS/SAE)

150mg/l

t (min)	qexp	qcalc	error	qex-qca
0	0	0.1979771	0.0391949	0.1979771
10	0	0.2383086	0.056791	0.2383086
15	0.01	0.2614581	0.0632312	0.2514581
25	0.2	0.3147218	0.0131611	0.1147218
40	0.48	0.4156368	0.0041426	0.0643632
50	0.69	0.5003095	0.0359825	0.1896905
60	0.83	0.6022315	0.0518785	0.2277685
70	0.88	0.7249169	0.0240508	0.1550831
75	0.89	0.7953359	0.0089613	0.0946641
95	0.9	1.1523917	0.0637016	0.2523917
			0.3610954	1.7864267

SAE   1.7864267

Marquardt's Percent Standard Deviation (MPSD)

150mg/l

t (min)	qexp	qcalc	error	qex-qca/qex
0	0	0.0056555	3.199E-05	0
10	0	0.0099783	9.957E-05	0
15	0.01	0.013254	1.059E-05	0.1058876
25	0.2	0.0233846	0.031193	0.7798246
40	0.48	0.054803	0.1807924	0.7846894
50	0.69	0.0966913	0.3520152	0.7393725
60	0.83	0.1705964	0.4348131	0.6311701
70	0.88	0.3009904	0.3352522	0.4329186
75	0.89	0.399801	0.240295	0.3033645
95	0.9	1.2445408	0.1187083	0.1465535
			1.6932114	3.9237808

MPSD   70.033749

Hybrid Fractional Error Function (HYBRID)

150mg/l

t (min)	qexp	qcalc	error	qex-qcq/qex
0	0	0.0402754	0.0016221	0
10	0	0.0578979	0.0033522	0

15	0.01	0.0694184	0.0035305	0.353054	==HYBRID==	==19.329727==
25	0.2	0.0997924	0.0100416	0.0502078		
40	0.48	0.1720015	0.0948631	0.1976314		
50	0.69	0.2472608	0.196018	0.284084		
60	0.83	0.35545	0.2251977	0.2713226		
70	0.88	0.5109773	0.1361777	0.1547474		
75	0.89	0.6126511	0.0769224	0.0864297		
95	0.9	1.2660753	0.1340111	0.1489012		
			==0.8817364==	1.5463782		

Sum of the Squares of the Errors (ERRSQ /SSE)

==MNFC==

t (min)	qexp	qcalc	error		
0	0	0.0697214	0.0048611		
20	0	0.1003554	0.0100712		
30	0	0.1204004	0.0144963		
40	0	0.1444493	0.0208656	==SSE==	==0.1912185==
50	0.01	0.1733017	0.0266674		
60	0.11	0.2079171	0.0095878		
80	0.32	0.2992713	0.0004297		
96	0.52	0.4005021	0.0142797		
105	0.62	0.4718277	0.021955		
122	0.81	0.6430311	0.0278786		
132	0.86	0.7714706	0.0078375		
138	0.88	0.8605415	0.0003786		
143	0.89	0.9425741	0.002764		
150	0.9	1.0707219	0.029146		
			==0.1912185==		

Sum of Absolute Errors (EABS/SAE)

MNFC

t (min)	qexp	qcalc	error	qex-qca	
0	0	0.0732651	0.0053678	0.0732651	
20	0	0.105041	0.0110336	0.105041	
30	0	0.1257737	0.015819	0.1257737	
40	0	0.1505985	0.0226799	0.1505985	==SAE== ==1.4685278==
50	0.01	0.1803231	0.02901	0.1703231	
60	0.11	0.2159147	0.0112179	0.1059147	
80	0.32	0.3095594	0.000109	0.0104406	
96	0.52	0.412965	0.0114565	0.107035	

t (min)	qexp	qcalc	error	qex-qca/qex
105	0.62	0.4856473	0.0180506	0.1343527
122	0.81	0.6596497	0.0226052	0.1503503
132	0.86	0.7898492	0.0049211	0.0701508
138	0.88	0.88	9.184E-20	3.031E-10
143	0.89	0.9629375	0.0053199	0.0729375
150	0.9	1.0923446	0.0369964	0.1923446
			0.194587	1.4685278

Marquardt's Percent Standard Deviation (MPSD)

t (min)	qexp	MNFC qcalc	error	qex-qca/qex		
0	0	0.0014353	2.06E-06	0		
20	0	0.003559	1.267E-05	0		
30	0	0.0056043	3.141E-05	0		
40	0	0.0088249	7.788E-05	0	MPSD	52.146569
50	0.01	0.0138964	1.518E-05	0.1518168		
60	0.11	0.0218822	0.0077647	0.6417142		
80	0.32	0.054259	0.0706183	0.6896314		
96	0.52	0.1121958	0.1663043	0.6150306		
105	0.62	0.1688293	0.203555	0.5295395		
122	0.81	0.3653182	0.1977419	0.3013898		
132	0.86	0.5752566	0.0810788	0.1096252		
138	0.88	0.755398	0.0155257	0.0200486		
143	0.89	0.9479184	0.0033545	0.004235		
150	0.9	1.3025793	0.1620701	0.2000865		
			0.9081524	3.2631176		

Hybrid Fractional Error Function (HYBRID)

t (min)	qexp	MNFC qcalc	error	qex-qca/qex		
0	0	0.0132104	0.0001745			
20	0	0.0240722	0.0005795			
30	0	0.0324949	0.0010559			
40	0	0.0438646	0.0019241		HYBRID	7.5076096
50	0.01	0.0592125	0.0024219	0.2421867		
60	0.11	0.0799305	0.0009042	0.0082198		
80	0.32	0.14565	0.0303979	0.0949935		
96	0.52	0.2353906	0.0810025	0.1557741		
105	0.62	0.3083602	0.0971194	0.1566442		
122	0.81	0.5135312	0.0878938	0.1085108		

132	0.86 0.6932117	0.0278183	0.0323469
138	0.88 0.8299375	0.0025063	0.002848
143	0.89 0.9642617	0.0055148	0.0061964
150	0.9 1.1896092	0.0838735	0.0931928
		0.4231865	0.9009131

Sum of the Squares of the Errors (ERRSQ /SSE)

MF-MNFC

t (min)	qexp	qcalc	error
0	0	0.0172351	0.000297
20	0	0.026675	0.0007116
40	0	0.0412853	0.0017045
50	0	0.0513618	0.002638
60	0	0.0638978	0.0040829
70	0	0.0794934	0.0063192
80	0.01	0.0988955	0.0079024
100	0.09	0.153062	0.0039768
115	0.21	0.2123906	5.715E-06
130	0.36	0.2947157	0.004262
140	0.46	0.3666474	0.0087147
165	0.72	0.6329391	0.0075796
180	0.88	0.8782738	2.98E-06
185	0.9	0.9796087	0.0063375
			0.0545351

SSE	0.0545351

Sum of Absolute Errors (EABS/SAE)

MF-MNFC

t (min)	qexp	qcalc	error	qex-qca
0	0	0.0172588	0.0002979	0.0172588
20	0	0.0267134	0.0007136	0.0267134
40	0	0.0413474	0.0017096	0.0413474
50	0	0.0514408	0.0026462	0.0514408
60	0	0.0639982	0.0040958	0.0639982
70	0	0.0796209	0.0063395	0.0796209
80	0.01	0.0990574	0.0079312	0.0890574
100	0.09	0.1533225	0.0040097	0.0633225
115	0.21	0.2127627	7.632E-06	0.0027627
130	0.36	0.2952466	0.004193	0.0647534
140	0.46	0.3673199	0.0085896	0.0926801
165	0.72	0.6341522	0.0073698	0.0858478
180	0.88	0.8800005	2.653E-13	5.151E-07

SAE	0.7603546

| 185 | 0.9 | 0.9815507 | 0.0066505 | 0.0815507 |
| | | | ==0.0545541== | 0.7603546 |

Marquardt's Percent Standard Deviation (MPSD

MF-MNFC

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0004804	2.308E-07	0		
20	0	0.001118	1.25E-06	0		
40	0	0.0026018	6.769E-06	0		
50	0	0.0039691	1.575E-05	0		
60	0	0.0060551	3.666E-05	0	==MPSD==	==37.416042==
70	0	0.0092372	8.533E-05	0		
80	0.01	0.0140918	1.674E-05	0.1674259		
100	0.09	0.0327954	0.0032724	0.4039956		
115	0.21	0.0617944	0.0219649	0.4980706		
130	0.36	0.1164352	0.0593238	0.4577453		
140	0.46	0.1776267	0.0797347	0.376818		
165	0.72	0.5105845	0.0438549	0.0845966		
180	0.88	0.9620625	0.0067342	0.0086961		
185	0.9	1.1882701	0.0830996	0.1025921		
			==0.2981472==	2.0999403		

Hybrid Fractional Error Function (HYBRID)

MF-MNFC

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0.0172351	0.000297	0		
20	0	0.026675	0.0007116	0		
40	0	0.0412853	0.0017045	0		
50	0	0.0513618	0.002638	0	==HYBRID==	==31.387765==
60	0	0.0638978	0.0040829	0		
70	0	0.0794934	0.0063192	0		
80	0.01	0.0988955	0.0079024	2.8018958		
100	0.09	0.153062	0.0039768	0.0848531		
115	0.21	0.2123906	5.715E-06	0.0050643		
130	0.36	0.2947157	0.004262	0.0926303		
140	0.46	0.3666474	0.0087147	0.1736286		

165	0.72	0.6329391	0.0075796	0.4089265
180	0.88	0.8782738	2.98E-06	0.5609804
185	0.9	0.9796087	0.0063375	0.5801857
			==0.0545351==	4.7081647

Summary of Bohart-Adams model parameters for Co (II) ion adsorption

 Bohart-Adams parameter at Bed height of 4 cm.

Error Func	K_{BA}(L/(m	N_0 (mg/L)	Objective function
SSE	0.000111	701.1197	0.2661
HYB	0.000183	692.6839	9.2289
MPSD	0.000284	694.745	52.73699
ARE	0.00011	692.864	13.184
SAE	0.00011	721.8051	1.7514

 Bohart-Adams parameter at Bed height of 8 cm.

Error Func	K_{BA}(L/(m	N_0 (mg/L)	Objective function
SSE	0.000101	1054.909	0.2348
HYB	0.000161	1042.018	1.0075
MPSD	0.000243	1042.025	46.73371
ARE	0.000161	1042.018	3.0075
SAE	0.000112	1026.93	1.842702

 Bohart-Adams parameter at Bed height of 12 cm.

Error Func	K_{BA}(L/(m	N_0 (mg/L)	Objective function
SSE	0.000136	913.2935	0.0778
HYB	0.000184	903.6156	1.7493
MPSD	0.000246	894.6997	28.97037
ARE	0.000184	903.6156	70,837
SAE	0.000138	914.3895	0.9673

 Bohart-Adams parameter at flow rate of 4 mL/min

Error Func	K_{BA}(L/(m	N_0 (mg/L)	Objective function
SSE	9.13E - 05	2406.32	0.154803
HYB	9.13E - 05	2406.32	34.1518
MPSD	9.13E - 05	2406.32	170.4413

Error Func	KBA(L/(m	N0 (mg/L)	Objective function	
ARE	9.13E-05	2406.32	7.0408	
SAE	0.000101	2399.035	1.446038	

Bohart-Adams parameter at flow rate of 12 mL/min

Error Func	KBA(L/(m	N0 (mg/L)	Objective function	
SSE	0.000132	816.0767	0.3291	1111
HYB	0.000132	816.0767	92.71287	
MPSD	0.000234	809.9063	47.05224	
ARE	0.000132	816.0767	1.7008	
SAE	0.000135	784.015	1.5421	

Bohart-Adams parameter at 50mg/L initial adsorbent concentration

Error Func	KBA(L/(m	N0 (mg/L)	Objective function
SSE	0.000137	1271.435	0.2978
HYB	0.000212	1259.547	2.507
MPSD	0.000313	1263.378	45.29498
ARE	0.000212	1259.547	0.7831
SAE	0.000151	1226.698	2.0142
R2	0.000137	1271.435	0.8804

Bohart-Adams parameter at 150mg/L initial adsorbent concentration

Error Func	KBA(L/(m	N0 (mg/L)	Objective function
SSE	0.000124	945.6747	0.361095
HYB	0.000242	958.1201	19.32973
MPSD	0.000379	986.7798	70.03375
ARE	0.000242	958.1201	3.9003
SAE	0.000124	945.6747	1.786427
	0.000124	945.6747	0.7494

Bohart-Adams parameter for C-MNFC

Error Func	KBA(L/(m	N0 (mg/L)	Objective function
SSE	0.0002	1055.54	0.1912
HYB	0.0003	1040.86	7.5076
MPSD	0.0004	1040.61	52.1466
ARE	0.0002	1040.86	0.9641

SAE	0.0002	1047.24	1.4685
R2	0.0002	1055.542	0.9066

Bohart-Adams parameter for MF-MNFC

Error Func	KBA(L/(m)	N0 (mg/L)	Objective function
SSE	0.000218	2013.767	0.054535
HYB	0.000218	2013.767	31.38776
MPSD	0.000422	1959.317	37.41604
ARE	0.000218	2013.767	3.0516
SAE	0.000218	2012.783	0.760355
	0.0002184	2013.7667	0.965

KBA	0.0001108
N0	701.11965

C0	100
H	4
v	0.1443
n	14
p	2

KBA	0.0001097
N0	721.80507

R^2	0.8417518

C0	100
H	4
v	0.1443
n	14
p	2

KBA	0.0001832
N0	692.68393

C0	100
H	4
v	0.1443
n	14
p	2

KBA	0.000284
N0	694.74499

C0	100
H	4
v	0.1443
n	14
p	2

KBA	0.0001116
N0	1026.9301

C0	100
H	8
v	0.2887
n	18
p	2

KBA	0.0002435
N0	1042.025

C0	100
H	8
v	0.2887
n	18
p	2

KBA	0.0001007
N0	1054.9092

C0	100
H	8
v	0.2887
n	18
p	2

KBA	0.0001613
N0	1042.018

C0	100
H	8
v	0.2887
n	18
p	2

KBA	0.0001364
N0	913.29353

C0	100
H	12
v	0.2887
n	23
p	2

KBA	0.0001383
N0	914.38946

R^2	0.9188909
C0	100
H	12
v	0.2887
n	23
p	2

KBA	0.0002457
N0	894.69972

C0	100
H	12
v	0.2887
n	23
p	2

KBA	0.000184
N0	903.6156
C0	100
H	12
v	0.2887
n	23
p	2

KBA	9.134E-05
N0	2406.3204

C0	100
H	4
v	0.2887
n	18
p	2

KBA	0.0001011
N0	2399.0354

R^2	0.8860766

C0	100
H	4
v	0.2887
n	18
p	2

KBA	9.134E-05
N0	2406.3204

C0	100
H	4
v	0.2887
n	18
p	2

C0	100
H	4
v	0.2887
n	18
p	2

KBA	0.0001324
N0	816.07671

C0	100
H	4
v	0.2887
n	9
p	2

KBA	0.0001351
N0	784.01498

R^2	0.777944

C0	100
H	4
v	0.2887
n	9
p	2

C0	100
H	4
v	0.2887
n	9
p	2

C0	100
H	4
v	0.2887
n	9

p | 2

| KBA | 0.0001369 |
| N0 | 1271.4349 |

R^2 | #DIV/0!

C0	50
H	4
v	0.2887
n	18
p	2
Q	8

| KBA | 0.0001514 |
| N0 | 1226.6983 |

C0	50
H	4
v	0.2887
n	18
p	2

| Q | 8 |

C0	50
H	4
v	0.2887
n	18
p	2
Q	8

C0	50
H	4
v	0.2887
n	18
p	2
Q	8

KBA	0.0001236
N0	945.67472

C0	150
H	4
v	0.2887
n	10
p	2
Q	8

KBA	0.0001236
N0	945.67472

C0	150
H	4
v	0.2887
n	10
p	2
Q	8

KBA	0.0003785
N0	986.77984

C0	150
H	4
v	0.2887
n	10
p	2
Q	8

KBA	0.000242
N0	958.12005

R^2	0.4298055
C0	150
H	4
v	0.2887
n	10
p	2
Q	8

KBA	0.0001821
N0	1055.5421

C0	100
H	4
v	0.2887
n	14
p	2

KBA	0.0001801
N0	1047.2348

C0	100
H	4
v	0.2887

n	14
p	2

KBA	0.000454
N0	1040.6047

C0	100
H	4
v	0.2887
n	14
p	2

KBA	0.0003
N0	1040.8572

C0	100
H	4
v	0.2887
n	14
p	2

KBA	0.0002184
N0	2013.7667

C0	100
H	4
v	0.4332
n	17
p	2

KBA	0.0002184
N0	2012.7831

C0	100
H	4
v	0.4332
n	17
p	2

KBA	0.0004223
N0	1959.3174

C0	100
H	4
v	0.4332
n	17
p	2

KBA	0.0002184
N0	2013.7667

C0	100
H	4
v	0.4332
n	17
p	2

for

NFC

DOSE-RESPONSE MODEL PARAMETERS FOR Co(II) ION BASED ON ADSORPTION BED HEIGHT VARIATI(

BH=4g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.1542895
10	0	0.0003815	1.455E-07	0.1542895
15	0	0.0015173	2.302E-06	0.1542895
20	0	0.004034	1.627E-05	0.1542895
25	0	0.00859	7.379E-05	0.1542895
40	0.01	0.0412153	0.0009744	0.1465335
70	0.24	0.2244706	0.0002412	0.0233469
92	0.43	0.4234875	4.241E-05	0.0013841
110	0.56	0.5745579	0.0002119	0.0279568
130	0.7	0.7046954	2.205E-05	0.0943737
160	0.85	0.828829	0.0004482	0.2090346
180	0.88	0.8785459	2.115E-06	0.2373668
190	0.89	0.8968756	4.727E-05	0.2472108
200	0.9	0.9119579	0.000143	0.2572549
		0.392797	0.002225	2.0159095

BH=8g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.1001266
20	0	1.386E-06	1.921E-12	0.1001266
30	0	1.506E-05	2.268E-10	0.1001266
40	0	8.183E-05	6.696E-09	0.1001266
50	0	0.0003041	9.246E-08	0.1001266
60	0	0.0008884	7.892E-07	0.1001266
70	0	0.0021974	4.829E-06	0.1001266
80	0	0.0048081	2.312E-05	0.1001266
115	0.01	0.0392613	0.0008562	0.093898
140	0.08	0.1150561	0.0012289	0.0558981
170	0.3	0.2895082	0.0001101	0.0002699
195	0.49	0.4773801	0.0001593	0.0301273
210	0.6	0.5855206	0.0002097	0.0804132
230	0.71	0.7069707	9.176E-06	0.154899
250	0.8	0.7975898	5.809E-06	0.233842
270	0.85	0.8610578	0.0001223	0.2846992

t (min)	qexp	qcalc	SSE	SSEA
285	0.87	0.8949388	0.0006219	0.3064421
300	0.9	0.9201216	0.0004049	0.3405565
		0.3164278	0.0037571	2.382058

BH=12g

t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.0851798
20	0	7.994E-15	6.39E-29	0.0851798
30	0	9.63E-13	9.274E-25	0.0851798
40	0	2.84E-11	8.068E-22	0.0851798
50	0	3.919E-10	1.536E-19	0.0851798
60	0	3.346E-09	1.12E-17	0.0851798
80	0	9.864E-08	9.729E-15	0.0851798
100	0	1.361E-06	1.852E-12	0.0851798
140	0	7.121E-05	5.072E-09	0.0851798
180	0	0.0013669	1.868E-06	0.0851798
230	0.02	0.0238753	1.502E-05	0.0739056
255	0.08	0.0760607	1.552E-05	0.0448829
280	0.21	0.19828	0.0001374	0.0067004
293	0.3	0.2966517	1.121E-05	6.633E-05
300	0.35	0.3576453	5.845E-05	0.0033807
315	0.49	0.4970654	4.992E-05	0.0392611
337	0.68	0.6861765	3.815E-05	0.1506559
354	0.8	0.7959464	1.643E-05	0.2582105
362	0.84	0.8353452	2.167E-05	0.300462
370	0.87	0.8677366	5.123E-06	0.3342507
375	0.89	0.8848285	2.674E-05	0.3577764
380	0.9	0.8997779	4.934E-08	0.3698393
		0.2918559	0.0003975	2.7911902

DOSE-RESPONSE MODEL PARAMETERS FOR C0(II) ION ADSORPTION AT DIFFERENT FLOW RATES

fr4ml/min

t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.1649985
20	0	3.289E-08	1.082E-15	0.1649985
30	0	5.453E-07	2.973E-13	0.1649985
40	0	3.999E-06	1.599E-11	0.1649985
50	0	1.876E-05	3.518E-10	0.1649985
60	0	6.63E-05	4.396E-09	0.1649985
90	0	0.0010982	1.206E-06	0.1649985
150	0.02	0.0364362	0.0002701	0.1491505
210	0.29	0.2799542	0.0001009	0.0135025
235	0.45	0.4586761	7.527E-05	0.0019184
260	0.63	0.6305348	2.86E-07	0.0500864
280	0.74	0.7403482	1.212E-07	0.1114224
290	0.79	0.7842859	3.265E-05	0.1473024
300	0.83	0.8213645	7.457E-05	0.1796064
315	0.87	0.8657087	1.842E-05	0.2151104
320	0.88	0.8778911	4.447E-06	0.2244864
330	0.89	0.8989609	8.03E-05	0.2340624
340	0.9	0.916253	0.0002642	0.2438384
		0.4062001	0.0009225	2.7254759

	fr12ml/min			
t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.2508597
10	0	0.0230248	0.0005301	0.2508597
20	0.08	0.1284351	0.002346	0.1771223
30	0.32	0.3009842	0.0003616	0.03271
48	0.62	0.5987615	0.0004511	0.0141946
60	0.74	0.7291688	0.0001173	0.0571884
85	0.86	0.8711882	0.0001252	0.1289823
100	0.89	0.9122391	0.0004946	0.1514307
120	0.9	0.9439291	0.0019298	0.1593135
		0.500859	0.0063556	1.2226613

DOSE-RESPONSE KINETIC MODEL PARAMETERS FOR VARIOUS INITIAL SOLUTE CONCENTRATIONS

BH=4g   50mg/l

t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.1173529
10	0	6.556E-06	4.299E-11	0.1173529
22	0	0.0001497	2.24E-08	0.1173529
30	0	0.0005121	2.623E-07	0.1173529
41	0	0.0017664	3.12E-06	0.1173529
50	0	0.0038735	1.5E-05	0.1173529
60	0	0.007952	6.323E-05	0.1173529
80	0.01	0.024483	0.0002098	0.1106015
100	0.05	0.0573416	5.39E-05	0.0855961
155	0.26	0.2571332	8.219E-06	0.0068175
210	0.54	0.5359187	1.666E-05	0.0389794
240	0.66	0.6623316	5.437E-06	0.100763
280	0.79	0.7833485	4.424E-05	0.2001953
300	0.83	0.8262117	1.435E-05	0.2375899
320	0.86	0.8599731	7.217E-10	0.2677358
340	0.88	0.8865115	4.24E-05	0.2888331
370	0.9	0.9161438	0.0002606	0.3107304
		0.3425681	0.0007372	2.4693121

150mg/l

t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.2428231
10	0	0.0098462	9.695E-05	0.2428231
15	0.01	0.0371889	0.0007392	0.2330677
25	0.2	0.1759094	0.0005804	0.0857147
40	0.48	0.5071513	0.0007372	0.0001631
50	0.69	0.6846839	2.826E-05	0.0388994
60	0.83	0.7998794	0.0009073	0.1137235
70	0.88	0.8700525	9.895E-05	0.1499464
75	0.89	0.8940046	1.604E-05	0.157791
95	0.9	0.9489919	0.0024002	0.1658356

0.4927708 0.0056044 1.4307876

DOSE-RESPONSE MODEL PARAMETERS FOR Co(II) ADSORPTION WITH MODIFIED NANOADSORBENT T\

MF-MNFC

t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.06637
20	0	9.017E-07	8.131E-13	0.06637
40	0	0.0001254	1.574E-08	0.06637
50	0	0.0006142	3.772E-07	0.06637
60	0	0.0022459	5.044E-06	0.06637
70	0	0.0067008	4.49E-05	0.06637
80	0.01	0.0171576	5.123E-05	0.0613175
100	0.09	0.0787726	0.0001261	0.0280977
115	0.21	0.1878589	0.0004902	0.002268
130	0.36	0.3564037	1.293E-05	0.0104809
140	0.46	0.4841726	0.0005843	0.0409562
165	0.72	0.751489	0.0009916	0.2137919
180	0.88	0.8489159	0.0009662	0.3873523
185	0.9	0.8722738	0.0007687	0.4126474
		0.2576237	0.0040416	1.5551315

MNFC

t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.1805177
20	0	0.0003889	1.512E-07	0.1805177
30	0	0.0030391	9.236E-06	0.1805177
40	0	0.012965	0.0001681	0.1805177
50	0.01	0.0391864	0.0008518	0.1721202
60	0.11	0.0933226	0.0002781	0.0991455
80	0.32	0.3072442	0.0001627	0.0109985
96	0.52	0.5281434	6.632E-05	0.009049
105	0.62	0.6382308	0.0003324	0.0380742

122	0.81	0.7907774	0.0003695	0.1483222
132	0.86	0.8493642	0.0001131	0.1893348
138	0.88	0.8760261	1.579E-05	0.2071399
143	0.89	0.8943566	1.898E-05	0.2163424
150	0.9	0.9151878	0.0002307	0.2257449
		0.4248738	0.0026169	2.0383426

$$q = 1 - [\frac{1}{1 + (\frac{CoQt}{q0m})^\wedge \alpha}$$

t (min)	qexp	qcalc	SSE	SSEA
0	0	0	0	0.0707603
20	0	1.336E-06	1.786E-12	0.0707603
40	0	0.0001607	2.584E-08	0.0707603
50	0	0.0007509	5.638E-07	0.0707603
60	0	0.002642	6.98E-06	0.0707603
70	0	0.0076276	5.818E-05	0.0707603
80	0.01	0.0189737	8.053E-05	0.0655402
100	0.09	0.0829061	5.032E-05	0.0309789
115	0.21	0.1919066	0.0003274	0.0031369
130	0.36	0.3565387	1.198E-05	0.0088345
140	0.46	0.480437	0.0004177	0.0376328
165	0.72	0.7421422	0.0004903	0.2061086
180	0.88	0.8400271	0.0015978	0.376986
185	0.9	1	0.01	0.4019457
		0.2660081	0.0130417	1.5557255

α	3.407796
q0	20143.28

R^2	0.998896

m	4
Q	8
C0	100
v	0.2887
n	14
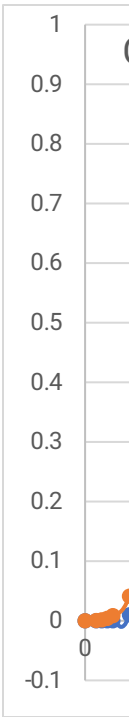
α	5.88357
q0	19802.4

R^2	0.998423

m	8
Q	8
C0	100
v	0.2887
n	18
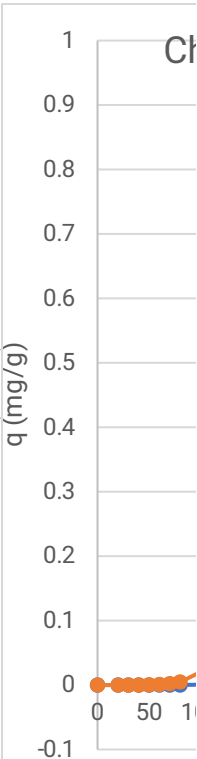
α	11.7618
q0	21020.97
R^2	0.999858

m	12
Q	8
C0	100
v	0.2887
n	23

Ch
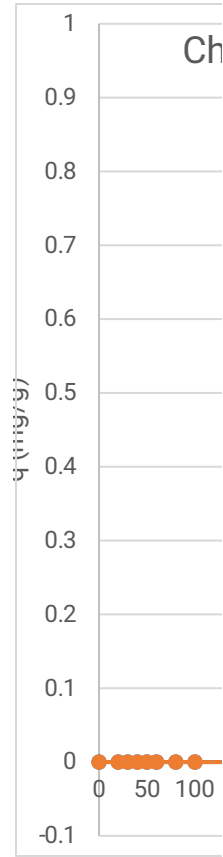
α	6.925938
q0	24068.91

R^2	0.999662

m	4
Q	4
C0	100
v	0.1443
n	18

Chart
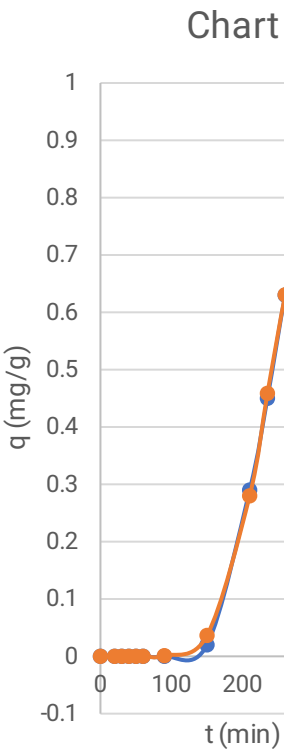
α	2.644496
q0	12377.18

R^2	0.994802

m	4
Q	12
C0	100
v	0.4332
n	9

Chart
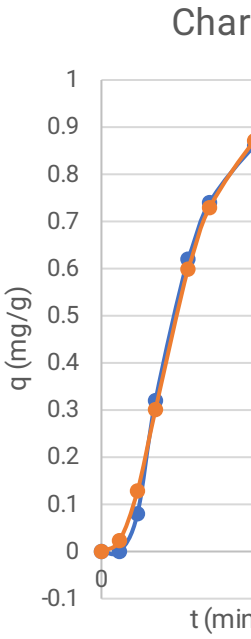
α	3.967452
q0	20251.86

R^2	0.999701

m	4
Q	8
C0	50
v	0.2887
n	17
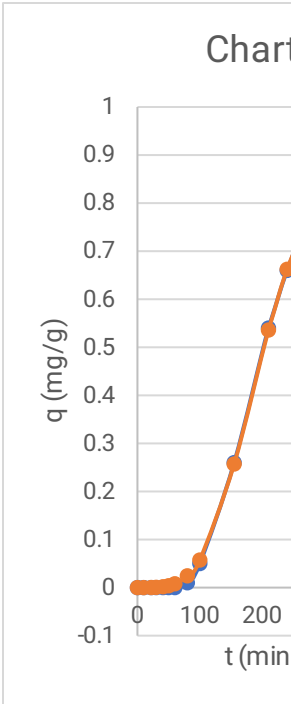
α	3.34661
q0	11897.86

R^2	0.996083

m	4
Q	8
C0	150
v	0.2887
n	10
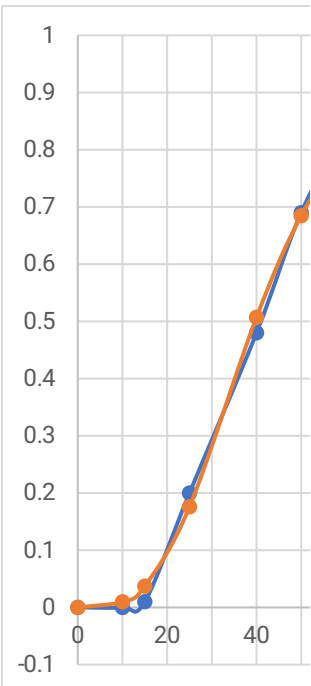
YPES

α	7.120381
q0	42375.23

R^2	0.997401

m	4
Q	12
C0	100
v	0.4332
n	14

Chart T
q (mg/g) vs t (m

α	5.077443
q0	28167.83

R^2	0.998716

m	4
Q	12
C0	100

Cha
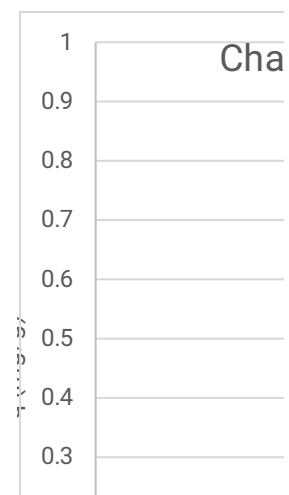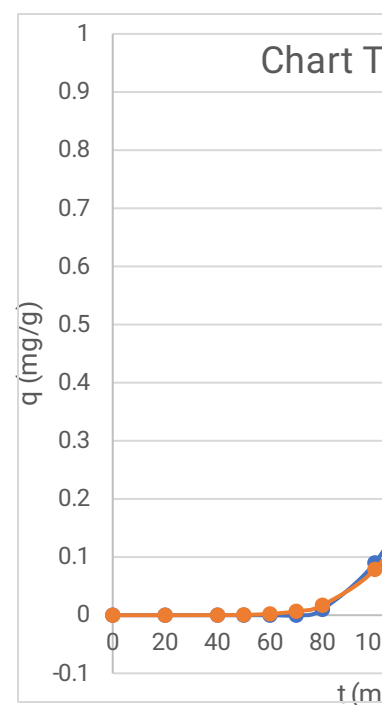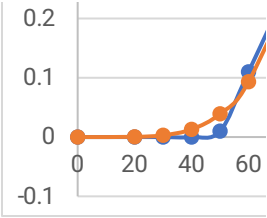
v	0.4332
n	14

α	6.910552
q0	42478.54

R^2	0.991617

m	4
Q	12
C0	100
v	0.4332
n	14

Chart Title

Chart Title

t (min)

Chart Title

qexp

qcalc

150 200 250 300 350 400

Title

qexp

qcalc

t Title

qexp

qcalc

300 400

140

)

t Title

qexp
qcalc

300   400
)

60   80   100

Title

qexp
qcalc

0 120 140 160 180 200

in)

rt Title

qexp
qcalc

80 100 120 140 160

t (min)

120 140 160 180 200
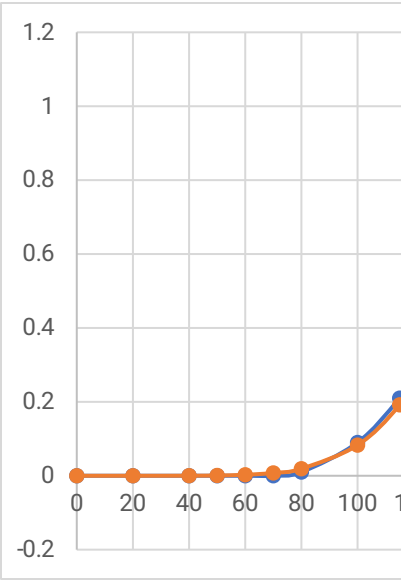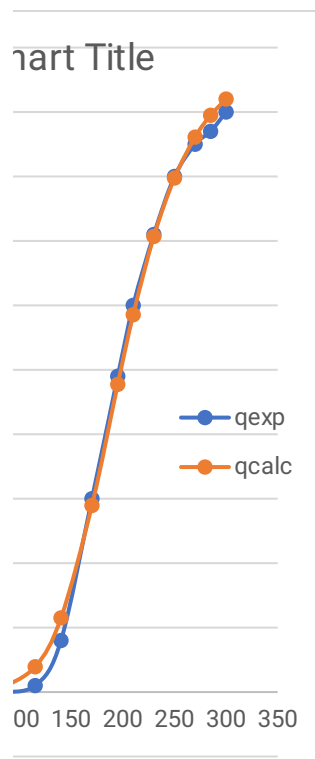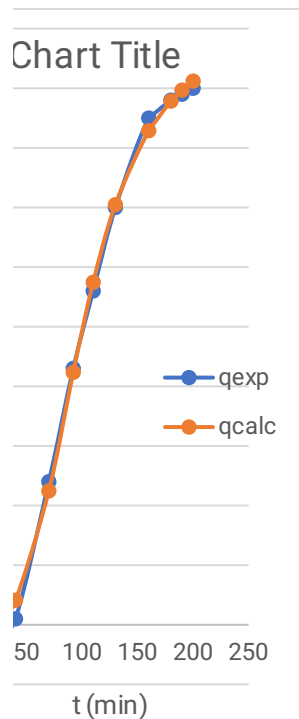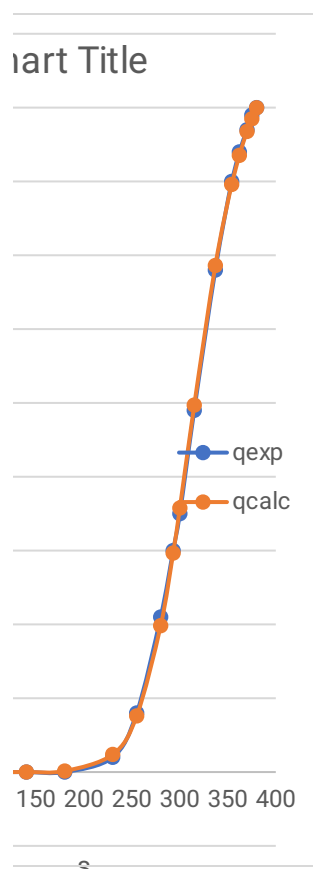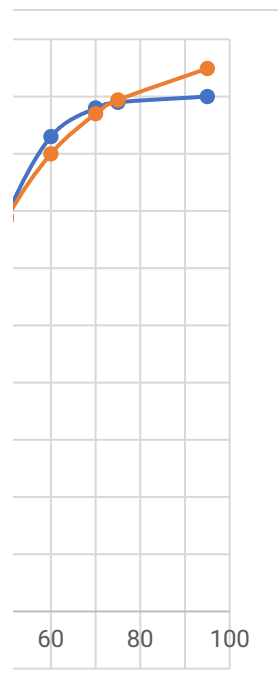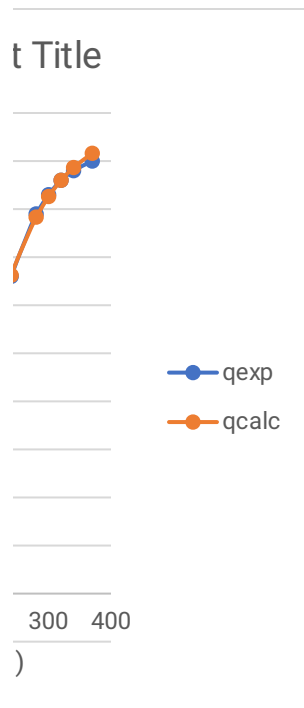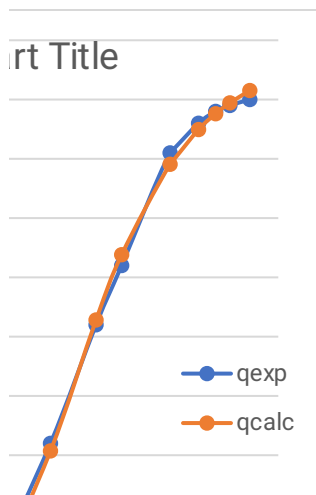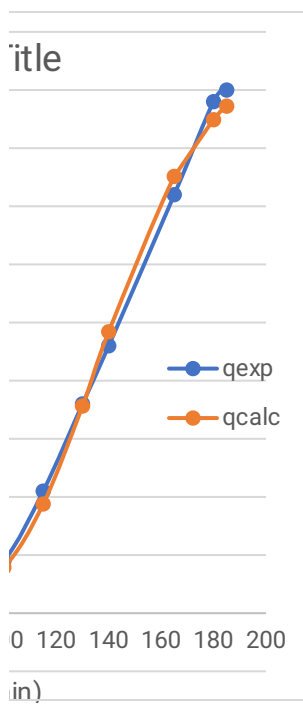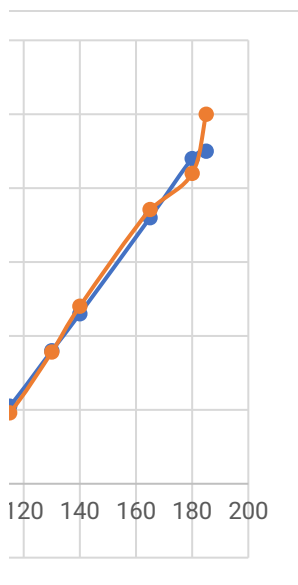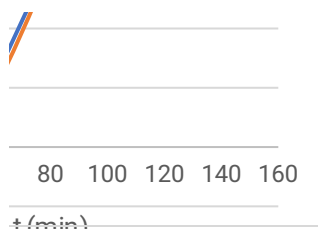
DOSE-RESPONSE MODEL ERRORS

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=4g

t (min)	qexp	qcalc	error			
0	0	0	0			
10	0	0.0003815	1.455E-07			
15	0	0.0015173	2.302E-06			
20	0	0.004034	1.627E-05			
25	0	0.00859	7.379E-05		SSE	0.002225
40	0.01	0.0412153	0.0009744			
70	0.24	0.2244706	0.0002412			
92	0.43	0.4234875	4.241E-05			
110	0.56	0.5745579	0.0002119			
130	0.7	0.7046954	2.205E-05			
160	0.85	0.828829	0.0004482			
180	0.88	0.8785459	2.115E-06			
190	0.89	0.8968756	4.727E-05			
200	0.9	0.9119579	0.000143			
			0.002225			

Sum of Absolute Errors (EABS/SAE)

BH=4g

t (min)	qexp	qcalc	error	qex-qca		
0	0	0	0	0		
10	0	0.0005301	2.81E-07	0.0005301		
15	0	0.0019943	3.977E-06	0.0019943		
20	0	0.0050954	2.596E-05	0.0050954	SAE	0.1171355
25	0	0.0105158	0.0001106	0.0105158		
40	0.01	0.0471243	0.0013782	0.0371243		
70	0.24	0.2357858	1.776E-05	0.0042142		
92	0.43	0.43	3.044E-20	1.745E-10		
110	0.56	0.575111	0.0002283	0.015111		
130	0.7	0.7004095	1.677E-07	0.0004095		
160	0.85	0.8217921	0.0007957	0.0282079		
180	0.88	0.8714523	7.306E-05	0.0085477		
190	0.89	0.89	1.071E-15	3.273E-08		
200	0.9	0.9053851	2.9E-05	0.0053851		
			0.002663	0.1171355		

Marquardt's Percent Standard Deviation (MPSD)

BH=4g

t (min)	qexp	qcalc	error	SSEA			
0	0	0	0	0			
10	0	1.067E-05	1.139E-10	0			
15	0	8.135E-05	6.617E-09	0			
20	0	0.0003436	1.181E-07	0		MPSD	1.1221098
25	0	0.0010501	1.103E-06	0			
40	0.01	0.0109492	9.009E-07	0.0090089			
70	0.24	0.1544347	0.0073214	0.1271079			
92	0.43	0.4179385	0.0001455	0.0007868			
110	0.56	0.6373471	0.0059826	0.0190771			
130	0.7	0.8022921	0.0104637	0.0213545			
160	0.85	0.9198859	0.004884	0.0067599	0.001510956		
180	0.88	0.9539464	0.0054681	0.007061			
190	0.89	0.9644849	0.005548	0.0070042			
200	0.9	0.9723093	0.0052286	0.0064551			
		5.46		0.045044	0.2046154		

Hybrid Fractional Error Function (HYBRID)

BH=4g

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0	0	0			
10	0	8.02E-05	6.432E-09	0			
15	0	0.0004171	1.74E-07	0			
20	0	0.0013429	1.803E-06	0			
25	0	0.0033216	1.103E-05	0		HYBRID	0.3194241
40	0.01	0.0220465	0.0001451	0.0145118			
70	0.24	0.1800302	0.0035964	0.0149849			
92	0.43	0.4002179	0.000887	0.0020627			
110	0.56	0.5798722	0.0003949	0.0007052			
130	0.7	0.7313966	0.0009857	0.0014082			
160	0.85	0.8636882	0.0001874	0.0002204			
180	0.88	0.9109536	0.0009581	0.0010888			
190	0.89	0.9272535	0.0013878	0.0015593			
200	0.9	0.9401318	0.0016106	0.0017895			
			0.010166	0.0383309			

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=8g

t (min)	qexp	qcalc	error

0	0	0	0
20	0	1.386E-06	1.921E-12
30	0	1.506E-05	2.268E-10
40	0	8.183E-05	6.695E-09
50	0	0.0003041	9.246E-08
60	0	0.0008883	7.892E-07
70	0	0.0021973	4.828E-06
80	0	0.0048079	2.312E-05
115	0.01	0.0392601	0.0008562
140	0.08	0.1150525	0.0012287
170	0.3	0.2895003	0.0001102
195	0.49	0.47737	0.0001595
210	0.6	0.5855105	0.0002099
230	0.71	0.7069619	9.23E-06
250	0.8	0.7975827	5.843E-06
270	0.85	0.8610524	0.0001222
285	0.87	0.8949345	0.0006217
300	0.9	0.9201181	0.0004047
			0.0037571

SSE 0.0037571

Sum of Absolute Errors (EABS/SAE)

BH=8g

t (min)	qexp	qcalc	error	qex-qca
0	0	0	0	0
20	0	1.861E-06	3.465E-12	1.861E-06
30	0	1.931E-05	3.728E-10	1.931E-05
40	0	0.0001015	1.031E-08	0.0001015
50	0	0.0003677	1.352E-07	0.0003677
60	0	0.0010522	1.107E-06	0.0010522
70	0	0.0025566	6.536E-06	0.0025566
80	0	0.0055076	3.033E-05	0.0055076
115	0.01	0.04301	0.0010897	0.03301
140	0.08	0.122662	0.00182	0.042662
170	0.3	0.3000003	1.166E-13	3.415E-07
195	0.49	0.4860716	1.543E-05	0.0039284
210	0.6	0.5919012	6.559E-05	0.0080988
230	0.71	0.7102674	7.151E-08	0.0002674
250	0.8	0.7986286	1.881E-06	0.0013714
270	0.85	0.8607777	0.0001162	0.0107777
285	0.87	0.8941357	0.0005825	0.0241357
300	0.9	0.9190591	0.0003632	0.0190591
			0.0040927	0.1529176

SAE 0.1529176

Marquardt's Percent Standard Deviation (MPSD)

BH=8g

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0	0	0			
20	0	3.942E-09	1.554E-17	0			
30	0	1.247E-07	1.555E-14	0			
40	0	1.446E-06	2.091E-12	0			
50	0	9.676E-06	9.362E-11	0			
60	0	4.573E-05	2.091E-09	0		MPSD	1.0048216
70	0	0.00017	2.89E-08	0			
80	0	0.00053	2.809E-07	0			
115	0.01	0.0115366	2.361E-06	0.0236129			
140	0.08	0.058695	0.0004539	0.0709223			
170	0.3	0.245833	0.0029341	0.0326007			
195	0.49	0.5119502	0.0004818	0.0020067			
210	0.6	0.6635403	0.0040374	0.0112149			
230	0.71	0.810624	0.0101252	0.0200857	0.001615466		
250	0.8	0.897004	0.0094098	0.0147028			
270	0.85	0.9437458	0.0087883	0.0121637			
285	0.87	0.9637557	0.0087901	0.0116133			
300	0.9	0.9762818	0.0058189	0.0071838			
		5.61		0.0508421	0.2061069		

Hybrid Fractional Error Function (HYBRID)

BH=8g

t (min)	qexp	qcalc	error	qex-qca/qca			
0	0	0	0	0			
20	0	9.735E-08	9.476E-15	0			
30	0	1.684E-06	2.834E-12	0			
40	0	1.272E-05	1.618E-10	0			
50	0	6.106E-05	3.728E-09	0			
60	0	0.0002199	4.838E-08	0		HYBRID	0.20303
70	0	0.0006498	4.222E-07	0			
80	0	0.0016595	2.754E-06	0			
115	0.01	0.0208694	0.0001181	0.0118143			
140	0.08	0.0783095	2.858E-06	3.572E-05			
170	0.3	0.2496173	0.0025384	0.0084614			
195	0.49	0.4660145	0.0005753	0.0011741			

210	0.6	0.595034	2.466E-05	4.11E-05
230	0.71	0.7358157	0.0006665	0.0009387
250	0.8	0.8334797	0.0011209	0.0014011
270	0.85	0.8958104	0.0020986	0.0024689
285	0.87	0.9263276	0.0031728	0.0036469
300	0.9	0.9474587	0.0022523	0.0025026
			0.0125737	0.0324848

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=12g

t (min)	qexp	qcalc	err0r		
0	0	0	0		
20	0	7.994E-15	6.39E-29		
30	0	9.63E-13	9.274E-25		
40	0	2.84E-11	8.068E-22		
50	0	3.919E-10	1.536E-19		
60	0	3.346E-09	1.12E-17		
80	0	9.864E-08	9.729E-15	SSE	0.0003975
100	0	1.361E-06	1.852E-12		
140	0	7.121E-05	5.072E-09		
180	0	0.0013669	1.868E-06		
230	0.02	0.0238753	1.502E-05		
255	0.08	0.0760607	1.552E-05		
280	0.21	0.19828	0.0001374		
293	0.3	0.2966517	1.121E-05		
300	0.35	0.3576453	5.845E-05		
315	0.49	0.4970654	4.992E-05		
337	0.68	0.6861765	3.815E-05		
354	0.8	0.7959464	1.643E-05		
362	0.84	0.8353452	2.167E-05		
370	0.87	0.8677366	5.123E-06		
375	0.89	0.8848285	2.674E-05		
380	0.9	0.8997779	4.934E-08		
			0.0003975		

Sum of Absolute Errors (EABS/SAE)

BH=12g

t (min)	qexp	qcalc	error	qex-qca/qex

t (min)	qexp	qcalc	error	qex-qca/qca
0	0	0	0	0
20	0	8.993E-15	8.087E-29	8.993E-15
30	0	1.021E-12	1.042E-24	1.021E-12
40	0	2.995E-11	8.969E-22	2.995E-11
50	0	4.116E-10	1.694E-19	4.116E-10
60	0	3.502E-09	1.226E-17	3.502E-09
80	0	1.027E-07	1.054E-14	1.027E-07
100	0	1.411E-06	1.991E-12	1.411E-06
140	0	7.336E-05	5.382E-09	7.336E-05
180	0	0.0014015	1.964E-06	0.0014015
230	0.02	0.0243575	1.899E-05	0.0043575
255	0.08	0.0773765	6.883E-06	0.0026235
280	0.21	0.2009704	8.153E-05	0.0090296
293	0.3	0.3000001	1.358E-14	1.165E-07
300	0.35	0.3612273	0.0001261	0.0112273
315	0.49	0.5007283	0.0001151	0.0107283
337	0.68	0.6890543	8.198E-05	0.0090543
354	0.8	0.7979665	4.135E-06	0.0020335
362	0.84	0.8369985	9.009E-06	0.0030015
370	0.87	0.8690694	8.66E-07	0.0009306
375	0.89	0.8859865	1.611E-05	0.0040135
380	0.9	0.9007805	6.092E-07	0.0007805
			0.0004632	0.0592567

SAE   0.0592567

Hybrid Fractional Error Function (HYBRID)

BH=12g

t (min)	qexp	qcalc	error	qex-qca/qca
0	0	0	0	0
20	0	7.994E-15	6.39E-29	0
30	0	9.56E-13	9.14E-25	0
40	0	2.823E-11	7.969E-22	0
50	0	3.899E-10	1.52E-19	0
60	0	3.331E-09	1.11E-17	0
80	0	9.833E-08	9.668E-15	0
100	0	1.358E-06	1.844E-12	0
140	0	7.116E-05	5.064E-09	0
180	0	0.0013674	1.87E-06	0
230	0.02	0.0239089	1.528E-05	0.000764
255	0.08	0.0761937	1.449E-05	0.0001811
280	0.21	0.1986456	0.0001289	0.0006139
293	0.3	0.2971727	7.993E-06	2.664E-05
300	0.35	0.3582425	6.794E-05	0.0001941
315	0.49	0.4977681	6.034E-05	0.0001231
337	0.68	0.6868447	4.685E-05	6.89E-05
354	0.8	0.7964849	1.236E-05	1.544E-05

HYBRID   0.0097051

t	qexp	qcalc	error	col5
362	0.84	0.8358145	1.752E-05	2.086E-05
370	0.87	0.8681391	3.463E-06	3.981E-06
375	0.89	0.8851918	2.312E-05	2.598E-05
380	0.9	0.9001045	1.093E-08	1.214E-08
			0.0004002	0.0020381

Marquardt's Percent Standard Deviation (MPSD)

BH=12g

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0	0	0		
20	0	1.998E-15	3.994E-30	0		
30	0	3.26E-13	1.063E-25	0		
40	0	1.102E-11	1.215E-22	0		
50	0	1.692E-10	2.864E-20	0		
60	0	1.577E-09	2.486E-18	0	MPSD	0.1412012
80	0	5.336E-08	2.847E-15	0		
100	0	8.194E-07	6.714E-13	0		
140	0	5.038E-05	2.538E-09	0		
180	0	0.0010911	1.19E-06	0		
230	0.02	0.0214799	2.19E-06	0.005475		
255	0.08	0.072036	6.343E-05	0.0099102		
280	0.21	0.1960834	0.0001937	0.0043917	4.18693E-05	
293	0.3	0.2982985	2.895E-06	3.217E-05		
300	0.35	0.3620679	0.0001456	0.0011888		
315	0.49	0.5077119	0.0003137	0.0013066		
337	0.68	0.7020872	0.0004878	0.001055		
354	0.8	0.8114861	0.0001319	0.0002061		
362	0.84	0.849828	9.659E-05	0.0001369		
370	0.87	0.8808843	0.0001185	0.0001565		
375	0.89	0.8970755	5.006E-05	6.32E-05		
380	0.9	0.9111115	0.0001235	0.0001524		
		6.43	0.0017311	0.0240746		

Sum of the Squares of the Errors (ERRSQ /SSE)

fr4ml/min

t (min)	qexp	qcalc	error			
0	0	0	0			
20	0	3.289E-08	1.082E-15			
30	0	5.453E-07	2.973E-13			
40	0	3.999E-06	1.599E-11			
50	0	1.876E-05	3.518E-10			
60	0	6.63E-05	4.396E-09		SSE	0.0009225
90	0	0.0010982	1.206E-06			
150	0.02	0.0364362	0.0002701			
210	0.29	0.2799542	0.0001009			
235	0.45	0.4586761	7.527E-05			
260	0.63	0.6305348	2.86E-07			
280	0.74	0.7403482	1.212E-07			
290	0.79	0.7842859	3.265E-05			
300	0.83	0.8213645	7.457E-05			
315	0.87	0.8657087	1.842E-05			
320	0.88	0.8778911	4.447E-06			
330	0.89	0.8989609	8.03E-05			
340	0.9	0.916253	0.0002642			
			0.0009225			

Sum of Absolute Errors (EABS/SAE)

fr4ml/min

t (min)	qexp	qcalc	error	qex-qca		
0	0	0	0	0		
20	0	2.213E-08	4.899E-16	2.213E-08		
30	0	3.906E-07	1.525E-13	3.906E-07		
40	0	2.994E-06	8.961E-12	2.994E-06		
50	0	1.453E-05	2.111E-10	1.453E-05	SAE	0.0803795
60	0	5.282E-05	2.79E-09	5.282E-05		
90	0	0.0009312	8.671E-07	0.0009312		
150	0.02	0.0335113	0.0001826	0.0135113		
210	0.29	0.2729389	0.0002911	0.0170611		
235	0.45	0.4542572	1.812E-05	0.0042572		
260	0.63	0.63	1.186E-20	1.089E-10		
280	0.74	0.7420896	4.366E-06	0.0020896		
290	0.79	0.7867229	1.074E-05	0.0032771		
300	0.83	0.824232	3.327E-05	0.005768		
315	0.87	0.8688345	1.358E-06	0.0011655		
320	0.88	0.8810259	1.053E-06	0.0010259		
330	0.89	0.9020336	0.0001448	0.0120336		

t (min)	qexp	qcalc	error	qex-qca/qex		
340	0.9	0.9191882	0.0003682	0.0191882		
			0.0010564	0.0803795		

Marquardt's Percent Standard Deviation (MPSD)

fr4ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0	0	0		
20	0	1.638E-09	2.683E-18	0		
30	0	4.427E-08	1.96E-15	0		
40	0	4.591E-07	2.108E-13	0		
50	0	2.817E-06	7.937E-12	0		
60	0	1.241E-05	1.539E-10	0	MPSD	0.3431783
90	0	0.0003351	1.123E-07	0		
150	0.02	0.0208909	7.938E-07	0.0019844		
210	0.29	0.2475722	0.0018001	0.0214045		
235	0.45	0.4508869	7.866E-07	3.885E-06		
260	0.63	0.6513289	0.0004549	0.0011462		
280	0.74	0.7733682	0.0011134	0.0020333		
290	0.79	0.8194673	0.0008683	0.0013913		
300	0.83	0.8567289	0.0007144	0.0010371		
315	0.87	0.8989014	0.0008353	0.0011036	0.000188434	
320	0.88	0.9099579	0.0008975	0.0011589		
330	0.89	0.9284628	0.0014794	0.0018677		
340	0.9	0.9430011	0.0018491	0.0022828		
	7.29		0.0100142	0.0354136		

Hybrid Fractional Error Function (HYBRID)

fr4ml/min

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0	0	0		
20	0	9.131E-09	8.338E-17	0		
30	0	1.856E-07	3.444E-14	0		
40	0	1.573E-06	2.473E-12	0		
50	0	8.25E-06	6.806E-11	0	HYBRID	0.0491679
60	0	3.196E-05	1.021E-09	0		
90	0	0.0006492	4.214E-07	0		
150	0.02	0.0280659	6.506E-05	0.0032529		
210	0.29	0.26011	0.0008934	0.0030807		
235	0.45	0.4477159	5.217E-06	1.159E-05		

260	0.63	0.6320553	4.224E-06	6.705E-06
280	0.74	0.7486683	7.514E-05	0.0001015
290	0.79	0.7944863	2.013E-05	2.548E-05
300	0.83	0.8325775	6.643E-06	8.004E-06
315	0.87	0.8772263	5.222E-05	6.002E-05
320	0.88	0.8892794	8.611E-05	9.785E-05
330	0.89	0.909864	0.0003946	0.0004433
340	0.9	0.9264725	0.0007008	0.0007787
			0.0023039	0.0078669

Sum of the Squares of the Errors (ERRSQ /

fr12ml/min

t (min)	qexp	qcalc	error			
0	0	0	0			
10	0	0.0230248	0.0005301			
20	0.08	0.1284351	0.002346	SSE	0.0063556	
30	0.32	0.3009842	0.0003616			
48	0.62	0.5987615	0.0004511			
60	0.74	0.7291688	0.0001173			
85	0.86	0.8711882	0.0001252			
100	0.89	0.9122391	0.0004946			
120	0.9	0.9439291	0.0019298			
			0.0063556			

Sum of Absolute Errors (EABS/SAE)

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca		
0	0	0	0	0		
10	0	0.0230248	0.0005301	0.0230248		
20	0.08	0.1284351	0.002346	0.0484351	SAE	0.1999017
30	0.32	0.3009842	0.0003616	0.0190158		
48	0.62	0.5987615	0.0004511	0.0212385		
60	0.74	0.7291688	0.0001173	0.0108312		
85	0.86	0.8711882	0.0001252	0.0111882		

t (min)	qexp	qcalc	error	qex-qca/qex
100	0.89	0.9122391	0.0004946	0.0222391
120	0.9	0.9439291	0.0019298	0.0439291
			0.0063556	0.1999017

Marquardt's Percent Standard Deviation (MPSD)

fr12ml/min

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0	0	0			
10	0	0.0091744	8.417E-05	0			
20	0.08	0.0855846	3.119E-05	0.0048731			
30	0.32	0.2658931	0.0029276	0.0285894			
48	0.62	0.6348437	0.0002203	0.0005732		MPSD	1.164128
60	0.74	0.7854618	0.0020668	0.0037742			
85	0.86	0.9213071	0.0037586	0.0050819			
100	0.89	0.9526932	0.0039304	0.004962			
120	0.9	0.9736896	0.0054302	0.0067039	0.000948636		
		4.41		0.0184492	0.0545577		

Hybrid Fractional Error Function (HYBRID)

fr12ml/min

t (min)	qexp	qcalc	error	Sqex-qca/qexA		
0	0	0	0	0		
10	0	0.0140074	0.0001962	0		
20	0.08	0.10091	0.0004372	0.0054654		
30	0.32	0.2732707	0.0021836	0.0068238		
48	0.62	0.6043013	0.0002464	0.0003975		HYBRID
60	0.74	0.7481585	6.656E-05	8.995E-05		
85	0.86	0.8935414	0.001125	0.0013082		
100	0.89	0.9316333	0.0017333	0.0019476		
120	0.9	0.9591336	0.0034968	0.0038853		
			0.0094852	0.0199177		

Sum of the Squares of the Errors (ERRSQ /SSE)

BH=4g   50mg/l

t (min)	qexp	qcalc			
0	0	0	0		
10	0	6.556E-06	4.299E-11		
22	0	0.0001497	2.24E-08		
30	0	0.0005121	2.623E-07		
41	0	0.0017664	3.12E-06		
50	0	0.0038735	1.5E-05	SSE	0.0007372
60	0	0.007952	6.323E-05		
80	0.01	0.024483	0.0002098		
100	0.05	0.0573416	5.39E-05		
155	0.26	0.2571332	8.219E-06		
210	0.54	0.5359187	1.666E-05		
240	0.66	0.6623316	5.437E-06		
280	0.79	0.7833485	4.424E-05		
300	0.83	0.8262117	1.435E-05		
320	0.86	0.8599731	7.217E-10		
340	0.88	0.8865115	4.24E-05		
370	0.9	0.9161438	0.0002606		
			0.0007372		

Sum of Absolute Errors (EABS/SAE)

BH=4g   50mg/l

t (min)	qexp	qcalc	error	qex-qca		
0	0	0	0	0		
10	0	6.556E-06	4.299E-11	6.556E-06		
22	0	0.0001497	2.24E-08	0.0001497		
30	0	0.0005121	2.623E-07	0.0005121		
41	0	0.0017664	3.12E-06	0.0017664		
50	0	0.0038735	1.5E-05	0.0038735	SAE	0.0784864
60	0	0.007952	6.323E-05	0.007952		
80	0.01	0.024483	0.0002098	0.014483		
100	0.05	0.0573416	5.39E-05	0.0073416		
155	0.26	0.2571332	8.219E-06	0.0028668		
210	0.54	0.5359187	1.666E-05	0.0040813		
240	0.66	0.6623316	5.437E-06	0.0023316		
280	0.79	0.7833485	4.424E-05	0.0066515		
300	0.83	0.8262117	1.435E-05	0.0037883		
320	0.86	0.8599731	7.217E-10	2.686E-05		
340	0.88	0.8865115	4.24E-05	0.0065115		
370	0.9	0.9161438	0.0002606	0.0161438		

0.0007372 0.0784864

Marquardt's Percent Standard Deviation (MPSD)

BH=4g   50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0	0	0			
10	0	4.601E-07	2.117E-13	0			
22	0	2.166E-05	4.691E-10	0			
30	0	9.854E-05	9.711E-09	0			
41	0	0.0004531	2.053E-07	0			
50	0	0.0011938	1.425E-06	0		MPSD	0.6251726
60	0	0.002904	8.433E-06	0			
80	0.01	0.0117352	3.011E-06	0.0301104			
100	0.05	0.0341169	0.0002523	0.1009096			
155	0.26	0.2310695	0.000837	0.0123813			
210	0.54	0.5698578	0.0008915	0.0030572			
240	0.66	0.7178051	0.0033414	0.0076709			
280	0.79	0.8437843	0.0028928	0.0046351	0.000586261		
300	0.83	0.8832635	0.002837	0.0041182			
320	0.86	0.912055	0.0027097	0.0036638			
340	0.88	0.93309	0.0028185	0.0036397			
370	0.9	0.9547062	0.0029928	0.0036948			
	5.78		0.019586	0.1738808			

Hybrid Fractional Error Function (HYBRID)

BH=4g   50mg/l

t (min)	qexp	qcalc	error	qex-qca/qex	
0	0	0	0	0	
10	0	2.36E-06	5.567E-12	0	
22	0	6.99E-05	4.886E-09	0	
30	0	0.0002651	7.025E-08	0	
41	0	0.0010141	1.028E-06	0	
50	0	0.0023763	5.647E-06	0	HYBRID
60	0	0.0051879	2.691E-05	0	
80	0.01	0.01764	5.837E-05	0.005837	
100	0.05	0.0447563	2.75E-05	0.0005499	
155	0.26	0.2355647	0.0005971	0.0022965	

210	0.54	0.531969	6.45E-05	0.0001194
240	0.66	0.6686216	7.433E-05	0.0001126
280	0.79	0.7964876	4.209E-05	5.328E-05
300	0.83	0.8403736	0.0001076	0.0001297
320	0.86	0.8741753	0.0002009	0.0002337
340	0.88	0.9001553	0.0004062	0.0004616
370	0.9	0.9284003	0.0008066	0.0008962
			0.0024189	0.0106899

Sum of the Squares of the Errors (ERRSQ /SSE)

150mg/l

t (min)	qexp	qcalc	error			
0	0	0	0	0		
10	0	0.0098462	9.695E-05			
15	0.01	0.0371889	0.0007392		SSE	0.0056044
25	0.2	0.1759094	0.0005804			
40	0.48	0.5071513	0.0007372			
50	0.69	0.6846839	2.826E-05			
60	0.83	0.7998794	0.0009073			
70	0.88	0.8700525	9.895E-05			
75	0.89	0.8940046	1.604E-05			
95	0.9	0.9489919	0.0024002			
			0.0056044			

Sum of Absolute Errors (EABS/SAE)

150mg/l

t (min)	qexp	qcalc	error	qex-qca	
0	0	0	0	0	
10	0	0.007386	5.455E-05	0.007386	
15	0.01	0.0303383	0.0004136	0.0203383	SAE
25	0.2	0.160419	0.0015667	0.039581	
40	0.48	0.5024278	0.000503	0.0224278	
50	0.69	0.6900002	5.289E-14	2.3E-07	
60	0.83	0.8093715	0.0004255	0.0206285	

t (min)	qexp	qcalc	error	qex-qca/qex
70	0.88	0.87995	2.497E-09	4.997E-05
75	0.89	0.9034658	0.0001813	0.0134658
95	0.9	0.9557933	0.0031129	0.0557933
			0.0062576	0.1796709

Marquardt's Percent Standard Deviation (MPSD)

150mg/l

t (min)	qexp	qcalc	error	qex-qca/qex		
0	0	0	0	0		
10	0	0.0016679	2.782E-06	0		
15	0.01	0.0111038	1.218E-06	0.012183		MPSD
25	0.2	0.1101706	0.0080693	0.201733		
40	0.48	0.5298366	0.0024837	0.0107799		
50	0.69	0.7627854	0.0052977	0.0111273		
60	0.83	0.8833679	0.0028481	0.0041343		
70	0.88	0.9398598	0.0035832	0.0046271		
75	0.89	0.9557754	0.0043264	0.0054619	0.00142082	
95	0.9	0.9849913	0.0072235	0.0089179		
	4.88		0.033836	0.2589645		

Hybrid Fractional Error Function (HYBRID)

150mg/l

t (min)	qexp	qcalc	error	qex-qca/qex	
0	0	0	0	0	
10	0	0.0044383	1.97E-05	0	
15	0.01	0.0210862	0.0001229	0.0122904	HYBRID
25	0.2	0.1354881	0.0041618	0.0208089	
40	0.48	0.4931678	0.0001734	0.0003612	
50	0.69	0.6983759	7.016E-05	0.0001017	
60	0.83	0.8246088	2.906E-05	3.502E-05	
70	0.88	0.8953657	0.0002361	0.0002683	
75	0.89	0.9179487	0.0007811	0.0008777	
95	0.9	0.9655491	0.0042967	0.0047741	

0.0098909 0.0395173

Sum of the Squares of the Errors (ERRSQ /SSE)

MNFC

t (min)	qexp	qcalc	error			
0	0	0	0			
20	0	0.0003889	1.512E-07			
30	0	0.0030391	9.236E-06			
40	0	0.012965	0.0001681		SSE	0.0026169
50	0.01	0.0391864	0.0008518			
60	0.11	0.0933226	0.0002781			
80	0.32	0.3072442	0.0001627			
96	0.52	0.5281434	6.632E-05			
105	0.62	0.6382308	0.0003324			
122	0.81	0.7907774	0.0003695			
132	0.86	0.8493642	0.0001131			
138	0.88	0.8760261	1.579E-05			
143	0.89	0.8943566	1.898E-05			
150	0.9	0.9151878	0.0002307			
			0.0026169			

Sum of Absolute Errors (EABS/SAE)

MNFC

t (min)	qexp	qcalc	error	qex-qca		
0	0	0	0	0		
20	0	0.0003987	1.59E-07	0.0003987		
30	0	0.0030711	9.432E-06	0.0030711		
40	0	0.0129678	0.0001682	0.0129678	SAE	0.1541483
50	0.01	0.0388954	0.0008349	0.0288954		
60	0.11	0.0921223	0.0003196	0.0178777		
80	0.32	0.3020446	0.0003224	0.0179554		
96	0.52	0.5203971	1.577E-07	0.0003971		
105	0.62	0.6302835	0.0001057	0.0102835		
122	0.81	0.7841467	0.0006684	0.0258533		
132	0.86	0.843854	0.0002607	0.016146		
138	0.88	0.8711653	7.805E-05	0.0088347		
143	0.89	0.89	1.731E-19	4.16E-10		
150	0.9	0.9114677	0.0001315	0.0114677		
			0.0028993	0.1541483		

Marquardt's Percent Standard Deviation (MPSD)

MNFC

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0	0	0			
20	0	1.624E-05	2.637E-10	0			
30	0	0.0003016	9.099E-08	0			
40	0	0.0023932	5.727E-06	0		MPSD	1.0173457
50	0.01	0.0118371	3.375E-06	0.0337506			
60	0.11	0.0426694	0.0045334	0.3746624			
80	0.32	0.2616469	0.0034051	0.0332528			
96	0.52	0.5686909	0.0023708	0.0087678			
105	0.62	0.7155147	0.0091231	0.0237333			
122	0.81	0.8811918	0.0050683	0.0077248			
132	0.86	0.9290057	0.0047618	0.0064383	0.001241991		
138	0.88	0.9474429	0.0045485	0.0058736			
143	0.89	0.9588441	0.0047395	0.0059835			
150	0.9	0.9704815	0.0049676	0.0061329			
		5.92		0.0435273	0.5063199		

Hybrid Fractional Error Function (HYBRID)

MNFC

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0	0	0			
20	0	0.0001186	1.406E-08	0			
30	0	0.0012534	1.571E-06	0			
40	0	0.0066483	4.42E-05	0		HYBRID	0.3975802
50	0.01	0.0239318	0.0001941	0.0194095			
60	0.11	0.066146	0.0019232	0.0174834			
80	0.32	0.2741772	0.0020997	0.0065616			
96	0.52	0.5218203	3.313E-06	6.372E-06			
105	0.62	0.6476578	0.000765	0.0012338			
122	0.81	0.8148612	2.363E-05	2.917E-05			

t	qexp	qcalc		
132	0.86	0.8743863	0.000207	0.0002407
138	0.88	0.9001562	0.0004063	0.0004617
143	0.89	0.9172877	0.0007446	0.0008367
150	0.9	0.9360837	0.001302	0.0014467
			0.0077146	0.0477096

Sum of the Squares of the Errors (ERRSQ /SSE)

MF-MNFC

t (min)	qexp	qcalc	SSE		
0	0	0	0		
20	0	9.017E-07	8.131E-13		
40	0	0.0001254	1.574E-08		
50	0	0.0006142	3.772E-07		
60	0	0.0022459	5.044E-06	SSE	0.0040416
70	0	0.0067008	4.49E-05		
80	0.01	0.0171576	5.123E-05		
100	0.09	0.0787726	0.0001261		
115	0.21	0.1878589	0.0004902		
130	0.36	0.3564037	1.293E-05		
140	0.46	0.4841726	0.0005843		
165	0.72	0.751489	0.0009916		
180	0.88	0.8489159	0.0009662		
185	0.9	0.8722738	0.0007687		
			0.0040416		

Sum of Absolute Errors (EABS/SAE)

MF-MNFC

t (min)	qexp	qcalc	error	qex-qca		
0	0	0	0	0		
20	0	1.554E-06	2.415E-12	1.554E-06		
40	0	0.0001778	3.16E-08	0.0001778		
50	0	0.000817	6.675E-07	0.000817		
60	0	0.0028364	8.045E-06	0.0028364		
70	0	0.0080957	6.554E-05	0.0080957		
80	0.01	0.0199334	9.867E-05	0.0099334	SAE	0.1637485
100	0.09	0.0855371	1.992E-05	0.0044629		

115	0.21	0.19565	0.0002059	0.01435
130	0.36	0.3600001	1.702E-14	1.305E-07
140	0.46	0.4828518	0.0005222	0.0228518
165	0.72	0.741709	0.0004713	0.021709
180	0.88	0.8388702	0.0016917	0.0411298
185	0.9	0.862617	0.0013975	0.037383
			0.0044814	0.1637485

Marquardt's Percent Standard Deviation (MPSD)

MF-MNFC

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0	0	0			
20	0	1.421E-07	2.019E-14	0			
40	0	4.036E-05	1.629E-09	0			
50	0	0.0002487	6.186E-08	0			
60	0	0.0010982	1.206E-06	0			
70	0	0.0038469	1.48E-05	0			
80	0.01	0.0113366	1.786E-06	0.0178647		MPSD	0.9297599
100	0.09	0.0660104	0.0005755	0.0710498			
115	0.21	0.180855	0.0008494	0.0192615			
130	0.36	0.3748813	0.0002215	0.0017087			
140	0.46	0.5231491	0.0039878	0.018846			
165	0.72	0.8071763	0.0075997	0.0146599	0.001037344		
180	0.88	0.8948178	0.0002196	0.0002835			
185	0.9	0.9140589	0.0001977	0.000244			
	3.63		0.013669	0.1439182			

Hybrid Fractional Error Function (HYBRID)

MF-MNFC

t (min)	qexp	qcalc	error	qex-qca/qex			
0	0	0	0	0			
20	0	8.073E-07	6.517E-13	0			
40	0	0.0001172	1.374E-08	0			
50	0	0.0005819	3.386E-07	0			
60	0	0.002152	4.631E-06	0			
70	0	0.006483	4.203E-05	0			
80	0.01	0.0167406	4.544E-05	0.0045436		HYBRID	0.11171

100	0.09	0.0779599	0.000145	0.0016107
115	0.21	0.1874589	0.0005081	0.0024195
130	0.36	0.3575388	6.058E-06	1.683E-05
140	0.46	0.4865506	0.0007049	0.0015325
165	0.72	0.7551431	0.001235	0.0017153
180	0.88	0.8520989	0.0007785	0.0008846
185	0.9	0.875222	0.0006139	0.0006822
			0.004084	0.0134052

Summary of Dose-Response model parameters for Co (II) ion adsorption

Dose-Response parameter at Bed height of 4 cm.

Error funct	a	N0 (mg/g)	Objective function
SSE	3.407796	20143.28	0.0022
HYB	4.067372	20324.25	0.3194
MPSD	5.00924	19957.85	13.05806
ARE	3.7701	201731.6	1.005
SAE	3.271478	20055.53	0.1171
R2	3.407796	20143.28	0.9989

Dose-Response parameter at Bed height of 8 cm.

Error funct	a	N0 (mg/g)	Objective function
SSE	5.8836	19802.54	0.0038
HYB	7.0298	198881.4	0.203
MPSD	8.5187	19390.87	11.34975
ARE	5.7901	19855.2	0.6251
SAE	5.7694	19689.27	0.1529
R2	5.8838	19802.4	0.9984

Dose-Response parameter at Bed height of 12 cm.

Error funct	a	N0 (mg/g)	Objective function
SSE	11.7618	21020.97	0.000398
HYB	11.76615	21015.94	0.0097
MPSD	12.2412	20947.14	3.3859
ARE	11.7666	21064	0.0739
SAE	11.74323	20994.79	0.0593
R2	11.7618	21020.97	0.9999

Dose-Response parameter for flow rate of 4mL/min

Error funct	α	N0 (mg/g)	Objective function
SSE	6.925938	24068.91	0.000923
HYB	7.428059	24173.54	0.049168
MPSD	8.130612	24076.61	4.704628
ARE	7.428059	24173.54	0.0198
SAE	7.079413	24117.04	0.080379
R2	6.925938	24068.91	0.9997

Dose-Response parameter for flow rate of 12 mL/min

Error funct	α	N0 (mg/g)	Objective function
SSE	2.644496	12377.18	0.0064
HYB	2.9819	12493.8	0.2846
MPSD	3.3375	12200.99	8.8283
ARE	2.9819	12493.8	0.1793
SAE	2.644496	12377.18	0.199902
R2	2.644496	12377.18	0.9948

Dose-Response parameter at 50 mg/L initial concentration

Error funct	α	N0 (mg/g)	Objective function
SSE	3.967452	20251.86	0.000737
HYB	4.297918	20383.56	0.071266
MPSD	4.885213	19825.05	10.76664
ARE	4.297918	20383.56	0.0341
SAE	3.967452	20251.86	0.078486
R2	3.967452	20251.86	0.9997

Dose-Response parameter at 150 mg/L initial concentration

Error funct	α	N0 (mg/g)	Objective function
SSE	3.34661	11897.86	0.005604
HYB	3.884972	12084.72	0.493966
MPSD	4.698874	11698.7	17.99182
ARE	3.884972	12084.72	0.0897
SAE	3.542155	11957.14	0.179671
R2	3.34661	11897.86	0.9961

Dose-Response parameter for C-MNFC

Error funct	α	N0 (mg/g)	Objective function
SSE	5.077443	28167.83	0.002617
HYB	5.818663	28370.4	0.39758
MPSD	7.206709	27715.91	20.54101
ARE	5.818663	28370.4	0.0994

SAE	5.04172	28337.44	0.154148
R2	5.077443	28167.83	0.9987

Dose-Response parameter for MF-MNFC

Error funct	α	N0 (mg/g)	Objective function
SSE	7.1204	42375.23	0.004
HYB	7.1821	42315.86	0.1117
MPSD	8.150201	41525.19	10.95134
ARE	7.1821	42315.86	0.1097
SAE	6.8379	42423.6	0.1637
R2	7.120381	42375.23	0.9974

α	3.4077957
q0	20143.275

m	4
Q	8
C0	100
v	0.2887
n	14

α	3.2714779
q0	20055.526

m	4
Q	8
C0	100
v	0.2887
n	14

α	5.0092402
q0	19657.851

m	4
Q	8
C0	100
v	0.2887
n	14

α	4.0673725
q0	20324.248

m	4
Q	8
C0	100
v	0.2887
n	14

α	5.8835547
q0	19802.54

m	8
Q	8
C0	100
v	0.2887
n	18

α	5.7694003
q0	19689.268

m	8
Q	8
C0	100
v	0.2887
n	18

α	8.5186709
q0	19390.866

R^2	0.7533216

m	8
Q	8
C0	100
v	0.2887
n	18

α	7.0298429
q0	19881.352

m	8
Q	8
C0	100
v	0.2887

n	18

α	11.761802
q0	21020.969

m	12
Q	8
C0	100
v	0.2887
n	23

α	11.743232
q0	20994.791
R^2	0.9921826
m	12
Q	8
C0	100
v	0.2887
n	23

α	11.766155
q0	21015.94
R^2	0.803658
m	12
Q	8
C0	100
v	0.2887
n	23

α	12.2412
q0	20947.143

m	12
Q	8
C0	100
v	0.2887
n	23

α	6.9259379
q0	24068.914

m	4
Q	4
C0	100
v	0.1443
n	18

α	7.0794131
q0	24117.035

m	4
Q	4
C0	100
v	0.1443
n	18

α	8.1306117
q0	24076.605

m	4
Q	4
C0	100
v	0.1443
n	18

α	7.4280592
q0	24173.54

m	4
Q	4

C0	100
v	0.1443
n	18

α	2.6444962
q0	12377.18

m	4
Q	12
C0	100
v	0.4332
n	9

α	2.6444962
q0	12377.18

m	4
Q	12
C0	100
v	0.4332
n	9

α	3.3374498
q0	12200.987

m	4
Q	12
C0	100
v	0.4332
n	9

α	2.9819158
q0	12493.797

0.2845384

m	4
Q	12
C0	100
v	0.4332

n	9

α	3.9674517
q0	20251.858

R^2	#DIV/0!

m	4
Q	8
C0	50
v	0.2887
n	17

α	3.9674517
q0	20251.858

m	4
Q	8
C0	50
v	0.2887
n	17

α	4.8852132
q0	19825.053

m	4
Q	8
C0	50
v	0.2887
n	17

α	4.2979181
q0	20383.562

0.0712657

m	4
Q	8

C0	50
v	0.2887
n	17

α	3.3466101
q0	11897.86

m	4
Q	8
C0	150
v	0.2887
n	10

α	3.5421545
q0	11967.145

0.1796709

m	4
Q	8

C0	150
v	0.2887
n	10

α	4.6988741
q0	11698.698

1.3326758

m	4
Q	8
C0	150
v	0.2887
n	10

α	3.884972
q0	12084.716

0.4939664

m	4
Q	8
C0	150
v	0.2887
n	10

α	5.077443
q0	28167.832

m	4
Q	12
C0	100
v	0.4332
n	14

α	5.0417198
q0	28337.436

R^2	0.9811918

m	4
Q	12
C0	100
v	0.4332
n	14

α	7.2067095
q0	27715.912

m	4
Q	12
C0	100
v	0.4332
n	14

α	5.8186629
q0	28370.948

R^2	0.8383016

m	4
Q	12
C0	100
v	0.4332

n   14

α   7.1203806
q0   42375.227

m   4
Q   12
C0   100
v   0.4332
n   14

α   6.8379117
q0   42423.6

R^2   0.9726322

m	4
Q	12
C0	100
v	0.4332
n	14

α	8.1502014
q0	41525.19

m	4
Q	12
C0	100
v	0.4332
n	14

α	7.1821171
q0	42315.858

R^2	0.6953452

m	4
Q	12
C0	100
v	0.4332
n	14

201