

APPENDIX A

Calculation

A.1 Calibration curve for Cd(II)

In order to determine the concentration of Cd(II), various concentrations of Cd(II) standard were prepared. The absorbance of standard and sample solutions were determined using atomic absorption spectrophotometer.

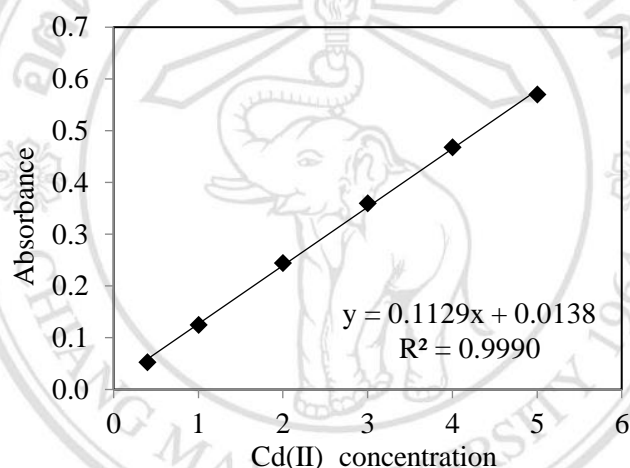


Fig. A1 Standard curve of Cd(II)

Equation of the calibration curve: $y = 0.1129x + 0.0138$

y is absorbance, and x is Cd(II) concentration; $x = \frac{y - 0.0138}{0.1129}$

A.2 Calibration curve for Zn(II)

In order to determine the concentration of Zn(II), various concentrations of Zn(II) standard were prepared. The absorbance of standard and sample solutions was determined using atomic absorption spectrophotometer.

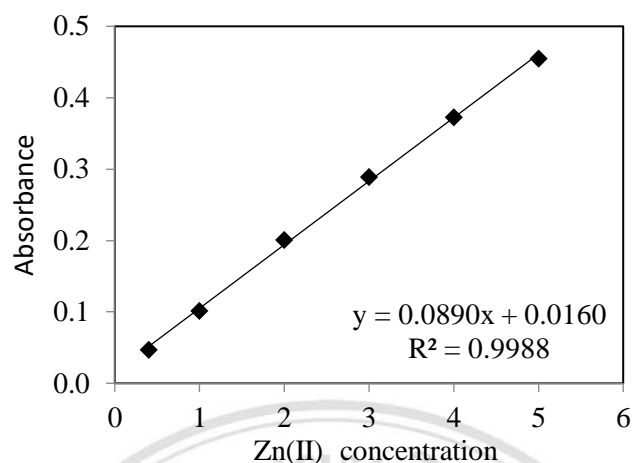


Fig. A2 Calibration curve of Zn(II)

Equation of the calibration curve: $y = 0.0890x + 0.0160$

y is absorbance, and x is Cd(II) concentration; $x = \frac{y - 0.0160}{0.0890}$

A.3 Sum of normalized errors

In order to calculate the sum of normalized errors (SNE), each isotherm parameter set was tested for all error functions to yield the error values for each error function. The obtained error values were divided by the maximum errors for that error function, and the results for each error function were combined as SNE value.

For example, the SNE values of Cd(II) adsorption for Langmuir equation are calculated as follows:

1. Determine the isotherm parameters by linear regression method.
2. Determine the isotherm parameters by non-linear regression method in a way that minimizes the applied error function.
3. The R^2 and error value for each error function are summarized in Table A1 (italic font).
4. Determine the values of other error functions based on isotherm parameters obtained from step (1) and (2). For example, by using the isotherm parameter obtained from linear regression method, the error value of RMSE, ERRSQ, MAPE, MPSD, and χ^2 are 2.655, 56.412, 21.417, 96.962, and 21.555, respectively. All the calculated error values are shown in Table A1.

5. Select the maximum output of each error function from all sets. For example, the maximum output for RMSE is 4.610. The maximum output is shown in Table A1 as the bold font.
6. The value of other sets should be divided into the maximum value. For example, in RMSE; 2.655, 2.311, 2.865, 2.572, and 4.610 are divided by 4.610. All the divided values are shown in Table A2.
7. Calculate the summation of all of these normalized errors for each parameter.

Table A1 R^2 value and error values of each error function for Cd(II)

		Linear regression	Error function				
			RMSE	ERRSQ	MAPE	MPSD	χ^2
R^2 value		0.9684					
Error value	RMSE	2.655	2.311	2.311	2.865	2.572	4.610
	ERRSQ	56.412	42.719	42.719	65.658	52.929	170.028
	MAPE	21.417	19.724	19.724	18.666	19.873	27.328
	MPSD	96.962	96.963	96.963	96.968	92.873	128.015
	χ^2	21.555	29.907	29.907	23.784	20.728	10.371

Table A2 Calculation of normalized error value.

		Linear regression	Error function				
			RMSE	ERRSQ	MAPE	MPSD	χ^2
R^2 value							
Normalized error value	RMSE	0.576	0.501	0.501	0.621	0.558	1.000
	ERRSQ	0.332	0.251	0.251	0.386	0.311	1.000
	MAPE	0.784	0.722	0.722	0.683	0.727	1.000
	MPSD	0.757	0.757	0.757	0.757	0.725	1.000
	χ^2	0.721	1.000	1.000	0.795	0.693	0.347
SNE value		3.170	3.232	3.232	3.243	3.015	4.347

APPENDIX B

Adsorption data

B.1 Effect of pH

Table B1 Effect of pH on the adsorption of Cd(II)
(Cd(II) 30 mg/L, 120 min, 30 °C)

pH	Adsorbed amount (mg/g)				
	1	2	3	4	5
2	0.609	0.830	0.775	0.664	0.775
3	1.716	2.104	2.104	1.993	1.882
4	6.975	7.252	7.640	7.307	7.363
5	18.268	18.434	18.545	18.434	18.379
6	23.195	23.029	23.251	22.919	23.085

Table B2 Effect of pH on the adsorption of Zn(II)
(Zn(II) 30 mg/L, 120 min, 30 °C)

pH	Adsorbed amount (mg/g)				
	1	2	3	4	5
2	0.281	0.351	0.140	0.351	0.140
3	0.843	1.124	0.983	0.983	1.053
4	4.213	4.143	4.354	4.073	4.143
5	12.781	12.851	13.202	13.062	12.921
6	18.329	18.539	18.469	18.329	18.539

B.2 Effect of contact time

Table B3 Effect of contact time on the adsorption of Cd(II)
(Cd(II) 30 mg/L, pH 6, 300 min, 30 °C)

Time (min)	Adsorbed amount (mg/g)				
	1	2	3	4	5
10	23.16	22.94	23.07	22.63	22.76
20	23.56	23.37	23.55	22.93	23.11
30	23.85	23.63	23.68	23.27	23.45
40	24.10	24.00	23.88	23.56	23.69
50	24.30	24.16	24.32	23.75	24.05
60	24.49	24.39	24.51	24.02	24.17
90	24.64	24.61	24.78	24.17	24.24
120	24.60	24.83	24.74	24.21	24.31
180	24.67	24.83	24.71	24.17	24.38
240	24.64	24.76	24.71	24.17	24.32
300	24.64	24.70	24.61	24.21	24.28

Table B4 Effect of contact time on the adsorption of Zn(II)
(Zn(II) 30 mg/L, pH 6, 300 min, 30 °C)

Time (min)	Adsorbed amount (mg/g)				
	1	2	3	4	5
10	17.87	17.67	17.40	16.60	16.93
20	18.06	17.73	17.79	16.79	17.13
30	18.19	17.86	17.85	16.98	17.31
40	18.31	17.80	17.97	17.10	17.31
50	18.43	18.15	18.09	17.22	17.59
60	18.31	18.15	18.21	17.34	17.55
90	18.43	18.15	18.26	17.28	17.66
120	18.59	18.15	18.37	17.53	17.72
180	18.69	18.31	18.37	17.45	17.87
240	18.69	18.24	18.47	17.40	17.72
300	18.71	18.11	18.38	17.44	17.72

B.3 Adsorption at different temperature

Table B5 The adsorption of Cd(II) at 10 °C (Cd(II) 5-50 mg/L, pH 6, 60 min)

	1	2	3	4	5	6	7
C_e (mg/L)	0.132	0.073	0.073	0.123	0.141	0.126	0.104
	0.568	0.602	0.686	-	0.534	0.578	0.593
	1.548	1.574	1.574	1.442	1.828	1.805	1.828
	2.827	3.030	2.894	2.928	2.695	2.932	2.843
	4.210	4.167	4.041	4.125	4.553	-	4.774
	6.372	6.213	6.372	6.160	6.430	6.477	6.338
	10.861	10.725	11.199	10.996	10.006	10.302	10.183
	16.196	16.450	16.703	-	17.315	17.241	17.019
q_e (mg/g)	4.877	4.937	4.937	4.886	4.896	4.911	4.933
	9.383	9.349	9.265	-	9.482	9.438	9.423
	13.446	13.419	13.419	13.551	13.152	13.175	13.152
	17.177	16.974	17.109	17.075	17.337	17.101	17.189
	20.752	20.795	20.921	20.837	20.377	-	20.155
	23.669	23.827	23.669	23.880	23.530	23.484	23.622
	29.146	29.281	28.808	29.011	29.822	29.527	29.645
	33.812	33.559	33.305	-	32.840	32.914	33.136

Table B6 The adsorption of Cd(II) at 20 °C (Cd(II) 5-50 mg/L, pH 6, 60 min)

	1	2	3	4	5	6	7
C_e (mg/L)	0.107	0.073	0.056	0.047	0.089	0.067	0.104
	0.517	0.619	0.534	0.551	0.460	0.475	0.578
	1.363	1.416	1.522	1.363	1.574	1.643	-
	2.793	2.725	2.759	-	2.695	2.666	2.725
	3.872	3.829	3.998	3.745	4.442	4.331	4.405
	5.843	5.896	6.055	6.002	6.060	6.107	6.107
	10.658	10.793	10.455	10.590	10.006	9.888	10.124
	15.604	15.689	16.027	15.943	16.797	16.575	-
q_e (mg/g)	4.903	4.937	4.954	4.962	4.948	4.970	4.933
	9.434	9.332	9.417	9.400	9.556	9.541	9.438
	13.631	13.578	13.472	13.631	13.406	13.337	-
	17.210	17.278	17.244	-	17.337	17.367	17.308
	21.090	21.133	20.964	21.217	20.488	20.599	20.525
	24.197	24.144	23.986	24.038	23.900	23.854	23.854
	29.349	29.214	29.552	29.417	29.822	29.941	29.704
	34.404	34.320	33.981	34.066	33.358	33.580	-

Table B7 The adsorption of Cd(II) at 30 °C (Cd(II) 5-50 mg/L, pH 6, 60 min)

	1	2	3	4	5	6	7
C_e (mg/L)	0.071	0.029	0.050	0.050	0.045	0.045	-
	0.420	0.463	0.527	0.591	0.386	0.386	0.475
	1.323	1.323	1.423	1.156	1.366	1.458	1.435
	2.461	2.546	2.674	2.503	2.399	2.547	2.518
	3.769	3.502	3.555	3.662	4.220	4.183	4.035
	5.644	5.577	5.777	5.510	5.737	5.598	5.506
	10.465	10.124	10.209	-	9.473	9.237	9.296
	15.000	15.640	15.320	15.213	16.354	16.280	16.058
q_e (mg/g)	4.936	4.979	4.957	4.957	4.993	4.993	-
	9.531	9.488	9.424	9.360	9.630	9.630	9.541
	13.659	13.659	13.559	13.826	13.614	13.522	13.545
	17.484	17.399	17.271	17.441	17.633	17.485	17.515
	21.215	21.482	21.429	21.322	20.710	20.747	20.895
	24.387	24.454	24.254	24.520	24.223	24.362	24.455
	29.510	29.851	29.765	-	30.355	30.592	30.533
	34.968	34.328	34.648	34.755	33.802	33.876	34.098

Table B8 The adsorption of Cd(II) at 40 °C (Cd(II) 5-50 mg/L, pH 6, 60 min)

	1	2	3	4	5	6	7
C_e (mg/L)	0.039	0.029	0.039	0.018	0.023	0.060	0.045
	0.313	0.335	0.441	0.420	0.342	-	0.460
	1.156	1.189	1.323	1.323	1.089	1.135	1.274
	2.333	2.461	2.461	2.247	2.518	2.399	2.340
	3.396	3.449	3.609	-	3.702	-	3.850
	5.311	5.644	5.111	5.377	5.275	5.413	5.460
	9.868	9.697	9.953	9.612	9.118	8.882	8.941
	14.680	14.574	15.000	-	15.688	15.688	15.540
q_e (mg/g)	4.968	4.979	4.968	4.989	5.015	4.978	4.993
	9.638	9.616	9.510	9.531	9.675	-	9.556
	13.826	13.793	13.659	13.659	13.891	13.845	13.707
	17.612	17.484	17.484	17.697	17.515	17.633	17.692
	21.588	21.535	21.375	-	21.228	-	21.080
	24.720	24.387	24.920	24.654	24.686	24.547	24.501
	30.107	30.277	30.021	30.362	30.710	30.947	30.888
	35.288	35.394	34.968	-	34.467	34.467	34.615

Table B9 The adsorption of Zn(II) at 10 °C (Zn(II) 5-50 mg/L, pH 6, 60 min)

	1	2	3	4	5	6	7
C_e (mg/L)	0.608	0.522	0.554	0.533	0.476	0.452	0.452
	2.228	2.250	2.185	2.121	1.880	1.905	1.954
	4.457	4.390	4.255	4.423	4.159	4.121	4.235
	6.738	6.566	-	6.825	7.521	7.375	-
	10.361	10.307	10.199	10.307	10.379	10.684	10.501
	13.018	13.287	12.883	13.085	13.202	13.049	13.278
	21.916	-	21.658	22.002	21.685	21.294	21.001
	30.947	30.732	31.055	30.947	31.258	31.258	30.891
q_e (mg/g)	4.672	4.758	4.726	4.747	4.640	4.664	4.664
	8.138	8.116	8.181	8.245	8.254	8.230	8.181
	10.596	10.663	10.798	10.630	10.836	10.875	10.760
	13.219	13.391	-	13.132	12.698	12.845	-
	14.801	14.855	14.962	14.855	14.774	14.469	14.652
	16.886	16.617	17.021	16.819	16.789	16.941	16.712
	18.342	-	18.601	18.256	18.266	18.657	18.950
	19.160	19.376	19.053	19.160	18.803	18.803	19.170

Table B10 The adsorption of Zn(II) at 20 °C (Zn(II) 5-50 mg/L, pH 6, 60 min)

	1	2	3	4	5	6	7
C_e (mg/L)	0.447	0.436	0.468	0.436	0.391	0.415	0.379
	2.056	2.099	2.099	2.185	1.783	1.856	-
	4.121	4.222	4.154	4.289	3.968	4.045	-
	6.609	6.480	6.351	6.437	7.131	7.179	7.082
	10.038	-	10.145	10.199	10.134	10.256	10.012
	12.749	12.547	12.682	12.883	12.973	13.049	12.592
	21.572	21.830	21.658	21.485	21.099	20.904	-
	30.624	30.732	30.409	30.517	30.647	31.013	30.769
q_e (mg/g)	4.833	4.844	4.812	4.844	4.725	4.701	4.737
	8.310	8.267	8.267	8.181	8.352	8.278	-
	10.932	10.832	10.899	10.764	11.027	10.951	-
	13.348	13.477	13.606	13.520	13.089	13.040	13.138
	15.124	-	15.016	14.962	15.018	14.896	15.140
	17.156	17.357	17.223	17.021	17.018	16.941	17.399
	18.687	18.428	18.601	18.773	18.852	19.048	-
	19.483	19.376	19.699	19.591	19.414	19.048	19.292

Table B11 The adsorption of Zn(II) at 30 °C (Zn(II) 5-50 mg/L, pH 6, 60 min)

	1	2	3	4	5	6	7
C_e (mg/L)	0.309	0.309	0.332	0.367	0.305	0.354	0.342
	2.009	1.940	1.916	1.963	1.685	1.685	1.783
	4.046	3.973	4.046	4.010	3.892	3.930	3.777
	6.478	6.524	6.385	6.339	6.935	6.740	6.984
	9.838	10.012	9.838	9.722	9.890	9.890	-
	12.660	12.587	12.587	12.805	12.515	12.897	12.363
	21.494	21.030	21.309	-	20.611	20.904	20.904
	30.348	30.000	29.884	-	30.281	-	30.647
q_e (mg/g)	4.942	4.942	4.919	4.884	4.811	4.762	4.774
	8.329	8.399	8.422	8.376	8.449	8.449	8.352
	11.021	11.093	11.021	11.057	11.103	11.065	11.218
	13.643	13.596	13.735	13.782	13.284	13.480	13.236
	15.371	15.197	15.371	15.487	15.263	15.263	-
	17.401	17.474	17.474	17.256	17.476	17.094	17.628
	18.654	19.118	18.840	-	19.341	19.048	19.048
	19.606	19.954	20.070	-	19.780	-	19.414

Table B12 The adsorption of Zn(II) at 40 °C (Zn(II) 5-50 mg/L, pH 6, 60 min)

	1	2	3	4	5	6	7
C_e (mg/L)	0.193	0.227	0.251	0.251	0.244	-	0.293
	1.870	1.847	1.777	1.870	1.661	1.612	1.490
	3.901	3.792	3.720	3.937	3.625	3.739	3.739
	6.060	6.060	6.153	6.339	6.642	6.642	6.886
	9.606	9.548	9.548	9.664	9.585	9.707	9.768
	12.587	12.224	12.369	12.732	12.134	-	12.515
	20.845	20.937	21.309	20.845	20.708	20.708	20.415
	29.652	29.884	29.536	-	30.281	29.915	30.281
q_e (mg/g)	5.058	5.023	5.000	5.000	4.872	-	4.823
	8.469	8.492	8.561	8.469	8.474	8.523	8.645
	11.166	11.275	11.347	11.130	11.371	11.256	11.256
	14.060	14.060	13.968	13.782	13.578	13.578	13.333
	15.603	15.661	15.661	15.545	15.568	15.446	15.385
	17.474	17.836	17.691	17.329	17.857	-	17.476
	19.304	19.211	18.840	19.304	19.243	19.243	19.536
	20.302	20.070	20.418	-	19.780	20.147	19.780

B.4 Adsorption of Cd(II) and Zn(II) in the binary system

Table B13 The adsorption of Cd(II) in binary system

Cd(II) (mg/L)	Zn(II) (mg/L)	Parameter	Cd(II) adsorption				
			1	2	3	4	5
5	5	C_e (mg/L)	1.187	1.195	1.145	1.237	1.178
		q_e (mg/g)	3.808	3.800	3.850	3.758	3.817
5	10	C_e (mg/L)	1.612	1.603	1.637	1.578	1.587
		q_e (mg/g)	3.375	3.383	3.350	3.408	3.400
5	15	C_e (mg/L)	-	1.887	1.878	1.895	1.878
		q_e (mg/g)	-	3.100	3.108	3.092	3.108
5	20	C_e (mg/L)	2.337	2.295	2.262	2.295	2.262
		q_e (mg/g)	2.667	2.708	2.742	2.708	2.742
5	25	C_e (mg/L)	2.437	2.445	2.462	2.487	2.503
		q_e (mg/g)	2.550	2.542	2.525	2.500	2.483
5	30	C_e (mg/L)	2.553	2.578	2.553	2.570	2.528
		q_e (mg/g)	2.450	2.425	2.450	2.433	2.475
10	5	C_e (mg/L)	3.607	3.523	3.457	3.590	-
		q_e (mg/g)	6.383	6.467	6.533	6.400	-
10	10	C_e (mg/L)	4.157	4.307	4.207	4.273	4.207
		q_e (mg/g)	5.850	5.700	5.800	5.733	5.800
10	15	C_e (mg/L)	4.857	4.957	4.840	4.907	4.823
		q_e (mg/g)	5.150	5.050	5.167	5.100	5.183
10	20	C_e (mg/L)	5.407	5.357	5.407	5.457	5.323
		q_e (mg/g)	4.583	4.633	4.583	4.533	4.667
10	25	C_e (mg/L)	5.490	5.540	5.490	5.557	5.523
		q_e (mg/g)	4.483	4.433	4.483	4.417	4.450
10	30	C_e (mg/L)	5.807	5.790	5.757	5.807	5.823
		q_e (mg/g)	4.167	4.183	4.217	4.167	4.150
15	5	C_e (mg/L)	6.755	6.472	6.495	6.684	6.542
		q_e (mg/g)	8.255	8.538	8.514	8.325	8.467
15	10	C_e (mg/L)	7.368	7.297	7.226	7.226	7.321
		q_e (mg/g)	7.642	7.712	7.783	7.783	7.689
15	15	C_e (mg/L)	8.028	7.981	7.958	8.005	8.005
		q_e (mg/g)	6.981	7.028	7.052	7.005	7.005
15	20	C_e (mg/L)	8.618	8.618	8.736	8.571	8.665
		q_e (mg/g)	6.368	6.368	6.250	6.415	6.321

Table B13 The adsorption of Cd(II) in binary system (Continued)

Cd(II) (mg/L)	Zn(II) (mg/L)	Parameter	1	2	3	4	5
15	25	C_e (mg/L)	9.042	9.019	8.995	9.042	8.948
		q_e (mg/g)	5.967	5.991	6.014	5.967	6.061
15	30	C_e (mg/L)	9.160	9.255	9.208	9.231	9.278
		q_e (mg/g)	5.825	5.731	5.778	5.755	5.708
20	5	C_e (mg/L)	9.491	9.371	9.340	9.280	9.431
		q_e (mg/g)	10.475	10.596	10.626	10.687	10.536
20	10	C_e (mg/L)	10.186	10.005	9.974	9.974	10.216
		q_e (mg/g)	9.751	9.932	9.962	9.962	9.721
20	15	C_e (mg/L)	11.182	11.122	11.091	10.971	10.971
		q_e (mg/g)	8.755	8.815	8.845	8.966	8.966
20	20	C_e (mg/L)	11.665	11.725	11.695	11.665	11.725
		q_e (mg/g)	8.423	8.362	8.392	8.423	8.362
20	25	C_e (mg/L)	12.088	12.057	12.238	12.148	12.178
		q_e (mg/g)	7.909	7.940	7.758	7.849	7.819
20	30	C_e (mg/L)	12.420	12.510	12.420	12.571	12.540
		q_e (mg/g)	7.608	7.517	7.608	7.457	7.487
25	5	C_e (mg/L)	11.895	12.052	11.973	12.013	11.895
		q_e (mg/g)	13.195	13.038	13.117	13.078	13.195
25	10	C_e (mg/L)	13.148	13.070	13.070	13.031	12.913
		q_e (mg/g)	12.020	12.099	12.099	12.138	12.255
25	15	C_e (mg/L)	13.814	13.892	13.970	13.696	13.931
		q_e (mg/g)	11.316	11.237	11.159	11.433	11.198
25	20	C_e (mg/L)	14.832	14.871	15.027	15.067	14.949
		q_e (mg/g)	10.376	10.337	10.180	10.141	10.258
25	25	C_e (mg/L)	15.536	15.380	15.576	15.497	15.341
		q_e (mg/g)	9.632	9.789	9.593	9.671	9.828
25	30	C_e (mg/L)	15.810	16.085	15.771	15.810	15.967
		q_e (mg/g)	9.280	9.005	9.319	9.280	9.123
30	5	C_e (mg/L)	15.211	15.211	15.016	15.162	15.211
		q_e (mg/g)	14.977	14.977	15.172	15.025	14.977
30	10	C_e (mg/L)	16.533	16.484	16.386	16.484	16.533
		q_e (mg/g)	13.655	13.704	13.802	13.704	13.655
30	15	C_e (mg/L)	17.267	17.365	17.512	17.120	17.365
		q_e (mg/g)	13.019	12.921	12.774	13.166	12.921

Table B13 The adsorption of Cd(II) in binary system (Continued)

Cd(II) (mg/L)	Zn(II) (mg/L)	Parameter	1	2	3	4	5
30	20	C_e (mg/L)	18.442	18.442	18.588	18.540	18.295
		q_e (mg/g)	11.795	11.795	11.648	11.697	11.942
30	25	C_e (mg/L)	19.029	18.882	18.931	-	19.078
		q_e (mg/g)	11.159	11.306	11.257	-	11.110
30	30	C_e (mg/L)	19.274	19.616	19.372	19.274	19.274
		q_e (mg/g)	10.963	10.621	10.865	10.963	10.963

Table B14 The adsorption of Zn(II) in binary system

Zn(II) (mg/L)	Cd(II) (mg/L)	Parameter	Zn(II) adsorption				
			1	2	3	4	5
5	5	C_e (mg/L)	1.900	1.912	1.837	1.837	1.862
		q_e (mg/g)	3.099	3.087	3.162	3.162	3.137
5	10	C_e (mg/L)	2.402	2.364	2.389	2.339	2.376
		q_e (mg/g)	2.622	2.660	2.635	2.685	2.647
5	15	C_e (mg/L)	2.903	2.924	2.895	2.981	2.839
		q_e (mg/g)	2.098	2.077	2.105	2.020	2.162
5	20	C_e (mg/L)	3.045	3.059	3.045	3.066	3.023
		q_e (mg/g)	1.956	1.942	1.956	1.935	1.977
5	25	C_e (mg/L)	3.152	3.191	3.114	3.101	3.088
		q_e (mg/g)	1.805	1.767	1.844	1.857	1.869
5	30	C_e (mg/L)	3.319	3.332	3.242	3.242	3.306
		q_e (mg/g)	1.690	1.677	1.767	1.767	1.703
10	5	C_e (mg/L)	4.627	4.577	4.678	4.778	4.552
		q_e (mg/g)	5.295	5.345	5.245	5.144	5.370
10	10	C_e (mg/L)	5.455	5.581	5.380	5.531	5.355
		q_e (mg/g)	4.467	4.341	4.542	4.391	4.567
10	15	C_e (mg/L)	6.303	6.246	6.161	6.303	6.232
		q_e (mg/g)	3.656	3.713	3.798	3.656	3.727
10	20	C_e (mg/L)	6.374	6.417	6.374	6.431	6.403
		q_e (mg/g)	3.556	3.514	3.556	3.499	3.528
10	25	C_e (mg/L)	6.484	6.382	6.484	6.484	6.433
		q_e (mg/g)	3.431	3.534	3.431	3.431	3.483

Table B14 The adsorption of Zn(II) in binary system (Continued)

Zn(II) (mg/L)	Cd(II) (mg/L)	Parameter	1	2	3	4	5
10	30	C_e (mg/L)	6.638	6.791	6.663	6.740	6.817
		q_e (mg/g)	3.406	3.252	3.380	3.303	3.227
15	5	C_e (mg/L)	8.132	8.289	8.328	8.210	8.289
		q_e (mg/g)	6.783	6.626	6.587	6.705	6.626
15	10	C_e (mg/L)	9.308	9.191	9.230	9.387	9.112
		q_e (mg/g)	5.607	5.725	5.685	5.529	5.803
15	15	C_e (mg/L)	10.115	10.182	10.093	10.048	10.048
		q_e (mg/g)	4.912	4.845	4.934	4.979	4.979
15	20	C_e (mg/L)	10.293	10.337	10.404	10.204	10.360
		q_e (mg/g)	4.712	4.667	4.601	4.801	4.645
15	25	C_e (mg/L)	10.371	10.491	10.531	10.691	10.571
		q_e (mg/g)	4.601	4.481	4.441	4.281	4.401
15	30	C_e (mg/L)	10.851	10.731	10.731	10.611	10.771
		q_e (mg/g)	4.121	4.241	4.241	4.361	4.201
20	5	C_e (mg/L)	12.467	12.517	12.216	12.467	12.366
		q_e (mg/g)	7.578	7.528	7.829	7.578	7.679
20	10	C_e (mg/L)	13.420	13.220	13.320	13.270	13.320
		q_e (mg/g)	6.575	6.775	6.675	6.725	6.675
20	15	C_e (mg/L)	14.000	14.057	14.085	14.142	14.000
		q_e (mg/g)	5.946	5.889	5.861	5.804	5.946
20	20	C_e (mg/L)	14.427	14.398	14.284	14.341	14.228
		q_e (mg/g)	5.576	5.605	5.718	5.661	5.775
20	25	C_e (mg/L)	14.351	14.709	14.812	14.351	14.658
		q_e (mg/g)	5.685	5.327	5.224	5.685	5.378
20	30	C_e (mg/L)	14.709	14.761	15.017	14.607	14.709
		q_e (mg/g)	5.378	5.327	5.070	5.480	5.378
25	5	C_e (mg/L)	16.211	16.085	16.148	16.399	16.148
		q_e (mg/g)	8.846	8.971	8.908	8.657	8.908
25	10	C_e (mg/L)	16.838	16.901	16.964	17.026	16.901
		q_e (mg/g)	8.218	8.156	8.093	8.030	8.156
25	15	C_e (mg/L)	18.105	18.176	17.891	18.033	17.856
		q_e (mg/g)	6.899	6.828	7.112	6.970	7.148
25	20	C_e (mg/L)	18.353	18.247	18.318	18.211	18.460
		q_e (mg/g)	6.579	6.686	6.615	6.721	6.472

Table B14 The adsorption of Zn(II) in binary system (Continued)

Zn(II) (mg/L)	Cd(II) (mg/L)	Parameter	1	2	3	4	5
25	25	C_e (mg/L)	18.643	18.579	18.771	18.707	18.771
		q_e (mg/g)	6.466	6.530	6.338	6.402	6.338
25	30	C_e (mg/L)	18.771	18.771	18.707	18.899	18.771
		q_e (mg/g)	6.274	6.274	6.338	6.146	6.274
30	5	C_e (mg/L)	19.793	19.793	19.871	20.263	20.263
		q_e (mg/g)	10.273	10.273	10.194	9.802	9.802
30	10	C_e (mg/L)	21.048	20.734	20.969	21.126	21.048
		q_e (mg/g)	9.097	9.410	9.175	9.018	9.097
30	15	C_e (mg/L)	21.919	21.831	22.008	22.053	22.142
		q_e (mg/g)	8.090	8.179	8.001	7.957	7.868
30	20	C_e (mg/L)	22.320	22.275	22.320	22.453	22.408
		q_e (mg/g)	7.735	7.779	7.735	7.601	7.646
30	25	C_e (mg/L)	22.663	22.663	22.583	22.823	-
		q_e (mg/g)	7.362	7.362	7.442	7.202	-
30	30	C_e (mg/L)	22.983	22.983	22.823	22.823	22.743
		q_e (mg/g)	7.042	7.042	7.202	7.202	7.282

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