Novel easily separable core-shell Fe_3O_4/PVP/ZIF-8 nanostructure adsorbent: Efficient removal and optimization of phosphorus from Fosfomycin pharmaceutical wastewater (Supplementary document)

Table S.1: The face centered adsorption model

File Version	13.0.7.0		
Study Type	Response Surface	**Subtype**	Randomized
Design Type	Central Composite	**Runs**	18.00
Design Model	Quadratic	**Blocks**	No Blocks

Table S.2: The coded and uncoded independent parameters

Factors	Name	Units	Type	Subtype	Minimum	Maximum	Coded Low	Coded High
A	Dose	gm/100 ml	Numeric	Continuous	0.1000	0.5000	-1 ↔ 0.10	+1 ↔ 0.50
B	Phosphorus initial concentration	ppm	Numeric	Continuous	30.00	900.00	-1 ↔ 30.00	+1 ↔ 900.00
C	Time	minutes	Numeric	Continuous	30.00	180.00	-1 ↔ 30.00	+1 ↔ 180.00

Table S.3: The responses of the optimization models

Response	Name	Units	Observations	Minimum	Maximum
R	% Phosphorus removal	%	18.00	17.2444	100

Table S.4: summary of the fitting for the model

Source	Sequential p-value	Lack of Fit p-value	Adjusted R^2	Predicted R^2	
Linear	**< 0.0001**	**< 0.0001**	**0.7722**	**0.6649**	**Suggested**
2FI	0.2162	< 0.0001	0.8034	0.6186	
Quadratic	0.7749	< 0.0001	0.7629	0.2770	
Cubic	0.4903	< 0.0001	0.7659	-76.4722	**Aliased**

Table S.5: 87 solutions that were suggested by the first model

Number	Dose	Phosphorus initial concentration	Time	Phosphorus final concentration	% Phosphorus removal	Desirability	
1	**0.340**	**30.225**	**154.022**	**5.805**	**100.000**	**1.000**	**Selected**
2	0.342	30.800	150.250	5.805	100.000	1.000	
3	0.362	37.155	108.393	5.805	100.000	1.000	
4	0.348	32.825	136.909	5.805	100.000	1.000	
5	0.357	35.405	119.909	5.805	100.000	1.000	
6	0.384	43.961	63.570	5.805	100.000	1.000	
7	0.355	34.893	123.289	5.805	100.000	1.000	
8	0.351	33.517	132.356	5.805	100.000	1.000	
9	0.375	41.312	81.006	5.805	100.000	1.000	
10	0.365	37.930	103.282	5.805	100.000	1.000	
11	0.363	37.341	107.181	5.805	100.000	1.000	
12	0.354	34.537	125.624	5.805	100.000	1.000	
13	0.395	47.483	40.367	5.805	100.000	1.000	
14	0.362	36.979	109.559	5.805	100.000	1.000	

15	0.352	34.021	129.026	5.805	100.000	1.000	
16	0.361	36.619	111.910	5.805	100.000	1.000	
17	0.374	40.758	84.665	5.805	100.000	1.000	
18	0.380	42.739	71.639	5.805	100.000	1.000	
19	0.377	41.804	77.771	5.805	100.000	1.000	
20	0.382	43.490	66.693	5.805	100.000	1.000	
21	0.398	48.507	33.644	5.805	100.000	1.000	
22	0.393	46.825	44.719	5.805	100.000	1.000	
23	0.380	42.824	71.070	5.805	100.000	1.000	
24	0.369	39.277	94.439	5.805	100.000	1.000	
25	0.346	32.079	141.837	5.805	100.000	1.000	
26	0.391	46.287	48.271	5.805	100.000	1.000	
27	0.381	42.936	70.333	5.805	100.000	1.000	
28	0.382	43.369	67.474	5.805	100.000	1.000	
29	0.360	36.358	113.645	5.805	100.000	1.000	
30	0.386	44.580	59.488	5.805	100.000	1.000	
31	0.364	37.686	104.914	5.805	100.000	1.000	
32	0.372	40.270	87.884	5.805	100.000	1.000	
33	0.378	42.256	74.827	5.805	100.000	1.000	
34	0.348	32.567	138.628	5.805	100.000	1.000	
35	0.399	48.685	32.471	5.805	100.000	1.000	
36	0.392	46.595	46.255	5.805	100.000	1.000	
37	0.347	32.241	140.778	5.805	100.000	1.000	

38	0.363	37.527	105.961	5.805	100.000	1.000	
39	0.389	45.530	53.242	5.805	100.000	1.000	
40	0.379	42.409	73.805	5.805	100.000	1.000	
41	0.377	41.941	76.881	5.805	100.000	1.000	
42	0.374	40.992	83.148	5.805	100.000	1.000	
43	0.381	43.211	68.520	5.805	100.000	1.000	
44	0.353	34.413	126.495	5.805	100.000	1.000	
45	0.390	45.931	50.557	5.805	100.000	1.000	
46	0.352	33.923	129.722	5.805	100.000	1.000	
47	0.385	44.202	61.975	5.805	100.000	1.000	
48	0.341	30.344	153.306	5.805	100.000	1.000	
49	0.365	38.033	102.698	5.805	100.000	1.000	
50	0.389	45.459	53.783	5.805	100.000	1.000	
51	0.385	44.442	60.256	5.805	99.998	1.000	
52	0.339	30.003	155.784	5.805	100.000	1.000	
53	0.343	31.224	148.086	5.805	100.000	1.000	
54	0.339	30.001	157.520	5.805	100.000	1.000	
55	0.338	30.003	159.398	5.805	100.000	1.000	
56	0.337	30.004	162.778	5.805	100.000	1.000	
57	0.335	30.006	167.559	5.806	100.000	1.000	
58	0.334	30.002	169.297	5.806	100.000	0.999	
59	0.398	47.609	31.252	5.805	99.910	0.999	
60	0.334	30.005	170.768	5.806	100.000	0.999	

61	0.333	30.000	173.671	5.807	100.000	0.999	
62	0.341	30.001	149.500	5.805	99.903	0.999	
63	0.397	47.284	30.001	5.805	99.873	0.999	
64	0.331	30.000	178.058	5.807	100.000	0.999	
65	0.335	30.001	165.637	5.806	99.948	0.999	
66	0.332	30.003	175.597	5.807	99.987	0.999	
67	0.331	30.490	179.995	5.808	100.000	0.999	
68	0.334	35.419	179.933	5.820	99.996	0.998	
69	0.390	42.452	30.001	5.805	99.529	0.997	
70	0.328	30.004	179.999	5.813	99.784	0.997	
71	0.380	35.960	30.007	5.805	99.065	0.994	
72	0.417	73.670	30.001	5.914	100.000	0.994	
73	0.347	53.688	179.999	5.940	100.000	0.993	
74	0.321	30.008	179.984	5.845	99.204	0.992	
75	0.426	85.586	30.003	6.046	99.993	0.991	
76	0.354	63.326	179.999	6.051	100.000	0.991	
77	0.425	85.077	30.005	6.047	99.953	0.991	
78	0.370	30.000	30.000	5.806	98.504	0.990	
79	0.361	73.429	179.998	6.204	100.000	0.988	
80	0.437	100.899	30.000	6.287	100.000	0.987	
81	0.367	81.131	180.000	6.345	100.000	0.986	
82	0.372	87.974	178.872	6.484	100.000	0.985	
83	0.382	103.299	179.998	6.869	100.000	0.981	

84	0.460	133.312	30.001	7.078	100.000	0.979	
85	0.475	155.497	30.001	7.837	100.000	0.974	
86	0.299	30.001	179.997	6.142	97.172	0.972	
87	0.471	228.608	179.977	13.158	99.988	0.949	

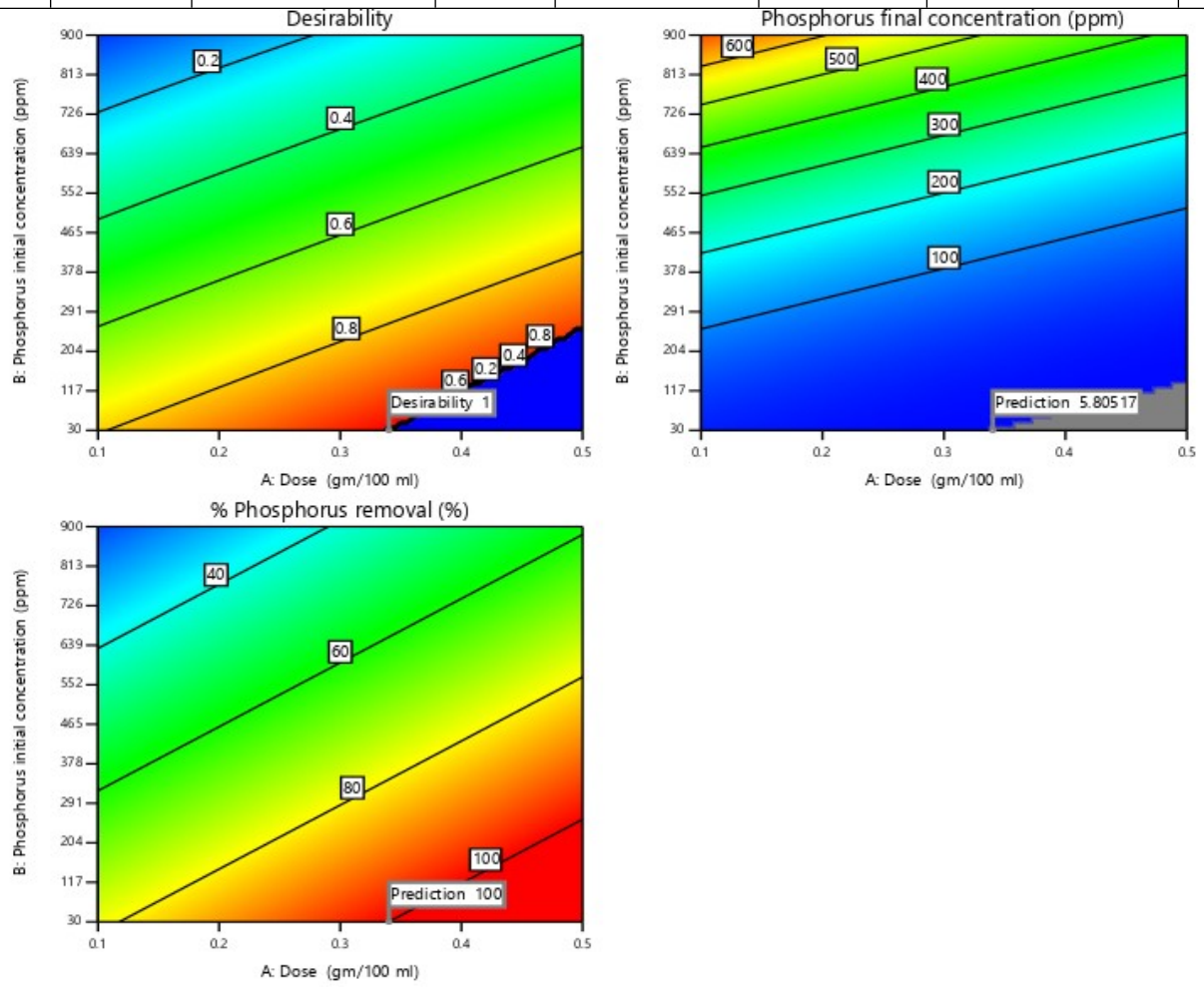

Figure S.1: Contours of the 1st model

Table S.6: 22 solutions that were suggested by the 2nd model

Number	Dose	Phosphorus initial	Time	Phosphorus final concentration	% Phosphorus removal	Desirability

		concentration				
1	**0.100**	**327.845**	**30.000**	**153.089**	**55.225**	**0.650**
2	0.100	325.446	30.010	151.615	55.378	0.650
3	0.100	332.009	30.001	155.656	54.961	0.650
4	0.100	339.548	30.000	160.381	54.478	0.650
5	0.100	321.014	30.134	148.899	55.665	0.650
6	0.102	335.484	30.001	157.067	54.902	0.650
7	0.100	343.509	30.000	162.891	54.225	0.650
8	0.100	314.971	30.151	145.254	56.051	0.650
9	0.100	310.730	30.000	142.741	56.317	0.650
10	0.105	332.396	30.000	153.862	55.380	0.650
11	0.102	309.003	30.000	141.097	56.569	0.650
12	0.105	316.272	30.001	144.063	56.412	0.650
13	0.100	324.090	30.961	150.682	55.498	0.650
14	0.100	302.500	30.001	137.897	56.842	0.650
15	0.108	328.667	30.000	150.317	55.895	0.650
16	0.100	330.004	31.798	154.229	55.149	0.649
17	0.100	312.129	32.126	143.356	56.300	0.649
18	0.118	341.083	30.002	153.761	56.022	0.648
19	0.121	333.150	30.001	147.737	56.789	0.648
20	0.122	338.268	30.001	150.646	56.507	0.648
21	0.160	334.697	30.000	133.432	60.184	0.642
22	0.100	259.483	41.682	112.968	59.980	0.637

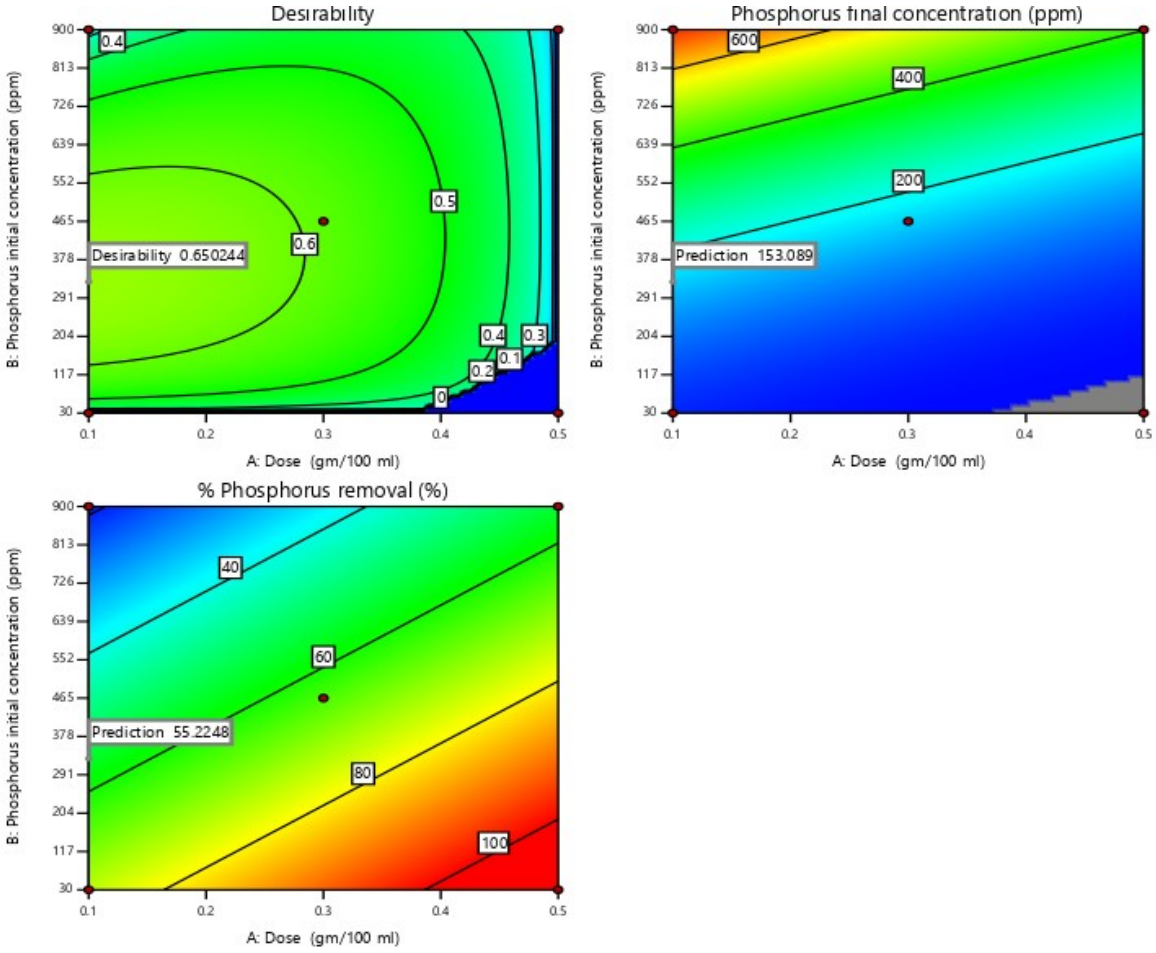

Figure S.2: Contours of 2nd model

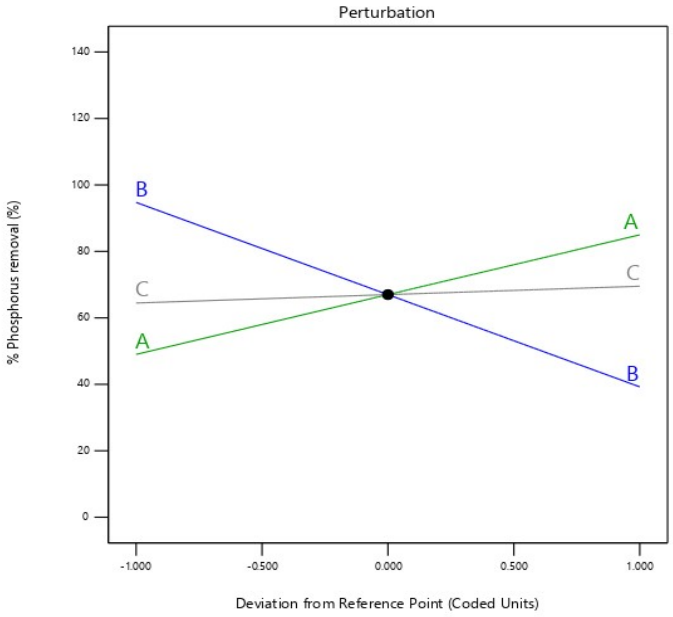

Figure S.3: Perturbation

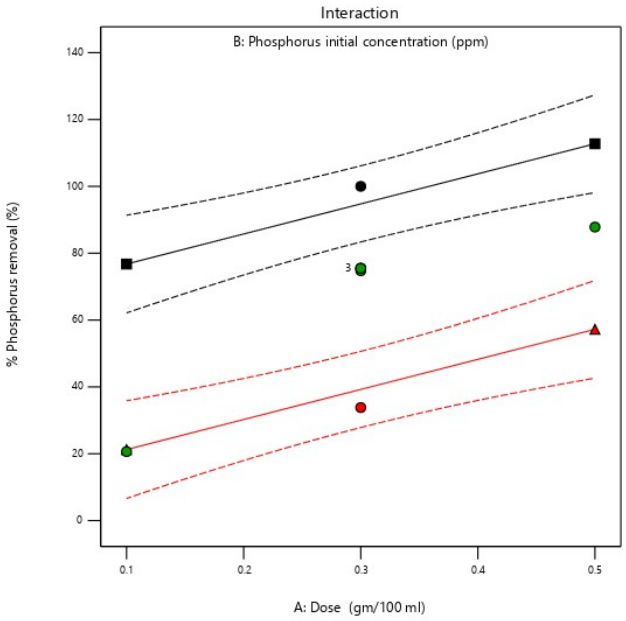

Figure S.4: Interaction between parameters