

SUPPLEMENTARY MATERIAL

Synergistic removal of textile dyes in water through combined hydrotalcite adsorption and H₂O₂/UV treatment

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Table S1. Characteristics of the UV reactor employed in this study and chemical composition of H₂O₂ solution.

UV reactor	- Lamp power: 12 W - Maximum pressure: 125 psi - 4-pole mercury lamp - Working volume: 270 ml - Reactor dimensions: 315 x 50.8 cm
Hydrogen peroxide	- Concentration: 30% - Free acids (H₂SO₄) < 0.01% - Cl < 0.001% - PO₄ < 0.003% - SO₄ < 0.001% - Heavy metals < 0.00005% - N < 0.005% - As < 0.00005% - Fe < 0.00005%

Table S2. Kinetic parameters obtained for methyl orange and crystal violet adsorption onto Mg–Al LDH.

Dye	LDH (mg mL ⁻¹)	Model	Parameter 1	Parameter 2	(R ²)	RMSE (mg g ⁻¹)
MO	1.25	PFO	$q_e = 15.723 \text{ mg g}^{-1}$	$k_1 = 0.2196 \text{ min}^{-1}$	0.9994	0.147
MO	1.25	PSO	$q_e = 18.820 \text{ mg g}^{-1}$	$k_2 = 0.01396 \text{ g mg}^{-1} \text{ min}^{-1}$	0.9982	0.249
MO	1.25	IPD	$k_{id} = 3.618 \text{ mg g}^{-1} \text{ min}^{-1/2}$	$C = 1.079 \text{ mg g}^{-1}$	0.9531	1.254
MO	2.50	PFO	$q_e = 7.568 \text{ mg g}^{-1}$	$k_1 = 0.4306 \text{ min}^{-1}$	0.9944	0.221
MO	2.50	PSO	$q_e = 8.114 \text{ mg g}^{-1}$	$k_2 = 0.1148 \text{ g mg}^{-1} \text{ min}^{-1}$	0.9971	0.158
MO	2.50	IPD	$k_{id} = 1.758 \text{ mg g}^{-1} \text{ min}^{-1/2}$	$C = 1.023 \text{ mg g}^{-1}$	0.8669	1.077
CV	1.25	PFO	$q_e = 2.413 \text{ mg g}^{-1}$	$k_1 = 0.04249 \text{ min}^{-1}$	0.9882	0.094
CV	1.25	PSO	$q_e = 3.169 \text{ mg g}^{-1}$	$k_2 = 0.01257 \text{ g mg}^{-1} \text{ min}^{-1}$	0.9921	0.077
CV	1.25	IPD	$k_{id} = 0.2940 \text{ mg g}^{-1} \text{ min}^{-1/2}$	$C = 0.0353 \text{ mg g}^{-1}$	0.9935	0.069
CV	2.50	PFO	$q_e = 1.399 \text{ mg g}^{-1}$	$k_1 = 0.03126 \text{ min}^{-1}$	0.9862	0.053
CV	2.50	PSO	$q_e = 1.957 \text{ mg g}^{-1}$	$k_2 = 0.01308 \text{ g mg}^{-1} \text{ min}^{-1}$	0.9893	0.047
CV	2.50	IPD	$k_{id} = 0.1539 \text{ mg g}^{-1} \text{ min}^{-1/2}$	$C = -0.0024 \text{ mg g}^{-1}$	0.9944	0.034

Table S3. Estimated regression coefficients, statistical significance, and goodness-of-fit parameters of the reduced polynomial model for methyl orange and crystal violet decolorization.

	Methyl orange						
Factor	Term	Regressn	Std. Err.	<i>p</i>	t	-95%	+95%
Mean/Interc.	β_0	88.33	2.18	0.00061	40.4121	78.9285	97.7381
LDH (L)	x_1	23.75	1.89	0.00629	12.5464	15.6052	31.8948
LDH (Q)	x_1^2	-18.79	1.97	0.01081	-9.5376	-27.2690	-10.3143
UV (L)	x_2	9.25	1.89	0.03942	4.8865	1.1052	17.3978
H ₂ O ₂ (L)	x_3	-9.75	1.89	0.03569	-5.1506	-17.8948	-1.6052
1L by 2L	x_1x_2	-18.75	1.89	0.01004	-9.9051	-26.8948	-10.6052
1L by 3L	x_1x_3	-21.25	1.89	0.00784	-11.2257	-29.3948	-13.1052
1Q by 3L	$x_1^2x_3$	28.00	2.68	0.0090	10.4592	16.4815	39.5185
R ²	0.9630						
Adjusted R ²	0.9261						
	Crystal violet						
Factor	Term	Regressn	Std. Err.	<i>p</i>	t	-95%	+95%
Mean/Interc.	β_0	99.00	0.57	0.00003	171.4730	96.5159	101.4841
LDH (L)	x_1	22.75	0.50	0.00048	45.5000	20.5987	24.9013
LDH (Q)	x_1^2	-13.87	0.52	0.00140	-26.6613	-16.1142	-11.6358
UV (L)	x_2	12.50	0.50	0.00156	25.0000	10.3487	14.6513
UV (Q)	x_2^2	-10.62	0.52	0.00239	-20.4163	-12.8642	-8.3858
H ₂ O ₂ (L)	x_3	15.00	0.50	0.00111	30.0000	12.8487	17.1513
H ₂ O ₂ (Q)	x_3^2	-15.37	0.52	0.00114	-29.5436	-17.6142	-13.1358
1L by 2L	x_1x_2	-18.00	0.50	0.00077	-36.0000	-20.1513	-15.8487
1Q by 2L	$x_1^2x_2$	7.50	0.70	0.00877	10.6066	4.4576	10.5424
1L by 3L	x_1x_3	-13.25	0.50	0.00142	-26.5000	-15.4013	-11.0987
2L by 3L	x_2x_3	-16.50	0.50	0.00092	-33.0000	-18.6513	-14.3487
R ²	0.9987						
Adjusted R ²	0.9954						

(*) p-values > 0.05 are considered non-significant and not shown on the table.

Table S4. Comparison of the color reduction predicted by the model with the experimental values obtained for the same conditions.

Experiment number	Methyl orange removal (%)		Crystal violet removal (%)	
	Experimental	Predicted	Experimental	Predicted
1	95	89	28	29
2	98	107	87	87
3	60	69	92	92
4	94	88	84	84
5	2	17	14	14
6	76	74	90	90
7	98	103	95	95
8	97	84	99	99
9	6	6	16	19
10	85	85	78	75
11	96	96	88	91
12	90	90	97	94
13	90	88	99	99
14	91	88	99	99
15	84	88	99	99

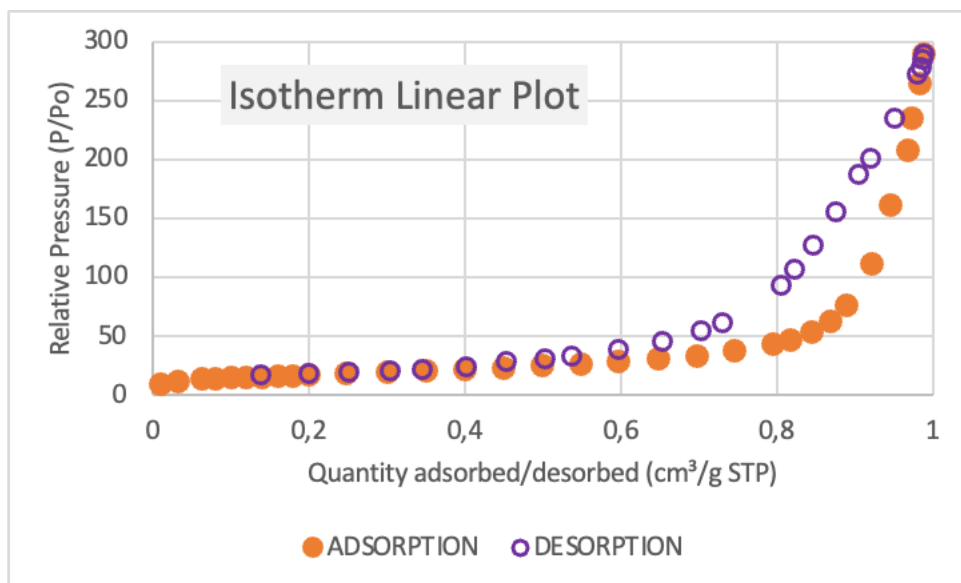
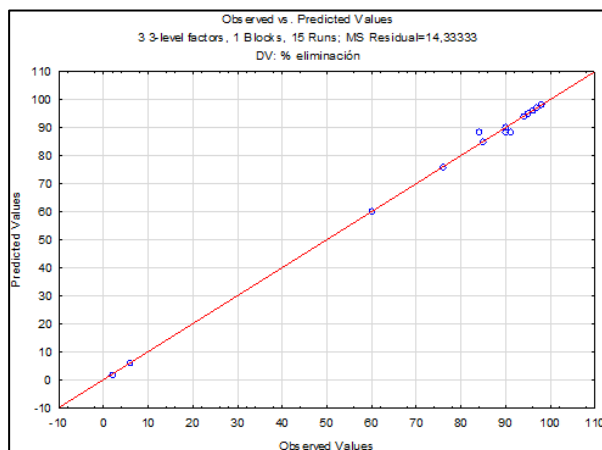
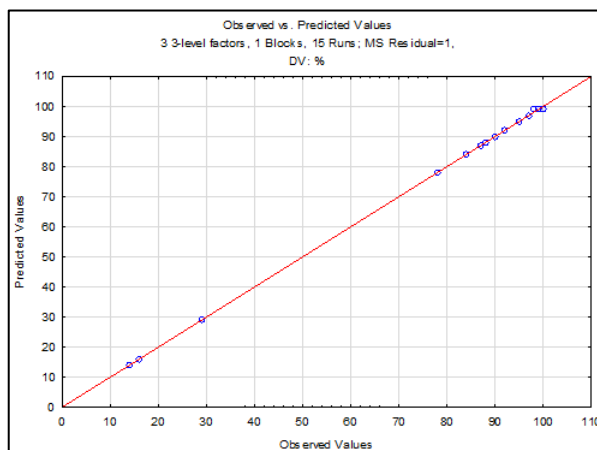


Figure S1. Isotherm linear plot for N₂ adsorption/desorption on LDH.



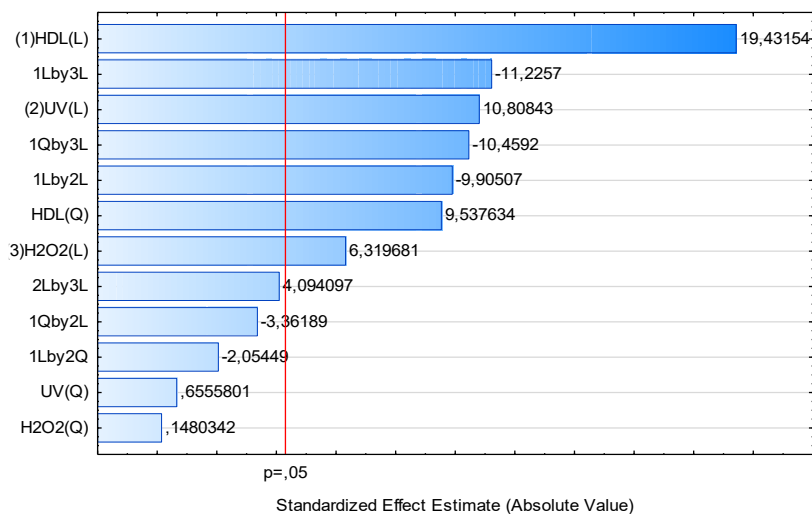
(a)



(b)

Figure S2 Predicted data (red line) vs. experimentally obtained data (blue dots) for the 15 Box-Behnken experiments. a) Results for dependent variable y_1 (methyl orange reduction); b) results for dependent variable y_2 (crystal violet reduction).

a)



b)

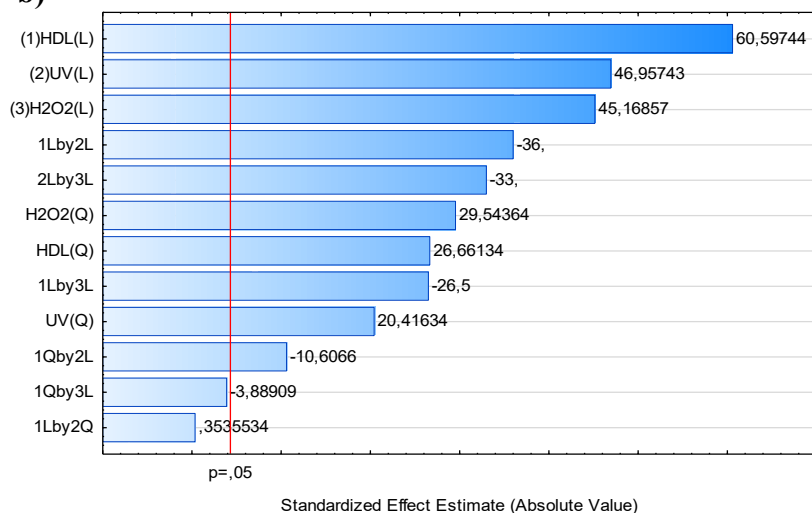


Figure S3. Pareto chart showing the standardized effect of independent variables and their interaction on the removal efficiency of a) methyl orange and b) crystal violet. The vertical red line indicates the threshold for considering the effect significant. (L: linear response; Q: quadratic response).