

Supplementary Materials

Integrated photocatalytic oxidation and adsorption process for robust treatment

Refinery wastewater using hybrid TiO_2/AC .

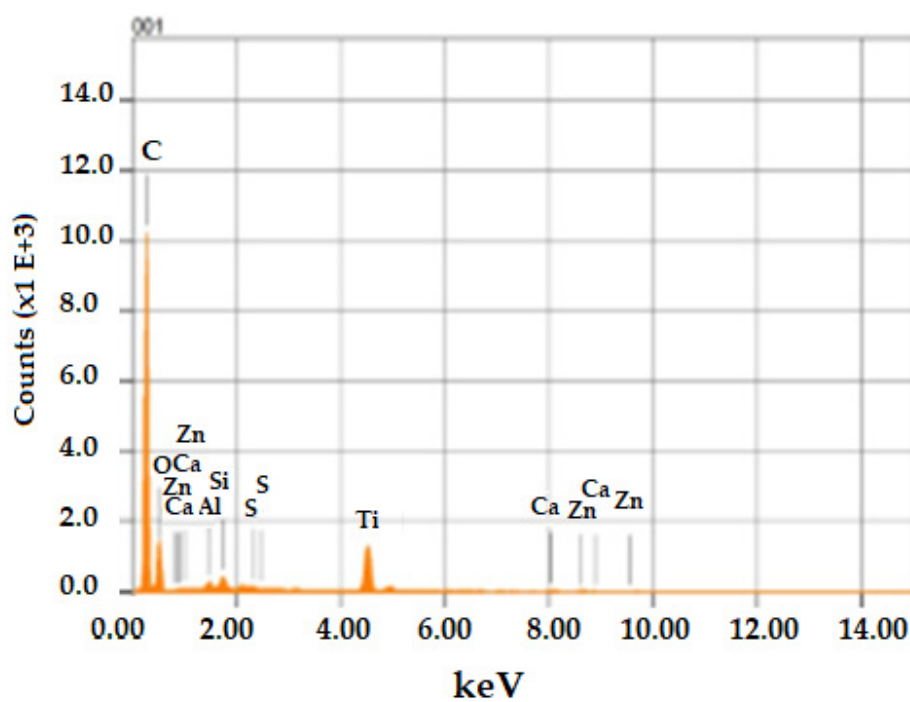


Fig. S1 EDX profile of TiO_2/AC .

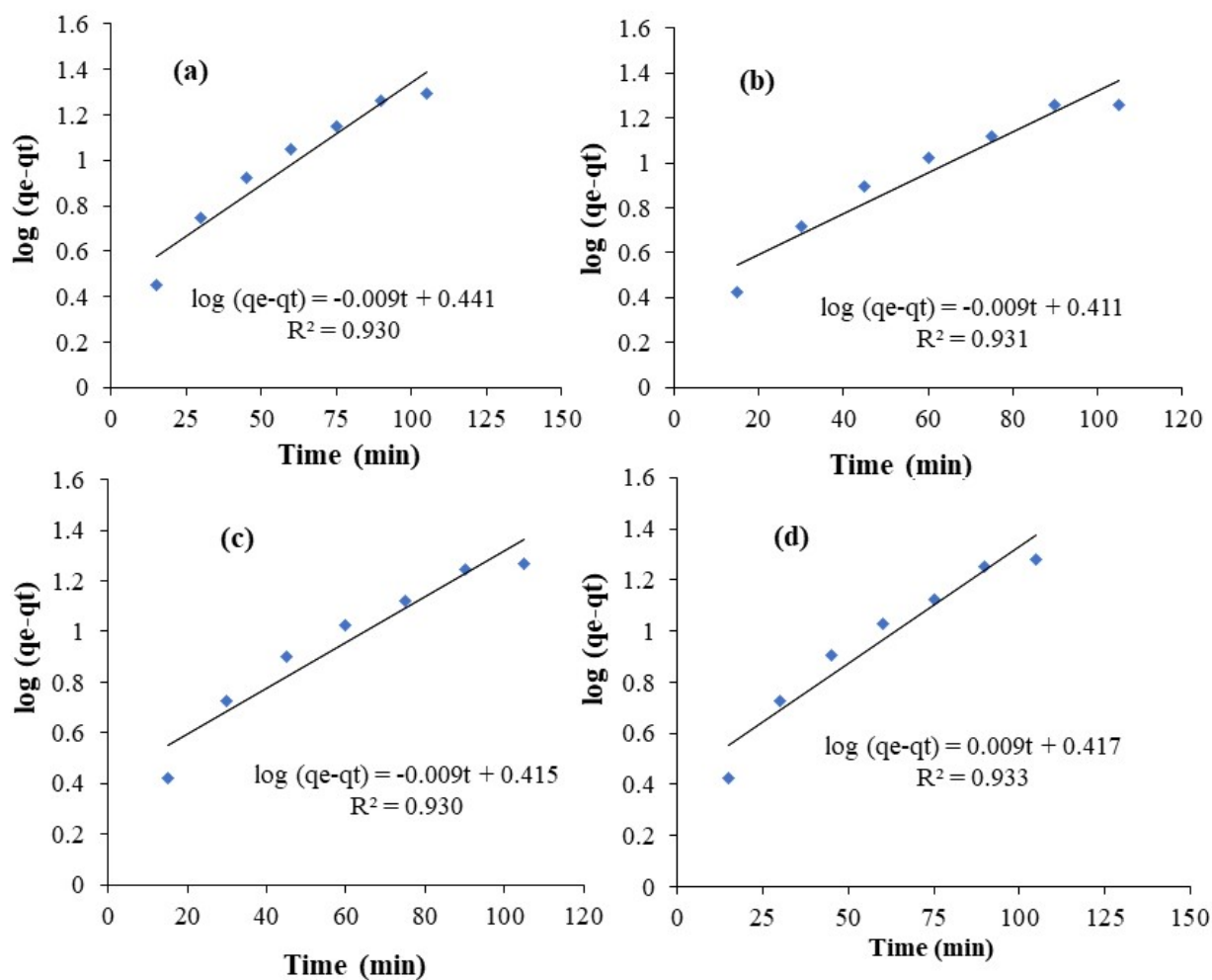


Fig. S2. First order kinetic plots for adsorption of (a) benzene (b) toluene (c) phenol and (d) naphthalene over activated carbon.

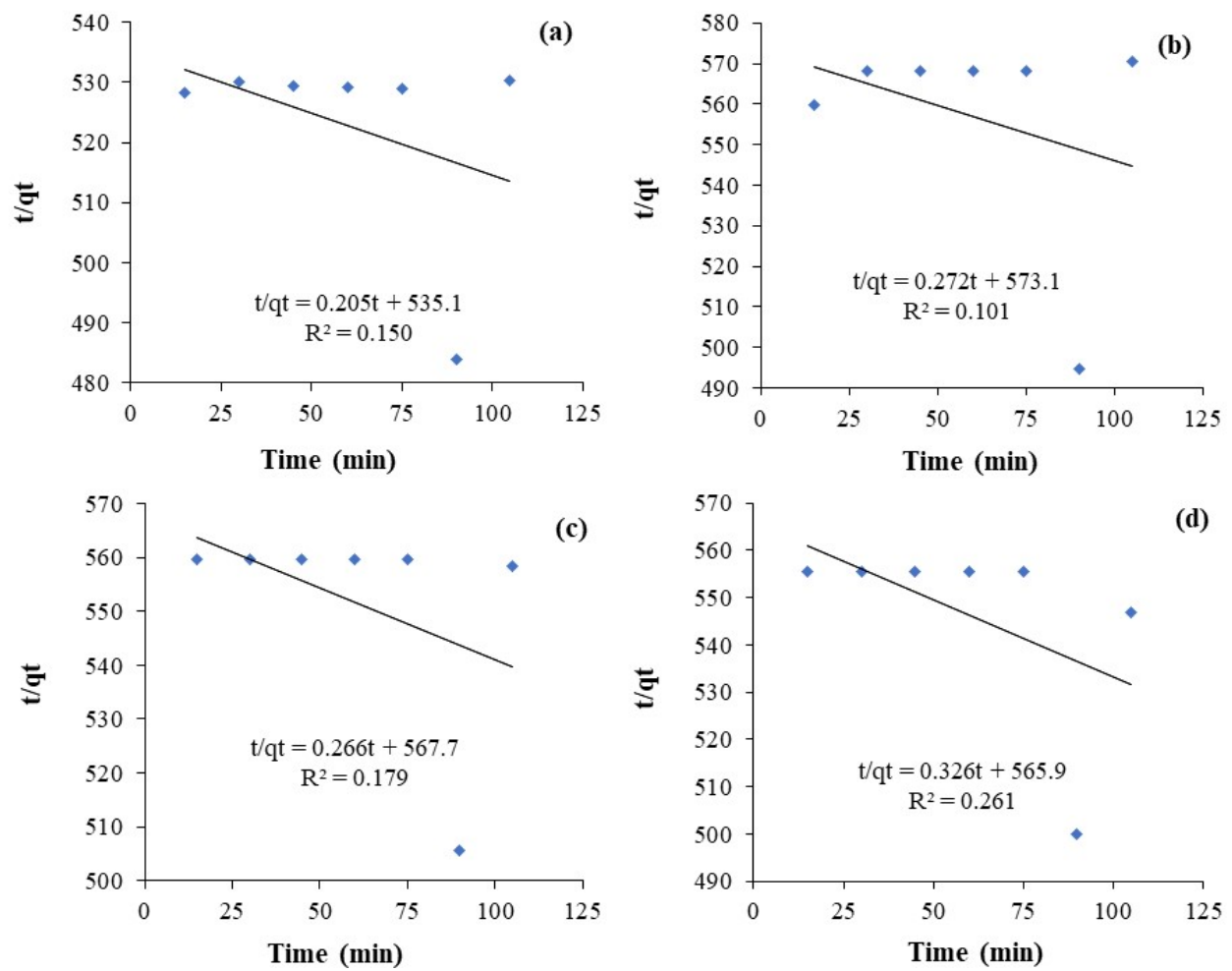


Fig. S3 Second order kinetic plots for adsorption of (a) benzene (b) toluene (c) phenol and (d) naphthalene over activated carbon.

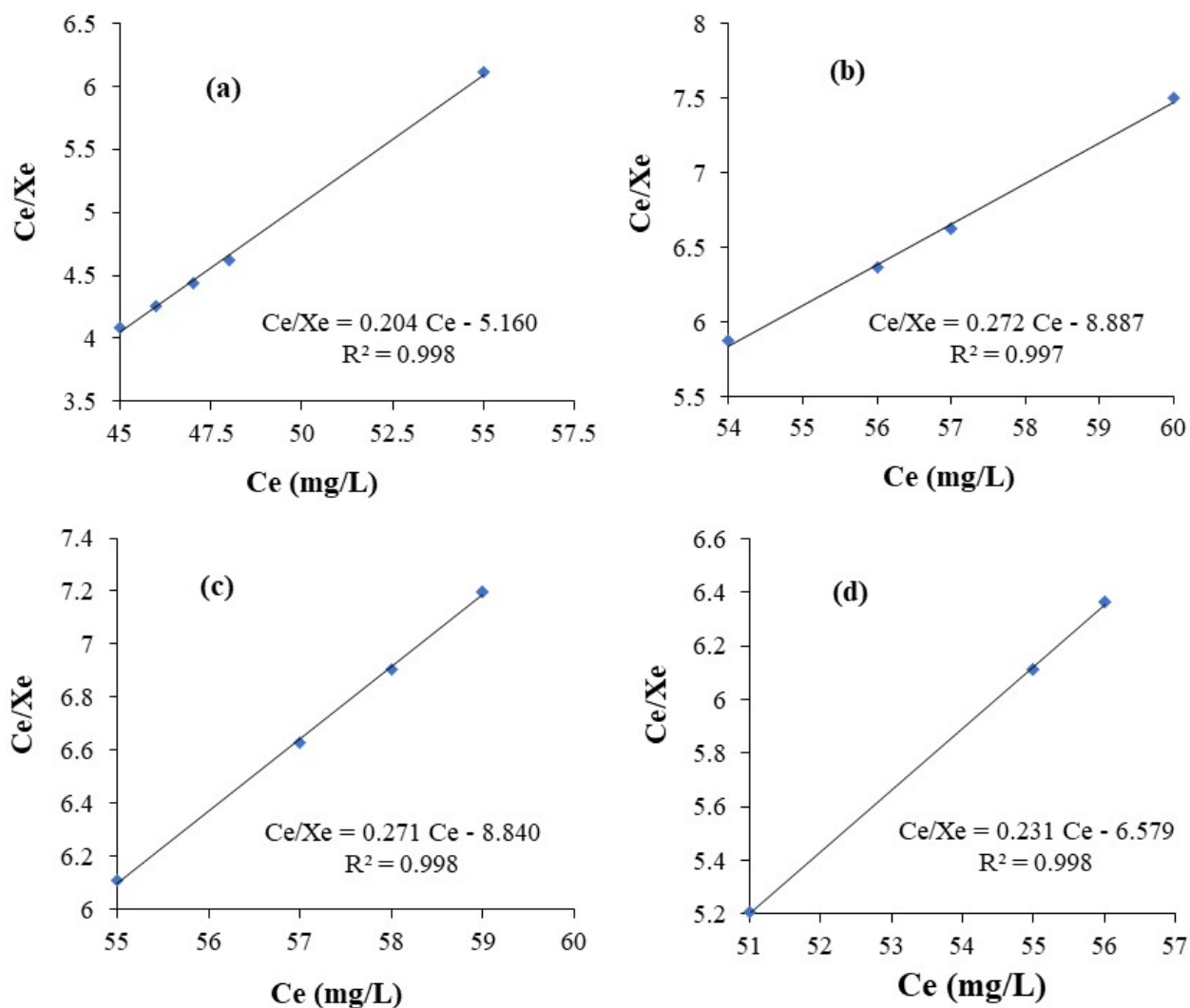


Fig. S4. Langmuir isotherms for Benzene (a), Toluene (b), Phenol (c) and Naphthalene (d) adsorption over activated carbon.

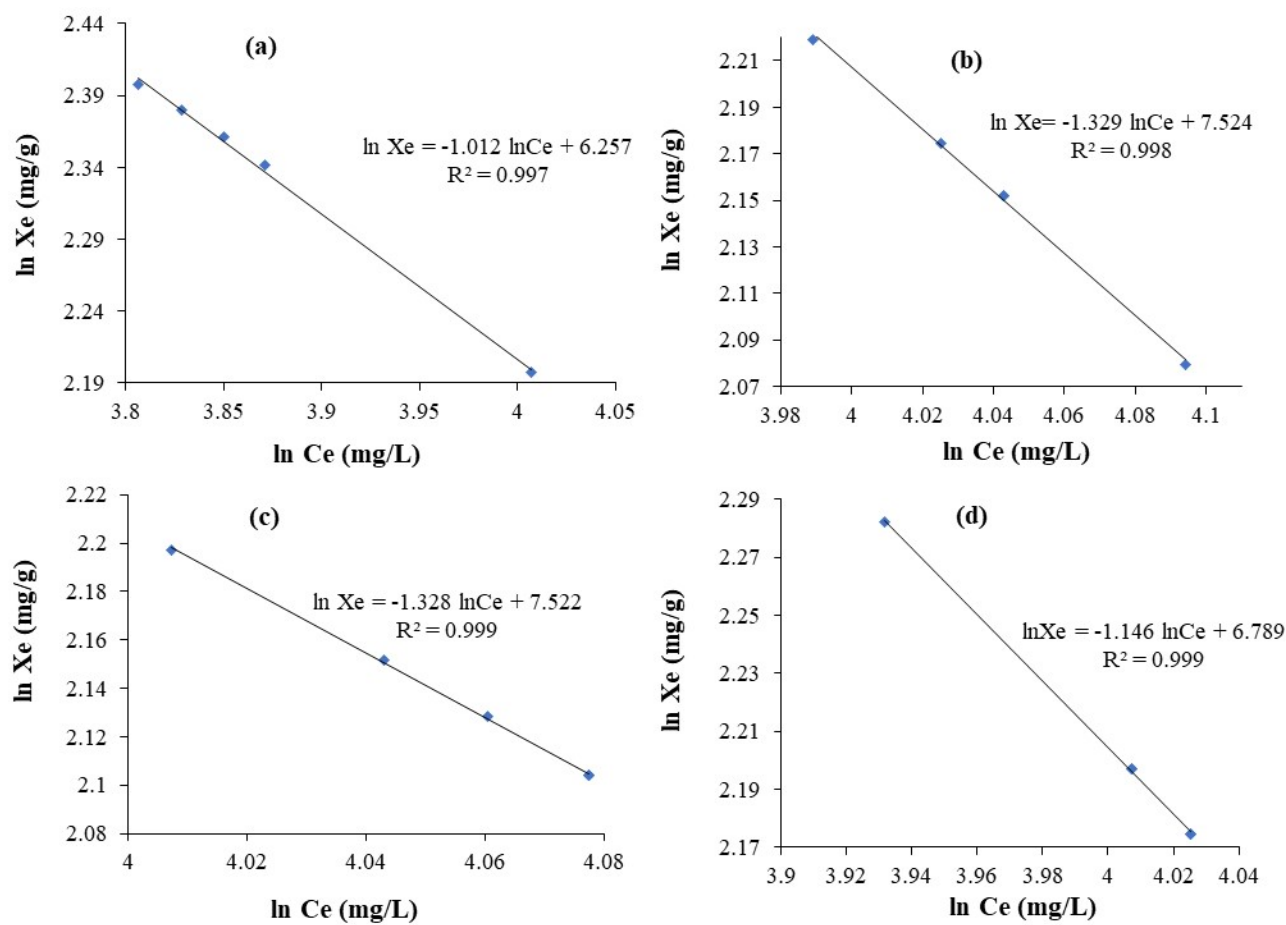


Fig. S5. Freundlich isotherms for Benzene (a), Toluene (b), Phenol (c) and Naphthalene (d) adsorption over activated carbon.

Table S1. Physiochemical characteristics of refinery wastewater collected from ARL

Parameter	Unit	Values	Standard limit [1-3]
Density	g/cm ³	1.01	-
pH		9.2	6-9
Turbidity	NTU	55	-
Electrical conductivity	µs/cm	2230	-
Phenol content	mg/L	15	-
Total Organic Carbon	mg/L	450	-
BOD	mg/L	1400	-
COD	mg/L	970	100-200
Suspended solids	mg/L	42.3	30-70
Total dissolved solid	mg/L	1220	-

Table. S2 Hydrocarbons identified by GC-MS analysis in untreated and treated refinery wastewater sample.

Retention time (min)	Compound name	Peak area (%)			
		A*	B	C	D
1.3	Toluene	0.94456	-	-	-
1.79	Cyclopentane, (2-methylbutyl)	0.61027	-	-	-
2.14	p-Xylene	2.24185	-	-	-
2.43	Nonane	1.98624	-	-	-
2.83	1-Dodecanol, 3,7,11-trimethyl	1.70494	-	-	-
3.24	Benzene, 1-ethyl-3-methyl	5.10822	-	-	-
3.67	Benzene, (1,3,3-trimethylnonyl)	5.92839	-	-	-
3.71	Stearic acid, 3-(octadecyloxy)propyl ester	-	0.00729	-	-
4.03	Benzene, 1,3-diethyl	3.27144	-	-	-
4.48	Benzene, 1,3-diethyl	3.05869	-	-	-
5.09	Undecane	6.01362	-	-	-
5.95	Octadecane, 1-chloro-	2.05911	-	-	-
6.48	Dodecane	5.95515	-	-	-
7.46	Tetradecane, 2,6,10-trimethyl-	3.85526	-	-	-
7.8	Tridecane	7.55008	-	-	-
7.84	Cyclopenta-dodecahydro-pentamethyl pentaacetate	-	0.00926	-	-
8.82	Tetradecane, 2,6,10-trimethyl	3.12976	-	-	-
9.13	Tetradecane	8.01044	-	-	-
9.13	9,12,15-Octadecatrienoic acid	-	0.01503	-	-
9.88	Hexadecane	3.80074	-	-	-
10.35	Pentadecane	4.47568	-	-	-
10.94	Naphthalene, 2,3,6-trimethyl-	3.91445	-	-	-
11.49	Hexadecane	3.99691	-	-	-
12.04	Octadecane	2.74804	-	-	-
12.63	Heptadecane	5.05087	-	-	-
13.2	Cyclohexane, (1-octylnonyl)-	1.46599	-	-	-
13.67	Octadecane	2.68821	-	-	-
14.26	Cholesta-5,7,9(11)-trien-3-ol acetate	0.65371	-	-	-
14.65	17-Pentatriacontene	1.7999	-	-	-
15.58	Eicosane	0.8766	-	-	-
15.97	Phenanthrene, 2,3-dimethyl-	0.31014	-	-	-
16.26	N-Normethadol	0.08388	-	-	-
16.52	Heneicosane	0.54233	-	-	-
17.01	Phenanthrene, 2,3,5-trimethyl-	0.58692	-	-	-

17.38	Docosane	0.60736	-	-	-
18.23	Tricosane	0.37202	-	-	-
18.54	Olean-12-ene-3,16,21,22,23,28-hexol	0.03436	-	-	-
19.03	Tetracosane	0.30716	-	-	-
19.31	1-Hexacosanol	0.03247	-	-	-
19.8	Pentacosane	0.41845	-	-	-
20.23	Oleic acid, 3-(octadecyloxy)propyl ester	0.13348	-	-	-
20.55	Nonacosane	0.28062	-	-	-
20.98	Tetracosahexaene 2,6,10,15,19,23-hexamethyl	0.05879	-	-	-
21.27	Heptacosane	0.22003	-	-	-
21.53	17-Pentatriacontene	0.10788	-	-	-
21.98	Tetratetracontane	0.39009	-	-	-
22.65	Cholestan-3-ol, 5-chloro-6-nitro	0.31007	-	-	-
23.32	Cholestan-26-oic acid 3,7,12-trihydroxy	0.37756	-	-	-
23.97	Octadecane, 3-ethyl-5-(2-ethylbutyl)	1.89004	-	-	-

*(A) Refinery wastewater sample, (B) Refinery wastewater treated by adsorption over AC, (C) Refinery wastewater treated by photo-oxidation by UV/TiO₂ (D) Refinery wastewater treated by integrated photo-oxidation and adsorption over TiO₂/AC.

Refernces

- [1] M.L. Hami, M. Al-Hashimi, M. Al-Doori, Effect of activated carbon on BOD and COD removal in a dissolved air flotation unit treating refinery wastewater, *Desalination*, 216 (2007) 116-122.
- [2] F. Ma, J.-b. Guo, L.-j. Zhao, C.-c. Chang, D. Cui, Application of bioaugmentation to improve the activated sludge system into the contact oxidation system treating petrochemical wastewater, *Bioresour. Technol.* 100 (2009) 597-602.
- [3] F. Santos, E. Azevedo, M. Dezotti, Photocatalysis as a tertiary treatment for petroleum refinery wastewaters, *Braz. J. Chem. Eng.* 23 (2006) 451-460.