

## Article

# Effect of Operational Parameters on the Removal of Carbamazepine and Nutrients in a Submerged Ceramic Membrane Bioreactor

hanh-Chau Dao <sup>1,2</sup>, Chih-Chi Yang <sup>1</sup>, Ku-Fan Chen <sup>1</sup> and Yung-Pin Tsai <sup>1,\*</sup>

<sup>1</sup> Department of Civil Engineering, National Chi Nan University, Nantou Hsien 54561, Taiwan; daokhanhchau07@gmail.com (K.C.D.); chi813@gmail.com (C.C.Y.); kfchen@ncnu.edu.tw (K.F.C.)

<sup>2</sup> Dong Nai Technology University, Bien Hoa, Dong Nai 810000, Vietnam

\* Correspondence: yptsai@ncnu.edu.tw; Tel.: +886-49-2910960 (ext. 4121)

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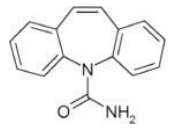


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**Figure S1.** MBR experimental setup in practice.

**Table S1.** Physico-chemical and pharmacological properties of CBZ.

Chemical structure	
Molecular formula	C <sub>15</sub> H <sub>12</sub> N <sub>2</sub> O
Molecular weight	236.27 g/mol
Drug Classes	Anticonvulsants
Water solubility	18 mg/L at 25 °C
Log Kow (octanol-water partitioning)	2.45
Henry's law constant	1.09 × 10 <sup>-5</sup> Pa m <sup>3</sup> /mol (25 °C)
pKa	13.9
Melting point	189–193 °C

Biological Half-Life	35 to 40 hours after one dose of carbamazepine extended-release formulations
Elimination of half-life (environmental)	328 d
Appearance	White, light yellowish powder

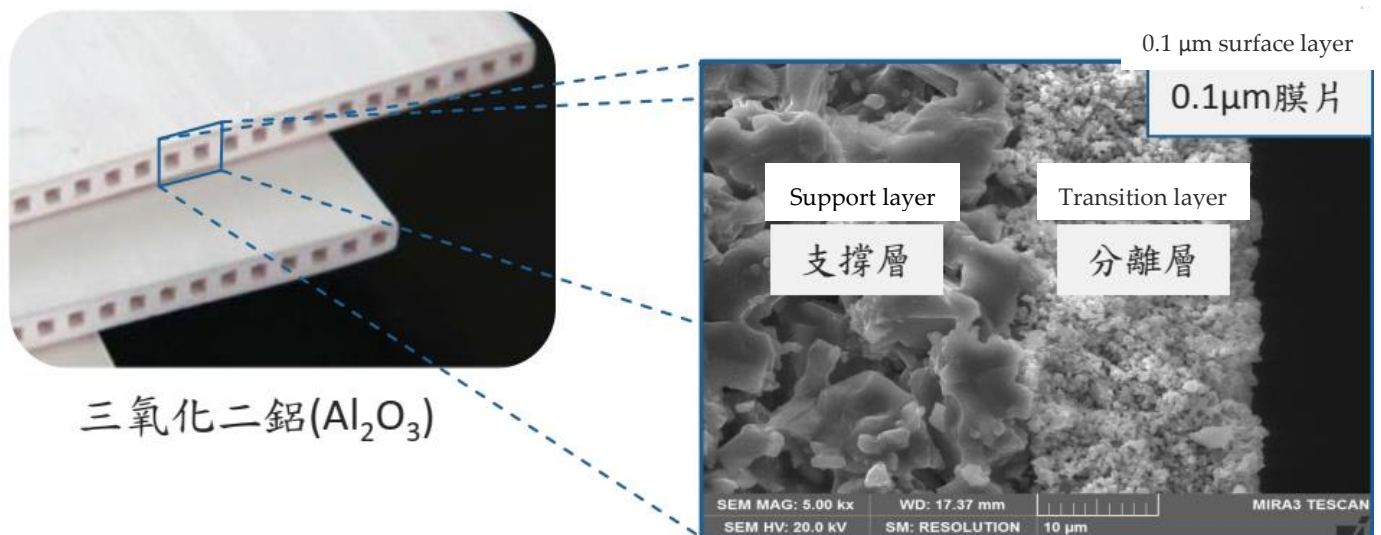
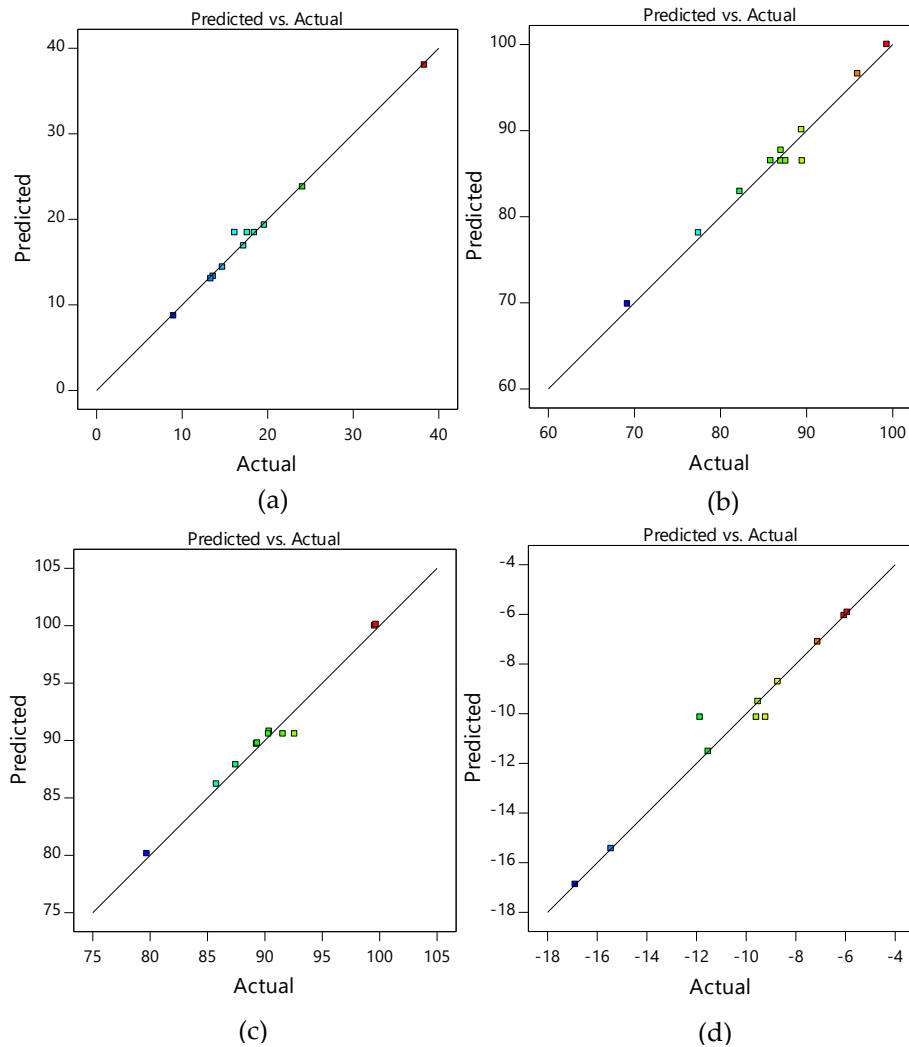


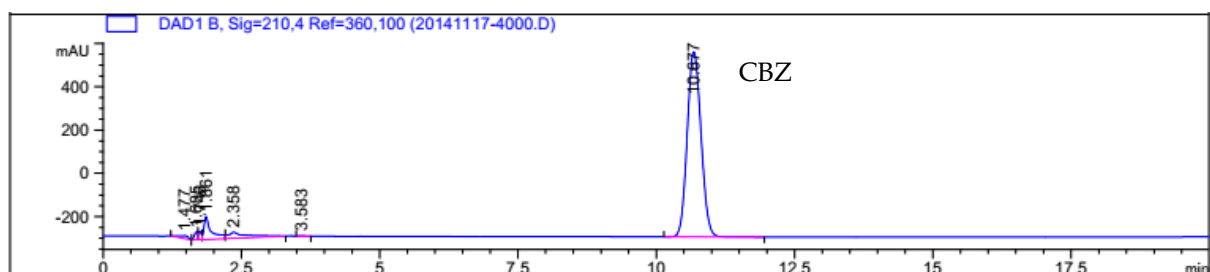
Figure S2. SEM photo of section part of flat-sheet ceramic membrane

Table S2. Experimental values of trans-membrane pressure (TMP).

Std	Run	Factor 1	Factor 2	Factor 3	TMP
		A:DO mg/L	B:HRT h	C:SRT days	kPa
9	1	3.5	18	10	9.1
7	2	1.5	24	15	13.4
4	3	5.5	24	5	10.1
8	4	5.5	24	15	10.7
6	5	5.5	12	15	9.5
2	6	5.5	12	5	9.3
10	7	3.5	18	10	8.8
1	8	1.5	12	5	12.8
11	9	3.5	18	10	8.7
5	10	1.5	12	15	12.6
3	11	1.5	24	5	12.1



**Figure S3.** Comparison of predicted and actual values of: (a) CBZ, (b) COD, (c) ammonia, and (d) phosphorus removal efficiency.



**Figure S4.** HPLC – DAD chromatogram of CBZ standard containing 100 µg/mL at 210 nm wavelength.

**Table S3.** Average influent and effluent concentrations ( $\pm$  SD) of CBZ, COD, ammonia, and phosphorus through experiments.

Number	CBZ (ug/L)		COD (mg/L)		Ammonia (mg/L)		Phosphorus (mg/L)	
	Influent (n=3)	Effluent (n=3)	Influent (n=3)	Effluent (n=3)	Influent (n=3)	Effluent (n=3)	Influent (n=3)	Effluent (n=3)
1	67.77 $\pm$ 2.43	55.77 $\pm$ 2.15	432.89 $\pm$ 30.97	55.11 $\pm$ 15.75	58.90 $\pm$ 12.55	5.14 $\pm$ 3.67	13.64 $\pm$ 0.22	14.94 $\pm$ 0.14
	91.30 $\pm$ 7.45	73.01 $\pm$ 1.11	517.78 $\pm$ 50.92	90.67 $\pm$ 17.64	59.94 $\pm$ 2.44		14.65 $\pm$ 0.09	15.92 $\pm$ 0.07
2	83.77 $\pm$ 6.95	69.10 $\pm$ 2.58	462.89 $\pm$ 19.53	2.89 $\pm$ 1.92	69.36 $\pm$ 1.37	0.29 $\pm$ 0.18	16.14 $\pm$ 0.05	18.63 $\pm$ 0.09
	82.51 $\pm$ 5.13	70.19 $\pm$ 0.79	628.89 $\pm$ 38.49		63.53 $\pm$ 0.90		15.24 $\pm$ 0.22	17.81 $\pm$ 0.04
3	94.12 $\pm$ 6.99	85.55 $\pm$ 5.40	437.33 $\pm$ 8.82	61.78 $\pm$ 10.18	58.23 $\pm$ 2.40	6.13 $\pm$ 1.89	15.02 $\pm$ 0.15	16.75 $\pm$ 0.21
	105.20 $\pm$ 2.78	90.77 $\pm$ 4.45	374.00 $\pm$ 15.28	39.56 $\pm$ 6.94	60.82 $\pm$ 1.70		15.09 $\pm$ 0.08	16.52 $\pm$ 0.35
4	84.70 $\pm$ 2.71	71.00 $\pm$ 4.66	491.78 $\pm$ 9.62	60.67 $\pm$ 14.53	67.86 $\pm$ 2.78	6.50 $\pm$ 1.35	15.49 $\pm$ 0.58	17.31 $\pm$ 0.32
	84.81 $\pm$ 5.56	64.31 $\pm$ 3.45	573.33 $\pm$ 66.67	128.44 $\pm$ 6.94	41.98 $\pm$ 13.29		14.87 $\pm$ 0.27	15.77 $\pm$ 0.21
5	99.22 $\pm$ 7.58	80.79 $\pm$ 5.83	474.00 $\pm$ 20.00	49.56 $\pm$ 1.92	63.78 $\pm$ 7.99	4.64 $\pm$ 0.67	14.89 $\pm$ 0.22	16.26 $\pm$ 0.31
	82.12 $\pm$ 17.55	70.88 $\pm$ 1.99	494.00 $\pm$ 14.53	151.78 $\pm$ 8.39	57.53 $\pm$ 0.50		15.25 $\pm$ 0.14	16.15 $\pm$ 0.05
6	85.75 $\pm$ 14.09	52.69 $\pm$ 8.07	451.11 $\pm$ 38.49	58.44 $\pm$ 6.94	66.03 $\pm$ 1.92	7.05 $\pm$ 0.73	13.68 $\pm$ 0.34	14.64 $\pm$ 0.29