Supplementary Information

Assessment of an electrochemical Advanced Oxidation System for removal of pharmaceutical compounds at the Vaudreuil-Dorion municipal wastewater treatment facility

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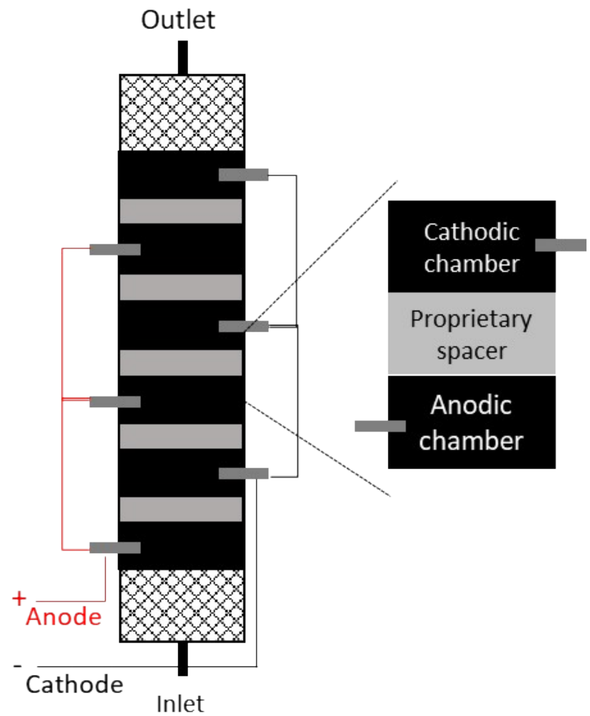
a.



b.

Figure S1. The AOS reactor is a carbon-based packed-bed electrochemical water treatment system that uses a graphite-based electrode bed material and a proprietary spacer to separate electrodes within the device. (a) Schematic of 6-chamber stacked geometry AOS reactor used for electrochemical characterization studies. (b) Schematic of pilot scale AOS spiral reactors used to examine removal of pharmaceuticals in municipal wastewater at large scale.

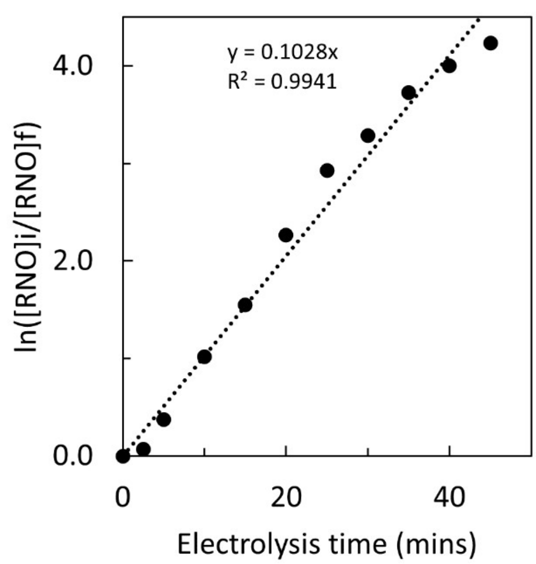


Figure S2. Kinetic studies of RNO bleaching. Electrochemical bleaching by the AOS reactor was determined at an applied current of 0.7 A and an electrolysis time of 60 minutes. Bleaching remained constant after 45 mins.

Table S1. Target pharmaceuticals selected for this study[1-7].

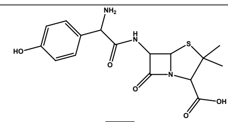
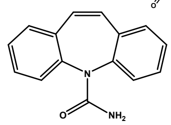
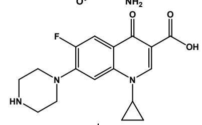
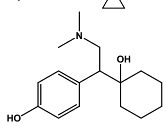
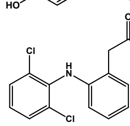
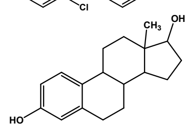
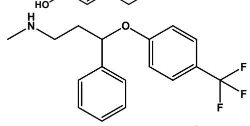
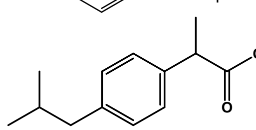
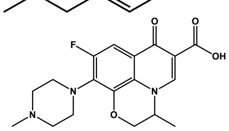
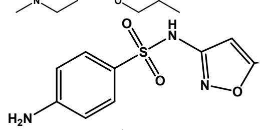
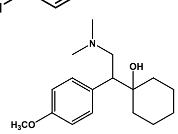
Pharmaceutical product	Therapeutic group	Structure	Molecular weight	Octanol-coefficient, Log K_{ow}	Acid dissociation coefficient, pK_a
Amoxicillin (AMX)	Antibiotic		365.4	0.9	2.7
Carbamazepine (CBZ)	Anticonvulsant		236.3	2.5	
Ciprofloxacin (CPFX)	Antibiotic		331.4	0.3	8.7
Desvenlafaxine (DVS)	Antidepressant		263.4	0.7	9.7
Diclofenac (DIC)	Analgesic		296.2	4.5	4.2
Estradiol (E2)	Hormone		272.4	4.0	10.5
Fluoxetine (FLU)	Antidepressant		309.3	4.1	10.1
Ibuprofen (IBU)	Analgesic		206.3	4.0	4.9
Levofloxacin (LFX)	Antibiotic		361.4	-0.4	8.12
Sulfamethoxazole (SMX)	Antibiotic		253.3	0.9	5.7
Venlafaxine (VEN)	Antidepressant		277.4	3.2	10.0

Table S2: Day by day concentration of target pharmaceuticals in tertiary treated MWW effluent before and after AOS treatment and % removal by AOS treatment at 0.10 mA/cm^2, 3 ppm KI, and 3.2 minutes residence for 9 days of AOS operations.

Day	Pharmaceutical product	Outlet MWW µg/L	AOS treatment µg/L	Removal %
1	Carbamazepine	61	11	82
	Ciprofloxacin	581	10	98
	Desvenlafaxine	803	47	94
	Diclofenac	147	0.1	100
	Fluoxetine	1.4	0.3	79
	Ibuprofen	638	117	81
	Levofloxacin	436	10	94
	Sulfamethoxazole	161	0.2	100
	Venlafaxine	223	26	88
2	Carbamazepine	120	19	84
	Ciprofloxacin	658	21	97
	Desvenlafaxine	1766	79	96
	Diclofenac	299	6	98
	Fluoxetine	2	0.3	84
	Ibuprofen	741	325	56
	Levofloxacin	523	18	98
	Sulfamethoxazole	160	0.2	100
	Venlafaxine	304	39	87
3	Carbamazepine	147	8	95
	Ciprofloxacin	585	13	98
	Desvenlafaxine	1973	86	96
	Diclofenac	349	7	98
	Fluoxetine	3	0.3	88
	Ibuprofen	1005	129	87
	Levofloxacin	746	18	98
	Sulfamethoxazole	174	0.2	100
	Venlafaxine	492	38	93
4	Carbamazepine	155	20	87
	Ciprofloxacin	395	10	97
	Desvenlafaxine	1313	120	91
	Diclofenac	317	11	97
	Fluoxetine	3	0.3	88
	Ibuprofen	831	114	86
	Levofloxacin	172	10	94
	Sulfamethoxazole	272	0.1	100
	Venlafaxine	382	90	76
5	Carbamazepine	164	16	90
	Ciprofloxacin	1364	10	99
	Desvenlafaxine	1753	190	89
	Diclofenac	487	9	98
	Fluoxetine	3	0.3	91
	Ibuprofen	796	124	84
	Levofloxacin	314	10	97
	Sulfamethoxazole	253	51	80
	Venlafaxine	690	106	85
6	Carbamazepine	187	15	92
	Ciprofloxacin	1289	10	99
	Desvenlafaxine	2355	121	95
	Diclofenac	478	6	99

	Fluoxetine	3	0.3	90
	Ibuprofen	696	188	73
	Levofloxacin	381	10	97
	Sulfamethoxazole	275	0.2	100
	Venlafaxine	699	133	81
7	Carbamazepine	89	11	88
	Ciprofloxacin	367	10	97
	Desvenlafaxine	1354	116	91
	Diclofenac	235	7	97
	Fluoxetine	10	0.3	97
	Ibuprofen	934	236	75
	Levofloxacin	190	10	95
	Sulfamethoxazole	192	14	93
	Venlafaxine	377	91	76
8	Carbamazepine	177	37	78
	Ciprofloxacin	571	10	98
	Desvenlafaxine	2109	192	92
	Diclofenac	424	13	97
	Fluoxetine	13	2	82
	Ibuprofen	1204	335	72
	Levofloxacin	302	10	97
	Sulfamethoxazole	264	22	92
	Venlafaxine	631	11	98
9	Carbamazepine	158	11	93
	Ciprofloxacin	661	110	83
	Desvenlafaxine	2289	95	96
	Diclofenac	439	9	98
	Fluoxetine	14	0.3	97
	Ibuprofen	870	85	90
	Levofloxacin	296	10	95
	Sulfamethoxazole	183	30	83
	Venlafaxine	697	98	86

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