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Degradation of endocrine disruptors via photocatalysis in a continuous-flow microreactor: a proposal for numbering-up

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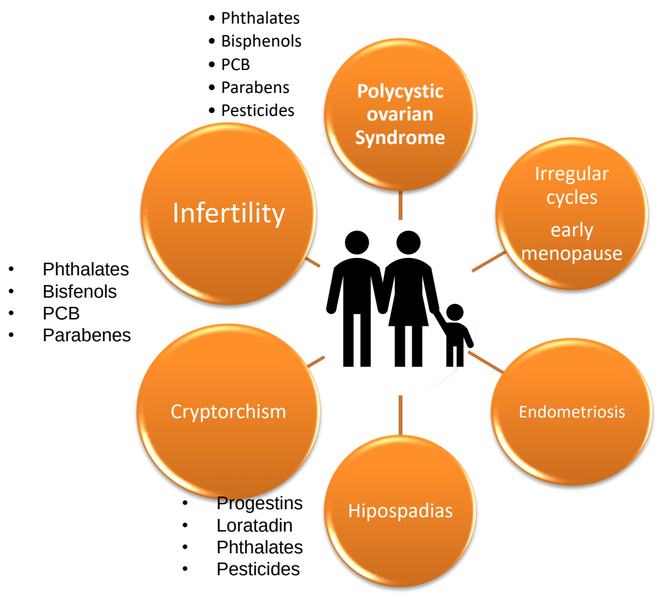
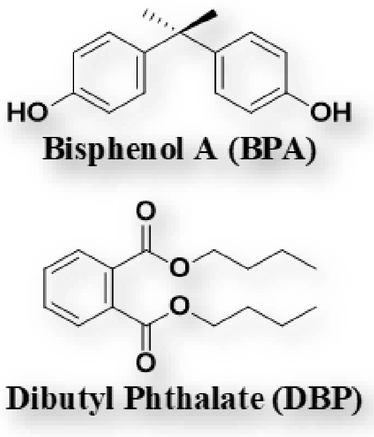
INTRODUCTION & AIM

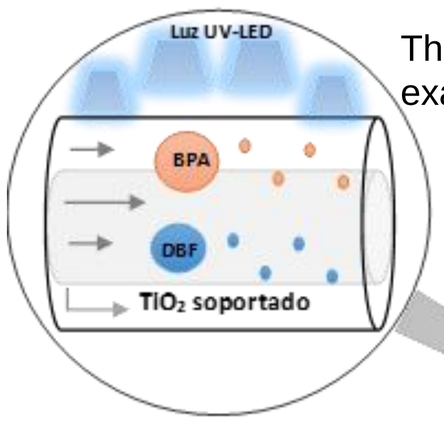
Endocrine disrupting chemicals (EDCs) are exogenous agents involves with the human and animal reproductive health [1].





In this work, the efficiency of a continuous-flow photo-microreactor with TiO2 supported and irradiated by UVA-LED was evaluated, considering the effects of its operating conditions on the degradation of two endocrine disruptors, BPA and DBP.

METHOD



The effects of operating conditions on the yield was examined by using a single microreactor (Fig.1)

Irradiation by a coaxial array of UVA-LED, λ=365 nm, irradiance 15 mW cm⁻².

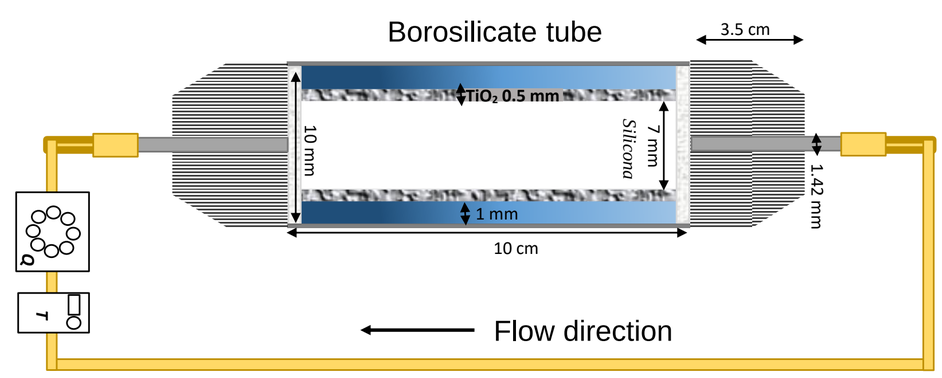


Figure 1. A borosilicate column packed with silicone coated with TiO_2.

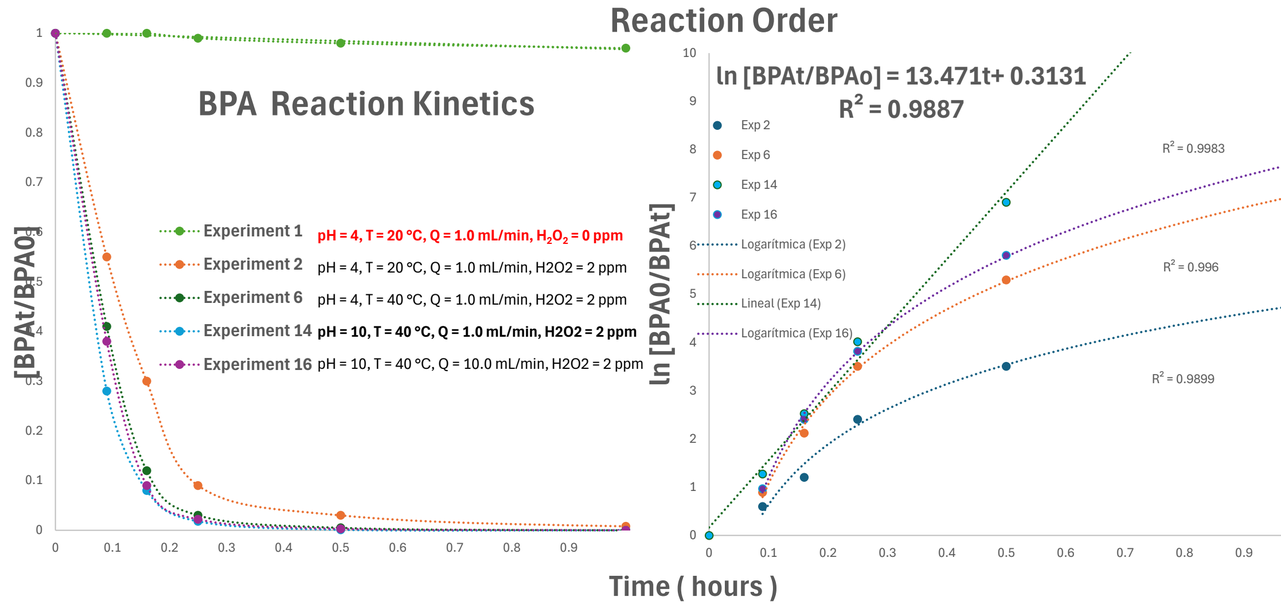
Table 1. DoE 2^4 was implemented to investigate interaction effects of four operational process variables

Independent Variables				Dependent Variables	Constants
pH	*T* (°C)	*Q* (mL/min)	[H_2O_2] (ppm)	• *Reaction time (t)* • *Final pH* • *Apparent rate constant (k_{app})* • *Degradation reaction efficiency (DRE)*	• *Energy source (UV-LED)* • *Initial BPA or DBP concentrations*
4	20	1	0		
10	40	10	2		

The output variables degradation reaction efficiency (DRE), assessed through reaction monitoring by NMR-1H, UV-Vis, and TOC.

Note: Variations in Reynolds numbers (all < 2500) were measured from the viscosity of the solutions at the set up and end of the reactions in a DV2T Brookfield viscometer.

RESULTS & DISCUSSION



Graphic 1. The photodegradation rate of BPA and DBP by this UV/TiO2/µreactor process to obey pseudo first-order kinetics represented by the Langmuir-Hinshelwood model.

Table 2. Response variables

DE	C_0 (µM)	Control Variables: t (h)	pH	T (°C)	Q (mL/min)	[H_2O_2] ppm	Response Variables: ERD %	k_{app} (min^{-1})	R^2	$t_{1/2}$ (min)
BPA	438.3	0.25	10	40	1.0	2	99.2	0.2397	0.9957	5.4
		0.25	4	40	1.0	2	97.5	0.1974	0.9960	7.7
DBP	35.9	0.25	4	40	1.0	2	62.3	0.0639	0.9867	12.0
		2	4	40	1.0	2	87.1			

A proposal for numbering-up

With these results, an array four borosilicate columns in parallel to degrade BPA (Figure 2, only two of them), using Exp 14´s control variables and considering that the viscosity is less than 100 cP. The following were required: mixer, flow splitter, and needle valves (1/8") controlled by a timer. Thus, a DRE was obtained at the process outlet (93%).

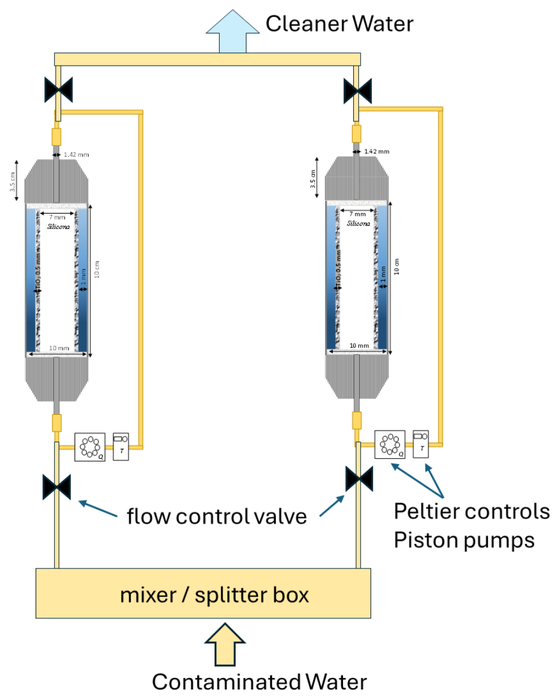


Figure 2. Array two parallel microreactors

CONCLUSION

The experimental results of this study show that: 1) Increases in T and H2O2 increase DRE by ~40-70%; 2) Promoting laminar flow at Q=1 mL/min improves DRE by 2-10%; 3) Influence of pH value to reaction rate was better at the pH 10 values over pH 4; 4) The process yielded a 99.2 % /87.1% degradation efficiency of BPA/DBP with initial concentration of 100/10 mg L-1 at 15/120 min reaction time, respectively.

The use of a continuous-flow microreactor supported by TiO2 is a potential method for the treatment of wastewater contaminated by endocrine disruptors. Furthermore, this model could improve the DRE in a parallel array of microreactors, kind numbering up.

FUTURE WORK / REFERENCES

Numbering up microreactors, enzymes inmovilization, and OLED´s synthesis.

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