DEGRADATION AND MINERALIZATION OF BISPHENOL A BY THE PHOTO FENTON PROCESS

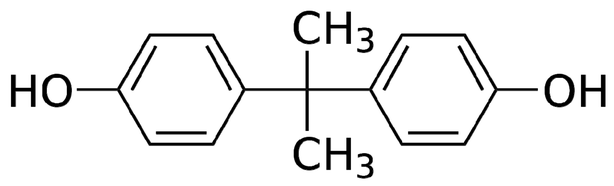
M. Navarro, M. Graells, M. Pérez-Moya

Escola Universitaria d'Enginyeria Tècnica Industrial de Barcelona, Universitat Politècnica de Catalunya, BARCELONATECH

e-mail: montserrat.perez-moya@upc.edu

Introduction

- ✓ Fenton and Photo-Fenton degradation of Bisphenol A (BPA) samples (0,5 L, 30 mg L^{-1}) is addressed.



2,2-bis (4-hydroxyphenyl) propane

- ✓ 2^2 experimental design with star points is used for characterizing the influence of two Fenton reagent with and without light source presence.
- ✓ BPA and TOC concentration profiles are the response of the studied process.
- ✓ A semi-empirical model is used for characterizing the process performance.

$$\xi = \xi^{max}\left(1 - e^{-kt}\right) \quad \text{being} \quad \xi^{max} = \frac{[TOC]^0 - [TOC]^\infty}{[TOC]^0}$$

Experimental Methods

Solution samples:

BPA: 0.5 L, 30 mg L^{-1} or $1.31 \cdot 10^{-1}$ mM

H_2O_2: (2.37-6.41) mM, Fe(II): ($1.42 \cdot 10^{-2}$ - $3.92 \cdot 10^{-2}$) mM

Temperature = 25 ± 0.5 ºC, pH = 3 ± 0.2

Batch reactor: thermostatic cylindrical 500 mL Pyrex cell

Irradiation source: sunlight lamp (Ultra-Vitalux®, Osram, 300 W)

Incident photon flux: 7.09×10^{-5} Einstein min^{-1}.

Sampling:

Addition of methanol (50:50) to stop reaction and prevent further BPA degradation.

Analytical methods:

TOC measured by means of a Shimadzu VCHS/CSN TOC analyzer.

BPA determined via HPLC Agilent 1200 series with UV-DAD array detector.

stationary phase: Akady 5 µm C-18 150x4.6 mm column, at 20ºC

mobile phase was a mixture of methanol:water (70:30) flowing at 1 $mL \cdot min^{-1}$

detector set at 224 nm. 20 µL samples. Retention time, 3.9 min.

Results & Discussion

Preliminary screening to evaluate presence and absence of irradiation

H_2O_2 stoichiometric dose: 161 mg L^{-1} , 80.50 – 201.25 mg L^{-1} , Fe(II) 5 – 10 mg L^{-1}

Table 1. Experimental conditions for BPA degradation by Fenton and photo-Fenton process.

Assay	Codified values		Variables levels (mg L^{-1})		Ratios	
	H_2O_2	Fe(II)	H_2O_2	Fe(II)	H_2O_2/BPA	Fe(II)/BPA
A	1	Min	161,00	5	5,37	0,17
B	1	Max	161,00	10	5,37	0,33
C	1/2	Min	80,50	5	2,68	0,17
D	1/2	Max	80,50	10	2,68	0,33
E	3/4	Max	120,75	10	4,03	0,33
F	5/4	Max	201,25	10	6,71	0,33

Photo-Fenton process produces higher conversions than the Fenton process

BPA is not detected: - after 25 min (Fenton process)

- after 10 min (photo-Fenton process)

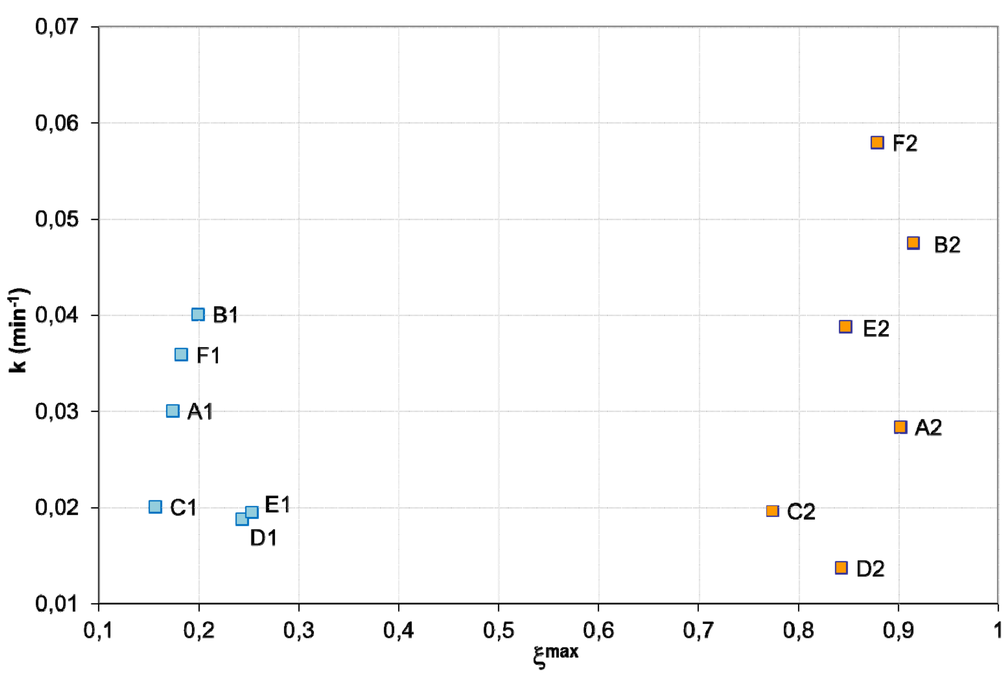


Figure 1. Results represented as a function of the two model parameters (k and ξ^{max}). Blue marks (A1 to F1) are used for Fenton results and orange marks (A2 to F2) for photo-Fenton.

Evaluation of the Photo-Fenton process

Table 2. Experimental conditions for BPA degradation by photo-Fenton process. Star experimental design.

Assay	Codified values		Variables levels (mg L^{-1})		Ratios	
	H_2O_2	Fe(II)	H_2O_2	Fe(II)	H_2O_2/BPA	Fe(II)/BPA
AA	-1	-1	120,75	5	4,03	0,17
BB	-1	1	120,75	10	4,03	0,33
CC	1	-1	201,25	5	6,71	0,17
DD	1	1	201,25	10	6,71	0,33
EE	0	0	161,00	7,5	5,37	0,25
FF	0	0	161,00	7,5	5,37	0,25
GG	0	0	161,00	7,5	5,37	0,25
HH	0	-√2	161,00	3,96	5,37	0,13
II	0	√2	161,00	11,04	5,37	0,37
JJ	-√2	0	104,08	7,5	3,47	0,25
KK	√2	0	217,92	7,5	7,26	0,25

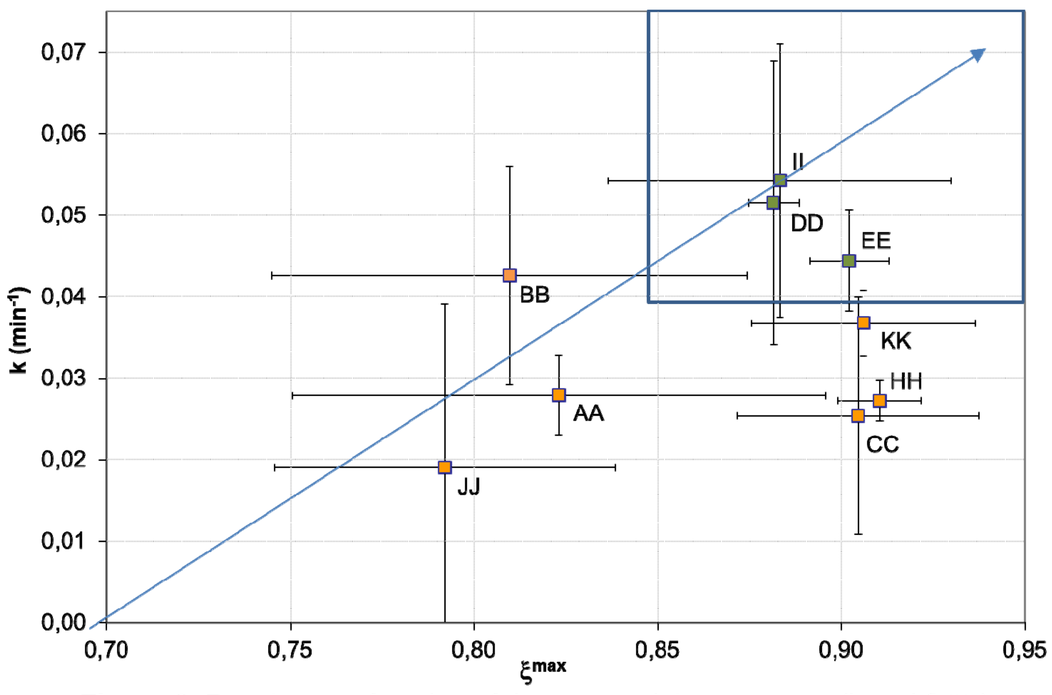


Figure 2. Results as a function of the two model parameters (k and ξ^{max})

When stoichiometric H_2O_2 is supplied (161 mg L^{-1}):

- Increasing Fe(II) load increases the reaction rate (50 percentage points when using 11 mg L^{-1} Fe(II) instead of 3.96 mg L^{-1}) .

- The highest conversion rates are obtained with the appropriate iron load (i.e. total BPA elimination and 90 % TOC decay).

Acknowledgements

Financial support received from the Spanish "Ministerio de Economía y Competitividad" and the European Regional Development Fund (both funding the research Projects EHMAN, DPI2009-09386 and SIGERA, DPI2012-37154-C02-01) are fully appreciated.