Naproxen degradation by catalytic wet air oxidation with Ru and Pt catalysts

E. Serra-Pérez, S. Álvarez-Torrellas, M. Larriba, V. I. Agueda, G. Ovejero, J. García

Grupo de Catálisis y Procesos de Separación (CyPS), Departamento de Ingeniería Química, Facultad de Ciencias Químicas, Universidad Complutense de Madrid, Avda. Complutense s/n, 28040 Madrid, Spain
**jgarciar@ucm.es*

1. Introduction – Naproxen (NPR) is an anti-inflammatory belonging to the group of non-steroidal anti-inflammatory drugs (NSAIDs), one of the most important classes of pharmaceuticals usually detected in hospital effluents and surface waters. NPR acts by reducing the levels of prostaglandins, chemicals that are responsible for pain, fever and inflammation [1]. In 2016 NPR was established as the second NSAID after ibuprofen consumed in Spain (8.56 DHD/1000 inhabitants per day) according to the Spanish Ministry of Health. The discharge of this pharmaceutically-active compound in the aquatic water bodies is an important environmental issue because of shortage of legislation and lack of comprehensive removal prescriptions.

The AOP processes are based on the production of hydroxyl radicals that oxidize many kinds of organic pollutants rapidly. Among AOPs, wet air oxidation (WAO) has already been applied successfully to treat effluents from pharmaceutical industry. The use of a catalyst strongly improves the degradation of the organic pollutants by using mild temperature and pressure conditions. In this sense, carbon nanospheres (CNS) have drawn considerable attention in the last years due to their ease of preparation, and their many practical applications as adsorbents, catalysts supports, etc. This study is focused on the synthesis and application of ruthenium supported on carbon nanospheres for the removal of the anti-inflammatory compound naproxen from aqueous solution by catalytic wet air oxidation (CWAO).

2. Experimental - The synthesis of the catalyst (CNS-Ru) started with the preparation of the carbon nanospheres (CNS) according to the method reported by Zhu et al. [2]. Then, CNS-Ru catalyst was prepared by incipient wetness impregnation technique varying the metal content from 1 to 10% wt.

All the experiments were conducted in a Hastelloy high-pressure 100 mL reactor equipped with an electrically heated jacket to control the temperature and a variable speed magnetic drive. The reactor was loaded in inert atmosphere with NPR solution in ultrapure water and the catalyst. NPR concentration was determined by high pressure liquid chromatography (HPLC).

3. Results and Discussion - Temperature, pressure and catalyst load were varied between 110-160ºC, 20-50 bar and 50-150 mg, respectively. It could be observed that an increasing in the operation temperature increased the rate of the pollutant removal at the first stage of the reaction, but it increased the operational costs of an industrial plant as well; therefore, the optimum temperature was established in 130ºC, that led to a degradation of 98% at 90 min reaction time. The optimum pressure and catalyst mass were of 20 bar and 75 mg, respectively.

4. Conclusions - Thus, ruthenium supported on carbon nanospheres was successfully used as catalyst for the catalytic wet air oxidation of naproxen from aqueous solution. A very high naproxen removal percentage (98%) at the optimal conditions of 130ºC, 20 bar and 75 mg of catalyst was achieved.

Acknowledgments. This research has been supported by the Spanish MICINN through the project CTM2017-84033-R. In addition the authors thank the financial support from the Regional Government of Madrid provided through REMTAVARES Network (S2018/EMT-4341) and the European Social Fund. E. Serra-Pérez thanks to the National Program of Scholarship (Training university lecturers (FPU) in Spain.

References

[1] N. A. Jain, R. T. Lohiya, and M. J. Umekar, *Int. J. Pharma Sci. Res.* **2**(5), (2011) p. 130–134.
[2] X. Zhu, S. Wang, W. Huang, Y. Tian, and X. Wang, **105,** (2016) p. 521–528.