

DOCTORAL CONGRESS  
IN ENGINEERING

# Book of Abstracts



*4<sup>th</sup> Symposium on  
Chemical and Biological Engineering*

**Book of Abstracts**  
of the  
4<sup>th</sup> Symposium on Chemical and  
Biological Engineering

**Editors:**

Alexandra Pinto, Ana Isabel Moreira, Ana Teresa Cerdeira, André  
Torres Pinto, Cláudio Rocha, Isabel Fernandes, Maria Amélia Barros,  
Maria João Romeu

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# Title

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## Magnetic carbon nanotubes obtained from plastic as catalysts for wet peroxide oxidation of paracetamol

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### Abstract

Magnetic carbon nanotubes (MCNTs) were prepared by catalytic chemical vapour deposition (CCVD) and tested as catalysts for catalytic wet peroxide oxidation (CWPO) of paracetamol (PCM). For the synthesis of the MCNTs, low-density polypropylene (LDPE) and high-density polypropylene (HDPE) were used as model carbon precursors present in urban plastic solid waste (Aboul-Enein, 2018). The catalyst employed in CCVD was magnetite supported on alumina prepared by a sol-gel process. The CWPO runs were conducted with the stoichiometric concentration of H<sub>2</sub>O<sub>2</sub> needed for the full mineralization of 100 ppm of PCM, at 80 °C and initial pH 3.5, following experimental methods described elsewhere (Silva, 2019). The catalyst prepared from LDPE, LDPE\_MCNTW, was able to completely degrade the pollutant within 6 h of reaction, while HDPE\_MCNTW took 8 h to achieve the same removal. Iron measurement in the final reaction solutions showed the absence of possible additional pollution coming from iron leaching of the catalysts.

**Author Keywords.** Magnetic catalyst; nanostructured carbon materials; CWPO; micropollutants.

### References

- Aboul-Enein, A. A., Awadallah, A. E., Abdel-Rahman, A. A. H., and Hagggar, A. M. 2018. "Synthesis of multi-walled carbon nanotubes via pyrolysis of plastic waste using a two-stage process". In *Fullerenes Nanotubes and Carbon Nanostructures*, 26(7), 443–450.
- Silva, A. S., Kalmakhanova, M. S., Massalimova, B. K., de Tuesta, J. L. D., and Gomes, H. T. 2019. "Wet peroxide oxidation of paracetamol using acid activated and Fe/Co-pillared clay catalysts prepared from natural clays". In *Catalysts*, 9, 705.

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