# *In situ* and *ex situ* loading of magnetic iron oxides onto a waste-based activated carbon for the removal of pharmaceuticals from water

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Activated carbons (AC) are porous materials known to be effective in the removal of emerging contaminants (such as pharmaceuticals) from water. Powdered ACs (PAC) are capable to achieve great performances due to their high specific surface area ($S_{BET}$); however, difficult separation of the exhausted PAC from treated waters, due to the small particle size, is one of the main disadvantages of this treatment process, implying an extra filtration step. Loading magnetic iron oxide nanoparticles onto the PACs' surface is an interesting strategy to allow for immediate and simple AC separation from water, through the application of a magnetic field [1]. In this work, the *in situ* and *ex situ* modification of a primary paper mill sludge-based PAC with magnetic iron oxides was studied. In a first stage, a PAC was obtained through KOH activation and pyrolysis of paper mill sludge. The resulting PAC was subsequently loaded with iron oxides either by *in situ* and *ex situ* co-precipitation of $Fe^{II}$ and $Fe^{III}$, at controlled temperature and alcaline conditions, and the effect of different iron salt:PAC ratios on the characteristics of the materials was studied. The $S_{BET}$ and magnetic properties of the magnetic PACs were determined, and their performance for the removal of the anti-epileptic carbamazepine (CBZ) from water was evaluated. Both *in situ* and *ex situ* magnetic PACs were able to satisfactorily remove CBZ, achieving removal efficiencies of up to ~ 90% in batch conditions, for a 50 mg $L^{-1}$ dosage of magnetic PAC and 5 mg $L^{-1}$ of CBZ. Also, fast magnetic separation of the materials from the aqueous phase was achieved, particularly for higher iron salt:PAC ratios and ex situ modified materials.

**References:**
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**Acknowledgements:**
This work is a contribution to the project WasteMAC (POCI-01-0145-FEDER-028598) funded by FCT – Fundação para a Ciência e a Tecnologia, I.P., through national funds, and the co-funding by the FEDER, within the PT2020 Partnership Agreement and Compete 2020. Thanks are also due for the financial support to CESAM (UID/AMB/50017/2019), to FCT/MEC through national funds, and the co-funding by the FEDER, within the PT2020 Partnership Agreement and Compete 2020. Guilaine Jaria, Marta Otero and Vânia Calisto thank FCT for the grant SFRH/BD/138388/2018, Investigator Program IF/00314/2015 and CEEC Program CEECIND/00007/2017, respectively. María V. Gil acknowledges support from the Ramón y Cajal grant (RYC-2017-21937) of the Spanish government.