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PROCESS ENGINEERING FOR POLLUTION CONTROL AND WASTE MINIMIZATION

Aspirin and paracetamol removal using a commercial micro-sized TiO_2 catalyst in deionized and tap water

Claudia L. Bianchi[1,2] · Benedetta Sacchi[1,2] · Carlo Pirola[1,2] · Francesco Demartin[1] · Giuseppina Cerrato[2,3] · Sara Morandi[2,3] · Valentino Capucci[4]

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Abstract Micro-sized TiO_2 catalyst was employed to degrade pharmaceutical compounds, i.e. aspirin and paracetamol, two of the most widely used drugs, purchasable without prescription. Their active agents, acetylsalicylic acid and acetaminophen, are characterized by different substituent groups, linked to the aromatic ring, which affect both the photodegradation and mineralization processes. The experimental conditions highlight the relationship between the nature of the pristine molecules, their degradation mechanisms, their mutual interference and the water's role. The research started from model systems with a single pollutant to the mixture of them and finally by moving from deionized water to tap water.

Keywords Aspirin · Paracetamol · Titanium dioxide · Photocatalytic degradation · Micro-sized TiO_2 · By-products identification

Introduction

The pharmaceutical pollutants raise worrisome questions and it was recognized the urgency of a legislative, technological and social action for preserving the water quality because no monitoring data are available and therefore no actions are planned. In the last decades, the European legislation stated new strategic approaches regarding pharmaceutical substances in surface and groundwater (European Parliament and Council 2015) considering also that the adverse effects could be magnified due to the simultaneous presence of many of such substances even if at low concentrations. Wastewater plant design ensures joint treatments to produce high quality water; i.e. hybrid technologies, combinations of conventional and advanced treatments, are proving effective solutions to reach almost complete removal and improving the economy of process (Oatley-Radcliffe and Williams 2015). Nevertheless, recent studies point out their inability to remove specific recalcitrant pollutants called "emerging substances", including drugs (Roccaro et al. 2013; Gadipelly et al. 2014). The scientific literature has deepened the multiple potentialities of TiO_2 photocatalysts leading to publication of many reviews investigating TiO_2 physical and chemical features (Bagheri et al. 2014), synthesis and arrangements (Imani et al. 2014; Roy et al. 2011), photocatalytic performances (He and Chen 2012; Neppolian et al. 2007), process parameters (Akpan and Hameed 2009; Sarkar et al. 2014), preparation methods (Boffito et al. 2013; Neppolian et al. 2004; Sakthivel et al. 2001), kinetic mechanisms in specific fields (Konstantinou and Albanis 2004; Tong et al. 2012; Kanakaraju et al. 2014; Neppolian et al. 2001; Sornalingama et al. 2016) and environmental applications (Pelaeza et al. 2012) with the purpose of developing environmentally and flexible usage. In almost all researches, nano-sized materials were investigated, justified by the great developments in nanotechnologies (Beydoun et al. 1999), but nowadays their wide applications raise serious doubt regarding their potential adverse impact on environment and living being inducing targeted studies (Song et al. 2015; Chen et al. 2014; CORDIS 2015).. At nanometre level, the materials show more

Responsible editor: Philippe Garrigues

✉ Benedetta Sacchi
benedetta.sacchi@unimi.it

1 Dipartimento di Chimica, Università degli Studi di Milano, Via Golgi 19, 20133 Milan, Italy

2 Consorzio INSTM, via Giusti 9, 50121 Florence, Italy

3 Dipartimento di Chimica and NIS, Inter-departmental Centre, Università degli Studi di Torino, Via Giuria 7, 10125 Torino, Italy

4 GranitiFiandre SpA, Via Radici Nord 112, 42014 Castellarano, Italy

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