

EFFECT OF OZONATION ON THE ACTIVATED CARBON SURFACE CHEMICAL PROPERTIES AND ON 2-MERCAPTOBENZOTHAZOLE ADSORPTION

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Abstract— Benzothiazoles are organic compounds that may produce negative environmental impact when released into watercourses. In particular, 2-mercaptobenzothiazole (MBT) are known to be toxic and hard to biodegrade. Activated carbon adsorption and ozonation have been identified as suitable treatment for those contaminants. However, there is some controversy about the effect of carbon surface chemical composition on the MBT adsorption. This paper focuses on this issue and presents experimental adsorption isotherms for MBT on Filtrasorb-400 activated carbon treated with different ozone doses. The activated carbon surface chemical properties were assessed by acid/basic neutralization, temperature programmed desorption (TPD), X-ray photoelectron spectroscopy (XPS), and the point of zero charge (pH_{PZC}). Results show that ozone treatment modified the oxygenated groups on the activated carbon surface, increasing the concentration of acid groups, and reducing the pH_{PZC}. Finally, ozone treatment led to a significant reduction of the carbon's MBT adsorption capacity, due to the increase in polar hydrophilic groups.

Keywords— 2-Mercaptobenzothiazole, Ozone, Activated Carbon, Surface Properties, Adsorption.

I. INTRODUCTION

2-Mercaptobenzothiazole (MBT) is a toxic xenobiotic compound widely used in the rubber industry, where effluents may be greater than 200 mg/dm³ (de Wever and Verachtert, 1997). It is also used as a biocorrosion inhibiting agent, as an anti-fungal drug in medical applications, as a metallic surface coating agent (Fiehn *et al.*, 1998); as a fungicide in leather and wood industries (Paxeus, 1996). Leachate from hospital solid waste has been found to contain significant amount of MBT, probably derived from rubber seals (Airaudo *et al.*, 1990). Moreover, MBT is highly resistant to biological attack in enriched activated sludge systems and tend to adsorb on the cell membrane leading to bioaccumulation (Gaja and Knapp, 1998).

On the other hand, ozonation combined with activated carbon adsorption offers an attractive option for MBT removal. Indeed, activated carbon presents a large surface area where ozone and MBT could adsorb and react. Ozone readily destroys adsorbed aromatic molecules, which may help to regenerate the activated carbon adsorption capacity (McKay and McAllevey, 1988; Kainulainen *et al.*, 1995; Cannon *et al.*, 1996; Croll, 1996). Also, activated surface groups may be responsible for catalytic effects found in ozonation in presence of activated carbon (Zaror, 1997).

However, ozone has been showed to oxidize the carbon and modify its surface chemical composition (Sutherland *et al.*, 1996; Zaror *et al.*, 2001). Unfortunately, little is known about the effect of such chemical modifications on the carbon adsorption capacity, which is key to process design. Surface properties may have a strong effect on both adsorptive and regenerative capacities.

Within this context, this paper reports experimental results on the chemical and physical modifications of activated carbon due to ozonation, and their effect on the MBT adsorption capacity. This work is part of a wider ongoing project to investigate the possibilities of the combined use of ozone and activated carbon in the elimination of contaminants from water.

II. EXPERIMENTAL

Commercial granulated activated carbon Filtrasorb 400 supplied by Calgon Carbon Corporation (Pittsburgh, USA) was used as starting material in this study. A batch of 500-800 μ m particle size activated carbon was washed several times with deionized water to remove fines, oven dried at 170 °C during 24 hours, and stored in a desiccator until use. MBT and all chemicals used for analysis were purchased from Merck. Ozone was produced from pure O₂ supplied by AGA using a generator rated at 5 g of O₃/h.

MBT was determined by High Performance Liquid Chromatographic (HPLC), Merck-Hitachi, L7100, using a RP18 LiChrospher column as the stationary phase. Mobile phase was acetonitrile-sodium phosphate buffer pH 2.3 (60:40), 0.7 cm³/min, reading at 215 nm. Ozone was monitored by UV spectrophotometry (Spectronic