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New design of gas diffusion electrode based on Printex L6 carbon supported on carbon cloth towards the electrogeneration of H_2O_2 for water treatment.

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Highlights

The new GDE design based on PL6C offered significant advantages compared to GDE commercial, including a longer time-life and a larger surface area. The new design of GDE more durable and efficient.

Resumo/Abstract

Gas diffusion electrodes (GDEs) have been widely used for the electrochemical production of H_2O_2 in aqueous media due to their highly porous structure, which allows for direct release of O_2 on the electrode surface increasing the reaction efficiency. However, the development of efficient and stable new designs of GDEs for producing H_2O_2 in complex aqueous matrices with low conductivity is a challenge that has been widely studied to enable homogeneous wastewater treatment processes [1,2]. In this work, we present a comparison between a commercial GDE and a new GDE made of Printex L6 Carbon (PL6C), both supported on carbon cloth, to produce H_2O_2. The PL6C-based GDE was produced using a hot press technique, consisting of applying a load of 10 mg cm^{-2} of PL6C/20% PTFE on a PX30-PW03 carbon cloth, pressed with 0.5 tons at a temperature of 270°C for 15 minutes. Comparative studies of H_2O_2 electrogeneration and Fe^{2+} regeneration were performed using an electrolyte of 50 mmol L^{-1} H_2SO_4 at pH 3 (8.2 mS) by applying current densities from 5 to 80 mA cm^{-2}, using the GDEs as cathode (under air flow of 0.2 L min^{-1}) and DSA® anode, both with 3 cm^2. It was found that after 300 minutes of electrolysis, the H_2O_2 production obtained by the GDEs showed significant similarities at all studied currents. However, the PL6C GDE achieved double the values obtained for Fe^{2+} regeneration compared to the commercial GDE. The similarity in H_2O_2 production between the GDEs can be explained by the fact that the reaction was not controlled by O_2 mass transport. On the other hand, the superiority of the Fe^{2+} regeneration values by the PL6C-based GDE compared to the commercial GDE can be justified by the higher surface area of the first (47.82 m^2 g^{-1}), compared to the second (14.85 m^2 g^{-1}). Another property in which the PL6C-based GDE was superior to the commercial GDE was related to the life-time tests, which were performed by applying a current density of 10 mA cm^{-2} in a filter press reactor with pre-pilot scale of a 2.5-liter solution capacity, scaling the electrode area from 3 to 20 cm^2. The results showed that the life-time of PL6C-based GDE was 6000 minutes while for the commercial GDE it was 4600 minutes, in accordance with the contact angle results that showed higher wettability of the commercial GDE over 30 minutes of a 15 μL water droplet staying. Thus, the PL6C GDE was economically viable for electrochemical production of H_2O_2 in low conductivity solution of 12 mmol L^{-1} H_2SO_4 at pH 3 (3.1 mS), as found in real wastewater, for current densities of 5 and 10 mA cm^{-2}. We studied different electrochemical advanced oxidation processes (EAOPs) at 10 mA cm^{-2} for the removal of Tebuconazole (TBZ) present in real wastewater, having found the photoelectro-fenton process (PEF) as the most efficient process after completely removing TBZ in 1h, apart from achieving the highest percentage of mineralization (~30%) among the studied EAOPs after 180 min.

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