Área: AMB
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Benzene removal from gas stream combining adsorption and electrochemical oxidation in methanol medium

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Palavras Chave: *volatile organic compounds; gas stream treatment; adsorption; electrochemical oxidation; benzene.*

Highlights

Benzene can be mineralized electrochemically in methanol medium.
GAC can be recovery with fresh methanol.
Value-added by-products were produced.
Electro-refinery can be used as treatment technology.

Resumo/Abstract

Benzene is a volatile organic compound (VOC) very harmful to humans and the environment because its proven carcinogenicity. Coal combustion is one of the main sources of benzene release. Adsorption technology has shown promise for VOC decontamination from gas streams due to its high efficiency, low cost, simplicity, and low energy consumption [1]. This work aims to evaluate the combination of adsorption technology and electrochemical oxidation to improve the removal of benzene from gas stream and to argue about electro-refinery as treatment technology. For this purpose, granular activated carbon (GAC) was used as adsorbent material, and, in a first step, to adsorb the benzene from the gas stream. Afterwards, methanol desorbs the contaminant, recovering the GAC. Finally, the obtained high concentrated solution is treated electrochemically using a boron-doped diamond anode. Seven cycles were performed to verify the GAC recovery: three using fresh methanol (FM) and four using the methanol solutions post treated (MSPT). Using FM to desorb the benzene, GAC is completely recovery and the same amount of benzene is adsorbed step by step. On the other hand, when MSPT was used, there was a decrease in the GAC adsorption capacity. It means that the amount of benzene desorbed after each step of desorption using this kind of methanol decreases. This can be related with the deactivation of the active sites of GAC. Considering the maximum adsorption on each cycle, the reduction was 4.6, 12.4 and 42.8% for the second, third and fourth cycle, respectively, with the desorption performed with the MSPT. During the electrochemical oxidation, benzene removal showed a pseudo-first order behavior with a kinetic constant of 0.0017 min^{-1}. It is very important to note that during the electrooxidation of benzene in methanol, some value-added by-products can be generated. Anisole is one of the main by-products that are produced, reaching a maximum concentration of 1,200 mg L^{-1}. The formation of value-added by-products opens the possibility of explore the electro-refinery concept as treatment technology.

[1] L. Zhu, D. Shen, K.H. Luo, A critical review on VOCs adsorption by different porous materials: Species, mechanisms and modification methods, Journal of Hazardous Materials. (2020) 122102. https://doi.org/10.1016/j.jhazmat.2020.122102.

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