“Investigating the removal efficiency of amoxicillin from aqueous solutions using the US/PS/CuOFe_3O_4 process”

Abstract

Background and Objectives: Antibiotics have spread usage in terms of consumption around the world and were entered into water resources in different ways after use. In recent years, global concerns about the potential impact of antibiotic residues on the environment have increased. The presence of these compounds in the environment has raised concerns about toxicity to aquatic organisms as well as the emergence of antibiotic-resistant bacteria. Therefore, many efforts have been made to remove these pollutants by various researchers. Therefore, the aim of this research was to investigate the removal efficiency of amoxicillin from aqueous solutions using the US/PS/CuO@Fe_3O_4 process.

Materials and methods: This study was conducted experimentally in a bench scale condition in a batch system. The structure and morphology of CuO@Fe_3O_4 were investigated using BET, VSM, XRD, FE-SEM, and FTIR techniques. The experiments were evaluated based on the statistical design of Benken's box with five input parameters such as reaction time, pH, persulfate concentration, amount of CuO@Fe_3O_4, and initial concentration of amoxicillin at three levels. The kinetics of the process at different concentrations was investigated to evaluate the oxidation process.

Findings: BET, VSM, XRD, FE-SEM, and FTIR analyses confirmed the nature and structure of CuO@Fe_3O_4. According to the analysis of variance (ANOVA) and the proposed quadratic model, pH and antibiotic concentration were identified as the most critical parameters in the efficiency of the oxidation process. Also, the results showed that with an increasing amount of CuO@Fe_3O_4 and contact time, the amoxicillin removal efficiency increased and decreased with increasing amoxicillin initial concentration and pH. In the optimal conditions, the studied parameters include pH = 3, contact time 60 minutes, amoxicillin initial concentration 13 mg/L, amount of persulfate 0.67 g/L, and amount of CuO@Fe_3O_4 equal to 0.7 g/L, the highest efficiency was obtained.

Conclusion: Based on the obtained results, the investigated process can be used as a suitable method to eliminate organic resistant compounds, including antibiotics. According to the analysis of variance (ANOVA) and the second-order model proposed, the amount of CuO@Fe_3O_4 and the contact time will be the most important positive parameters, and pH and concentration will be the most important negative parameters in the effective oxidation process of amoxicillin. Also, the results showed that with an increase in the amount of CuO@Fe_3O_4 and contact time, the removal efficiency of amoxicillin increased ,and with an increase in the initial concentration of amoxicillin, the pH decreased. Degradation amoxicillin is first-order kinetics. The results of this research showed that the US/PS/CuO@Fe_3O_4 process has a good ability to remove amoxicillin from aqueous solutions and can be considered as a suitable option for removing this pollutant.

Keywords: Amoxicillin, Ultrasonic, Oxidation, Copper Oxide, Nanoparticles, Persulfate