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Porous cordierite-supported polyethyleneimine composites for nickel(II) and cadmium(II) ions removal

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ABSTRACT

Industrial/technological growth is directly connected with environmental pollution, but its influence can be minimized through pollution abatement approaches such as the treatment of industrial wastewater. In this study, novel porous amine-functionalized silicate minerals, specifically, cordierite was investigated for the removal of toxic heavy metals from industrial wastewaters. Cordierite supports were synthesized by mixing MgO, Al_2O_3, and SiO_2 powders in 2:2:5 molar ratios, and mechanically activated via ball milling in ethanol for 10, 40, or 80 min. Pellets were sintered by heating in air at 20°C min^{-1} to 1,350°C, for 2 h. Porous supports were produced by coarsely crushing the sintered pellets and mixing the crushed and sieved cordierite powder with 20 wt.% of a pore-forming agent, either nanocellulose or yeast. The resulting pellets were sintered by heating at 5°C min^{-1} to 700°C in air. The synthetic cordierite support was modified by treatment in polyethylenimine. Activated supports were then tested for the removal of Ni^{2+} and Cd^{2+} ions. The phase composition of the cordierite supports was analyzed by the X-ray diffraction, Fourier-transform infrared spectroscopy, and scanning electron microscopy. Analysis of adsorption isotherms, kinetics, and thermodynamic parameters indicated that adsorption was a spontaneous, endothermic process with a maximum adsorption capacity of 36 mg g^{-1} for Cd^{2+} and 43 mg g^{-1} for Ni^{2+}. This work has shed light on the mechanism of heavy metal removal from the aquatic medium using the novel hybrid functionalized cordierite-based ceramic.

Keywords: Adsorption capacity; Cordierite; Heavy metals; Porous ceramics; Sorbent

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