Preparation and Characterization of Bimetallic nZVI-Based Catalysts for the Degradation of Nitrophenol

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Abstract

After nitrophenol (4-NP) compound releasing into the environment, it is very difficult to be degraded and thus it may cause serious environmental problem. However, these contaminants are often difficult to degrade directly by conventional biological treatment routes. Since the high toxicity and low biodegradability of 4-NP contaminants, it is often subject to high cost constraints. Therefore, the objective of this study was to introduce the concept of circular economy, which simulated the degradation of heavy metals from wastewater by nanophase zero-valent iron (nZVI) prepared by a liquid-phase reduction method. Moreover, the as-synthesized nZVI powders were used for degrading nitrophenol wastewaters and then 4-NP was converted into higher value aminophenol (4-AP). The UV/ Vis spectrometer (UV-Vis) and total organic carbon (TOC) analyzer were used to determine the degradation efficiencies of 4-NP over nZVI@Cu and Fe-TNs.The XRD pattern shows that nZVI@Cu has 2θ = 44.8°, which is the main diffraction peak of nZVI. After the reaction, three specific diffraction peaks of Cu structures were 36.52°, 42.42°, and 63.55° (2θ). The adsorption isotherms of nZVI and nZVI@Cu were Type IV-H3 confirmed by BET measurement (ASAP). The formation of iron and copper oxide on the surface resulting from the deposition of Cu lead to a rough surface and an increased specific surface area and volume. The XPS patterns revealed that the surface mainly consisted of Fe^0 and FeO(OH) species. In addition, the structural parameters of the EXAFS indicated that the Fe-O bond length of the central Fe atom was about 2.07 Å (first-shell) with a coordination number of 4.24. Under UV light irradiation, H_2O_2 was added as an oxidant and TNs were used as a photocatalytic carrier. Experimentally, the comparison of the copper removal efficiencies of different loading ratios is nZVI@Cu-800> nZVI@Cu-400> nZVI@Cu-200> nZVI@Cu-100. The present study has successfully proved that the use of nZVI to reduce heavy metal contamination for the degradation of nitrophenol in wastewater was a highly efficient and a green wastewater treatment process. Thus, the as-synthesized nZVIs could also effectively convert 4-NP harmful wastewater into useful and high-value of 4-AP by-products.

Keywords - Nanophase zero-valent iron, Bimetallic nanocatalyst, Nitrophenol, Circular economy.

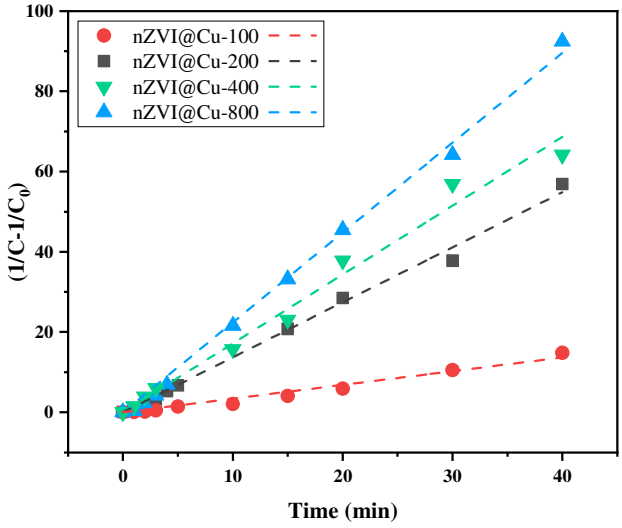

Fig 1. Linear regression for first-order kinetic reaction.