World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:18, No:01, 2024

Enhancing Industrial Wastewater Treatment through Fe3o4 Nanoparticles-loaded Activated Charcoal: Design and Optimization for Sustainable Development

Authors : Komal Verma, V. S. Moholkar

Abstract : This paper reports investigations in the mineralization of industrial wastewater (COD = 3246 mg/L, TOC = 2500 mg/L) using a ternary (ultrasound + Fenton + adsorption) hybrid advanced oxidation process. Fe3O4 decorated activated charcoal (Fe3O4@AC) nanocomposites (surface area = 538.88 m2/g; adsorption capacity = 294.31 mg/g) were synthesized using co-precipitation. The wastewater treatment process was optimized using central composite statistical design. At optimum conditions, viz. pH = 4.2, H2O2 loading = 0.71 M, adsorbent dose = 0.34 g/L, reduction in COD and TOC of wastewater were 94.75% and 89%, respectively. This result is essentially a consequence of synergistic interactions among the adsorption of pollutants onto activated charcoal and surface Fenton reactions induced due to the leaching of Fe2+/Fe3+ ions from the Fe3O4 nanoparticles. Microconvection generated due to sonication assisted faster mass transport (adsorption/desorption) of pollutants between Fe_3O_4@AC nanocomposite and the solution. The net result of this synergism was high interactions and reactions among and radicals and pollutants that resulted in the effective mineralization of wastewater The Fe_3O_4@AC showed excellent recovery (> 90 wt%) and reusability (> 90% COD removal) in 5 successive cycles of treatment. LC-MS analysis revealed effective (> 50%) degradation of more than 25 significant contaminants (in the form of herbicides and pesticides) after the treatment with ternary hybrid AOP. Similarly, the toxicity analysis test using the seed germination technique revealed ~ 60% reduction in the toxicity of the wastewater after treatment.

Keywords : Fe_3O_4@AC nanocomposite, RSM, COD;, LC-MS, Toxicity
Conference Title : ICEFTA 2024 : International Conference on Environment-Friendly Technologies and Applications
Conference Location : Dubai, United Arab Emirates
Conference Dates : January 18-19, 2024