World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:9, No:10, 2015

A Study on Adsorption Ability of MnO2 Nanoparticles to Remove Methyl Violet Dye from Aqueous Solution

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Abstract : The textile industries are becoming a major source of environmental contamination because an alarming amount of dye pollutants are generated during the dyeing processes. Organic dyes are one of the largest pollutants released into wastewater from textile and other industrial processes, which have shown severe impacts on human physiology. Nano-structure compounds have gained importance in this category due their anticipated high surface area and improved reactive sites. In recent years several novel adsorbents have been reported to possess great adsorption potential due to their enhanced adsorptive capacity. Nano-MnO2 has great potential applications in environment protection field and has gained importance in this category because it has a wide variety of structure with large surface area. The diverse structures, chemical properties of manganese oxides are taken advantage of in potential applications such as adsorbents, sensor catalysis and it is also used for wide catalytic applications, such as degradation of dyes. In this study, adsorption of Methyl Violet (MV) dye from aqueous solutions onto MnO2 nanoparticles (MNP) has been investigated. The surface characterization of these nano particles was examined by Particle size analysis, Scanning Electron Microscopy (SEM), Fourier Transform Infrared (FTIR) spectroscopy and X-Ray Diffraction (XRD). The effects of process parameters such as initial concentration, pH, temperature and contact duration on the adsorption capacities have been evaluated, in which pH has been found to be most effective parameter among all. The data were analyzed using the Langmuir and Freundlich for explaining the equilibrium characteristics of adsorption. And kinetic models like pseudo first- order, second-order model and Elovich equation were utilized to describe the kinetic data. The experimental data were well fitted with Langmuir adsorption isotherm model and pseudo second order kinetic model. The thermodynamic parameters, such as Free energy of adsorption (ΔG°), enthalpy change (ΔH°) and entropy change (ΔS°) were also determined and evaluated.

Keywords : MnO2 nanoparticles, adsorption, methyl violet, isotherm models, kinetic models, surface chemistry
Conference Title : ICC 2015 : International Conference on Chemistry
Conference Location : Barcelona, Spain
Conference Dates : October 26-27, 2015