ABSTRACT

The scientific and research studies concerned with the removal of pollutants from both groundwater and surface water are distinguished by its vital importance and unrivaled scientific concern throughout the whole world. This is so not only because they are considered among the most essential environmental fields, but also because they focus on one of the most vital natural resources upon which all aspects of life do depend. It is water through which Almighty God hath made everything live, and without it life will no more exist.

Iron nanomaterials are emerging as very effective tools for the removal of a wide spectrum of pollutants from water. These materials are based on iron nanoparticles, the effectiveness of which is attributed to large surface area and enhanced surface activity. In addition to extensive laboratory-scale research that is being carried out internationally, field studies are also being performed in many countries to assess the feasibility of iron nanotechnology in environmental remediation. In this context, *in-situ* and *ex-situ* treatment methodologies are being investigated. *In-situ* treatment

involves direct injection of iron nanoparticles into underground water bodies, while *ex-situ* treatment involves deploying slurries of iron nanoparticles into large tanks containing polluted water or soil. Moreover, iron nanomaterials are being proposed to replace iron powder in modern water treatment facilities known as permeable reactive barriers (PRBs)

In this study, iron nanoparticles along with nano iron supported on natural zeolite (clinoptilolite) and alumina have been produced via reduction of iron ions using sodium borohydride. The composite materials demonstrated high dye removal capabilities. The usage of the given substrates contributed to decreasing the aggregation of iron nanoparticles, thus enhancing their surface activity and, as such, increasing their uptake capacity allowing for better reusability.

Iron nanoparticles and their based materials were characterized using XRD, XPS, FTIR, SEM, TEM, EDX and BET-N_2. The produced iron nanomaterials were then used in the removal of aqueous methylene blue and methyl orange as two models of cationic and anionic dyes, the dye removal was monitored using UV-visible and GC-MS. The experiments investigated the effects of contact time and

dyes concentrations, in order to assess the kinetic behavior of the dye removal process and the extent of dye removal using iron nanoparticles and compare it with the nano iron based materials.

The results indicate that the composite of iron nanoparticles supported on zeolite has the fastest dye removal kinetics which can be adequately described using 2^{nd} order kinetics for the removal of methylene blue with k_2 values of $8.8\pm1.5x10^{-2}$ – $9.9\pm4.9x10^{-1}$ L mg^{-1} min^{-1} followed by 1^{st} order kinetics for the removal of methyl orange at low initial concentrations with k_1 value of $1.9\pm2.7x10^{-1}$ min^{-1} and 2^{nd} order kinetics at high initial concentrations with k_2 value of $9.8\pm4.8x10^{-3}$ L mg^{-1} min^{-1}. Moreover, the same composite demonstrated applicability in dyes removal over a wide range of concentrations and high reusability of five successive cycles with stable dye removal percentages.