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Removal of Pb^{2+} from Waste Water Using Nano Silica Spheres Synthesized on $CaCO_3$ as a Template: Equilibrium and Thermodynamic Studies

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Abstract : The availability and access to fresh water is today a serious global challenge. This has been a direct result of factors such as the current rapid industrialization and industrial growth, persistent droughts in some parts of the world, especially in the sub-Saharan Africa as well as population growth. Growth of the chemical processing industry has also seen an increase in the levels of pollutants in our water bodies which include heavy metals among others. Heavy metals are known to be dangerous to both human and aquatic life. As such, they have been linked to several diseases. This is mainly because they are highly toxic. They are also known to be bio accumulative and non-biodegradable. Lead for example, has been linked to a number of health problems which include damage of vital internal body systems like the nervous and reproductive system as well as the kidneys. From this background therefore, the removal of the toxic heavy metal, Pb2+ from waste water was investigated using nano silica hollow spheres (NSHS) as the adsorbent. Synthesis of NSHS was done using a three-stage process in which CaCO3 nanoparticles were initially prepared as a template. This was followed by treatment of the formed oxide particles with NaSiO3 to give a nanocomposite. Finally, the template was destroyed using 2.0M HCl to give NSHS. Characterization of the nanoparticles was done using analytical techniques like XRD, SEM, and TGA. For the adsorption process, both thermodynamic and equilibrium studies were carried out. Thermodynamic studies were carried out and the Gibbs free energy, Enthalpy and Entropy of the adsorption process were determined. The results revealed that the adsorption process was both endothermic and spontaneous. Equilibrium studies were also carried out in which the Langmuir and Freundlich isotherms were tested. The results showed that the Langmuir model best described the adsorption equilibrium.

Keywords : characterization, endothermic, equilibrium studies, Freundlich, Langmuir, nanoparticles, thermodynamic studies
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