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Kinetic and isotherm studies for lead adsorption from aqueous phase on carbon coated monolith

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HIGHLIGHTS

- Adsorption performance of PEG modified CCMs for Pb(II) was evaluated.
- PEG 8000 modified CCM showed better performance than PEG 600 modified CCM.
- PEG 8000 modified CCM showed higher surface area and more acidic sites.
- Equilibration time was less on CCM 8000 with higher adsorption capacity.
- Adsorption follows Freundlich isotherm.

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ABSTRACT

Adsorption of lead [Pb(II)] ions on two different types of carbon coated monoliths (CCM 600 and CCM 8000) was investigated with variations in the parameters such as agitation speed, pH, contact time, and Pb(II) initial concentration. Optimum Pb(II) adsorption was observed at pH: 5. The observed equilibration time on CCM 600 and CCM 8000 was 470 min and 350 min, respectively while, the equilibrium adsorption capacities were 14.2 mg/g and 15.2 mg/g at 50 mg/L initial Pb(II) concentration. The adsorption capacities on CCM 600 and CCM 8000 increased to 48 mg/g and 53.5 mg/g at 250 mg/L initial Pb(II) concentration. Linear and non-linear isotherm studies showed that equilibrium data better fitted to Freundlich isotherm model. Kinetic studies showed better applicability of pseudo-second order kinetics model. It was concluded that CCM 8000 showed better performance for Pb(II) ions removal compared to CCM 600.

1. Introduction

The excessive use of heavy metals for industrial and domestic practices contaminates ground and surface water and is considered as a major challenge to the environment. Industries such as electroplating, lead batteries, paint and dyes, glass operation, mining and smelters discharging large amounts of heavy metals in water bodies [1]. Lead, a heavy metal, toxic even in traces. It can enter human body through inhalation, ingestion or skin contact and may accumulate in bones, brain, kidney and muscles causing severe damage to kidney, nervous and reproductive system [2]. It causes anemia and sometimes even death [3]. Owing to the hazardous effects of Pb(II) it is essential to check waste streams containing Pb(II) before being discharged into the water resources. The maximum permissible limit assigned by World Health Organization (WHO) for Pb(II) in drinking water is 0.05 mg/L [2].

Some of the currently available techniques extensively used for the abatement and remediation of heavy metals are precipitation, membrane filtration, reverse osmosis, adsorption and solidification/stabilization. However, some of these processes are not economically feasible and are inadequate to meet present environmental regulations. Among the aforementioned technologies adsorption is achieving considerable interest for the past decade as it is effective for removing heavy metals in even trace levels [4]. Various adsorbents such as chitosan [5], chitosan–tripolyphosphate [6], modified lignin [7], kaolinite clay [8] have been reported for heavy metals removal from aqueous medium.

Activated carbon (AC), a commercially acclaimed adsorbent being used for water decontamination as it has comparatively high porosity, large internal surface area and relatively high mechanical strength [9]. Higher regeneration cost and fouling of industrial

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