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## Adsorption of Pb(II) ions from aqueous environment using eco-friendly chitosan schiff's base@Fe<sub>3</sub>O<sub>4</sub> (CSB@Fe<sub>3</sub>O<sub>4</sub>) as an adsorbent; kinetics, isotherm and thermodynamic studies

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### Highlights

- Removal of Pb(II) ions by CSB@Fe<sub>3</sub>O<sub>4</sub> was studied.
- Adsorption equilibrium was achieved within 105 minutes of contact time and followed pseudo second order kinetics.
- The maximum adsorption capacity of the CSB@Fe<sub>3</sub>O<sub>4</sub> was found to be 83.33 mg/g.
- The best fit isothermal model is the Langmuir and thermodynamic analysis revealed that the sorption process was feasible, spontaneous, and endothermic in nature.

### Abstract

Chitosan and its derivatives can be used to modify magnetic materials to promote the adsorption properties of the magnetic materials for the removal of metal ions. In this study a novel CSB@Fe<sub>3</sub>O<sub>4</sub> was prepared, characterized by FTIR, SEM, TEM, and VSM analysis and utilized as an adsorbent material for the removal of Pb(II) ions from aqueous solution. Batch studies were performed to evaluate the influences of various experimental parameters like pH, adsorbent dosage, contact time, initial concentration, and the effect of temperature. Optimum conditions for Pb(II) removal were found to be pH 5, adsorbent dosage 0.5 g and equilibrium time of 105 min. The pseudo-first-order, pseudo-second-order and intraparticle diffusion models were used to analyze kinetic data. The data fit well with the second-order kinetic model. The equilibrium data were analyzed using the Langmuir, and Freundlich isotherm models. The best interpretation for the equilibrium data was given by Langmuir isotherm, and the maximum adsorption capacity was found to be 83.33 mg/g for CSB@Fe<sub>3</sub>O<sub>4</sub>. The calculated thermodynamic parameters  $\Delta G^\circ$  (-9.728, -9.034 and -7.883 kJ/mol for 303, 313, and 323 K),  $\Delta H^\circ$  (20.39 kJ/mol) and  $\Delta S^\circ$  (0.0947 J/mol K) showed that the adsorption of Pb(II) ions were feasible, spontaneous and endothermic in nature.

**Keywords:** Chitosan; Fe<sub>3</sub>O<sub>4</sub>; 2-thiophenecarboxaldehyde; Pb(II) removal

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### 1. Introduction

Wastewaters containing various notorious toxic chemicals, heavy metals, dyes, organics and pharmaceuticals are difficult to remove because of their inert properties [1-17]. Heavy metals are stable and persistent environmental contaminants since they cannot be degraded or destroyed. These metal ions can be harmful to aquatic life, and water contaminated by toxic metal ions remains a serious public health problem. Among the various heavy metals, lead is one of the most toxic pollutants generated by the many industries especially metal industries, electroplating, battery manufacturing, pigment and dye

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