

## ***Zircon-Modified Polyaniline Composite for Aluminium Removal in Water***

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Aluminium contamination in water can occur through various pathways including water treatment processes such as alum treatment and electrocoagulation techniques, significantly impacting both the environment and human health. This study introduces the novel composite, Zircon-Polyaniline (ZrSiO<sub>4</sub>/PANI) for effective adsorption of aluminum ions. ZrSiO<sub>4</sub>/PANI, synthesized through oxidative polymerization method, involves coating polyaniline onto the ZrSiO<sub>4</sub> surface. Characterization via Scanning Electron Microscopy (SEM), Fourier Transform Infrared (FTIR), and Cyclic Voltammetry (CV) revealed the composite's structural and electrochemical properties. Adsorption of aluminium onto the composite surface was confirmed through 6.6% of aluminium in SEM elemental analysis. Two characteristic peaks were obtained for cyclic voltammetry of polyaniline. Redox peaks of iron impurity were observed in cyclic voltammetry of zircon. Zr-O and Si-O stretch peaks were apparent around 600cm<sup>-1</sup> and 900cm<sup>-1</sup> in the FTIR spectrum. The C=C stretch at 1506cm<sup>-1</sup> verifies polyaniline coating while intensified Al-O-H stretch at 3416cm<sup>-1</sup> signifies the adsorption of aluminium. Batch experiments explored the adsorption dynamics, examining contact time, Initial pH levels, and kinetics. Thermodynamic parameters  $\Delta H$ ,  $\Delta S$  and  $\Delta G$  were calculated.  $\Delta H$  value 450.33 kJmol<sup>-1</sup> indicates an endothermic process. Negative  $\Delta G$  values (-5.75 kJmol<sup>-1</sup> at 15°C, -7.46 kJmol<sup>-1</sup> at 25°C, and -8.67 kJmol<sup>-1</sup> at 35°C) confirm adsorption spontaneity. The Aluminon colorimetric method, utilizing a UV-visible spectrometer, feasibly quantified aluminum ions. Statistical analysis using Response Surface Methodology (RSM) optimizes the process. Adsorbate removal was confirmed through Inductively Coupled Plasma Mass Spectrometry (ICPMS) analysis. In a 100 ppm Al<sup>3+</sup> solution, the ZrSiO<sub>4</sub>/PANI composite exhibited a removal efficiency of 98.9% within 30 minutes at an optimal pH of 5. The pseudo-second-order model describes the adsorption kinetics well, with Freundlich and Temkin isotherm models fitting the data. This research not only introduces an efficient and reusable method for aluminum removal but also provides valuable insights into the adsorption mechanism.

**Keywords:** Aluminium, Polyaniline, Zircon, Adsorption, Composite, Aluminon