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Kinetics and equilibriums for adsorption of poly(vinyl alcohol) from aqueous solution onto natural bentonite

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HIGHLIGHTS

- Kinetics and isotherms for adsorption of PVA onto bentonite were investigated systematically.
- The adsorption process obeyed pseudo-second-order kinetic model.
- Langmuir isotherm model fitted well with the experimental equilibrium data.
- PVA molecules were adsorbed on the surfaces of bentonite particles with a certain degree of intercalation.
- Zeta potential of bentonite particles decreased with increasing PVA concentration.

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ABSTRACT

Kinetics and isotherms for the adsorption of poly(vinyl alcohol) (PVA) from aqueous solution onto natural bentonite were investigated systematically with respect to initial concentration, contact time and temperature. The kinetics of the adsorption process were discussed using three kinetic models, viz., pseudo-first-order, pseudo-second-order, and intraparticle diffusion kinetic model. The experimental data fitted well with pseudo-second-order kinetic model. The adsorption isotherms were also described by Langmuir, Freundlich and Dubinin–Radushkevich (D–R) isotherm model, respectively. It was found that the isotherms obeyed Langmuir model. FTIR results indicated the presence of PVA on the surface of bentonite/PVA complexes. XRD measurements showed that PVA molecules intercalated into the interlayers of bentonite. Zeta potential of bentonite particles decreased with increasing PVA concentration.

1. Introduction

Stabilizing and flocculating properties of water-soluble polymers find practical applications in industry, agriculture, environment protection, etc. For example, stabilization effect is used to obtain stable suspensions and emulsions in the production of pigments [1,2], cosmetics [3] and pharmaceuticals [4]. Destabilization effect is helpful in water purification [5,6], mineral flotation [7], etc. All of which are ascribed to the interaction between polymers and solid surfaces, viz., steric stabilization and bridging flocculation.

The wide applications of polymers mentioned above make it possible for polymer adsorption on the dispersed solid surfaces to attract attention. For which, investigation on polymer adsorption on the solid/liquid interface is of vital theoretical and practical importance.

In this work, poly(vinyl alcohol) (PVA) and bentonite were chosen for studies because both of them find a wide practical application. PVA has main usage in adhesives, and is also very popular in many industrial branches as stabilizers and flocculants (e.g., production of cosmetics, pharmaceutics, paints and papers, etc.) [8].

The enormous amount of PVA discharged from industrial effluents has posed a significant threat to both human health and natural environment [9]. However, the conventional biological systems are not efficient for the degradation of PVA. Adsorption is one of the effective methods to remove contaminants from wastewaters. Even though the most promising adsorbent for adsorption is activated carbon with high surface area and high adsorption capacity, it is very expensive and has high operation costs. Therefore, there is a growing need to find adsorbents with high cost performance.

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