

ADSORPTION OF PHOSPHATE BY PAPER MILL SLUDGE

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ABSTRACT

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The utilization of paper mill sludge as adsorbent for removal of phosphates from aqueous solution has been investigated. The influences of experimental condition such as pH of solution, amount of adsorbent and initial concentration of phosphate were studied in detail. The adsorption of phosphate was pH dependant and adsorption process being more efficient in the basic pH region and maximum at pH 12. The adsorption isotherm and adsorption kinetics of paper mill sludge were studied. It shows that the Langmuir model is better in describing the adsorption isotherm process compared to Freundlich. The maximum adsorption capacity was 12.65 mg/g at pH 12 at room temperature. Two kinetics models, pseudo-first order and pseudo-second order were applied in order to analyze the kinetics data. It was found that the pseudo-second order model is the better choice to describe the adsorption behavior. The thermodynamics parameters have been evaluated. Thermodynamic calculations showed that the phosphate adsorption process of paper mill sludge was endothermic and spontaneous in nature. From the study, the paper mill sludge has the potential to be utilized as cost effective removal of phosphate from real water samples due to their low cost and high capability.

ABSTRAK

PENJERAPAN FOSFAT OLEH ENAPCEMAR KILANG KERTAS

Di dalam kajian ini, penggunaan enapcemar kilang kertas sebagai penjerap fosfat daripada larutan dikaji. Pengaruh pH, kuantiti penjerap, dan kepekatan permulaan fosfat dikaji dengan terperinci. Penjerapan fosfat adalah bergantung kepada pH dan penjerapan adalah lebih efektif pada pH beralkali dan maksimum pada pH 12. Selain daripada itu, penjerapan isoterm dan kinetik penjerapan turut dikaji. Model isoterma Langmuir adalah model yang paling sesuai untuk menghuraikan penjerapan isoterm oleh enapcemar kilang kertas. Penjerapan kapasiti maksimum adalah 12.65 mg/g pada pH 12 pada suhu bilik. 2 model kinetik digunakan iaitu tertib pseudo-pertama dan tertib pseudo-kedua digunakan untuk menganalisis data kinetik. Tertib pseudo-kedua adalah lebih sesuai digunakan berbanding tertib pseudo-pertama untuk menghuraikan penjerapan fosfat oleh enapcemar kilang kertas. Daripada pengiraan termodinamik, proses penjerapan fosfat adalah endotermik dan spontan. Pada keseluruhan kajian yang dijalankan, enapcemar kilang kertas berpotensi digunakan untuk menjerap fosfat daripada air kerana sangat efektif dan melibatkan kos yang rendah.

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LIST OF SYMBOLS AND ABBREVIATION

| | |
|---------------------------|--|
| ICP-MS | Inductively coupled plasma mass spectrometry |
| FTIR | Fourier transform infrared |
| XRD | X-ray diffraction |
| IC | Ion chromatography |
| ISWM | Integrated solid waste management |
| ΔH | Enthalpy |
| ΔG | Gibbs free energy |
| ΔS | Entropy |
| PO_3^{4-} | Phosphate ion |
| H_2PO_4^- | Dihydrogen phosphate ion |
| HPO_4^{2-} | Monohydrogen phosphate ion |
| CaCO_3 | Calcium carbonate |
| K_1 | The rate constant of pseudo-first order adsorption |
| K_2 | The rate constant of pseudo second order adsorption |
| q_t | The amount of phosphates adsorption (mg/g) at time |
| q_e | The amount of phosphate adsorption (mg/g) at equilibrium |
| K_d | The distribution coefficient |
| C_e | The concentration of phosphate at the equilibrium (mg/L) |
| R | The gas constant (8.314 J/Kmol) |
| E_a | Arrhenius activation energy |
| A | Pre-exponential factor or the Arrhenius factor |
| Q_m | Langmuir maximum adsorption capacity |
| b | Langmuir adsorption equilibrium constant |
| R_L | Langmuir dimensionless constant |
| K_f | Freundlich constant |
| n_f | Freundlich coefficient |

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