ADSORPTION OF PHOSPHATE BY PAPER MILL SLUDGE

AHMAD RAZALI BIN ISHAK

FACULTY OF SCIENCE

UNIVERSITY OF MALAYA

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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 isotem dankinetik jerapan turut dikaji. Model isoterma Langmuir adalah model yang paling sesuai untuk menghuraikan penjerapan isotem 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 fospfat 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	Freundlinch coefficient

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