Batch and Kinetic Studies of Ni Adsorption on Highly Humified Newfoundland Peat

by

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6th Sept. 2010

CONTENTS

- **Introduction**
- **Peat as Metal Adsorbent**
- **Peat-Ni Adsorption Kinetics**
- **Peat-Ni Adsorption Equilibrium**
- **Discussions**
- **Conclusions**

2

Fig.1: Urban effluents discharge into the St. Lawrence River

Source: www.qc.ec.gc.ca

Fig.2: 64 Species of Fish killed due to cyanide and heavy metal contaminations

Source: www.american.edu/TED

3

Introduction

- Gradual accumulation of metals (non-biodegradable) is a threat to the environment and human health.
- Effective removal options are required to support existing treatment methods to reduce/eliminate hazards.
- Precipitation (carbonate, lime or sulfide) is the widely used treatment for metal contaminated wastewater.
- This is not an effective method when metal concentrations are very low.
- Adsorption via low cost adsorbents is an effective option.

4

Peat as Metal Adsorbent

- Peat lands occupy ~ 13.4% of the total land area of NL (Daigle and Gautreau-Daigle, 2001).
- Peat possesses unique physico-chemical properties that enables it filter, coalesce and remove metals from contaminated water (Pérez et al., 2005).
- Peat is often classified based on the von Post scale with 1H being the least decomposed and 10H highly decomposed.

5

Peat as Metal Adsorbent-contd.

- Poorly humified peat (1H to 5H) has been widely studied as a potential metal adsorbent.
- Information on the uptake chemistry remain scarce and controversial although ion exchange and complexation are usually reported (Brown et al., 2000).
- The use of highly humified peat (8H to 10H) as metal adsorbent could offer the needed understanding of the uptake chemistry.
- This peat type from NL have high cation exchange capacity and is known to be homogenous in nature (Asapo & Coles, 2010).

6

Fig.2a: Harvesting Peat from a Natural NL Bog

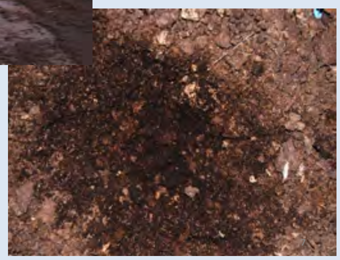


Fig. 2b: Air dried Highly Humified NL Peat

Peat-Ni Adsorption Kinetics

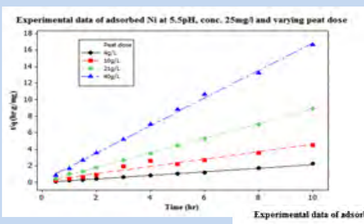
- Peat-Ni adsorption kinetics is better predicted by the pseudo-second order kinetic model.
- The pseudo-second order kinetic is represented by equation1.

$$\frac{t}{q_t} = \frac{1}{K_{1,ad}\, q_e^2} + \frac{1}{q_e} t \qquad (1)$$

Where ,

$$q_t = (C_i - C_t)V / M$$

- Ci is the initial metal conc. (mg/L) and Ct is the metal conc. (mg/L) at a given time, V is the volume of the contaminant (L) and M is the mass of peat used (g).
- $K_{1,ad}$ is the pseudo-second order rate constant (g/mg.h)
- q_e is the quantity of Ni adsorbed at equilibrium (mg/g)



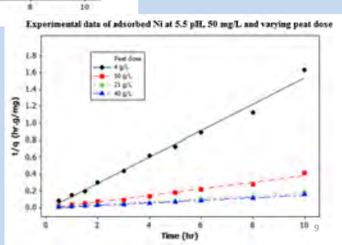


Fig. 3: Profiles of pseudo-second order kinetics

Peat-Ni Adsorption Kinetics – contd.

- Equilibrium was Ni concentration dependent.
- Equilibrium concentration of Ni in solution was higher at lower peat dose.
- Kinetic equilibrium time was 8-10hrs.
- Regression coefficients for Ni uptake was ~ 1.
- Agitation of the reactions vessels influence initial mode of reaction allowing desorption at lower peat dose.

Peat Ni-Adsorption Equilibrium

- Langmuir (eq.1) and Freundlich (eq.2) isotherms described the adsorption equilibrium over 24 hrs.

$$\frac{1}{q_e} = \frac{1}{q_m} + \frac{1}{bq_m Ce} \qquad (1)$$

Where, q_m is the monolayer maximum capacity that q approaches, b is the ratio of desorption to adsorption .

$$\log q = \log K + \frac{1}{n} \log C_e \qquad (2)$$

Where K (Freundlich constant and 1/n (Freundlich exponent) are measures of adsorption capacity.

Peat Ni-Adsorption Equilibrium

- Summary of the adsorption equilibrium parameters

	Langmuir Parameters			Freundlich Parameters		
Peat dose (g/L)	b*10^{-3}	q_m	R^2	1/n	K	R^2
4	8.42	24.03	0.928	0.56	0.72	0.971
10	3.76	25.37	0.998	0.81	0.16	0.993
21	2.29	20.58	0.995	0.93	0.05	0.995
40	1.04	23.85	0.999	0.96	0.03	0.999

- At 4g/L peat dose the Freundlich isotherm is a better model compared to Langmuir isotherm.

Discussion

- At low peat dose, impact of desorption is significant which may be reduced by agitation.
- Adsorption capacity of peat increases as peat dose is increased as more active sites are available.
- Ni adsorption is concentration dependent with the optimum removal obtained at 125mg/L .
- The kinetic of adsorption indicated that Ni uptake involved more than one reaction.

13

Conclusions

- NL saprist peat is a potential adsorbent for the Ni removal from mining and refining wastewaters.
- Over 90% removal efficiency was obtained.
- If Ni concentration can be maintained at 125 mg/L, higher removal rates will be favoured.
- Ni Desorption rate is reduced as peat dose is increased.
- The chemistry of the uptake involves more than one reaction and can be investigated.

14

THANK YOU

QUESTIONS?

15