



**UNIVERSITI PUTRA MALAYSIA**

***ADSORPTION POTENTIAL OF KENAF FOR COPPER AND  
NICKEL REMOVAL FROM AQUEOUS SOLUTION***

**MARYAM RAHMATI ZADEH**

**FK 2010 26**

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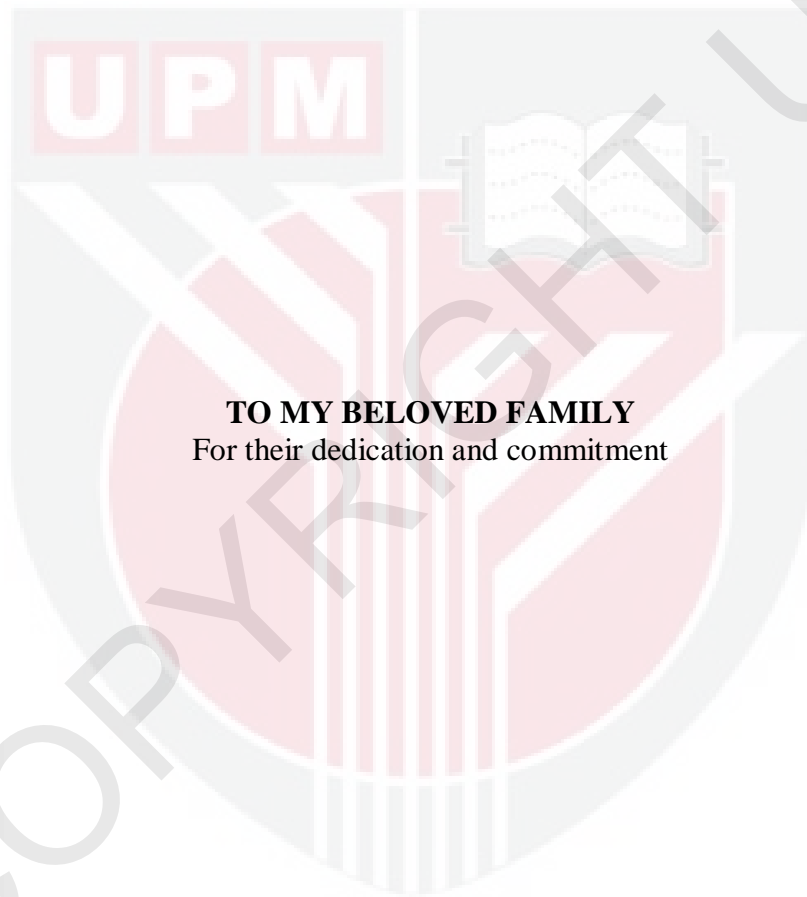
By

**MARYAM RAHMATI ZADEH**

**Thesis Submitted to the School of Graduate Studies, University Putra Malaysia, in  
Fulfilment of the Requirements for the Degree of Master of Science**

**May 2010**

**DEDICATION**



**TO MY BELOVED FAMILY**  
For their dedication and commitment

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Abstract of thesis presented to the Senate of University Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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REMOVAL FROM AQUEOUS SOLUTION**

By

**MARYAM RAHMATI ZADEH**

**May 2010**

**Chairman: Dr. Hasfalina bt Che Man, PhD**

**Faculty: Faculty of Engineering**

Heavy metal pollution is one of the environmental issues that become a concern due to their toxic effect to environment and human health. Adsorption has been widely used to remove heavy metals from industrial wastewater. Therefore, there is a need to explore new sources of an alternative and inexpensive adsorbent for elimination of heavy metals. In this study, a series of batch experiment was conducted to study the adsorption potential of kenaf as a biosorbent for Cu (II) and Ni (II) removal from aqueous solutions. The specific objectives are to obtain adsorption isotherms, kinetics determination, and measure the adsorption capacity in batch and fixed bed column system. The single adsorption isotherm and kinetics were carried out at a constant temperature of  $30 \pm 1^\circ\text{C}$  using an incubator shaker operated at 200 rpm. Some of the parameters that affect the adsorption process such as pH, initial concentration of adsorbate, adsorbent dosage and contact time was determined. The column study experiment was conducted with 100 mg/L of individual heavy metal solution. The effect of bed depth was examined with a flow rate of 6 mL/min and different bed depths of 15, 20, 25 and 30 cm to obtain the adsorption capacity and exhaustion time by evaluating the breakthrough curves. Also, to

determine the effect of different flow rates, the column study experiment was conducted at a constant bed depth (20 cm) with different flow rates of 4, 6, and 9 mL/min.

The optimum pH was observed to be at pH 5.0 and 6.0 for Cu (II) and Ni (II), respectively. The equilibrium time of Cu (II) was determined at 3 hours and for Ni (II) was at 4.5 hours. The single component equilibrium of each metal was analyzed using the Langmuir and Freundlich models. Langmuir isotherm model showed rather better fit for Cu (II) adsorption based on the correlation coefficient ( $R^2$ ) values. As for Ni (II) adsorption, Freundlich isotherm model showed the better fit. The pseudo first-order and pseudo second-order models were used to describe adsorption kinetics of Cu (II) and Ni (II), respectively. The adsorption kinetics of these metal ions onto kenaf followed pseudo second-order model assuming chemisorptions mechanisms. The bed depth service time model (BDST) fitted well with experimental data due to the effect of bed depth. Thomas model also described well the adsorption parameters to determine the effect of flow rate on adsorption capacity and breakthrough curves.

Abstrak tesis ini dikemukakan kepada Senat Universiti Putra Malaysia untuk memenuhi keperluan ijazah Master Sains

**POTENSI JERAPAN KENAF BAGI PENYINGKIRAN KUPRUM DAN NIKEL  
DARIPADA LARUTAN AKUEUS**

Oleh

**MARYAM RAHMATI ZADEH**

**Mei 2010**

**Penyelia: Dr. Hasfalina bt Che Man, PhD**

**Fakulti: Kejuruteraan**

Pencemaran logam berat merupakan salah satu isu kesekitaran yang menjadi perhatian kerana kesan toksik darinya terhadap persekitaran dan kesihatan manusia. Penjerapan telah banyak digunakan dalam penyingkiran logam berat dari air sisa industri. Oleh kerana itu adalah perlu untuk meneroka sumber baru sebagai alternatif penjerap yang murah dalam penyingkiran logam berat. Dalam kajian ini, beberapa percubaan sesekumpul telah dilakukan untuk mengkaji potensi kenaf sebagai bio-penyerap untuk penyingkiran Cu (II) dan Ni (II) dari larutan akueus. Objektif khusus adalah untuk mendapatkan isoterma jerapan, penentuan kinetik, dan keupayaan jerapan secara sesekumpul dan sistem kolum lapisan tetap. Isoterma jerapan tunggal dan kinetik dilakukan pada suhu tetap  $30 \pm 1^\circ\text{C}$  menggunakan penggoncang inkubator yang beroperasi pada 200 putaran per minit. Beberapa parameter yang mempengaruhi proses jerapan ditentukan seperti pH, kepekatan awal larutan, dos jerapan dan masa kontak. Eksperimen kajian kolum telah dilakukan dengan 100 mg/L bagi setiap larutan logam

berat. Pengaruh kedalaman lapisan ditentukan dengan laju alir 6 mL / menit dan pada kedalaman lapisan yang berbeza iaitu 15, 20, 25 dan 30 cm untuk mendapatkan kapasiti penjerapan masa ketepuan dengan menilai lengkung terobosan. Juga untuk mengetahui pengaruh laju aliran yang berbeza, kajian kolum telah dilakukan pada kedalaman tetap (20 cm) dengan laju aliran yang berbeza dari 4, 6, dan 9 mL/minit.

pH optimum adalah diperhatikan pada pH 5.0 dan 6.0 bagi setiap Cu (II) dan Ni (II). Masa keseimbangan bagi Cu (II) adalah ditentukan pada 3 jam dan Ni (II) adalah pada 4.5 jam. Keseimbangan komponen tunggal daripada setiap logam telah dianalisis dengan menggunakan model Langmuir dan Freundlich. Model isoterma Langmuir menunjukkan penjerapan Cu (II) adalah berpadanan dengan baik berdasarkan nilai koefisien korelasi ( $R^2$ ). Manakala bagi penjerapan Ni (II), model isoterma Freundlich didapati lebih bersesuaian. Model pseudo urutan-pertama dan model pseudo urutan-kedua digunakan untuk menjelaskan kinetik jerapan bagi Cu (II) dan Ni (II). Kinetik jerapan bagi ion logam ini ke atas kenaf yang mematuhi pseudo urutan- kedua adalah diandaikan menepati mekanisma serapan-kimia. Model servis masa kedalaman lapisan (BDST) menepati dengan baik data eksperimen bagi kesan kedalaman. Model Thomas juga menjelaskan dengan baik parameter jerapan untuk menentukan pengaruh laju aliran ke atas keupayaan jerapan dan lengkung terobosan.

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I certify that a Thesis Examination Committee has met on 27 May 2010 to conduct the final examination of Maryam Rahmati Zadeh on her thesis entitled “**Adsorption Potential of Kenaf for Copper and Nickel Removal from Aqueous Solutions**” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

**Mohd Amin Mohd Soom, PhD**

Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Chairman)

**Zurina Zainal Abidin, PhD**

Lecturer  
Faculty of Engineering  
Universiti Putra Malaysia  
(Internal Examiner)

**Shafreeza Sobri, PhD**

Lecturer  
Faculty of Engineering  
Universiti Putra Malaysia  
(Internal Examiner)

**Abu Bakar Mohamad, PhD**

Professor  
Department of Chemical and Process Engineering  
Faculty of Engineering  
Universiti Kebangsaan Malaysia  
(External Examiner)

---

**BUJANG BIN KIM HUAT, PhD**

Professor and Deputy Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 23 July 2010

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

**Hasfalina Che Man, PhD**

Senior Lecturer  
Faculty of Engineering  
University Putra Malaysia  
(Chairman)

**Azni b. Idris, PhD**

Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Member)

**Luqman Chuah Abdullah, PhD**

Associate Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Member)

---

**HASANAH MOHD GHAZALI, PhD**

Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 12 August 2010

## DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Putra Malaysia or other institutions.



**MARYAM RAHMATI ZADEH**

Date: 27 May 2010

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