AMMONIA REMOVAL FROM AQUEOUS SOLUTION USING MODIFIED OIL PALM EMPTY FRUIT BUNCHES BASED ADSORBENT

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2017

DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, excepts, equations, summaries and references, which have been duly acknowledged.

20th June 2017

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CERTIFICATION

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Ricky Lee Nyuk San
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ABSTRACT

Highly ammonia-nitrogen concentration in water will destroy the marine ecology and contribute to bad odor. In this study, oil palm empty fruit bunches fibers (EFB),an abundant agricultural by-product/waste in Malaysia are selected for the ammonia-nitrogen removal from urban drainage water . The main aim is to study the effectiveness of EFB on ammonia-nitrogen removal from synthetic ammonia-nitrogen aqueous solutions under various experimental parameter conditions. The recovery of ammonia-nitrogen was studied with different soil media and submerged modified fresh EFB by planting the *Cymbopogon* citrus. In modification of the oil palm EFB, the sodium hydroxide (NaOH) and sulphuric acid (H_2SO_4) are used in the pretreatment of oil palm EFB under various parameters such as soaking time and concentration. The results showed that the modification of oil palm EFB using NaOH petreatment gives a better adsorption of ammonia nitrogen. The ammonia-nitrogen adsorption experiment was done in 180 minutes with the effect of different temperature (15, 20, 25, 30, 35, 40 ^{o}C) for sorption isotherm, kinetic modeling and thermodynamics studies. After that, these submerged EFB fibers are further tested with *Cymbopogon* citrus plant growth resulted best condition media of 50 % soils and submerged EFB fibers. The preliminary study shown that the optimized ammonia-nitrogen adsorption capacity was 0.828 mg/g under the NaOH treatment onto the EFB fibers which is better than H_2SO_4 modification with the adsorption capacity of 0.561 mg/g. The ammonia nitrogen removal by using partly decomposed EFB give adsorption capacity of 0.821 mg/g. The adsorption isotherm (Langmuir, Freundlich, Tempkin and Dubinin-Radushkevich (DB-R)) data analysis were used for mathematical description of the adsorption equilibrium of ammonia nitrogen for unmodified (fresh) and modified EFB fibers. The Tempkin isotherm model fitted the biosorption experimental data with the best correlation for fresh EFB (R^2 = 1) and modified EFB (R^2 = 0.9999). Adsorption of ammonia nitrogen kinetics modeling data showed that the pseudo-second-order model fits the experimental data very well for fresh EFB (R^2 = 0.9900) and modified (R^2 = 0.9997) at 298 K predicting a chemisorption process for both fresh and modified EFB fibers. Thermodynamic parameter (ΔG^o, $\Delta H^o$and ΔS^o) studies showed that the biosorption ammonia nitrogen onto modified EFB was predicted to be spontaneous and endothermic in nature. These modified fresh EFB were applied into urban drainage at *Kampung Sembulan Lama,* Kota Kinabalu for 7 days and the recovery of ammonia nitrogen recovered by *Cymbopogon* citrus plant growth. After 90 days, the optimum total weight for this plant was determined to be 93.33 grams in the media soil condition of 50 % soil and 50 % submerged EFB fibers. It can be concluded that the ammonia nitrogen from the water can be recovered by applying the empty fruit bunches fibers.

ABSTRAK

PENYINGKIRAN AMMONIA DARIPADA LARUTAN AKUEUS YANG MENGGUNAKAN SERAT TANDAN KELAPA SAWIT KOSONG YANG DIUBAHSUAI

Kepekatan ammonia-nitrogen yang tinggi dalam air akan memusnahkan ekologi kehidupan di laut dan menyumbang kepada bau busuk. Dalam kajian ini, serat tandan kelapa sawit kosong (EFB) telah dipilih untuk menyingkirkan ammonia nitrogen dalam saliran longkang. EFB dipilih kerana ianya merupakan sisa pertanian yang dihasilkan dalam jumlah yang banyak di Malaysia. Keberkesanan serat tandan EFB menyingkirkan ammonia-nitrogen dalam larutan sintetik telah dijalankan. Pemulihan ammonia-nitrogen dikaji melalui penanaman serai Cymbopogon yang menggunakan 50% tanah dan tandan EFB tenggelam. Dalam pengubahsuaian serat tandan kelapa sawit kosong, natrium hidroksida (NaOH) dan asid sulfurik (H_2SO_4) telah digunakan untuk pra-rawatan serat tandan kelapa sawit EFB. Keputusan eksperimen menunjukkan bahawa pengubahsuaian serat tandan kelapa sawit EFB yang menggunakan pra-rawatan NaOH telah memberi penyikiran ammonia nitrogen yang lebih baik. Eksperimen penjerapan ammonia-nitrogen telah dilakukan selama 180 minit dalam pelbagai suhu (15, 20, 25, 30, 35 dan 40 °C) untuk kajian-kajian isoterma jerapan, pemodelan kinetik dan termodinamik. Kajian permulaan membuktikan bahawa pengoptimum keupayaan jerapan ammonia-nitrogen ialah 0.828 mg/g pada rawatan NaOH ke atas serat EFB yang mana lebih baik daripada pengubahsuaian H_2SO_4 dengan keupayaan jerapan 0.561 mg/g. Penjerapan untuk penyingkiran ammonia-nitrogen yang mengambil masa keseimbangan selama 40 minit. Keupayaan jerapan semakin bertambah apabila kepekatan ammonia-nitrogen sintetik dengan peningkatan nilai pH ke maksimum iaitu pH 7. Sebahagian serat EFB yang mula reput telah digunakan bagi penyingkiran ammonia-nitrogen yang memberi keupayan jerapan sebanyak 0.821 mg/g. Di samping itu, pengubahsuaian yang menggunakan kepekatan NaOH yang tinggi telah menunjukkan penyingkiran ammonia-nitrogen yang rendah iaitu 0.333 mg/g. Isoterma jerapan (Langmuir, Freundich, Tempkin dan Dubinin Radushkevich) analisis data telah digunakan untuk mengambarkan keseimbangan matematik jerapan ammonia-nitrogen keatas serat tandan EFB yang diubahsuaikan. Isoterma Tempkin model dengan pemasangan data percubaan jerapan yang mempunyai kolerasi yang terbaik untuk Serat tandan EFB segar (R^2 = 1) dan EFB terubahsuai (R^2 = 0.9999). Penjerapan ilmu kinetik ammonia-nitrogen memperagakan data menunjukkan bahawa model pseudo-kedua order adalah paling sesuai dengan data percubaan dengan begitu baik untuk EFB segar (R2 = 0.9900) dan diubahsuaikan (R2 = 0.9997) di suhu 298K meramal proses serapan kimia untuk kedua-dua jenis tandan iaitu serat tandan tanpa ubahsuai dan serat tandan EFB yang diubahsuaikan. Parameter termodinamik (ΔG^o, ΔH^o and ΔS^o) kajian menunjukkan bahawa biosorption ammonia-nitrogen ke atas EFB yang diubah sesuai untuk diramalkan spontan dan bersifat endorterma Serat EFB yang telah diubahsuai telah diaplikasi ke dalam saliran air longkang yang mengandungi ammonia nitrogen selama 7 hari di di Kampung Sembulan Lama, Kota Kinabalu dan pemuliharaan ammonia nitrogen pada serat tandan sawit kosong yang

ditenggelamkan dalam saliran air longkang di Kampung Sembulan Lama telah dilakukan dengan penanaman serai Cymbopogon. Selepas 90 hari, serai Cymbopogon telah memperolehi berat yang optimum iaitu 93.33 gram pada keadaan media 50 % tanah dan 50 % serat tandan sawit kosong terendam. Dengan ini disimpulkan bahawa pemuliharaan ammonia-nitrogen dari air longkang dapat dilaksanaan dengan menggunakan serat tandan sawit kosong

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LIST OF ABBREVIATION

EFB	-	Empty Fruit Bunch
COD	-	Chemical oxygen demand
NH_3-N	-	Ammonia nitrogen
Λ	-	Wavelength (nm)
mg/L	-	Milligram per liter
g/L	-	Gram per liter
mmol/L	-	millimole per liter
Q_e	-	Adsorption capacity (mg/g)
C_o	-	Initial Concentration (mg/L)
C_e	-	Equilibrium Concentration (mg/L)

LIST OF APPENDICES