ADSORPTION OF BASIC RED 46 DYE USING SEA MANGO (*Cerbera odollam*) ACTIVATED CARBON

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LIST OF SYMBOLS

m^2/g	meter square per gram
g/L	gram per liter
mg/L	milligram per liter
%	percentage
mmHg	millimeter of Mercury
ºC	degree Celsius
kg/m^3	kilogram per meter cube
kg/L	kilogram per liter
µm	micrometer
mm	millimeter
mg/g	milligram per gram
L/mg	liter per milligram
g/mg.min	gram per milligram. minute
g/mol	gram per mol
cm^3/min	centimeter cube per minute
rpm	revolution per minute
mL	millimeter
cm	centimeter
nm	nanometer
wt	weight percent
L	liter
g	gram

M	molar
N	number of experiment
n	number of factors
A_i	measured absorbance
A_c	ash content
λ	wavelength
b_c	path length of the cell
ε_λ	molar absorptivity coefficient of solute wavelength
C	concentration
C_t	concentration at time t
C_0	initial concentration
C_e	equilibrium concentration
q_e	adsorption uptake
q_{max}	monolayer capacity
q_t	adsorption uptake at time t
K_L	Langmuir constant
R_L	Langmuir dimensionless
V	volume
W	mass of adsorbent used
K_F	Freundlich constant
n	Freundlich constant
k_1	pseudo-first order rate constant
k_2	pseudo-second order rate constant
Y	predicted response

b_0	constant coefficient
b_i	linear coefficient
b_{ij}	interaction coefficient
b_{ii}	quadratic coefficient
x_ix_j	coded values of variables

LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CCD	Central Composite Design
CV	Coefficient of Variance
BET	Brunaeur-Emmet-Teller
DOE	Design of Experiment
FTIR	Fourier Transform Infrared Spectroscopy
GAC	Granular Activated Carbon
IR	Impregnation ratio
PAC	Powdered Activated Carbon
RSM	Response Surface Methodology
SEM	Scanning Electron Microscope
SMP	Sea Mango Precursor
TAS	Total Ash Content
UC	Uniform Coefficient

LIST OF NOMENCLATURES

$AlCl_3$	Aluminum Chloride
BR46	Basic Red 46
H_2SO_4	Sulfuric Acid
H_3PO_4	Phosphoric Acid
HCl	Hydrochloric Acid
KOH	Potassium Hydroxide
K_2CO_3	Potassium Carbonate
N_2	Nitrogen gas
O_2	Oxygen gas
NaOH	Sodium Hydroxide
Na_2CO_3	Sodium Carbonate
$ZnCl_2$	Zinc Chloride

Penjerapan Pencelup Merah Beralkali 46 menggunakan Karbon Teraktif Mangga Laut (*Cerbera odollam*)

ABSTRAK

Pengurangan sumber asas untuk penghasilan karbon teraktif telah menyebabkan peningkatan harganya di pasaran. Mangga laut menjadi satu tarikan baru untuk dijadikan karbon teraktif kerana lignin dan selulosa yang terkandung dalamnya. Dalam kajian ini, mangga laut diaktifkan menggunakan teknik pengaktifan kimia dengan merendamkannya dalam agen pengaktif, kalium hidroksida (KOH) dan dikarbonkan pada dua suhu berbeza 500ºC (AC500) dan 600ºC (AC600) dengan pengaliran gas nitrogen. Permukaan kedua-dua karbon teraktif manga laut dan mangga laut yang mentah (SMP) kemudian dianalisis menggunakan Imbasan Elektron Mikroskop (SEM), Brunaer-Emmet-Teller (BET) untuk melihat perubahan struktur permukaan dan luas permukaan pori masing-masing. Analisis AC500 dan AC600 karbon teraktif telah menunjukkan pori-pori baru terhasil diatas permukaannya. Luas permukaan melalui analisis BET yang dikira bagi SMP, AC500 dan AC600 masing-masing ialah 0.03 m^2/g, 108.79 m^2/g dan 451.87 m^2/g. Analisis Infra-merah Pengubahan Fourier Spektroskopi (FTIR) dalam kumpulan berfungsi menunjukkan perubahan berlaku dalam jalur diantara ketiga-tiga sampel yang membuktikan bahawa transformasi kimia telah berlaku semasa proses pengkatifan. Analisis jumlah kandungan abu (TAS) telah menunjukkan bahawa kandungan abu bertambah dalam kedua-dua karbon teraktif berbanding manga laut mentah, iaitu 38.97%, 41.82% dan 2.53% di mana kadar penghasilan AC500 lebih tinggi. Karbon teraktif mangga laut AC600 seterusnya digunakan untuk penjerapan pencelup merah beralkali 46 dalam proses berkelompok. Faktor yang dikaji adalah kepekatan awal pencelup, larutan pH awal, dos karbon teraktif dan suhu penjerapan. Kepekatan awal pencelup yang tinggi telah menyebabkan penjerapan pencelup merah beralkali 46 yang rendah. Kajian mendapati larutan pH awal yang terbaik ialah pada pH 11 dan peningkatan dos karbon teraktif sehingga 2.0 g/L telah mengakibatkan penjerapan pencelup merah beralkali 46 meningkat. Kajian pengoptimuman menggunakan Metodologi Tindakbalas Permukaan (RSM) Rekabentuk Eksperimen (DOE) mendapati keadaan optimum adalah pada jumlah dos karbon teraktif ialah 1.00 g/L, larutan pH awal 11 dan kepekatan pencelup 150 mg/L dimana R^2 ialah 0.9943. Dengan menjalankan analisis sesuhu dan kinetik, data eksperimen telah mematuhi model sesuhu Langmuir berbanding model sesuhu Freundlich manakala model kinetik tertib kedua lebih baik berbanding dengan model kinetik tertib pertama. Kedua-dua model sesuhu Langmuir dan model kinetic tertib kedua menunjukkan nilai R^2 menghampiri 1.

Adsorption of Basic Red 46 dye using Sea Mango (*Cerbera odollam*) Activated Carbon

ABSTRACT

The limited source of raw materials for production of activated carbon has increased the price of commercial activated carbon price. Due to the presence of lignin and cellulose in sea mango make it as new potential for activated carbon. Sea mango activated carbon was prepared by chemical activation using potassium hydroxide (KOH) at different carbonization temperatures, which are 500ºC (AC500) and 600ºC (AC600) under nitrogen (N_2) gas flow. The activated carbon prepared together with sea mango precursor (SMP) was characterized using Scanning Electron Microscope (SEM) and Brunaer Emmet Teller (BET) for surface morphology and specific surface area, respectively. The result showed that the surface of AC500 and AC600 has undergone some alteration where some new pores were developed. The specific surface area measured for SMP, AC500 and AC600 were 0.03 m^2/g, 108.79 m^2/g and 451.87m^2/g, respectively. Fourier Transform Infrared Spectroscopy (FTIR) use to analyse functional group showed band transition between the three samples which indicated that chemical transformation had occurred during activation process. Analysis of Total Ash Content (TAS) has shown that the ash content increased in both AC500 (38.97%) and AC600 (41.82%) compared to SMP (2.53%) whereas AC500 has better yield compared to AC600. In order to study the performance of sea mango activated carbon, AC600 was further used in adsorption of Basic Red 46 dye in batch process. The effects of operating parameters, initial pH solution, adsorbent dosage, initial dye concentration and adsorption temperature were varied where the result obtained indicated that all parameters have played important roles in the adsorption process. High initial dye concentration has resulted in low adsorption of Basic Red 46 dye with the best initial pH solution was 11. It was found that the removal of Basic Red 46 dye increased with the increasing amount of adsorbent dosage and adsorption temperature. Interaction between parameters was studied using Response Surface Methodology (RSM). The optimum parameters were recorded at 150 mg/L initial dye concentration, initial pH solution of 11.00 and 1.00 g/L adsorbent dosage with R^2 of 0.9943. Moreover, from the isotherm and kinetic analysis conducted, the results showed a monolayer adsorption as the data fitted well on Langmuir isotherm model and pseudo-second-order kinetic model with R^2 values closed to 1.

CHAPTER 1

INTRODUCTION

1.1 Background

Around 1 million tonnes and more than 10,000 different synthetic dyes have been produced annually worldwide from industrial activities, and of this amount about 10% are freely discharged in industrial effluent without any treatment (Kyzas et al., 2009). Dyes that are discharged from paper, leather, plastic and other industries have contributed to water pollution as well as intruding the environment. Textile industry has incorporated a large variety of dyes and chemical addition (Karim et al., 2009).

Dyes are generally created from dyeing and finishing process that include a wide range of chemical and dyestuffs which consist of organic compound with complex chemical structure (Othman et al., 2011). Dyes are physiochemical, thermal and optical stability and commonly synthetic origin that may contribute to carcinogenic and mutagenic to human (Almeida et al., 2008). Dyes are also carcinogenic to various microbiological and fish species (Yagub et al., 2014). Some dyes are reported as the cause of allergy, skin irritation, cancer and dermatitis (Ansari & Mosayebzadeh et al., 2010).

The industrial exposure of workers in the textile industries is correlated to a higher cancer risk (Charumathi & Das, 2012). Contamination of drinking water by dyes as low as concentration of 1.0 mg/L could impact significant colour which is unhealthy for human consumption (Gad & El-Sayed, 2009). Dyes stuff discharged from the industries can contribute to certain hazards and environmental pollution (Chandra et al., 2007). The released of dyes into the river can be easily noticed since dyes are highly visible (Fernandez et al., 2010).

Dyes from industrial wastewater diminishing the transparency of water and modify penetration of solar radiation. In fact, it will also modify the photosynthetic activity by slow down the growth of flora and tendency to involve with metal ions that result in micro-toxicity (Gad & El-Sayed, 2009). This will become harmful to nature of environment and toxic to aquatic life (Almeida et al., 2008).

Currently, there are a lot of wastewater treatments such as physical, chemical and biological methods that available for treating dyes in wastewater (Raquel et al., 2008). The physical method is easy and has simple steps compared to other method whereas the most favorable choice is adsorption (Yagub et al., 2014). Adsorption is a process that required adsorbent to accumulate the dye adsorbate. There are two types of adsorbent that commonly used, which are natural adsorbent and activated carbon. Activated carbon was the most preferable as it has high surface area and adsorption capacity (Chandra et al., 2007). However, the expensive price of commercial activated carbon, RM60 to RM200 per kilogram is now become a major problem to industry (Weinstein & Dash, 2014). This situation happened due to the limited source of raw materials for preparing commercial activated carbon.