Modeling of Chromium Removal from Tannery Wastewater using Bagasse

BY

Dina Diaa Mohammed El-Sawy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE
in
CHEMICAL ENGINEERING

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Title of Thesis:
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Key Words:
Tannery waste, Chromium removal, Bagasse waste, Adsorption, Wastewater.

Summary:
The objective of this study is the removal of chromium ions from tannery wastewater using bagasse as adsorbent. The batch kinetic studies indicated that the use of bagasse as adsorbent is an effective tool to remove around 70% of chromium from tannery wastewater after 2 hours and that the best pH was 6. The equilibrium data based on correlation coefficients could be best explained by the Langmuir, Freundlich, Temkin and Dubinin–Radushkevich isotherm. The Langmuir isotherm was found to describe the best adsorption isotherm in comparison with other isotherm. The kinetic data obtained have been analyzed using pseudo-first-order and pseudo-second-order models. The best fitted kinetic model was found to be pseudo-second-order model.

The results revealed that waste bagasse may efficiently be used for the removal of chromium from tannery wastewater effluents with pH around 6, weight ratio 10 g/l, using agitation rate 250 rpm at 75°C.

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List of Symbols

a_L	Empirical constants for Langmuir isotherm
C_o	Initial concentration of the metal ions
C_i	Final concentration of the metal ions
C_e	equilibrium concentration of adsorbate in solution after adsorption
D	Dubinin–Radushkevich isotherm constant
Ɛ	Dubinin–Radushkevich isotherm constant.
K_f	Freundlich capacity factor
K_L	Empirical constants for Langmuir isotherm
K_T	Temkin isotherm equilibrium binding constant
k_1	rate constant of pseudo first order sorption
k_2	rate constant of pseudo-second order sorption
m	Mass of adsorbent used
q_e	mass of adsorbate adsorbed per unit mass of adsorbent
q_m	Constant related to heat of sorption
q_t	sorption capacity at equilibrium and at time t
R	gas constant
T	Temperature, ^oC
V	Volume of the solution
φ	Particle size

List of Abbreviation

AAS	Atomic Absorption Spectrometer
BOD	Biochemical Oxygen Demand
COD	Chemical oxygen demand
EEAA	Egyptian Environmental Affairs Agency
EC	Electro Coagulation
EPA	Environmental Protection Agency
FCE	$FeCl_3$ induced crude extract
FS	Filterable solids
IWW	Industrial Wastewater
MCLS	Maximum Contamination Limit Standards
MPSD	Marquardt's percent standard deviation
NTU	Nephelometric Turbidity Units
PVC	Poly Vinyl Chloride
RO	Reverse Osmosis
SEM	Scanning electron microscopy
SS	Suspended solids
TDS	Total Dissolved solids
TKN	Total Kjeidahi Nitogen
TOC	Total Organic Carbon
TON	Threshold Odor Number
TS	Total solids
UV	Ultra Violet
WHO	World Health Organization
WW	Wastewater

ABSTRACT

The presence of heavy metals in the wastewater is wide spreading all over the world. In Egypt, industrial wastewater is considered the main source of pollution that leads to serious environmental problems which have reached 50000-70000 m^3/year and from which tannery waste represents the most toxic streams with its chromium content. Agriculture wastes are being used also to eliminate heavy metals from wastewater through adsorption processes.

The present study evaluate the effect of different engineering parameters to develop a dual solution for environmental pollution by the uptake of chromium from chromium contaminated tannery wastewater using waste bagasse produced from sugarcane industry as adsorbent.

Removal of chromium ions from tannery wastewater was studied on both acidic and alkaline ranges of pH (2, 4, 6 and 8) with contact time (5, 15, 40, 80 and 120 min), bagasse to wastewater ratio (1, 2, 4, 8 and 10 g/l), using an agitation rate of (50, 150 and 250 rpm) at temperature, T, (30, 50 and 75°C) as main operation conditions.

The batch kinetic studies indicated that the use of bagasse as adsorbent is an effective tool to remove around 70% of chromium after 2 hours and that the best pH was 6. The equilibrium data based on correlation coefficients could be best explained by the Langmuir, Freundlich, Temkin and Dubinin–Radushkevich isotherm. The Langmuir isotherm was found to describe the best adsorption isotherm in comparison with other isotherm. The kinetic data obtained have been analyzed using pseudo-first-order and pseudo-second-order models. The best fitted kinetic model was found to be pseudo-second-order model.

The results revealed that waste bagasse may efficiently be used for the removal of chromium from tannery wastewater effluents with pH around 6, weight ratio 10 g/l, using agitation rate 250 rpm at 75°C.

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