OPTIMIZATION OF CURRENT AND VOLTAGE PLATE CONFIGURATIONS IN ELECTROCOAGULATION UNIT FOR PALM OIL MILL EFFLUENT TREATMENT

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ABSTRACT

DAFFA AQILLA PRAYOGI. Optimization of Current and Voltage Plate Configurations in Electrocoagulation Unit for Palm Oil Mill Effluent Treatment. Supervised by ALLEN KURNIAWAN.

As one of the countries that were the leading exports of palm oil worldwide. With that fact also concludes that the production of palm oil mill effluent treatment needed to be more efficient and effective. Therefore, this research aims to analyze the quality of waste water through the electrocoagulation unit, determine the optimum variations for the palm oil mill effluent against sCOD and TSS test parameters. Voltage variations that were in this research are 12, 18, and 24 V. For a toal of 35 days on operating the electrocoagulation. The unit has already succeeded to increase the removal percentage of pollutants. Configuration for POME with the highest variaton is 24 V resulted sCOD removal percentage of 16 % and TSS removal percentage of 98%, while for testing various combinations showed that the EC-MBBR combination in the same reactore provided high and stable removal percentages with sCOD removal of 89 % and TSS removal of 97 % and comparing it to the mathematical model used to predict the level of removal. This research underscores the effectiveness of combining electrocoagulation with MBBR in POME treatment and contributes valuable insights into the efficiency of plates and electricity usage thus requiring many data sets.

Keywords: Electrocoagulation, Optimum, Electricity, Model, Removal

ABSTRAK

DAFFA AQILLA PRAYOGI. Optimization of Current and Voltage Plate Configurations in Electrocoagulation Unit for Palm Oil Mill Effluent Treatment. Dibimbing oleh ALLEN KURNIAWAN.

Sebagai salah satu negara yang menjadi pengekspor utama minyak sawit di dunia. Dengan fakta tersebut juga menyimpulkan bahwa pengolahan limbah pabrik kelapa sawit perlu lebih efisien dan efektif. Oleh karena itu, penelitian ini bertujuan untuk menganalisis kualitas air limbah melalui unit elektrokoagulasi, menentukan variasi optimal untuk limbah pabrik kelapa sawit terhadap parameter uji sCOD dan TSS. Variasi tegangan yang digunakan dalam penelitian ini adalah 12, 18, dan 24 V. Selama total 35 hari pengoperasian elektrokoagulasi, unit tersebut telah berhasil meningkatkan persentase penghilangan polutan. Konfigurasi untuk POME dengan variasi tertinggi yaitu 24 V menghasilkan persentase penghilangan sCOD sebesar 16% dan penghilangan TSS sebesar 98%, sementara pengujian berbagai kombinasi menunjukkan bahwa kombinasi EC-MBBR dalam reaktor yang sama memberikan persentase penghilangan yang tinggi dan stabil dengan penghilangan sCOD sebesar 89% dan penghilangan TSS sebesar 97% dan membandingkannya dengan model matematika yang digunakan untuk memprediksi tingkat penghilangan. Penelitian ini menekankan efektivitas menggabungkan elektrokoagulasi dengan MBBR dalam pengolahan POME dan memberikan wawasan berharga tentang efisiensi penggunaan pelat dan listrik sehingga memerlukan banyak data set.

Kata kunci: Elektrokoagulasi, Optimum, Listrik, Model, Penyisihan

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PREFACE

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The author has contrived the thesis as best as possible, but the author is also aware of many imperfections in both content and grammar. Consequently, the author welcomes any suggestions and constructive corrections to improve. The author wishes this thesis would be helpful in enriching readers' knowledge.

Bogor, July 2024

Daffa Aqilla Prayogi

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LIST OF NOTATIONS

A_e – active surface area of electrode (cm^2)
A_f – frequency factor for flotation
A_R – base area of EC reactor (cm^2)
BM_{Fe} – molecular weight of Fe (56 g/mol)
$BM_{Fe(OH)2}$ – molecular weight of Fe(OH)2 (90 g/mol)
C_{COD} – concentration of sCOD (mg/L)
C_p – caloric capacity of solution (J/K)
d – distance between electrodes (cm)
E_f – activation energy for flotation (J/mol)
F – Faraday's constant (96,500 C/mol)
H – number of Hydrogen molecules per electron (½)
I – current (A)
J – current density (A/cm^2)
k_a – reaction rate constant for adsorption (/(g.s)
k_{cg} – rate constant for $Fe(OH)_2$ formation (/s)
k_e – reaction rate constant for entrapment (/s)
k_f – reaction rate constant for flotation (/s)
K_S – equilibrium constant of Fe(OH)2 (mol^3 /dm^9) at T
K_{s0} – equilibrium constant of Fe(OH)2 (mol^3 /dm^9) at T_0
K_w – equilibrium constant of water (mol^2 /dm^6) at T
K_{w0} – equilibrium constant of water (mol^2 /dm^6) at T_0
l_e – length of electrode (cm)
m_{anode} – weight of anode (g)
m_{COD} – mass of sCOD (g)
$m_{Fe(OH)2}$ – mass of $Fe(OH)_2$ (g)
m_{scum} – mass of scum (g)
m_{sludge} – mass of sludge (g)
nFe_{sat} – mol of Fe2+ at saturation (mol)
$nFe(OH)_2$ – mol of $Fe(OH)_2$ (mol)
nFe_d – mol of total dissolved Fe^{2+} (mol)
nH_2 – Hydrogen amount (mol)
P – Pressure (atm)
Q – energy (J)
R – ideal gas constant (8.314 J/K.mol or 0.08206 L.atm/K.mol)
t – retention time (s)
t_e – thickness of electrode (cm)
T – solution temperature (K)
V – voltage (V)
VH_2 – Hydrogen volume (cm^3)
v – volume of POME (cm^3)
v_i – initial volume of POME (cm^3)
v'– $\frac{dv}{dt}$
w_e – width of electrode (cm)
x – Decrease of liquid level (cm)
z – number of electron transfer for Fe (2)

α – kinetic constant (cm^3 /mol)
β – kinetic constant (J/mol)
ΔH_s – enthalpy of $Fe(OH)_2$ ionization (J/mol)
ΔH_w – enthalpy of water ionization (J/mol)
ΔT – increase in temperature (K)
$[Fe]_{sat}$ – molar of Fe^{2+} at saturation (mol/cm^3)
$[Fe^{2+}]$ – molar of Fe^{2+} (mol/cm^3)
$[H^+]$ – molar of H^+ (mol/cm^3)
$[OH^-]$ – molar of OH^- (mol/cm^3)