PALM OIL EMPTY FRUIT BUNCHES EFFECTS AS OIL ADSORBENT ON UPFLOW ANAEROBIC SLUDGE BLANKET UNIT PERFORMANCES

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ABSTRACT

ALIYAH BAIDA WIWIYANTI. Palm Oil Empty Fruit Bunches Effects as Oil Adsorbent on Upflow Anaerobic Sludge Blanket Unit Performances. Supervised by ALLEN KURNIAWAN, CHUSNUL ARIEF, and MARK LARRACAS SIBAG.

Indonesia, as the world's leading palm oil producer, faces significant environmental challenges due to the large amounts of waste generated during the extraction process, particularly Empty Fruit Bunches (EFB) and Palm Oil Mill Effluent (POME). The research explores the use of EFB as an oil adsorbent within a modified Upflow Anaerobic Sludge Blanket (UASB) unit to enhance the treatment of POME. The study's objective was to evaluate the effectiveness of various EFB treatments in adsorbing oil from POME and to assess the overall performance of a modified UASB system. The methodology involved batch adsorption experiments to determine the best EFB variant, followed by the integration of this variant into the modified UASB unit for POME treatment. The results demonstrated that 0.8M citric acid (CA)-treated EFB had the highest oil adsorption efficiency, removing 96% of the oil. The modified UASB unit effectively treated POME, raising pH levels to neutral, reducing Total Suspended Solids by 95%, soluble Chemical Oxygen Demand by 92%, and Oil and Grease by 95%. The study concludes that the combined Monod and Flory-Huggins models provide a better understanding of the modified UASB unit's performance, although further refinement is needed for more accurate predictions. The research offers a new approach to improving POME treatment and advancing sustainable waste management practices in the palm oil industry.

Keywords: Adsorption, Empty Fruit Bunches, Palm Oil Mill Effluent, Upflow Anaerobic Sludge Blanket

ABSTRAK

ALIYAH BAIDA WIWIYANTI. Palm Oil Empty Fruit Bunches Effects as Oil Adsorbent on Upflow Anaerobic Sludge Blanket Unit Performances. Dibimbing oleh ALLEN KURNIAWAN, CHUSNUL ARIEF, dan MARK LARRACAS SIBAG.

Indonesia sebagai produsen minyak sawit terkemuka di dunia, menghadapi tantangan lingkungan yang signifikan karena banyaknya limbah yang dihasilkan selama proses ekstraksi, khususnya Tandan Kosong Kelapa Sawit (TKKS) dan Limbah Cair Kelapa Sawit (LCKS). Penelitian ini mengeksplorasi penggunaan TKKS sebagai penyerap minyak dalam unit *Upflow Anaerobic Sludge Blanket* (UASB) yang dimodifikasi untuk meningkatkan pengolahan LCKS. Tujuan penelitian ini adalah untuk mengevaluasi efektivitas berbagai pengolahan TKKS dalam menyerap minyak dari LCKS dan untuk menilai kinerja keseluruhan sistem UASB yang dimodifikasi. Metodologi yang digunakan melibatkan eksperimen adsorpsi untuk menentukan varian TKKS terbaik, diikuti dengan integrasi varian ini ke dalam unit UASB untuk pengolahan LCKS. Hasil penelitian menunjukkan bahwa TKKS yang diolah dengan asam sitrat 0.8M memiliki efisiensi adsorpsi minyak tertinggi sebesar 96%. Unit UASB yang dimodifikasi secara efektif mengolah LCKS, meningkatkan kadar pH menjadi netral, mengurangi *Total Suspended Solids* hingga 95%, *soluble Chemical Oxygen Demand* hingga 92%, serta Minyak dan Lemak hingga 95%. Studi ini menyimpulkan bahwa gabungan model Monod dan Flory-Huggins memberikan pemahaman yang lebih baik tentang kinerja unit UASB, meskipun penyempurnaan lebih lanjut diperlukan untuk prediksi yang lebih akurat. Penelitian ini menawarkan pendekatan baru untuk meningkatkan pengolahan LCKS dan memajukan praktik pengelolaan limbah berkelanjutan dalam industri minyak sawit.

Kata kunci: Adsorben, Limbah Cair Kelapa Sawit, Tandan Kosong Kelapa Sawit, *Upflow Anaerobic Sludge Blanket*

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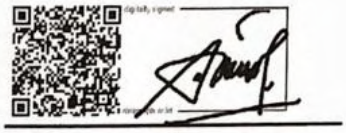

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PREFACE

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The author has contrived the thesis as best as possible but is also aware of many opportunities for improvements in both content and grammar. Thus, any suggestions and constructive corrections are highly appreciated. The author wishes this thesis would help enrich readers' knowledge in this interesting field of research.

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Aliyah Baida Wiwiyanti

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A = the energy interaction between adsorbate and EFB surface
C_t = effluent concentration of OG after t days (mg/L)
C_0 = influent concentration of OG (mg/L)
K = adsorption equilibrium constant
k = hydrolyzed substrate transport rate coefficient (L g^{-1} d^{-1})
K_1 = HB model's parameter constant (L/mg)
k_1 = pseudo-first-order adsorption rate constant (g/mg.d)
K_2 = HB model's energetic constant (kJ/mol)
k_2 = rate constant of pseudo-second-order adsorption (g/mg.d)
K_e = constant of death rate (d^{-1})
K_{FH} = equilibrium constant
K_h = hydrolysis rate coefficient (d^{-1})
K_s = the substrate concentration at half of the maximum rate (mg OG L^{-1})
m = weight of adsorbent in the modified UASB unit (g)
n = number of observations
n_{FH} = number of adsorbate ions occupying sorption sites
pH_{max} = maximum pH
pH_{min} = minimum pH
q_e = amount of solute adsorbed at equilibrium per weight of adsorbent (mg/g)
q_t = amount of solute adsorbed at a given time (mg/g)
S_h = concentration of hydrolyzed substrate
S_{an} = concentration of substrate effluent (mg OG L^{-1})
S_{in} = concentration of substrate influent (g OG L^{-1})
t = experiment day (d)
T_{max} = maximum temperatures
T_{min} = minimum temperatures
T_{opt} = optimal temperatures
V = volume of the modified UASB unit (L)
$X_{an\ eff}$ = biomass concentrations in the effluent of the UASB unit (g MLSS L^{-1})
X_{an} = biomass concentrations in the UASB unit (g MLSS L^{-1})
x_m = the amount of OG adsorbed by the EFB to form a monolayer (mg/mg)
Y = yield coefficient (g MLSS g OG^{-1})
y_i = observed values

$\bar{y}_i$ = mean of the observed values
$\hat{y}_i$ = predicted values from the model
θ_{ian} = HRT of the modified UASB unit (d)
μ = specific growth rate (d^{-1})
μ_{max} = maximum specific growth rate (d^{-1})