OPTIMIZATION OF ACTIVATED OIL PALM EMPTY FRUIT BUNCHES FOR INTEGRATED ADSORPTION-BIOLOGICAL TREATMENT OF PALM OIL MILL EFFLUENT

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ABSTRACT

GIAN AZARIA. Optimization of Activated Oil Palm Empty Fruit Bunches for Integrated Adsorption-Biological Treatment of Palm Oil Mill Effluent. Supervised by ALLEN KURNIAWAN and ARIANI DWI ASTUTI.

POME contains high OG levels that hinder biological treatment, requiring preliminary removal through adsorption. This study evaluated the performance of KOH-activated OPEFB in the adsorption unit. Activation with 0.5 M KOH achieved the highest OG removal efficiency at 31.10% and did not increase COD, unlike 1.0 M and 2.0 M concentrations, which increased COD by up to 8.87%. Functional group analysis via FTIR showed a shift in –OH stretching from 3627 to 3745 cm^{-1} and a decrease in C=O and C=C intensity, indicating lignin degradation and enhanced surface polarity. This led to dominant polar interactions and limited OG diffusion into pores. The Bangham model yielded an α value near zero, confirming surface-limited adsorption. Excessive activation caused fiber degradation, increasing TSS to 3880 mg/L. These findings indicate that 0.5 M KOH activation effectively improves OG adsorption efficiency without significant side effects, making it the optimal concentration for OPEFB-based adsorption in POME treatment systems.

***Keywords*:** adsorption kinetics, POME, KOH activation, OPEFB, integrated reactor

ABSTRACT

GIAN AZARIA. Optimization of Activated Oil Palm Empty Fruit Bunches in Integrating Adsorption and Biological Unit of Palm Oil Mill Effluent. Dibimbing oleh ALLEN KURNIAWAN dan ARIANI DWI ASTUTI.

LCKS memiliki kandungan OG tinggi yang mengganggu proses biologis dan memerlukan penanganan awal melalui adsorpsi. Penelitian ini mengevaluasi kinerja adsorben TKKS teraktivasi KOH dalam unit adsorpsi. Aktivasi dengan 0,5 M KOH menunjukkan kinerja terbaik dengan efisiensi penyisihan OG sebesar 31,10%, serta tidak menambah kadar COD, berbeda dengan aktivasi 1,0 M dan 2,0 M yang justru meningkatkan COD hingga 8,87%. Analisis gugus fungsi menggunakan FTIR menunjukkan pergeseran pita –OH dari 3627 menjadi 3745 cm^{-1}, serta penurunan intensitas C=O dan C=C, mengindikasikan degradasi lignin dan peningkatan polaritas permukaan. Hal ini berdampak pada dominansi interaksi polar dan terbatasnya difusi OG ke dalam pori. Model Bangham menghasilkan nilai α mendekati nol, yang mengonfirmasi bahwa adsorpsi terjadi pada permukaan luar. Konsentrasi KOH yang terlalu tinggi menyebabkan kerusakan struktur TKKS, meningkatkan TSS hingga 3880 mg/L. Hasil ini menunjukkan bahwa aktivasi 0,5 M KOH mampu meningkatkan efisiensi adsorpsi OG tanpa efek samping signifikan, menjadikannya konsentrasi optimal dalam sistem adsorpsi LCKS berbasis TKKS.

Kata kunci: kinetika adsorpsi, POME, aktivasi KOH, OPEFB, reaktor terintegrasi

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PREFACE

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The author has put forth the best effort in compiling this thesis; however, they acknowledge that it may still contain shortcomings in both content and grammar. Therefore, the author welcomes any constructive feedback and corrections for improvement. It is hoped that this thesis will contribute to enriching the readers' knowledge.

Bogor, July 2025

Gian Azaria

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIXES