



ESTIMATION OF BIOKINETICS PARAMETERS IN INTEGRATED MOVING BED BIOFILM REACTORS WITH ELECTROCOAGULATION FOR TREATING PALM OIL MILL EFFLUENT

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ABSTRAK

KHUSNITA AZIZAH. Estimation of Biokinetics Parameter in Integrated Moving Bed Biofilm Reactors with Electrocoagulation for Treating Palm Oil Mill Effluent. Dibimbing oleh ALLEN KURNIAWAN dan PUTERI KUSUMA WARDHANI.

Produksi minyak kelapa sawit yang ekstensif telah meningkatkan limbah cair pabrik kelapa sawit (POME) secara signifikan. Oleh karena itu, sangat penting untuk mengolah limbah ini secara menyeluruh sebelum dibuang ke lingkungan. Moving-bed biofilm reactor (MBBR) merupakan contoh dari sistem moving-medium yang menawarkan stabilitas proses dan membutuhkan lebih sedikit waktu dan ruang untuk mengolah POME. Dalam penelitian ini, reaktor EC-MBBR menggabungkan unit elektrokoagulasi sebagai prekursor koagulan dan unit sedimentasi sebagai unit pra-pengolahan untuk menghilangkan kandungan padat sebelum unit MBBR. Model biokinetik telah dikembangkan untuk mengatasi debit dan kontaminan yang berfluktuasi dalam POME, yang mengakibatkan kondisi yang tidak stabil. Model ini didasarkan pada persamaan dasar reaktor hibrida dan ekspresi tipe Monod untuk pertumbuhan melekat dan tersuspensi. Parameter biokinetik untuk mengolah POME dalam sistem hibrida dengan unit MBBR meliputi μ_{\max} , K_e , K_s , dan Y , dengan nilai masing-masing 4,30/hari, 1,14/hari, 2087,02 mgCOD/L, dan 0,22 mgTSS/mgCOD.

Kata kunci: Elektrokoagulasi, MBBR, Monod, sistem hybrid, POME.

ABSTRACT

KHUSNITA AZIZAH. Estimation of Biokinetics Parameter in Integrated Moving Bed Biofilm Reactors with Electrocoagulation for Treating Palm Oil Mill Effluent Supervised by ALLEN KURNIAWAN and PUTERI KUSUMA WARDHANI.

The extensive palm oil production has significantly increased palm oil mill effluent (POME). Consequently, it is imperative to thoroughly treat this effluent before its release into the environment. The moving-bed biofilm reactor (MBBR) exemplifies a moving-medium system that offers process stability and requires less treatment time and space for treating POME. In this study, the EC-MBBR reactor incorporates an electrocoagulation unit as a coagulant precursor and a sedimentation unit as a pre-treatment unit to remove solid content before the MBBR unit. A biokinetic model has been developed to address the fluctuating discharge and contaminants in POME, resulting in an unsteady state. This model is based on the basic equations of the hybrid reactor and Monod-type expressions for both attached and suspended growth. The biokinetic parameters for treating POME in the hybrid system with the MBBR unit include μ_{\max} , K_e , K_s , and Y , with values of 4.30/d, 1.14/d, 2087.02 mgCOD/L, and 0.22 mgTSS/mgCOD, respectively.

Keywords: Electrocoagulation; hybrid system; MBBR; Monod; POME.



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Undergraduate thesis
as the requirement to obtain Bachelor's Degree in
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PREFACE

The author prays the praise and gratitude to the Almighty, Allah SWT., who has given the author health and blessing to properly complete the undergraduate thesis entitled “Estimation of Biokinetics Parameters in Integrated Moving Bed Biofilm Reactors with Electrocoagulation for Treating Palm Oil Mill Effluent” right on time. The thesis was created and submitted to fulfil the requirement for a bachelor’s degree in the Department of Civil and Environmental Engineering, IPB University.

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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

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LIST OF NOTATIONS

S	=	sCOD in MBBR unit (mg/L)
V	=	Volume reactor (L)
S_0	=	sCOD influen in MBBR unit (mg/L)
Q	=	Flow discharge (L/day)
X	=	Biomass concentration (mg/L)
μ	=	Spesific growth rate of microorganism (/day)
μ_{\max}	=	Maximum specific growth rate of microorganism (/day)
a	=	Biofilm thickness (μm)
J	=	Substrate flux into biofilm ($\text{m}^2 \cdot \text{mg/L} \cdot \text{s}^2$)
K_s	=	Saturation concentration (mg·sCOD/L)
S_{mb}	=	sCOD effluent unit MBBR (mg/L)
S_{mb}'	=	sCOD effluent prediction in MBBR unit (mg/L)
K_e	=	Death rate of microorganism (/day)
Y	=	Sludge production coefficient (mgTSS/mg·sCOD)
θ_i	=	Hydraulic retention time (day)
t	=	Time (day)
bt	=	Sum of specific decay and shear loss rate (/day)

GLOSSARY

Attached Growth	:	A type of biological treatment where microorganisms grow on the surface of media rather than being suspended in the liquid phase.
Biofilm	:	A complex aggregation of microorganisms growing on a solid substrate, typically encased in a self-produced matrix of extracellular polymeric substances (EPS).
Biokinetics	:	A complex aggregation of microorganisms growing on a solid substrate, typically encased in a self-produced matrix of extracellular polymeric substances (EPS).
Biomass	:	The total mass of living microorganisms in a given volume of water, typically used in the context of biological wastewater treatment.
BOD	:	A measure of the amount of oxygen required by aerobic microorganisms to break down organic matter in water over a specific period, typically five days.
EC	:	Electrocoagulation, a water treatment process that uses electrical current to remove contaminants by coagulating and precipitating particles from the water.
HRT	:	Hydraulic retention time, a measure of the average length of time that a soluble compound remains in a constructed reactor or other treatment system.
MBBR	:	Moving Bed Biofilm Reactor, an attached growth biological treatment process that uses biomass carriers to support the growth of biofilm within a reactor.
MLSS	:	Mixed Liquor Suspended Solids, the concentration of suspended solids in the mixed liquor of a suspended growth biological treatment process, representing the amount of biomass in the aeration tank.
Monod	:	A mathematical model describing the growth rate of microorganisms as a function of substrate concentration, commonly used in environmental and biochemical engineering.
POME	:	Palm Oil Mill Effluent, a by-product of the palm oil milling process and contains high organic matter, suspended solids, and nutrients.
Reactor	:	A vessel or structure in which chemical or biological reactions are carried out, typically used in the context of industrial processes and wastewater treatment.

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- sCOD : Soluble Chemical Oxygen Demand (sCOD), a parameter used to measure the amount of oxygen required to oxidize dissolved organic matter in water.
- Substrate : Any substance or material that is used or consumed by microorganisms for growth and metabolism in biological treatment processes.
- Supernatant : Supernatant is the clear liquid found on top of a solid residue after centrifugation, precipitation, settling, or similar processes.
- Suspended Growth : A type of biological treatment where microorganisms are suspended in the liquid phase.
- TSS : Total Suspended Solid, the measure of the suspended solid particles in a liquid, typically water, which are not dissolved and can be removed by filtration.
- Unsteady-state : A condition in which the variables (such as concentrations, MLSS) in a system change with time, as opposed to steady-state where they remain constant over time.
- VBA : Visual Basic Application, an event-driven programming language from Microsoft that is primarily used for automating tasks in Microsoft Office applications.

