

**DEVELOPMENT OF MATHEMATICAL MODEL FOR BIOETHANOL
PRODUCTION IN A CONTINUOUS STIRRED TANK REACTOR**

By

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STATEMENT BY THE AUTHOR

I hereby declare that this submission is my own work and to the best of my knowledge, it contains no material previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any other degree or diploma at any educational institution, except where due acknowledgement is made in the thesis.



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ABSTRACT

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This paper proposes a mathematical model of a continuous stirred-tank reactor (CSTR) for bioethanol production and evaluates its local stability. Utilizing microbial kinetics based on the Monod and Haldane models to account for substrate and product inhibition, this formulated a system of ordinary differential equations describing the CSTR's mass balance. Additionally, a data-driven Gaussian Process was added to correct the mechanistic model's predictions. The Gaussian Process was used to model the residuals of the mechanistic model.

State variables at steady state were determined as a function of the operating parameter: the dilution rate. Stability analysis was conducted by evaluating the eigenvalues of the corresponding Jacobian matrix from the CSTR's system of ordinary differential equations. The analysis reveals that the model is locally stable at steady state under the condition that the dilution rate is less than the maximum specific growth rate. Therefore, identifying the exact boundaries of a washout, where large dilution rates overpowered microbial growth.

Keywords: mechanistic modeling, hybrid modeling, data-driven modeling, local stability analysis, industrial fermentation



DEDICATION

I dedicate this work to God, my family and friends, and the betterment of the environment.



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