Modelling Framework for the Identification of Critical Variables and Parameters under Uncertainty in the Bioethanol Production from Lignocellulose

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Modelling Framework for Identification of Critical Variables and Parameters under Uncertainty in the Bioethanol Production from Lignocellulose

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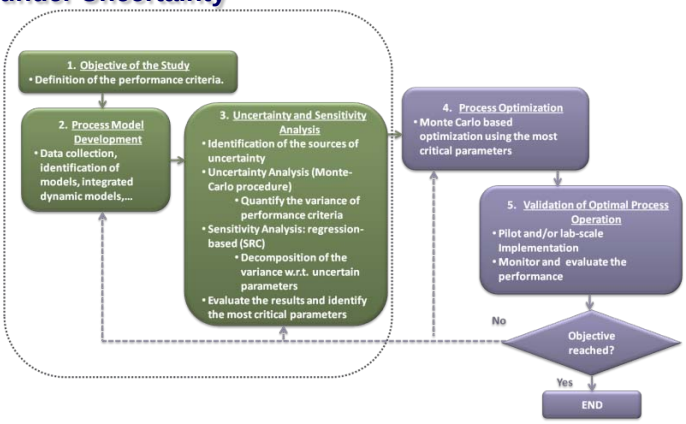
I. Introduction

This study presents the development of a systematic modelling framework for identification of the most critical variables and parameters under uncertainty, evaluated on a lignocellulosic ethanol production case study. The systematic framework starts with: (1) definition of the objectives; (2) Collection of data and the implementation of dynamic models for each unit operation in the process; (3) Uncertainty and sensitivity analysis, performed to identify the critical operational variables and parameters in the process. The uncertainty and sensitivity analysis identified the following most critical variables and parameters involved in the lignocellulosic ethanol production case study. For the operating cost, the enzyme loading showed the strongest impact, while reaction volume showed a significant impact on the ethanol/biomass ratio. The results showed also that it is possible to find a better alternative operation of the plant in comparison with the base case.

II. Objective:

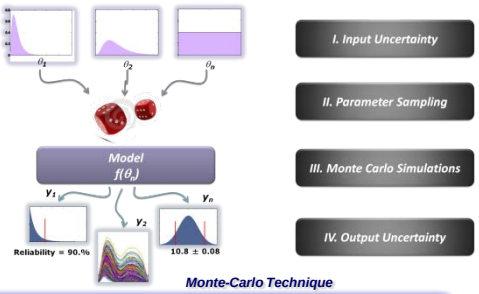
Develop a systematic framework for the identification of the most critical variables and parameter of bioprocesses subject to various sources of uncertainties.

III. Systematic Framework for Bioprocess Identification under Uncertainty



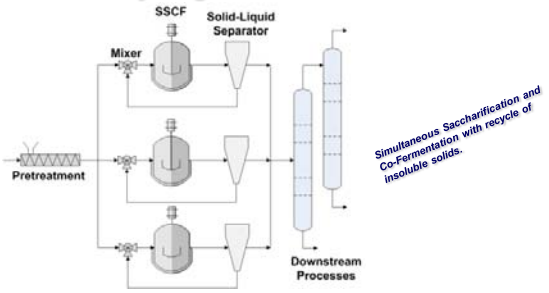
IV. Uncertainty and Sensitivity Analysis

The uncertainty analysis is carried out using the Monte-Carlo technique. Sensitivity analysis employs the standardized regression coefficient (SRC) method, which provides a global sensitivity measure, β_i, thereby showing how much each parameter contributes to the variance (uncertainty) of the model predictions.



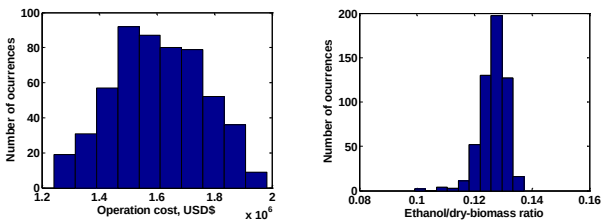
Monte-Carlo Technique

V. Case Study: Lignocellulosic Ethanol Production

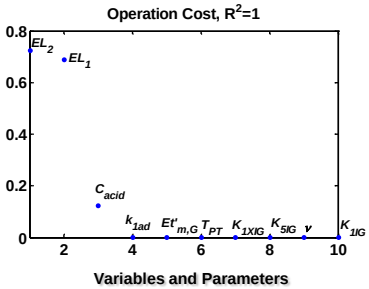


(Morales-Rodríguez, et al., 2011. *Bioresour. Technol.* (102) 1174-1184.)

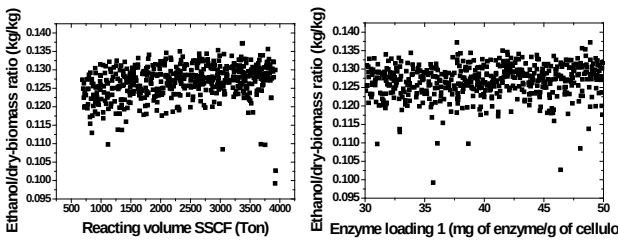
V.a Averaged Plant Performance from Monte-Carlo Simulation



V.b Influence of Parameters and Variables in the Operating Cost



V.c Correlation among Parameters and Performance Criteria



VI. Discussion and Concluding Remarks

- A systematic framework for identification of the most critical parameters and operation variables under uncertainty has been introduced.
- Employing a bioethanol process flowsheet, the operating cost and the enzyme loading showed the strongest impact, while reaction volume showed a significant impact on the ethanol/biomass ratio.
- The results showed also that it is possible to find a better alternative operation of the plant in comparison with the base case.

Acknowledgment

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