Technology Evaluation of Process Configurations for Second Generation Bioethanol Production using Dynamic Model-based Simulations

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Publication date:
2011

Document Version
Publisher’s PDF, also known as Version of record

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Citation (APA):

Introduction

Bioethanol production involves a number of unit operations such as, pretreatment, enzymatic hydrolysis, co-fermentation, downstream processes. Currently the transfer of these processes from proof-of-concept to industrial scale has been mainly done on an empirical and experimental basis that might be inefficient and costly in terms of times and resources consumption. This study considers the use of a dynamic model-based simulation framework to identify optimal process configurations for improved bioethanol production from lignocellulosic feedstock.

Objective:

Technology evaluation for optimal process configurations for bioethanol production using a dynamic model-based simulation framework.

Dynamic Model-Based Simulation Framework

1) Collection, analysis and identification: reliable dynamic mathematical models for the different unit operations

- Pretreatment
- Enzymatic Hydrolysis
- Co-fermentation
- Simultaneous Saccharification and Co-fermentation
- Process conditions and unit dimensions

Benchmarking Criteria

- Ethanol/dry-biomass ratio: $R_{\text{Ethanol}} = \frac{\text{Total Mass Ethanol}}{\text{Total Mass Dry Biomass}}$

- Unprocessed raw material: $\text{URM} = \text{ADB} + \text{Solid stream from S-L separator}$

- Ethanol concentration:

Discussion and Concluding Remarks

- 12 novel process configurations for cellulosic bioethanol production have been analyzed. The main findings are:
  - Recycling in general has a positive effect on the ethanol yield.
  - The best configuration: continuous SSCF with recycle
  - Ethanol yield of 0.18 kg/kg-dry biomass could be obtained. This is a significant improvement compared with the NREL configuration (three-folds).
  - Pilot plant validation of these promising results is recommended.

Acknowledgment

Mexican National Council for Science and Technology (CONACyT).