Synthesis, Simulation and Optimization of Advanced Separation Processes for Biomass-to-Liquid Transportation Fuels Production

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Project Period: September, 2016 to August, 2019

Background

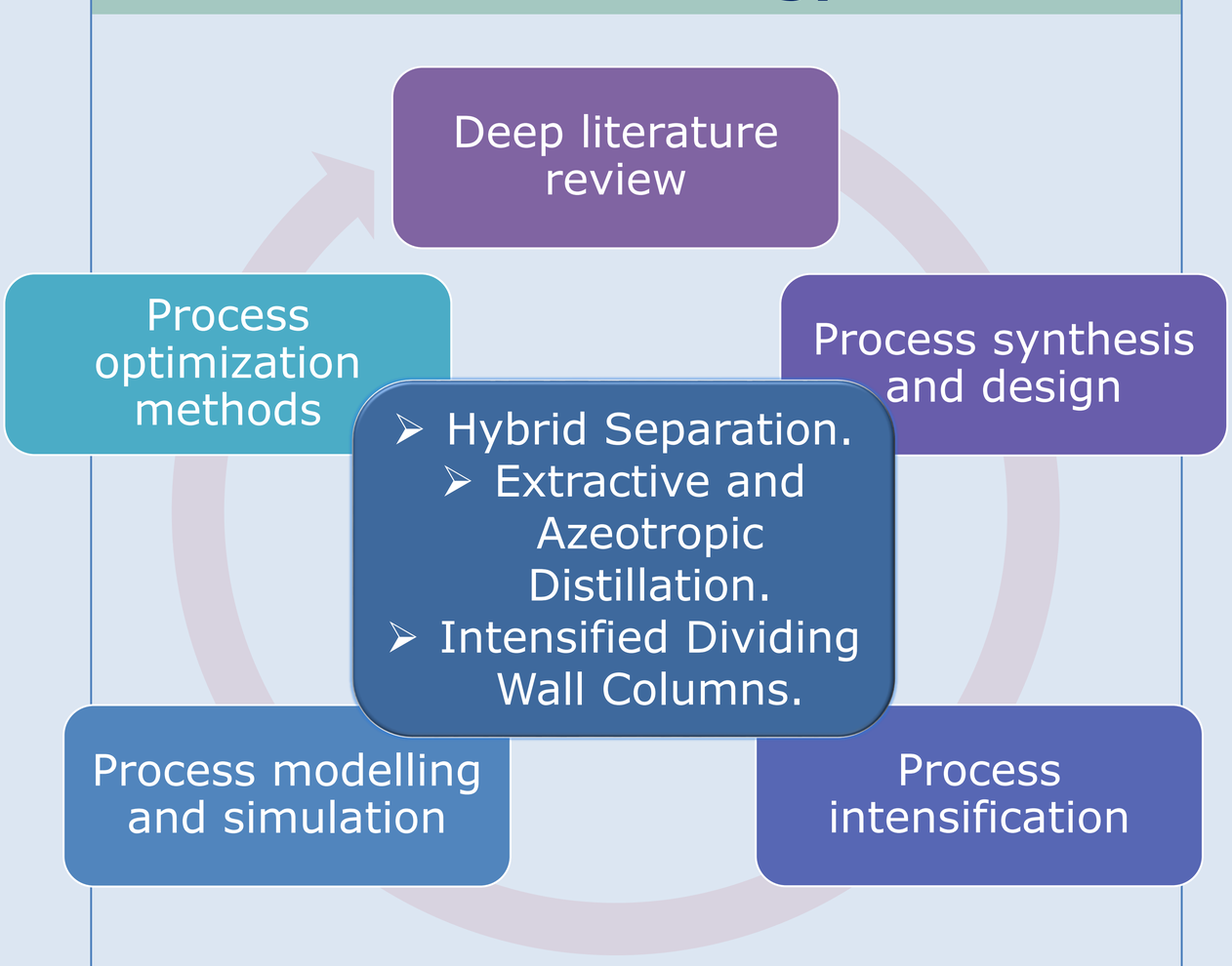
The production of liquid transportation fuels from a variety of feedstocks is currently a hot research area in chemical and process engineering. During 2014 in the United States 71% of petroleum usage went directly to transportation fuels. Currently, only 4.7% of liquid transportation fuel production originates with renewable resources [1]. Thus, the transportation industry is an opportune sector for replacing petroleum consumption, and it is imperative that alternative methods of producing liquid transportation fuels are investigated [2]. One such feedstock for reducing petroleum dependence is biomass [3,4]. However, its success, market share and speed to replace the fossil fuels to a large extent depend on the production technology and the total production costs.

Currently, considerable efforts have been devoted to explore the various technological routes, mainly focusing on the reaction technologies. Due to the multicomponent and multiphase nature of the reaction effluents for the biomass conversion and transformation, therefore, multiple separation methods and units for the recovery and purification of the products are needed. Generally, the costs of separation and purification processes account for 50-70% of the total production costs [5]. It is therefore crucial to have robust separation technologies to make biorefineries economically viable.

Aim

Develop and design novel separation processes based on hybrid separations and intensified equipment to reduce the production costs and energy consumption for biomass-to-liquid transportation fuels production.

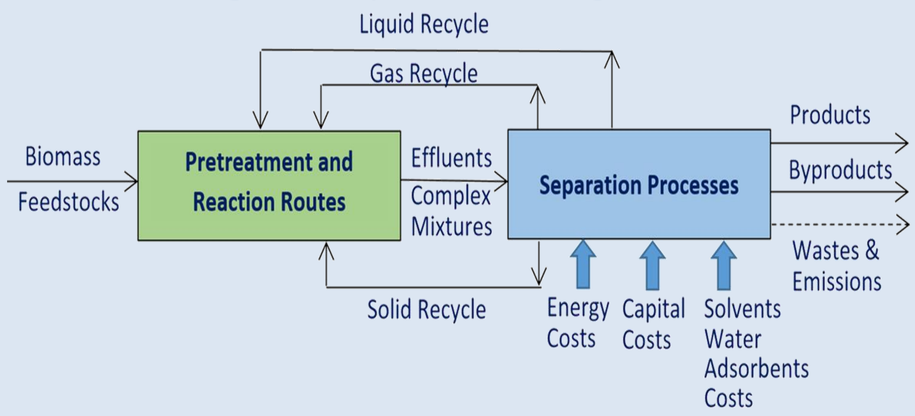
Methodology



Synthesis and integration of the separation process with the whole process

Objectives

- Analysis of the real separation needs in the real industrial production processes from typical technological routes.
- Synthesis, intensification, simulation and optimization of various hybrid and intensified separation process configurations.
- Apply separation process integration with the whole process: synthesis, intensification, simulation and optimization at different levels.
- Analysis and evaluation of the separation processes with the help of Aspen Plus™.
- Develop our own methods and tools including modelling and simulation, design and optimization algorithms.



Acknowledgements

CONACYT (The Mexican National Council for Science and Technology) for the maintenance grant.

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References

[1] U.S. Energy Information Administration. Monthly Energy Review, October 2015. http://www.eia.gov/totalenergy/data/monthly/pdf/ mer.pdf.
[2] Matthews, L. R., Niziolek, A. M., Onel, O., Pinnaduwage, N., & Floudas, C. A. Biomass to Liquid Transportation Fuels via Biological and Thermochemical Conversion: Process Synthesis and Global Optimization Strategies. Industrial & Engineering Chemistry Research, 2015.
[3] Perlack, R. D., Wright, L. L., Turhollow, A. F., Graham, R. L., Stokes, B. J., Erbach, D. C. Biomass as Feedstock for A Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply, 2005.
[4] Downing, M.; Eaton, L. M.; Graham, R. L.; Langholtz, M. H., Perlack, R. D.; Turhollow, A. F., Jr.; Stokes, B.; Brandt, C. C. U. S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry, 2011.
[5] Ramaswamy, S., Huang, H. J., & Ramarao, B. V. Separation and purification technologies in biorefineries, John Wiley & Sons Incorporated, 2013.

Expected Research Results

Developing new knowledge and Advanced Separation Processes technologies for Biomass-to-Liquid Transportation Fuels Production at both process level and equipment level.

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