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OPTIMAL DESIGN OF FLEXIBLE AND OPERABLE BIOREFINERY PROCESSES

Conception optimale des processus de bioraffinerie flexibles et opérationnels

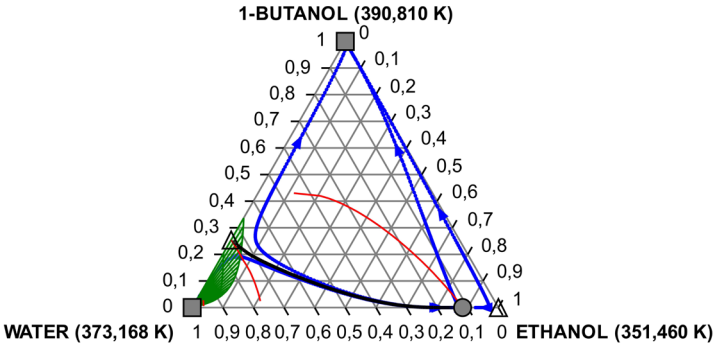
With the considerable growth of transportation sector and demand for transport fuels rising globally, besides the fossil fuel price increase, the International Energy Association assesses biofuels as one of the key technologies to reduce both CO_2 emissions and the dependency on fossil transport fuels. Thus the synthesis, design and operation of sustainable biorefineries has seen renewed attention during the last years.

Being the fermentation process usually very expensive, a constant good performance of the products recovery section is of critical importance for the profitability of the plant. The standard design procedure is strictly related to the operating conditions, i.e. when perturbations are present they can seriously turn the tables. Composition disturbances downstream the fermenter are nevertheless typical of bioprocesses in general due to the floating nature of the feedstock. Therefore both a flexibility and economic based multi-objective optimization for the separation section design has to be performed.

However, the existence of a range of operating conditions doesn't imply the system is able to smoothly operate and switch between them. Due to the intrinsic non-ideal thermodynamics of the alcoholic mixtures, process control plays a major role in the operability of the process. Thus, dynamic modeling and process control design should be taken into account as well during the design phase.

Moreover, since the final goal is to provide a fossil fuel free alternative, a sustainability assessment of the process needs to be coupled to the whole analysis and design.

In conclusion, the purpose of this thesis is to combine the former four aspects into a multi-objective design optimization for a new concept of profitable, flexible, operable and sustainable biorefinery.



Critical surface of a pyramidal 4-components equilibrium diagram.

- *Green: L-L Immiscibility Region;*
- *Red: Univolatility Curves;*
- *Blue: Residue Curves;*
- *Black: Distillation Boundary.*