

An integrated tool for global optimization of a sugarcane biorefinery producing first and second generation ethanol

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Sugarcane juice is used in Brazil for first generation ethanol production, while sugarcane biomass is used mainly as fuel for both steam and electric power production. Bioethanol production may be intensified with hydrolysis of sugarcane biomass (bagasse and straw/trash) and fermentation of the resulting sugars. The second generation process, nevertheless, must be integrated to the first generation, in order to reduce costs and increase biofuel competitiveness. Consequently, the production of bioethanol will compete with the delivery of electric energy to the grid. Since part of bagasse would be directed to lignocellulosic ethanol production, and bearing in mind that the whole process must be energetically self-sufficient, the energetic demand of the integrated process must be precisely evaluated. This implies that the fraction of bagasse diverted to hydrolysis becomes a key parameter in process feasibility and economics. In the present work, an integrated first and second generation bioethanol-from-sugarcane plant is simulated using the applicative Environment for Modeling, Simulation and Optimization (EMSO, www.enq.ufrgs.br/trac/alsoc/wiki/EMSO) and the Particle Swarm Optimization (PSO) algorithm is used to optimize the process, in terms of maximizing plant profit, having the many demands of the plant as constraints. In this way, the fraction of bagasse diverted to hydrolysis is constrained by the energetic self-sufficiency of the plant. The second generation technology, here used as a case study for the economic assessment methodology, makes use of enzymes to hydrolyze cellulose and hemicelluloses of pretreated bagasse. Lignin is burned, contributing to energy supply. The developed tool joins simulation of the integrated process to optimization, in order to indicate the most profitable use of bagasse, considering process demands and prices of enzymes, ethanol, electricity and the surplus bagasse (sold as process residue for animal feed).

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