Study of second generation sugarcane bioethanol viability through integrated process optimization

Furlan, F.F.[1], Costa, C. B. B.[1], Cruz, A. J. G.[1], Fonseca, G. C.[1], Secchi, A. R.[2], Soares, R. P.[3], Giordano, R. C.[1]

[1]Federal University of São Carlos, Brazil; [2]Federal University of Rio de Janeiro, Brazil; [3]Federal University of Rio Grande do Sul, Brazil

Introduction

Sugarcane biomass can be exploited in order to increase the production of bioethanol, produced in Brazil from sugarcane juice. The second generation process, whichever technology is selected to be implemented, must be integrated to the first generation production process, in order to reduce costs and increase biofuel competitiveness. Nevertheless, the integration of a second generation plant to the first generation one poses a process challenge, since the whole process must be energetically self-sufficient, besides exhibiting economic advantages over the conventional first generation industry. The combustion of sugarcane bagasse is responsible in these plants for the energetic supply (steam and electric power), and any energy surplus is sold to electric power companies. When part of bagasse is diverted to lignocellulosic ethanol production, the energetic demand of the integrated process must be precisely evaluated. Furthermore, if enzymatic hydrolysis is selected, enzyme costs play important role. Hence, the fraction of bagasse diverted to hydrolysis becomes a key parameter in process 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 to the energetic self-sufficiency of the plant. The second generation technology here makes use of enzymes to hydrolyze cellulose and hemicelluloses of pretreated bagasse. Lignin is burned, contributing to energy supply. Since prices of enzymes, ethanol, electricity and the surplus bagasse (sold as process residue for animal feed) impact on the viability of the integrated process, different economic scenarios are studied.

Results and Conclusions

The main result of the work is the developed tool, which joins simulation of the integrated process to optimization, in order to indicate the most profitable use of bagasse as a function of the market situation, considering process demands. In this way, the process may be properly adjusted to the most profitable operating condition.

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