Optimal operation of an integrated first + second generation ethanol-from-sugarcane plant: electric power generation *vs* bagasse hydrolysis

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The production of first generation bioethanol from sugarcane juice is well established in Brazil. Modern plants have their energetic demands supplied by the combustion of bagasse, and the surplus of energy is sold to the electric power companies. Any second generation process will certainly be integrated to the first generation, in order to reduce logistic costs. In this plant, the stream of bagasse, after extraction of the juice, may be split into three fractions: feedstock for cellulosic ethanol, fuel for high pressure boilers, and animal feed. One key decision for establishing a feasible industrial process is to decide the values of those fractions.

This is a complex constrained nonlinear optimization problem, since the process vapor and electric power demanded by the plant must be provided by the burning of bagasse and lignin. The prices of electricity, celullases, animal feed and ethanol will, of course, impact the decision.

This work presents the results of a global optimization algorithm, integrated to an equation oriented process simulator, which seeks for the most profitable operating condition. The biorefinery employs enzymatic hydrolysis of cellulose and hemicellulose after pretreatment of the bagasse, and fermentation of hexoses and pentoses.

The Particle Swarm Optimization (PSO) algorithm solved the optimization problem, while the applicative Environment for Modeling, Simulation, and Optimization (EMSO, www.enq.ufrgs.br/trac/alsoc/wiki/EMSO) simulated the bioprocess. Our results show the importance of applying a global optimization method to avoid local minima for such a problem, despite its higher computational demand.