378d Simulation and Optimization of Escherichia Coli Ko11 Based Bioethanol Production

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Biomass conversion (forests, cereal waste, etc.) to ethanol appears to be an attractive and sustainable energy alternative. Bioethanol is a versatile fuel and fuel additive that can provide environmental and strategic benefits. Ethanol is generated by enzymatic hydrolysis of lignocellulosic biomass using micro-organisms like E Coli, S. Cerevisiae and Z. Mobilis. Currently, the Bioethanol industry of US tends to be concentrated in the Midwest, most of which uses corn as main feedstock. Recent studies indicate that Texas has a good biomass resource potential which includes in five general categories: urban residues, mill residues, forest residues, agricultural residues and energy crops. With the advances in the field of genetic engineering and metabolic engineering it has become possible to use mixed sugars for commercial scale production of Bioethanol. This fact can be utilized to explore the opportunities of Bioethanol production using local resources for the state of Texas. This research work is directed towards developing an optimization methodology to maximize the amount of ethanol generated by Escherichia Coli (K-11) while minimizing the amount of resources being used and the amount of by-products being released. This would also reduce the sequential separation cost. In this work, optimization is conducted for the metabolic network of E. Coli, which incorporates both FBA and Gene-Knockout strategy. In this model, the succinate-producing pathway of the wild-type E. Coli is knocked out and a new ethanol-producing pathway (using enzymes pyruvate decarboxylase and alchohol dehydrogenase) is incorporated to increase the ethanol yield. The behavior of this new metabolic network is studied by manipulating the amount of glucose and oxygen available to it along with other constituents (like potassium, water, sodium, sulfates etc.) in the extra-cellular media. In this way the optimum solutions are generated to achieve desired production of ethanol. These solutions are going to be used to conduct a feasibility study for the production of Bioethanol consuming local biomass resources, like grain sorghum and rice straw, in terms of their economic feasibility as well as sustainability. The optimum operating conditions for different types of feed stocks (e.g. mixtures of rice straw, grain sorghum in varied proportions) will be identified by simulating a customized model. Simultaneously, a feasibility study will be conducted for each case in terms of its profitability and environmental sustainability. The environmental performance will be evaluated using Life Cycle Assessment for each case. The results of these case studies will be used to identify the process design and operating conditions to set-up a pilot plant to imitate a future Bioethanol-production facility for the region.