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“INTEGRATING CLEANER PRODUCTION INTO SUSTAINABILITY STRATEGIES”

Life Cycle Assessment of Biobutanol Production Integrated to Sugarcane Biorefineries in Brazil

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Abstract

New sugarcane biorefinery routes considering the integral use of biomass have become more important to the strategic objectives of the bioenergy production expansion in Brazil, especially for diversifying and adding value to the sugarcane production chain. Among these new products, biobutanol has been increasingly investigated, mostly for its use as a fuel, since its energy density is greater than that of ethanol, but also to replace an established use as feedstock in the chemical industry. In view of the new green chemistry technological routes development, it becomes interesting and necessary assessing the viability of the butanol production from sugarcane. In this study, the sugarchemical route characterized by the fermentation of sugarcane juice was evaluated using the Life Cycle Assessment method considering arrangements for the process integration in the existing Brazilian sugarcane biorefineries: first and second generation using ABE fermentation (acetone-butanol-ethanol) with wild and genetically modified strains. The evaluation approach took into account the whole production chain, from the agricultural stage, through the transportation of sugarcane and vinasse, to the industrial process of biobutanol production and its use as liquid fuel for transport. The software package SimaPro and the CML 2 Baseline 2000 v2.05 method were used as tools for the environmental impact assessment. The life cycle inventories were obtained from literature and mass and energy balances taken from process computer simulation. Results showed that butanol produced from the lignocellulosic material (cane bagasse and straw) presents lower environmental impacts compared to first generation scenarios evaluated. As well as previous biofuels production assessment studies have already pointed out, the agricultural stage is the most relevant to the total environmental impacts in the butanol case. Nevertheless, the use of water, enzyme, equipment (carbon steel), and the emissions from the bagasse combustion could be highlighted as the most important in terms of environmental impacts for the industrial stage. Results for the productivity per tonne of sugarcane in first generation scenarios indicate that the efficiency of the ABE fermentation process needs to be improved so biobutanol could turn into an economic viable alternative. The production of second generation biobutanol, on the other hand, could be a viable alternative for the integral use of biomass adding value to the sugarcane production chain. Its analysis accounting for production and use as liquid fuel for transportation has shown that results are at the same level as the impacts related to ethanol from sugarcane, presenting advantages if compared with gasoline in terms of global impacts, such as global warming and ozone depletion potentials. Nevertheless, categories related to local impacts such as eutrophication and acidification potentials presented higher values for butanol in comparison with gasoline.

Keywords: *life cycle assessment, butanol, sugarcane, biorefinery*