São Paulo - Brazil - May - 22nd to 24th - 2013

4th INTERNATIONAL WORKSHOP
ADVANCES IN CLEANER PRODUCTION

''INTEGRATING CLEANER PRODUCTION INTO SUSTAINABILITY STRATEGIES''

The Influence of Cellulase Enzyme on the Energetic-Environmental Performance of Second Generation Ethanol Production – A Preliminary Study

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Abstract

First generation ethanol from sugarcane is produced by Brazilian mills since 1960, currently recognized as a mature technology with high productivity. In a parallel way, the so called second generation ethanol (obtained from lignocellulosic materials) has great potential as an alternative to increase the amount of ethanol currently produced without requiring any surplus of land - avoiding the food versus energy debate. This new technological route demands enzymes for the hydrolysis process, converting the existing cellulose and hemicelulose from vegetal biomass into fermentable sugars. Quantifying the energetic-environmental cost of enzyme production is essential when assessing the total cost of second generation ethanol. In this sense, the aim of this work is to assess the influence of *celulase* enzyme industrial production on the energetic-environmental performance of second generation ethanol. Two main approaches are considered: (i) embodied energy analysis and (ii) emission inventory. Results indicates that enzyme *celulase* production requires about 900 MJ/kg_{enzyme}, which increases from 5,49 to 20,72 MJ the embodied energy used to produce 1 Liter of second generation ethanol. Emission inventory shows that CO_2 is the most released gas to atmosphere (99,9% of total in mass units), reaching 13300 g/kg_{enzima} and Global Warming Potential (GWP) of 13,32 $kgCO_{2\text{-eq.}}/kg_{enzima}$. The enzyme's GWP correspond to 0.01% of total second generation ethanol's GWP production, thus its influence could be considered insignificant. While enzyme's industrial production emissions can be considered inapplicable on the total emissions from second generation ethanol, the embodied energy value has a strong influence.

Keywords: *celulase enzyme; CO_2; embodied energy; second generation ethanol.*