FUEL ETHANOL PRODUCTION FROM LIGNOCELLULOSE: ADVANCES AND PROSPECTIVES

Carlos Martín. Bioresource Technology Group, Department of Chemistry and Chemical Engineering. University of Matanzas. Cuba. Fax: +53-45-253101. E-mail: carlos.martin@umcc.cu

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The increase of oil prices and concerns on greenhouse effect have incentivated the interest for the use of cellulosic ethanol, a second generation biofuel produced from lignocellulosic materials (LCM), and which has potential for satisfying the energetic requeriments without affecting food production (Wyman, 2008).

LCM are composed of three main polymers (cellulose, hemicelluloses and lignin), which can be converted into different products. Cellulose hydrolysis yields glucose, which can be used as substrate for ethanol production by fermentation. Ethanol can also be produced from hemicelluloses, but special organisms are required since the yeast *S. cerevisiae*, traditionally used in the ethanol industry, is not able to ferment the hemicellulose-derived pentoses.

The conversion strategies have evolved from the hexoses fermentation during the first half of XX century to the fermentation of both cellulosic and hemicellulosic hydrolysates today.

The cellulosic ethanol process includes a hydrolysis step that can be catalysed by acids or enzymes. Acid hydrolysis has the disadvantages of formation of fermentation inhibitors, the use of expensive anticorrosive materials, the requirement of neutralisation, and in some cases the acid recovery. Enzymatic hydrolysis gives higher sugar yields, lower by-products formation and it is an environmentally-friendly process.

Several new technologies developed during the last years are been evaluated in pilot and demonstration plants. Some of those technologies are already in the initial stages of commercialisation, and for the near future a considerable expansion of cellulosic ethanol production is envisaged (Wyman, 2008).

Process integration is very important for increasing the technical and economic efficiency of cellulosic ethanol production. There are several integrated schemes, such as simultaneous saccharification and fermentation (SSF), simultaneous saccharification and co-fermentation (SSCF) and direct microbial conversion (DMC).

For ensuring an appropriate utilisation of LCM novel concepts are required in the exploitation of those raw materials. The application of the biorefinery concept, which combines the technologies required for converting different bioresources in industrial intermediates and in high value-added products, is essential for the future development of cellulosic ethanol.

For achieving the transition in the cellulosic ethanol production towards a completely-developed technology is required to consider the following points:

- Improvement of hydrolysis with efficient and low-cost enzymes.
- Development of microorganisms able to tolerate inhibitors and to ferment hexoses and pentoses with high ethanol yield and productivity.
- Extension of process integration and recycling of process streams (Hahn-Hägerdal *et al.*, 2006).

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