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Abstract
This review provides current information on the production of ethanol from lignocellulosic biomass, with the main focus on relationships between process design and efficiency, expressed as ethanol concentration, yield and productivity. In spite of unquestionable advantages of lignocellulosic biomass as a feedstock for ethanol production (availability, price, non-competitiveness with food, waste material), many technological bottlenecks hinder its wide industrial application and competitiveness with 1st generation ethanol production. Among the main technological challenges are the recalcitrant structure of the material, and thus the need for extensive pretreatment (usually physico-chemical followed by enzymatic hydrolysis) to yield fermentable sugars, and a relatively low concentration of monosaccharides in the medium that hinder the achievement of ethanol concentrations comparable with those obtained using 1st generation feedstocks (e.g. corn or molasses). The presence of both pentose and hexose sugars in the fermentation broth, the price of cellulolytic enzymes, and the presence of toxic compounds that can inhibit cellulolytic enzymes and microbial producers of ethanol are major issues.
In this review, different process configurations of the main technological steps (enzymatic hydrolysis, fermentation of hexose/and or pentose sugars) are discussed and their efficiencies are compared. The main features, benefits and drawbacks of simultaneous saccharification and fermentation (SSF), simultaneous saccharification and fermentation with delayed inoculation (dSSF), consolidated bioprocesses (CBP) combining production of cellulolytic enzymes, hydrolysis of biomass and fermentation into one step, together with an approach combining utilization of both pentose and hexose sugars are discussed and compared with separate hydrolysis and fermentation (SHF) processes. The impact of individual technological steps on final process efficiency is emphasized and the potential for use of immobilized biocatalysts is considered.

Keywords: lignocellulose, ethanol, pretreatment, enzymatic hydrolysis, fermentation, process configuration, SHF, SSF, CBP, pentose, hexose, immobilization, yield, productivity

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