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Kinetics of ethanol production from sugarcane bagasse enzymatic hydrolysate concentrated with molasses under cell recycle

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HIGHLIGHTS

- Kinetics using hydrolysates was evaluated and a model proposed.
- A kinetic model developed predicted fermentation data with cell recycle.
- A term of acetic acid inhibition increased the model accuracy.
- Kinetic parameters were estimated as function of temperature.
- Cell recycle has demonstrated good stability of the yeasts in hydrolysates.

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ABSTRACT

In this work, a kinetic model for ethanol fermentation from sugarcane bagasse enzymatic hydrolysate concentrated with molasses was developed. A model previously developed for fermentation of pure molasses was modified by the inclusion of a new term for acetic acid inhibition on microorganism growth rate and the kinetic parameters were estimated as functions of temperature.

The influence of the hydrolysate on the kinetic parameters is analyzed by comparing with the parameters from fermentation of pure molasses. The impact of cells recycling in the kinetic parameters is also evaluated, as well as on the ethanol yield and productivity. The model developed described accurately most of the fermentations performed in several successive batches for temperatures from 30 to 38 °C.

1. Introduction

Ethanol is one of the most attractive renewable energy sources for large scale production (Wang et al., 2011), either to be used as a pure fuel or blended with gasoline. Due to the increased awareness of the environmental problems related to the burning of fossil fuels, there is a need for the identification of new energy sources and new technologies to expand the production of biofuels. One alternative to increase ethanol production is to provide the total use of sugarcane (including straw and bagasse) by depolymerizing, through hydrolysis, the cellulose and hemicellulose fractions into fermentable sugars, which can be fermented to ethanol. *Saccharomyces cerevisiae* is the microorganism most commonly used to convert reducing sugars into ethanol in an efficient and cost-competitive manner (da Cunha-Pereira et al., 2012), due to its robustness and high productivity (Fujitomi et al., 2012) when sugarcane juice and molasses are used. However, the kinetics of ethanol fermentation by this yeast when hydrolysate (from enzymatic hydrolysis of lignocellulosic biomass) is used as fermentation media has not yet been fully investigated.

The fermentation of non-detoxified hydrolysates is expected to present low kinetic rates, leading to lower ethanol productivities and yields when compared to traditional processes which use sugarcane juice as media. Thus, new kinetic studies are required to develop reliable models to describe the fermentation step in the process of ethanol production from lignocellulosic biomass. The models are important to achieve efficient and optimal configurations (Morales-Rodriguez et al., 2011) for large scale production through optimization procedures, studies of process dynamics and development of control strategies; however, few studies taking this issue into account were published so far.

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