Bioresource Technology 130 (2013) 306–313

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Bioconversion of sawdust into ethanol using dilute sulfuric acid-assisted continuous twin screw-driven reactor pretreatment and fed-batch simultaneous saccharification and fermentation

Tae Hyun Kim [a], Chang Ho Choi [b], Kyeong Keun Oh [b,*]

[a] Department of Environmental Engineering, Kongju National University, Cheonan, Chungnam 330-717, Republic of Korea
[b] Department of Applied Chemical Engineering, Dankook University, Cheonan, Chungnam 330-714, Republic of Korea

HIGHLIGHTS

- Acid-assisted CTSR pretreatment enhances sawdust digestibility.
- Optimal operating conditions of CTSR pretreatment were estimated.
- Timing of enzyme and solid addition in fed-batch SSF were investigated.
- Ethanol titer in three stage fed-batch SSF of pretreated sawdust almost reached a 4%.

GRAPHICAL ABSTRACT

Multi-fermentors system for three stage fed-batch SSF

ARTICLE INFO

Article history:
Received 20 August 2012
Received in revised form 8 November 2012
Accepted 28 November 2012
Available online 8 December 2012

Keywords:
Lignocellulose
Ethanol
Continuous pretreatment
Extrusion
Fed-batch SSF

ABSTRACT

Ethanol production from poplar sawdust using sulfuric acid-assisted continuous twin screw-driven reactor (CTSR) pretreatment followed by simultaneous saccharification and fermentation (SSF) was investigated. Pretreatment with high acid concentration increased the cellulose content in the pretreated solid (74.9–76.9% in the range of 4.0–5.5 wt.% H_2SO_4). The sugar content (XMG; xylan + mannan + galactan) in the treated-solid was 11.1–15.2% and 0.9–5.7% with 0.5 wt.% and 7.0 wt.%, respectively. The XMG recovery yield of the sample treated with 4.0 wt.% H_2SO_4 at 185 °C was maximized at 88.6%. Enzymatic hydrolysis test showed a cellulose digestibility of 67.1%, 70.1%, and 73.6% with 15, 30, and 45 FPU/g-cellulose, respectively. In the fed-batch SSF tests with initial enzyme addition, the ethanol yield of each stage almost reached a maximum at 28 h, 48 h, and 56 h, respectively, with yields of 63.9% (16.5 g/L), 78.4% (30.1 g/L), and 81.7% (39.9 g/L), respectively.

1. Introduction

Over the last several decades, biofuels, in particular ethanol, have gathered increasing attention as promising fuels for transportation. The use of fossil fuels has contributed to the buildup of carbon dioxide in the atmosphere, while ethanol produced from lignocellulosic biomass is a clean-burning fuel that does not contribute to global warming (Lee et al., 2012). Lignocellulosic biomass, a heterogeneous material, has a highly crystalline structure and various components such as cellulose, hemicellulose, and lignin (Won et al., 2012). Biofuels can be produced from lignocellulosic materials; however, production of ethanol from lignocellulosic biomass differs significantly from the corn-to-ethanol processing because lignocellulosic carbohydrates are more heterogeneous and much more difficult to solubilize than cornstarch in kernels (Khattak et al., 2012). Although most of the fuel ethanol in the world is currently produced from corn kernel and sugarcane, corn or sugar ethanol production would still displace less than

* Corresponding author. Tel.: +82 41 550 3558; fax: +82 41 559 7867.
E-mail address: kkoh@dankook.ac.kr (K.K. Oh).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.11.125