



Acetone–butanol–ethanol fermentation in a continuous and closed-circulating fermentation system with PDMS membrane bioreactor

Chunyan Chen^a, Zeyi Xiao^{a,*}, Xiaoyu Tang^b, Haidi Cui^a, Junqing Zhang^a, Weijia Li^a, Chao Ying^a

^a School of Chemical Engineering, Sichuan University, 610065 Chengdu, China

^b Biomass Energy Technology Research Center, Biogas Institute of Ministry of Agriculture, 610041 Chengdu, China

HIGHLIGHTS

- Continuous and closed-circulating ABE fermentation.
- Fermentation intermittent coupling with pervaporation.
- Fermentation continuous coupling with pervaporation.
- Overall kinetic parameters.
- Time course profiles of fermentation kinetics.

ARTICLE INFO

Article history:

Received 20 August 2012

Received in revised form 17 October 2012

Accepted 18 October 2012

Available online 26 October 2012

Keywords:

ABE fermentation

PDMS membrane bioreactor

Butanol

Pervaporation

ABSTRACT

Acetone–butanol–ethanol (ABE) fermentation by combining a PDMS membrane bioreactor and *Clostridium acetobutylicum* was studied, and a long continuous and closed-circulating fermentation (CCCCF) system has been achieved. Two cycles of experiment were conducted, lasting for 274 h and 300 h, respectively. The operation mode of the first cycle was of fermentation intermittent coupling with pervaporation, and the second cycle was of continuous coupling. The average cell weight, glucose consumption rate, butanol productivity and butanol production of the first cycle were 1.59 g L⁻¹, 0.63 g L⁻¹ h⁻¹, 0.105 g L⁻¹ h⁻¹ and 28.03 g L⁻¹, respectively. Correspondingly, the four parameters of the second cycle were 1.68 g L⁻¹, 1.12 g L⁻¹ h⁻¹, 0.205 g L⁻¹ h⁻¹ and 61.43 g L⁻¹, respectively. The results indicate the fermentation behaviors under continuous coupling mode were superior to that under intermittent coupling mode. Besides, two peak values were observed in the time course profiles, which means the microorganism could adapt the long CCCC membrane bioreactor system.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

The production of *n*-butanol with solvent-producing strains of *clostridium*, commonly known as ABE (acetone–butanol–ethanol) fermentation is one of the largest biotechnological processes ever developed (Van Hecke et al., 2012). Butanol and acetone are excellent organic solvents and important industrial chemicals, which are widely used in chemical industries, such as pharmaceuticals, agrochemicals and organic syntheses. In recent years, butanol is regarded as genuine biofuel due to its considerably higher combustion value than ethanol and blending in fuels more readily than ethanol (Kumar and Gayen, 2011; Thirmal and Dahman, 2012).

Many researches on ABE fermentation have been indexed. Qureshi et al. investigated butanol production from wheat straw

by simultaneous saccharification and fermentation in five different batch fermentation processes (Qureshi et al., 2008). Cheng et al. studied bio-butanol production by solvent-producing bacterial microflora and the maximum butanol concentration of 12.4 g L⁻¹ was obtained in batch fermentation (Cheng et al., 2012). However, as known, the economics of the ABE bio-fermentation are hampered by the high cost of substrates and butanol toxicity leading to cell inhibition, low product accumulation, low space-time-yields and high purification costs (Bankar et al., 2012; Garcia et al., 2011).

To relieve butanol inhibition and improve the fermentation efficiency, several separation technologies have been investigated for extracting products and controlling their concentrations in fermentation broth, such as distillation (Wang et al., 2012), gas stripping (Ezeji et al., 2003; Qureshi and Blaschek, 2001), extraction (Bankar et al., 2012; Kraemer et al., 2011), adsorption (Qureshi et al., 2005), perstraction (Qureshi and Maddox, 2005) and pervaporation (Liu et al., 2011; Yen et al., 2012). For example, Lu et al. investigated fed-batch fermentation for butanol production from

* Corresponding author. Address: Sichuan University, No.24 South Section 1, Yihuan Road, 610065 Chengdu, China. Tel./fax: +86 028 85401057.

E-mail address: mgch@scu.edu.cn (Z. Xiao).