Journal of Applied Sciences 9 (8): 1568-1572, 2009
ISSN 1812-5654

Investigation of Production of Ethanol from Cotton Linter and Waste Textile

[1]Hossein Aliee and [2]Maryam Teimori
[1]Department of Textile Engineering, Islamic Azad University, Arak Branch, Iran
[2]Department of Biology, Islamic Azad University, Arak Branch, Iran

Abstract: In this study, ethanol production from cotton linter and waste of blue jeans textiles was investigated. In the best case, alkali pretreatment followed by enzymatic hydrolysis resulted in almost complete conversion of the cotton and jeans to glucose, which was then fermented by *Saccharomyces cerevisiae* to ethanol. If no pretreatment applied, hydrolyses of the textiles by cellulose and β-glucosidase for 24 h followed by simultaneous saccharification and fermentation (SSF) in 4 days, resulted in 0.140-0.145 g ethanol g^{-1} textiles, which was 25-26% of the corresponding theoretical yield. A pretreatment with concentrated phosphoric acid prior to the hydrolysis improved ethanol production from the textiles up to 66% of the theoretical yield. However, the best results obtained from alkali pretreatment of the materials by NaOH. The alkaline pretreatment of cotton fibers were carried out with 0-20% NaOH at 0, 23 and 100°C, followed by enzymatic hydrolysis up to 4 days. In general, higher concentration of NaOH resulted in a better yield of the hydrolysis, whereas temperature had a reverse effect and better results were obtained at lower temperature. The best conditions for the alkali pretreatment of the cotton were obtained in this study at 12% NaOH and 0°C and 3 h. In this condition, the materials with 3% solid content were enzymatically hydrolyzed at 85.1% of the theoretical yield in 24 h and 99.1% in 4 days. The alkali pretreatment of the waste textiles at these conditions and subsequent SSF resulted in 0.48 g ethanol g^{-1} pretreated textiles used.

Key words: Cotton, textile, industrial, engineering, ethanol

INTRODUCTION

Used clothes and surplus of textile industries end sooner or later in waste collection stations and usually landfilled or incinerated (Miranda *et al*., 2007). Cotton with annual production of more than 23 million tons per year (FAO, 2003) stands for about 1/3 of the global market of textile fibers (Aizenshtein, 200[illegible]). Cotton fibers are the seed hairs of the plant Gossypium. Cotton is typically composed of 88-96% cellulose, the remainder being protein, pectin materials and wax. Cotton must be scoured and usually bleached before use, whereby its cellulose content is enriched to about 99% (Miranda *et al*., 2007). It is therefore possible to hydrolyze the cotton by e.g., enzyme or acids to glucose and then ferment it to ethanol. Ethanol is currently the most abundant renewable in the global fuel market. It is currently produced from sugars and starchy materials, but lignocelluloses are most likely the alternative feedstocks for the second generation of ethanol production in the future (Lynd *et al*., 2005; Taherzadeh *et al*., 2007a). The polymers of cellulose and hemicelluloses should be first released from the fibrils in pretreatment in order to have an effective hydrolysis (Taherzadeh *et al*., 2007b). The general ideas in various pretreatment technologies are to alter or remove lignin and hemicelluloses, increasing the surface area and decreasing the crystallinity of cellulose (Galbe and Zacchi, 2002; Jørgensen *et al*., 2007; Wyman *et al*., 2005). In cotton, there is no lignin or hemicelluloses, but its crystallinity is relatively high. The crystallinity index of avicel, wood pulp, bacterial cellulose and cotton is 0.50-0.60, 0.50-0.70, 0.76-0.95 and 0.81-0.95, respectively (Zhang and Lynd, 2004). Therefore, the main goal of any possible pretreatment of cotton-based textiles should be to increase the surface area and decrease the crystallinity. In order to approach this goal, one should efficiently disrupt hydrogen bonds between the glucan chains in crystalline cellulose and produce amorphous cellulose. Zhang *et al*. (2006, 2007) developed a procedure for producing regenerated amorphous cellulose, by dissolving homogenous cellulose in concentrated phosphoric acid followed by a precipitation by acetone. They concluded that in this method, by breaking down the hydrogen bonds and precipitating amorphous cellulose, it is possible to approach complete enzymatic hydrolysis. This pretreatment method was used in present study on waste

Corresponding Author: Hossein Aliee, Department of Textile Engineering, Islamic Azad University, Arak Branch, Iran
Tel: 09194051360 Fax: +98 861 2210153