CHAPTER I
INTRODUCTION

Nowadays, the energy crisis became the main problem that people concern. The energy crisis cause by a global decrease in availability of natural oil and gas resources. The other concern is about environmental issue such as greenhouse effect from carbon dioxide emission, global warming, etc. Therefore, the search for alternative fuel sources has gained much attention. Renewable sources utilization technology and bioenergy production technology was developed for solving these problems. Biofuels have been defined as solid, liquid, and gaseous fuels that are mainly derived from biomass. Among biofuels, biobutanol is one of new types of biofuels and became attracted the attention of researchers and industrialists because of its several distinct advantages.

Butanol, a colorless liquid with a distinct odor used as a precursor for the synthesis of myriad chemicals, is regarded as the most promising alternative fuels. Biobutanol available as fermentation product of various carbohydrate derivatives obtained from different resources of agricultural production. It is produced by acetone-butanol-ethanol (ABE) fermentation which is an anaerobic fermentation. The *Clostridia* genus is very common for butanol synthesis under anaerobic conditions, and the fermentation products are often the mixture of acetone, butanol, and ethanol (Qureshi and Maddox, 1995). From this fermentation, acetone, butanol, and ethanol are typically produced in an approximate ratio of 3:6:1 (w/w) (Forberg and Haggstrom, 1984). The limitation associated with ABE fermentation are the toxic effects that butanol has on microorganisms, low solvent productivity, and unstable for solvent production (Qureshi *et al.*, 2000). Therefore, it was necessary to search for new technique to develop ABE fermentation.

To improve ABE fermentation, several attempts have been made to examine the potential applications for a cell immobilization technique, either through entrapment or by adsorption, aimed at increasing butanol productivity. Immobilization of *Clostridium* strains prevents bacteria from existing in the ferment mash and is a very essential facility in a variety of integrated solvent recovery methods. The immobilization of desired bacteria onto suitable materials as carriers can improve the productivity of ABE fermentation, the production performance of ABE process has more stable productivity (Yen *et al.*, 2011). The importance for the immobilization technique is also improve the butanol resistance of the growing cells because when cells attach to a solid surface, they exhibit a different pattern of gene expression which is an increased resistance to antimicrobial agents (Liu *et al.*, 2013), leading to more productivity for ABE fermentation. Moreover, the advantages of this method are simplicity, minor influence on conformation of the biocatalyst, higher cell density in bioreactors can be achieved. Based on this advantage, smaller reactors, shorter retention time or higher flow rates can be employed and there is no need for utilization of chemicals which could cause a damage of bacterial cells (Hrenovic *et al.*, 2011; Djukić-Vuković *et al.*, 2013).

The purpose of this work is to investigate and compare biobutanol production by immobilized *Clostridium beijerinckii* TISTR 1461 onto different porous materials and free mobilized cells. Materials used for immobilization in this work are brick, activated carbon, and zeolite. The studied parameters are biobutanol productivity and butanol stability production. In addition, the fresh porous materials were characterized for materials composition, surface area, porous, initial pH, and surface morphology.