CHAPTER I
INTRODUCTION

In recent years, fuel oil demand is continually increased because of extended population in the world. On the other hand, natural source of fuel oil that is petroleum fuel is perpetually decreasing. Alcohol-based fuels are alternative energy sources which have been used as replacements for gasoline. Especially, ethanol fuel that is the most widely used due to its low toxicity and wide abundance is produced from renewable agricultural product, which is called "Bioethanol". Ethanol can be directly used or blended with gasoline to any percentage such as 10% ethanol mixed with 90% gasoline is called E10. This blend is referred to "gasohol". Blending ethanol with gasoline has several advantages: increasing octane value of gasoline, decreasing carbon monoxide emission and hydrocarbon exhaust.

Bioethanol means ethanol liquid biofuel which is produced from renewable agricultural sugar crops (sugar cane, molasses), corn, lignocellulosic (bagasse and wood) sources via hydrolysis and fermentation process. Fermentation process is more important to produce ethanol. Therefore, process of continuous ethanol fermentation in packed-bed bioreactor is considered in order to get high ethanol production. Moreover, cell immobilization is a technique that has been extensively investigated during few decades to enhance fermentation productivity.

Cell immobilization is more interesting. There are many advantages of cell immobilization over free cells such as high volumetric productivity of ethanol, relative ease of product separation, reusable of biocatalysts, important protection of biocatalysts from inhibitions (Bangrak, 2007). It normally involves attachment of yeast cells to, or location within, an insoluble support material by adsorption, covalent binding, entrapment, encapsulation or cross-linking (Gordon *et al.*, 2002). Among the different immobilization techniques, entrapment of microbial cell with the polymeric matrixes such as calcium alginate, gelatin, agar, k-carrageenan, etc or within some materials such as sponge, silicon carbide, polyurethane foam or chitosan has been widely studied (Razmovski *et al.*, 2011).

Silk fibroin (SF) is the typical natural macromolecule spun by *Bombyx mori* silkworm. It is an insoluble protein containing up to 90 % of the amino acids, like glycine (Gly), alanine (Ala), and serine (Ser). SF has been widely used as biotechnology and biomedical materials because of its unique properties including good biocompatibility, good oxygen and water vapor permeability, biodegradability, minimal inflammatory reaction and non-toxicity (Um *et al.*, 2001). SF can be prepared for different morphologies such as particles, fibers, films, sponges, hydrogels and scaffolds (Vepari *et al.*, 2007). There are several fillers which may be mixed with SF in order to improve its mechanical properties and other properties. Cellulose whiskers (CLWs) are nanofiller extracted from plants. They can give reinforcement, tensile strength, Young's modulus and other good properties to composite.

The overall objective of this study is to develop a new carrier for yeast cells immobilization in order to use in continuous ethanol production. This carrier was prepared by fabricating SF/CLWs bionanocomposite sponges by using freeze drying technique. Furthermore, this study was considered the effect of SF-to-CLWs blended ratio on the chemical structure and morphology of bionanocomposite sponge. The carrier potential was evaluated by using in continuous ethanol fermentation in terms of % sugar consumption, residual sugar, ethanol production, ethanol yield and volumetric ethanol productivity that obtained from fermentation.