CHAPTER I

INTRODUCTION

1.1 Background

Thailand imports considerable quantities of petroleum for both generation of electricity and also for transportation sector which accounted for almost 50% or almost 400,000 million baht per year respectively. Petroleum energy, not only poses continual increasing costs, but also environmental impacts which derived from their utilization. Withstanding this, study and research on alternative energy are now having high potentiality in order to reduce the imported quantities of petroleum energies as well as to minimize environmental impact. It was found that biohydrogen generation by fuel cell, both that is used in automobile and that of co-utilization with natural gas, is currently a more promising alternative which gains more increasing interests in many countries. The biohydrogen energy is considered as clean energy without pollution generation which supports fuel cell technology. Currently many countries including United States of America, European and Asian countries are now focusing on substantial development of the biohydrogen energy.

Biohydrogen production with cheaper cost is the topmost priority for development of this technology; otherwise its possibility for future application will not be very likely. The study therefore focuses on dark biohydrogen fermentation process under anaerobic condition that requires low investment, but high hydrogen productivity. In Thailand, there is plenty of organic residues from food industries. For example the brewery, thousand of tons of spent malt and brewery waste yeast (with 10% increase each year) have been produced annually as a by product from main beer manufacturers (Suphantharika, 1997). This may lead to a large amount of a major by-product being produced, which might be subsequently caused to increasing waste management cost. These brewery residues are regarded as a rich source of carbohydrate and protein.

Carbohydrates are well known as the preferred substrate for fermentative hydrogen producing bacteria such as *Clostridium species.* Whereas yeast contains the high nutritional value such as amino acids and various vitamins (Jean de Clerck, 1957). The utilization of yeast for human and animal food supplement has long been applied since the early 1900s. Stoichiometrically, the maximum yield of four mol hydrogen is obtained from one mol of glucose (or hexose) fermentation (Thauer, 1977). This yield is the ultimate goal and challenge for fermentative hydrogen research and development focuses on attaining higher yield of hydrogen. In practice, H_2 yields by pure or mixed cultures are lower. Several researcher have used various ways to improve hydrogen yield, by vigorous stirring (Lamed *et al*., 1988), by sparging with nitrogen gas (Mizuno *et al*., 2000), by applying vacuum to the headspace of a bioreactor (Kataoka *et al*.,1997), by extraction through membranes (Liang *et al*., 2002; Nielsen *et al*., 2001; Teplyakov *et al*., 2002). These include optimising operating condition such as pH (Fang and Liu, 2002), temperature (Lin and Chang, 2004) and hydraulic retention time (HRT) (Fan *et al.,* 2006). In this work the feasibility of anaerobic H_2 fermentation employing organic materials containing carbohydrate including brewery wastes such as spent malt and brewery waste yeast as initial substrate was therefore carried out under the hypothesis that brewery waste yeast, being as nutrient supplement, may help improved hydrogen production. If the study could support the hypothesis, the brewery wastes may become a plentiful source of inexpensive organic substrate for fermentative hydrogen production.

1.2 Objectives

The objectives of the study include the following:

1) To screen microbial strains with biohydrogen generation efficiency using wastes generated from brewery production for use as alternative fuel.

2) To study optimum conditions of maximum biohydrogen using Continuous Stirred Tank Reactor (CSTR) in laboratory scale.

3) To study optimum Hydraulic Retention Time (HRT) for maximum biohydrogen generation.

4) To study microbial community structure which produce maximum biohydrogen generation using molecular biological techniques of Denaturing Gradient Gel Electropholysis (DGGE).