CHAPTER I
INTRODUCTION

Energy is now a necessary factor for daily life. The current major energy source of the world is fossil fuels, but these resources are limited. The excessive demand of fossil fuels subsequently affects the global warming since the combustion of fossil fuels can release greenhouse gases, such as carbon dioxide, which affects the ozone layer, leading to earth climate change, acid rain, and agriculture problems.

In order to reduce global warming problems and reserve the existing energy sources, renewable energy sources have been increasingly focused. Hydrogen is an interesting renewable energy source for replacing fossil fuels as clean energy for various applications since it only produces water when burnt. Hydrogen can be used by itself or blended with another fuel, such as methane (CH_4). The combustion of hydrogen mixed with methane results in lower nitrogen oxide emission from internal combustion engines, which is desirable for environment. It does not produce a greenhouse gas, gives high energy yield of 112 kJ/g, which is 2.75 times greater than hydrocarbon fuels, can easily be used in fuel cells for generation of electricity (Kapdan and Kargi, 2006), and can be produced by less-energy intensive process as compared to chemical processes.

Hydrogen can be generated from many ways, such as steam reforming of methane (SRM), non-catalytic partial oxidation (POX) of fossil fuels, autothermal reforming which combines SRM and POX, photochemical processes, photocatalytic processes, and photo-electrochemical processes. However, these convectional processes are all energy-intensive, do not give the dual goals of energy production and waste reduction, give low amount of hydrogen, require high temperature energy, and are not environmentally friendly (Kapdan and Kargi, 2006). Therefore, hydrogen production by biological processes has been considered more feasible because they can operate under mild conditions (30–40 °C).

Biological hydrogen production processes can convert organic wastes into hydrogen gas by anaerobic fermentative bacteria (O-Thong *et al.*, 2007) and can be classified as photo and dark fermentation processes. Dark fermentative process by anaerobic bacteria is a promising alternative method for hydrogen production because it gives higher hydrogen production rate than other biological processes and is stable and fast when compared with photo fermentation process. Under anaerobic conditions, organic wastes can be converted to organic acids by acidogenic bacteria and then give hydrogen gas as a by-product. There are many parameters that have been considered to affect hydrogen production, such as pH, organic loading rate, cycle duration, solid retention time (SRT), and hydraulic retention time (HRT). Another important factor that greatly affects hydrogen production yield is type of waste material. Simple sugars, such as glucose, sucrose, and lactose, can be used as substrates for hydrogen production. One mole of glucose can produce four moles of hydrogen gas; however, pure carbohydrate sources are expensive. Many previous studies used starch, such as cassava and corn, as a carbohydrate source for hydrogen production. Nevertheless, glucose and starch are still not economically feasible to be used due to their high cost. Therefore, industrial organic wastewaters containing high concentration of carbohydrate are an attractive source to be used as substrates for hydrogen production. The use of industrial wastewaters for hydrogen production provides dual benefits for both reducing wastewater treatment step and producing hydrogen as a renewable source. There are various industrial wastewaters that have been used for hydrogen production, such as cheese processing wastewater, winery wastewater, and beer lees wastewater. Another attractive waste is alcohol distillery wastewater.

Alcohol distillery wastewater is the wastewater from alcohol distillation process, using sugar-cane molasses as raw material. Wastewaters from alcohol distillation processes have very high chemical oxygen demand (COD) up to 120,000 mg/l and contain high amount of carbohydrate and yeast. Therefore, anaerobic treatment is a suitable process for these effluents. However, biohydrogen production from a real alcohol distillery wastewater using anaerobic sequencing batch reactor (ASBR) has not been extensively studied. In this research, an alcohol distillery wastewater from an alcohol distillation process was used as a substrate for biohydrogen production. The effects of initial feed COD value and COD loading rate were investigated for the ASBR operation in order to achieve the maximum hydrogen production rate by using mixed culture of hydrogen-producing bacteria.