CHAPTER I
INTRODUCTION

Nowadays, the major energy source of the world is fossil fuels, such as oil coal, and natural gas. The demand of fossil fuels has increased in recent years, so the limited amount of fossil fuels results in their high price. Moreover, the combustion of fossil fuels can release greenhouse gases, such as carbon dioxide, that cause a global warming effect. Carbon dioxide affects ozone layer, increases the Earth's temperature, and causes acid rain. For these reasons, the researchers are looking for alternative fuels.

In order to avoid carbon dioxide emission, hydrogen has been increasingly focused. It is an odorless, colorless, tasteless, and non-poisonous gas. There are a lot of advantages of hydrogen utilization, such as its high conversion efficiency, its ability to be recycled, and its non-pollution. When hydrogen is used as a fuel, it produces only water, thus reducing carbon dioxide emission (Chong *et al.*, 2009). Moreover, hydrogen gives high energy yield of 112 kJ/g, which is 2.75 times greater than hydrocarbon fuels. Hydrogen can also be used to generate electricity through fuel cells (Lay *et al.*, 1999; Mizuno *et al.*, 2000).

There are several methods for hydrogen production, 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 processes need high operating cost, give low amount of hydrogen, and are not environmentally friendly. So, biohydrogen production from renewable sources is interesting because it can operate under mild conditions and also reduce waste (Kapdan and Kargi, 2006).

Biohydrogen production can be achieved by photosynthetic or anaerobic microorganisms. Photosynthetic microorganisms use carbon dioxide, light, and water for hydrogen production. Although photosynthetic microorganisms can produce high rate of hydrogen, light requirement is a problem for designing an efficient photo-bioreactor (Chong *et al.*, 2009). Anaerobic fermentation or dark fermentation not only produces high hydrogen rate but also does not depend on sunlight, so it can

produce hydrogen thoughout the day and night at a constant rate (Vijayaraghavan and Soom, 2006). Anaerobic fermentation or dark fermentation requires carbohydrate-rich biomass as a substrate, such as sugarcane, corn, and cassava. However, the price of pure carbohydrate source is expensive, therefore organic wastes from the industry, such as ethanol industry, which contain high level of carbohydrate, is preferably used for hydrogen production.

In this research, ethanol wastewater from an ethanol production plant was used for producing hydrogen by using upflow anaerobic sludge blanket (UASB) reactors. Each UASB reactor with a 24-liter liquid holding volume was operated at a mesophilic temperature of 37 °C and a controlled pH of 5.5. Hydrogen-producing bacteria in seed sludge obtained from wastewater treatment system of the ethanol production plant were used as microorganisms. The effect of COD loading rate on hydrogen production efficiency was mainly studied. The volatile fatty acids (VFA) in the effluent and the microbial concentration in the bioreactor were also examined.