CHAPTER I
INTRODUCTION

The world is faced with insufficient global energy and the majority of the energy consumed today is derived from fossil fuels. When fossil fuels are burned, carbon dioxide and other pollutants are generated. Excess carbon dioxide in atmosphere causes global warming due to the greenhouse effect. Thus, it is necessary to find alternative energy sources that are renewable and environmentally friendly.

Hydrogen is one of the alternative energy sources, which is a clean energy, possessing a high energy yield (122 kJ g^{-1}), and does not contribute to the greenhouse effect (Gavala *et al.*, 2006). Moreover, hydrogen 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). From these reasons hydrogen has been an unrealized "fuel of the future".

At present, hydrogen can be produced via various process technologies, such as fossil fuels processing or by electrolysis using solar power or gasification. But in these processes are highly energy intensive, expensive and not always environmentally friendly, so the biological hydrogen production is more attractive (and even more attractive if waste/wastewater could be used as raw material) (Gavala *et al.*, 2006).

Biological hydrogen production is the most challenging area of biotechnology with respect to environmental problems. Biological method mainly includes photosynthetic hydrogen production and fermentative hydrogen production. Most studies have been related to fermentative hydrogen production. The scarcity of information related photosynthetic hydrogen production is due to two reasons: (a) It is difficult to control light penetration and its uniform distribution and (b) the process is likely not cost-effective unless the free sunlight can be used as the light source (Fang *et al.*, 2002). Moreover, fermentative hydrogen production has the advantages of rapid hydrogen production rate and simple operation. In addition, it can use various organic wastes as substrate for fermentative hydrogen production. Thus, compared with the photosynthetic hydrogen production, fermentative hydrogen production is more feasible and widely used.

In this work, bio-hydrogen production and methane production via dark fermentation from alcohol wastewater by using upflow anaerobic sludge blanket reactors (UASB) with a working volume of 4 L was investigated. For hydrogen production, the system was operated at different COD loading rates (23, 31, 45 and 62 kg/m^{3}d) at mesophilic temperature (37 °C) and pH 5.5. The seed sludge was pretreated before being fed to the UASB system by boiling at 95 °C for 15 min. For methane production, the effluent from the hydrogen production step operated at the optimum conditions will be fed into a second UASB which was operated at different COD loading rate (4.5, 6.2, 8.8 and 11.6 kg/m^{3}d) without pH control and without recycling. Moreover, the effect of COD loading rate on methane production was studied.