CHAPTER I
INTRODUCTION

Nowadays, global energy demand and consumption are mostly dependent on fossil fuels (about 80% of the present world energy demand), eventually leading to foreseeable depletion due to limited fossil energy resources. The utilization of fossil fuels is causing global climate change mainly due to the emission of pollutants, including CO_x, NO_x, SO_x, C_xH_x, soot, ash, droplets of tars, and other organic compounds, which are released into the atmosphere as a result of their combustion. The main concern about global climate change is the greenhouse effect that is a serious global environmental problem (Das *et al.*, 2001; Yokoi *et al.*, 2002). This effect is the increase in earth surface temperature due to the presence of these pollutants since they can reflect most of the heat released from the earth surface. Considering the energy security and the global environment, alternative energy resources are the potential way to reduce the greenhouse effect problem. Hydrogen is one of renewable energy sources, which is considered as the major energy carrier of the future. It is an ideal and clean energy source because of its high conversion capability, recyclability, and non-polluting nature (Lin and Jo, 2003). It has a high energy content of 122 kJ/g, which is 2.75 times greater than hydrocarbon fuels. Moreover, it produces water as its only end-product when it burns (Argun *et al.*, 2008; Khanal *et al.*, 2004).

Presently, hydrogen is produced mainly from fossil fuels, biomass, and water. About 90% of hydrogen is produced by the reactions of natural gas with steam at high temperatures. These methods are considered to be energy intensive, and not always environmentally friendly. Biological production of hydrogen is one of the alternative methods, where biological hydrogen production processes can be operated at ambient temperatures and pressures, less energy intensive and more environmentally friendly (Mohan *et al.*, 2007). Biological hydrogen production processes can be realized by anaerobic or fermentative (dark or anaerobic fermentation) and photosynthetic (photo-fermentation) microorganisms using carbohydrate-rich biomass as a renewable resource. The first step is the enzymatic hydrolysis of organics with high molecular weight to soluble organics, which are further fermented as the second step by anaerobic organisms to produce volatile fatty acids (VFA), hydrogen, and carbon dioxide (Argan *et al.*, 2008). The dark fermentation is more advantageous than photo-fermentation since dark fermentation does not depend on energy provided by sunlight. So, it is capable of high hydrogen generation rate, and hydrogen is produced throughout the day and night at a constant rate (Vijayaraghavan *et al.*, 2005). From these advantages, it is feasible for mass production of hydrogen. Hence, hydrogen production through dark fermentation using wastewater as substrate has been attracting considerable attention. Exploitation of wastewater as the substrate for hydrogen production with current anaerobic treatment technology is an attractive and effective way of tapping clean energy from renewable resources in a sustainable approach. This provides dual environmental benefits in the direction of wastewater treatment along with sustainable bio-energy (hydrogen) generation (Mohan *et al.*, 2007).

Thailand is the world's largest exporter of cassava products, and about 18 million tons of starch is processed annually (Food and Agricultural Organization of United Nations, 2000; International Starch Institute, 1999). One kilogram of fresh cassava roots yields about 0.2 kg of starch, 0.4-0.9 kg of cake, and about 5-7 L of wastewater in the starch production process (Plevin and Donnelly, 2004). Cassava wastewater is a carbohydrate-rich waste, and has a very high chemical oxygen demand (COD), biochemical oxygen demand (BOD), and total solid (Sriroth, 2005). It has already been proved to be feasible for hydrogen production. It could be conducted in batch, repeated-batch, upflow anaerobic sludge blanket (UASB), and anaerobic contact process by dark fermentation (Sangyoka, 2006; Thailand Institute of Scientific and Technological Research, 1988). However, the biohydrogen production from cassava wastewater using anaerobic sequencing batch reactor (ASBR) has not been reported. Therefore, this research was conducted to investigate the effects of operational parameters, i.e. number of cycles per day, COD loading rate, and nutrient supplementation, on the biological hydrogen production by mixed culture and also to find the optimum conditions, which provided maximum hydrogen production. An anaerobic sequencing batch reactor (ASBR) was used as the fermentor, and a COD-rich wastewater from a cassava starch production plant was used as the organic substrate for hydrogen production in the present study.