CHAPTER I
INTRODUCTION

1.1 Background

In present, energy demand increases day by day, and fossil fuels which is mainly usage today are continuously depleting. Consequently, searching for alternative fuels that response to consumption demands and environmental friendly comes interesting, since fossil fuels release some pollutants that may be cause the global warming such as carbon dioxide, methane, sulfur dioxide, and others. Among many alternative energy fuels, hydrogen is proposed as a promising alternative fuel because of its potentially high efficiency, safety usage, zero-emission of pollutants, and low effective cost (Vezirocjlu and Barbir, 1992). Furthermore, it can be produced from cheap and abundant sources such as food waste, animal manure, or wastewater via biological fermentation process. Therefore, biological hydrogen (biohydrogen) fermentation is grown concern because its ability to transform various organic wastes into clean and environmental friendly hydrogen gas. From many biohydrogen production process, for example, direct bio-photolysis, indirect bio-photolysis, photo-fermentation, and more, (Karthic and Shiny, 2012), dark fermentation requires smaller operational space due to independent of light contacting surface. Besides, it is able to operate with various waste streams and bacterial cultures. O-Thong et al. (2011) studied feasibility of starch processing wastewater to produce hydrogen by fermentation under thermophilic condition (53-68°C) with mixed cultured collected from hot spring on souther part of Thailand. Sangyoka et al. (2007) also used cassava wastewater as substrate in fermentative hydrogen production with mixed culture. However, dark fermentation comparatively obtained fewer hydrogen yields.

Among many factors, important factors that affect hydrogen generation via fermentation are pH and temperature. They influence to microbial community, metabolic pathway selection, thus affect hydrogen yield and efficiency. (Guo et al., 2010; Show et al, 2011; Valdez-Vazquez and Poggi-Varaldo, 2009) Wang and Wan (2009) also reported of another hydrogen fermentation enhancing factor which is iron concentration. As an essential component of hydrogenase enzyme which corresponding for hydrogen formation, iron affect to hydrogenase activity thus affect hydrogen productivity (Lee et al., 2001; Li and Fang, 2007, Show et al., 2011)

Moreover, many works has reported about immobilization of bacteria on supporting materials to improve hydrogen productivity by helping acclimatization of microbes, decreasing lag phase of bacterial cultivation (Cheng et al., 2006; Prieto et al., 2002), and increasing density of consortia (Wu et al., 2003). Synthesized materials were, for example, activated carbon (Wu et al., 2003; Zhang et al., 2008; Chang et al., 2002), expanded clay (Barros et al., 2010; Amorim et al., 2009; Chang et al., 2002), glass bead (Zhang et al., 2006; Zhang et al., 2007a), polystyrene, PET (Barros and Silva, 2012). Biological supporting materials (BM), for instance, were loofa sponge (Chang et al., 2002), coir (Kumar and Das, 2001), rice straw (Kumar and Das, 2001), bagasse (Kumar and Das, 2001). Nonetheless, few biological supporting materials from animals were studied in biohydrogen process.

In conclusion, this research was focused on improvement of biohydrogen production through anaerobic dark fermentation of starch processing wastewater by biological supporting materials both from animals and plants, and comparison hydrogen productivity enhancement of flora and fauna BM.

1.2 Objectives

1.2.1 To identify an optimal conditions for biological hydrogen production through anaerobic dark fermentation of starch processing wastewater

1.2.2 To study the difference between two types of biological supporting materials from animals and plants on hydrogen production

1.2.3 To study cell morphology and microbial population of hydrogen producing bacteria on the surface of biological supporting materials

1.3 Scopes of study

All research was operated in a lab scale at Faculty of Environment and Resource Studies, Mahidol University, Thailand. Seed sludge was a mixed culture and was collected from anaerobic digestion of municipal excrement treatment plant, Nonthaburi, Thailand. Wastewater was starch processing wastewater from Nakhonpathom province, Thailand.

1.3.1 Studied parameters were initial pH between 4.0 to 8.0, operating temperature (mesophilic condition at 35±2°C and thermophilic condition at 55±2°C), initial iron concentrations at 200, 400, 600, 800, 1000 mg Fe/L (Yang and Shen, 2006; Lee et al., 2001).

1.3.2 Biological supporting materials (BMs) from plants were loofa sponge, coir, corncob, and pine tree bark. BMs from animals were silkworm cocoon, shell, and crab exoskeleton. Studied additional BM concentration was 0, 5, 10, 15, 20 % (v/v).

1.3.3 Hydrogen producing microbes which immobilized on the BMs were studied for cell morphology (shape and size) and microbial population.

1.4 Concept framework

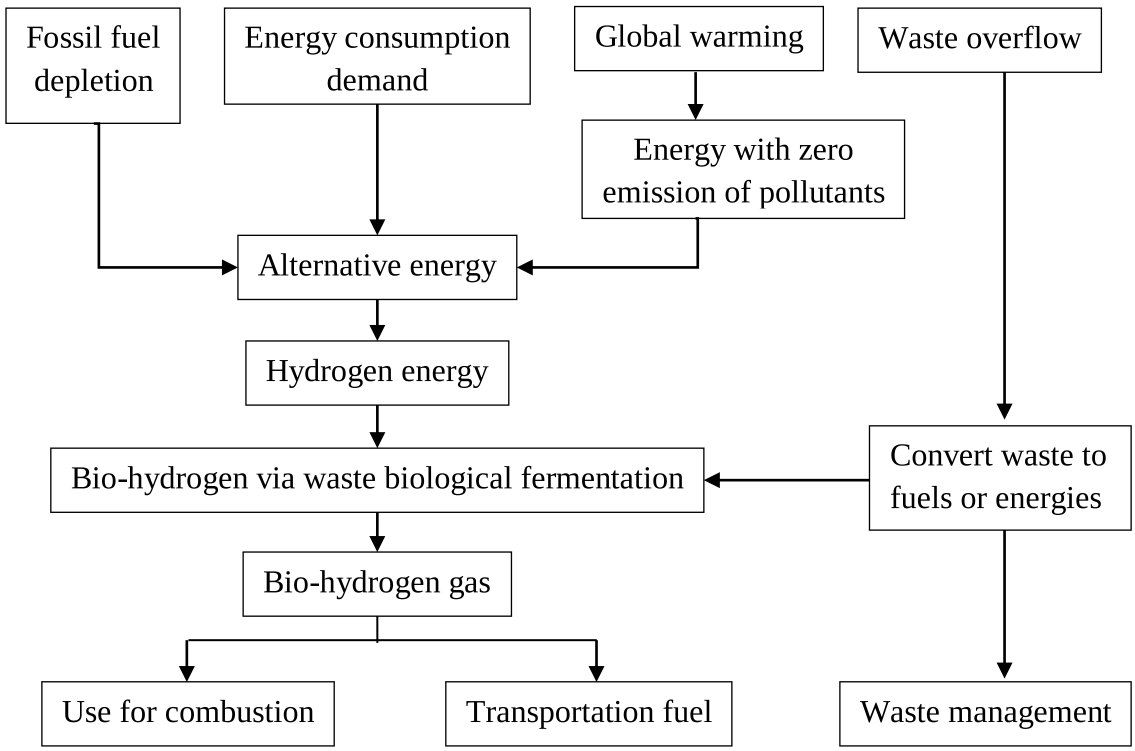

Figure 1.1 Concept framework

1.5 Expected results

1.5.1 Attainment of an optimum condition which continuously produce and obtain maximum hydrogen production yield by anaerobic dark fermentation of starch processing wastewater

1.5.2 BMs are able to improve hydrogen production yield

1.5.3 Comparison of BM from plants and animals on effect of hydrogen production

1.5.4 Wastewater was treated, and observed by deduction of COD after the fermentation

1.6 Definitions

1.6.1 Biological hydrogen (Biohydrogen) - Hydrogen gas production via biological anaerobic dark fermentation process of starch processing wastewater by mixed culture from anaerobic digestion treatment plants in Nonthaburi, Thailand.

1.6.2 Biological supporting material (BM) - Biological materials from part of animals and plants; loofa sponge, coir, corncob, pine tree bark, silkworm cocoon, shell, crab exoskeleton

1.6.3 Microbial population - Observation of microbial population of dominant species on BMs in the fermented cultures using bioinformatics analysis