CHAPTER I
INTRODUCTION

1.1 Background

For decades, energy crisis and global warming from using the fossil fuels are important problems that several countries in worldwide are interesting. Fossil fuels such as oil, natural gas and coal are non-renewable resources therefore they have not enough for response to energy consumption of population and industry in the near future. Moreover, combustion of fossil fuels has caused gas emission that has carbon (C), nitrogen (N) or sulfur (S) to directly ambient, thus environments which are air, soil and water have been contaminated by pollutants (Valdez-Vazquez and Poggi-Varaldo, 2009; Wang and Wan, 2009b). Recently, renewable energy is more researched and developed for effectively application and sustainable development.

Hydrogen gas (H_2) is a renewable energy that recognizes as a clean energy and an environmental friendly energy because it produces only water (H_2O) when it is in combustion as a fuel or conversion to electricity. H_2 production process has several methods such as thermochemical process, electrolysis and biological method. Biological method can be carried out at ambient temperature and pressure thus it is well known as more environmental friendly and less energy than other methods. Dark fermentation is a biological H_2 (biohydrogen) production process that applies anaerobic bacteria to decompose the organic materials. This process requires low energy for input to system and it does not use light therefore it makes rapidly H_2 production rate and easy operating. Moreover, organic waste such as wastewater from municipalities or industries, agricultural waste, dung, food waste etc. is used as substrate for biohydrogen production and can reduce a quantity of waste to environment (Wang and Wan, 2009a). However, the products of biohydrogen production by a dark fermentation are not only H_2 but also volatile fatty acids (VFAs) and alcohols that are byproducts. As a result, H_2 fermentation effluent is acidity. It is necessary to treat the fermentation effluent that has three main methods for post

treatment which are photo fermentation, microbial fuel cells and anaerobic digestion (Show et al., 2012). The operation of anaerobic digestion is similar to a dark fermentation because it is an anaerobic process. Hence, it is an easy maintenance if anaerobic digestion is applied for a post treatment. Moreover, anaerobic digestion gives methane (CH_4) as a product that is a renewable energy and is similar to H_2. There are several advantages in H_2 and CH_4 production from a two-stage fermentation process such as increase efficient substrate digestion, high biogas product and stable system (Yang et al., 2011). Carbon dioxide (CO_2) and carbon monoxide (CO) emission from a two-stage process are less than a one-stage process (Luo et al., 2011). Fermentation process is a complicate process and is encouraged by various factors such as substrate, inoculum, pH, temperature, C/N ratio, etc. These factors at optimal conditions can enhance biohydrogen and biomethane production (Abbasi et al., 2012). However, the optimal conditions for biohydrogen and biomethane production are different since the difference of microorganisms each process.

Thus, this research focused on to study biohydrogen and biomethane production from food waste by a two-stage fermentation process. Furthermore, the optimum of environmental conditions for the maximum biohydrogen and biomethane production were studied.

1.2 Objectives of the research

1.2.1 To study the feasibility of biohydrogen and biomethane production from food waste by a two-stage fermentation process.

1.2.2 To investigate the optimum of environmental conditions (initial pH, temperature and C/N ratio) on biohydrogen production from food waste by a dark fermentation.

1.2.3 To investigate the optimum of environmental conditions (initial pH and temperature) on biomethane production from hydrogen fermentation effluent by an anaerobic digestion.

1.3 Conceptual framework

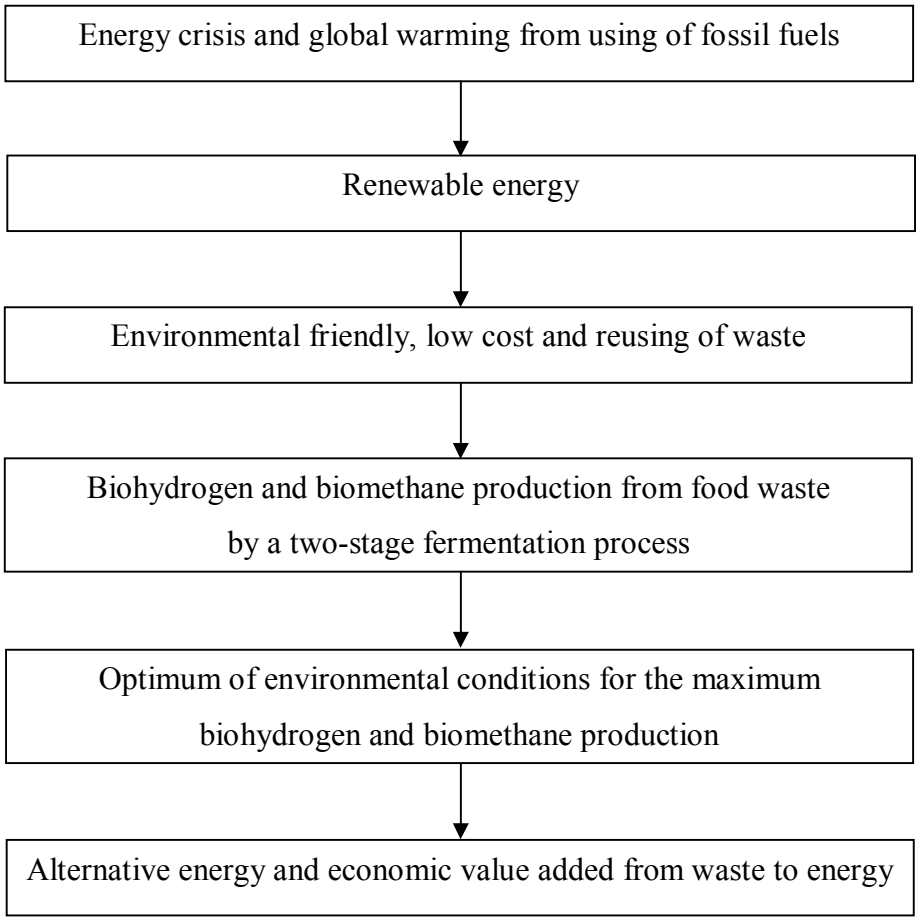

Figure 1.1 Diagram of conceptual framework.

1.4 Hypothesis

1.4.1 Food waste could be produced the biohydrogen and biomethane production by a two-stage fermentation process.

1.4.2 The environmental conditions, i.e. initial pH, temperature and C/N ratio affect on biohydrogen and biomethane production from food waste by a two-stage fermentation process.

1.5 Scopes of the research

1.5.1 This study was carried out in the batch experiment and was operated in a laboratory at Faculty of Environment and Resource Studies, Mahidol University.

1.5.2 Food waste was used as substrate that was collected from central cafeteria of Mahidol University (Salaya campus), Thailand.

1.5.3 Seed sludge was used as mixed cultures of microorganisms source that was collected from anaerobic digestion of municipal excrement treatment plant in Nonthaburi, Thailand.

1.6 Expected output

1.6.1 The feasibility of biohydrogen and biomethane production from food waste by a two-stage fermentation process can be investigated.

1.6.2 The optimal environmental conditions for biohydrogen and biomethane production from food waste by a two-stage fermentation process can be obtained.

1.6.3 The intermediate production and its effects on biohydrogen and biomethane production from food waste by a two-stage fermentation process can be realized.

1.6.4 The research data can be applied to a basic design of continuous biogas production by a two-stage fermentation process.

1.7 Definition

1.7.1 Biohydrogen production is the fermentation process for H_2 production under anaerobic condition.

1.7.2 Biomethane production is the fermentation process for CH_4 production under anaerobic condition.

1.7.3 Dark fermentation is the biological process under anaerobic condition and without light.

1.7.4 Two-stage fermentation process is the dark fermentation for biohydrogen and biomethane production.

1.7.5 Hydrogen fermentation effluent is liquid phase which is separated from solid phase after filtration of organic waste from biohydrogen production. It contains the acidity from byproducts such as volatile fatty acids and alcohols.

1.7.6 Optimum environmental condition is the environmental condition, i.e. initial pH, temperature and C/N ratio enhances the maximum biohydrogen and biomethane production.

1.7.7 Intermediate products are volatile fatty acids (VFAs such as acetate butyrate and propionate) that occur in during biohydrogen production and ammonia-nitrogen (NH_3-N) and methanol that occur in during biomethane production.