CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The world generates high amount of municipal solid wastes (MSW) each year. Increasing population and tremendous urbanisation growth and other factors influence directly the MSW generation in Malaysia. Generally, the per capita generation rate has increased to 1.7 kg/person/day in major cities (Kathirvale et al., 2003). Organic materials such as food waste, paper and paperboard, yard trimmings and plastics, wood, rubber, etc. are the largest component of MSW and contain large amounts of energy that can be recovered.

Food waste (FW) represents a significant and largely underutilized fraction of MSW in Malaysia. In major city such as Kuala Lumpur, the average composition weight percentage of FW in MSW generated varies with different residential income. The highest FW generated by residential low income, followed by residential medium income and residemtial high income which accounted for 54.04%, 38.42% and 30.84% respectively (Kathirvale et al., 2004). However, there is no concrete reasoning for this but it could be suggested that the low-income residents cook and eat in their respective houses, thus generating FW. Contrarily, the high-income people tend to have meals outside more frequently resulting in less FW. It is the main cause of smell and nuisance in MSW and is responsible for most environmental hazards associated with municipal waste management, such as the formation of polluting leachate and methane gas under anaerobic conditions. The problem of FW is a global issue nowadays and even the developed countries are concerned to find its appropriate management solution along with the MSW. The high amount of food waste generated is the main cause to most issues related to landfills such as foul odor, toxic leachate, emission of greenhouse gases and vermin infestation (Lee et al., 2007).

As spelled out in Vision 2020, the rise of solid waste disposal issues have become more challenging due to the increasing of population (Idris et al., 2004). In this context, countries such as Korea and Japan separate food waste from MSW due to food waste degradation, insufficient areas for landfills, problems with transportation of food waste to disposal sites and problems arising from landfill and incineration (Kim and Kim, 2010). MSW generated daily in Malaysia range from 0.8 to 0.9 kg per household in general and about 1.62 kg per household in densely populated cities such as Kuala Lumpur with food waste constituting approximately 60% of the total solid waste (Saeed et al., 2009; Kathrivale et al., 2003). Improper management of these MSWs can cause large scale contamination of soil, water and air, is a significant contributor to greenhouse gas emissions and allow huge potential economic values uncaptured. Therefore, in this work is trying its best to turn food waste into a biomass.

In this context, biomass is an important energy source to create a more sustainable society and it is expected to be an important energy source in the upcoming years as it is widely available and considered to be carbon neutral, at which the net carbon emissions resulting from the burning of biomass is zero. This is because the carbon emitted when plants are burned is equal to that absorbed during growing, so it seems self-evident that biomass is a zero carbon or carbon neutral fuel (Grant et al., 2010). However, FW is usually characterized by its high moisture content, low higher heating value (HHV), low energy density levels compared to fossil fuels, produce a lot of smokes during combustion and transport difficulties. So, it is clearly shown that food waste needs to be pre-treated to improve its quality and to allow an efficient energy conversion. In this work, a treatment on biomass by using temperatures ranging from 280°C to 320°C under an inert atmosphere is expected to be effective in improving the energy density and shelf life of biomass. This treatment is called as “torrefaction”.

1.2 Motivation

There is an abundant amount of food waste which can be utilized as an energy source rather than being left as waste. Moreover, the current research in biomass is growing involving the addition or utilization of organic waste in biofuel industry.

1.3 Problem Statement

High amount of FW generated is the main cause to most issues related to landfills such as foul odor, toxic leachate, emission of greenhouse gases and vermin infestation (Lee et al., 2007). Improper management of these MSWs can cause large scale contamination of soil, water and air which is a significant contributor to greenhouse gas emissions.

Nowadays, biomass has gained significant interest due to uncertainty of remaining resources and its positive effect on the environment. Biomass is the only source of renewable carbon which is an important element for production of chemicals and materials. MSW generated daily in Malaysia range from 0.8 to 0.9 kg per household in general and about 1.62 kg per household in densely populated cities such as Kuala Lumpur with food waste constituting approximately 60% of the total solid waste (Saeed, et al. 2009; Kathrivale, et al.2003). These amount of food waste can be utilized as an energy source rather than being left as waste at landfill and allow huge potential economic values uncaptured. Although FW is available in large quantities, but it possesses characteristics that make its utilization complex and expensive. For example, it has high moisture content, susceptibility to microbial degradation, low energy density, high oxygen content and heterogeneity (Uemura et al., 2011). In order to address these problems, torrefaction of FW can produce an energy dense and consistent quality of solid biomass, known as biochar for combustion and co-firing applications besides it helps to save the cost in terms of feedstock storage and transportation.

Torrefaction is a pre-treatment process, carried out in a temperature range between 200°C to 320°C under an inert atmosphere which aims to improve biomass properties. There have been several studies on torrefaction of different types of woody biomasses such as agricultural residues and herbaceous energy crops include pine sawdust (Gong et al., 2016), forest residues (Bach et al., 2016), tomato peels (Toscano et al., 2015) and corn stover (Kaliyan et al., 2014). Nevertheless, torrefaction of FW has not been sufficiently studied until now. Hence, it is important to experimentally study on torrefaction of FW to evaluate the characterization of its properties before and after torrefaction process.