CHAPTER 1

Introduction

1.1 Historical background

Nowadays, energy situation in Thailand has been increased during the years of 2011 – 2015. Energy consumption in 2015 is 1.12 percent higher the energy usage in 2011. However, there are limited of energy sources in Thailand. So, it is need to import more energies from foreign country. The import energies are natural gas, coal and electricity. These energies are imported up to 1.23 percent from the year of 2011 (EPPO, 2016). Then, the Ministry of Energy of Thailand has proposed the "10 years Alternative Energy Development Plan: AEDP 2012-2021". The plan promotes that renewable energy must be used up to 25% within 2014. The target of electricity produced from renewable energy is 5,608 MW. Electricity and thermal energies which are produced by fossil fuel may be substituted by those of renewable energy. Moreover, renewable energy can also be utilized in transportation, industrial and household sectors.

Waste that must be dispose, i.e., solid waste, agriculture waste and industrial waste, has been increased. The pollution control department of Thailand reported that solid waste in Thailand is 41,410 ton/ day in 2009 and it is increased to 43,800 ton/ day in 2011. Therefore, solid waste is needed to have properly management at present, there are three types of solid waste disposal for local government: 35% of sanitary landfill, 64% of open dumping with burning and 1% of incineration. Sanitary landfill cannot dispose solid waste in time because of several problems, i.e., the increasing of solid waste amount, lack of landfill, completely of solid waste management problems, etc. Solid waste burning is the most used method. It can reduce the amount of waste. In addition, it can disinfect which contaminate with the waste. This method produces an environmental effect to air and water. Moreover, it has ash which is residue after burning. There are four types of waste to energy technologies including direct use,

Refuse Derived Fuel (RDF), gaseous fuel transformation (gasification), and liquid phase transformation (pyrolysis).

In Thailand, there are a number of agriculture wastes which cannot be managed and are increased every year. For example, the wastes such as sugarcane, rice, soybeans, corn, palm oil, cassava, coconut and rubber trees are 4397 billion ton in 2008. While in 2012, they are increased to 4521 billion ton (EPPO, 2016). In order to dispose these wastes, the farmers burns them in the field. The burning method is easy and uses less time to disposal, but it makes pollutions including air pollution and loss of mineral and water in soil. Thailand's governments realizes and suggest to reduce agriculture waste burning. These wastes can be used as fertilizer. It can reduce the destroying of ground soil, cost of production and air pollution. However, most of farmer select the method of burning which is more comfort and less time to disposal.

The calorific heat values of agriculture waste, or biomass, and plastic waste are 15 – 20 MJ/kg and 20-50 MJ/kg (Ayhan, 1997; Li, Liu, & Zhang, 2001; *Thailand Energy Statistics (preliminary)*, 2012), respectively. Using RDF technology is an alternative method to disposal of solid waste including plastic waste and agriculture waste. And, RDF can be transforms to fuel energy. The composition of plastic waste is sulfur or chlorine which produces air pollution gas which are HCl, SOx. Physical properties (such as calorific heating value) and chemical properties (such as air pollution gas) can be improved by mixing and compressing plastic and biomass into pellet, bale, cubic or briquette and others. The compaction into several forms is called Refused Derived Fuel: RDF. It is used as other commercial fuel since its calorific heating value is nearly commercial fuel (such as coal, natural gas). A type of RDF that is easy to keep, transportation, usability, and low emissions is RDF-5.

Waste fuel technology or RDF technology has been studied continuously in order to improve the quality of waste fuel, such as strength, durability, calorific heating value and low pollution emission. There are the study of fuel improving from literatures for binder selection, material production, equipment selecting, and production factors (such as temperature, pressure and moisture content). European country attempts to produce briquette fuel as recommended by European standard (Thek, 2010). Following the

standard, for example, RDF should has a typical calorific heating value 16.0 – 19.0 MJ/kg, chlorine content of 0.02 – 0.03% and moisture content of not more than 10%.

Solidification is a process that combines any material into solid form by compression. During compression process, binding agents either natural binding or chemical binding are necessary for material adhesion. Natural binding agents are starch, protein, fiber, fat, lignin and extractives which are in monoculture crop, such as corn and switch grass (native grass). These binding agents can improve the strength and durability of briquette fuel (Chang, Chang, & Chen, 1997). Coal briquette is strengthen by binding agents which are molasses, organic waste (fat and fiber), tar, starch, waste paper milled, and others. Binding agents also reduce sulfur and ash quantity (Velis, Longhurst, Drew, Smith, & Polland, 2010). The chemical binding agents are calcium compounds including to CaO, $Ca(OH)_2$ and CaO.MgO. These agents can reduce the HCl which is released to the exhaust gas after burning.

Several studies from literature of Chapter 2 found that the important things for RDF technology are improving of quality, composition, chemical property, mechanical property, calorific heating value, environmental effecting, and commercial ability of waste fuel. They also studied biomass compaction from agriculture waste such as briquette fuel from coal and biomass, briquette fuel from wood-plastic and paper with and without binding agent, and briquette fuel from biomass and paper. Then, it is an advantage to study the improvement of pellet fuel from mixed plastic waste and corn stover. This is because plastic waste has high calorific heating value and corn stover is monoculture crop which is natural binding agent for solidification improvement. Using natural binding agents which is a composition of corn stover can improve pellet's quality such as calorific heating value, size, density and mechanical strength. It is hoped that the mixed plastic waste and corn stover pellization can be used as an alternative fuel in the future.

1.2 Objectives of this study

The objectives of this research are:

(1) Study the factors which affect to pelletization of mixed plastic waste and corn stover.

(2) To find constitutive model from the pelletization of mixed plastic waste and corn stover.

(3) To create the mathematic model and compare with the experiment result of pelletization of mixed plastic waste and corn stover.

1.3 Reference

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