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Municipal Plastic Waste Composition Study at Transfer Station of Bangkok and Possibility of its Energy Recovery by Pyrolysis

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Abstract

The pyrolysis of waste plastic was performed based on the characterization of municipal plastic waste (MPW) from one of Bangkok city's waste transfer station. Results showed that heating value of oil product (49, 47, 43, and 42 MJ/kg, from LDPE, mixture of HDPE and LDPE, PP and HDPE, respectively) was significantly higher than that of the raw plastic waste. Yield of the oil product from the pyrolysis of LDPE was highest (60%). Energy recovery from plastic via pyrolysis was 75%, 59%, 50%, and 49% for LDPE, mixture of HDPE and LDPE, PP, and HDPE, respectively. Results from GC-MS of pyrolysis oil showed that different raw materials produced very different sets of chemical compounds, with alkanes and alkenes found in the pyrolysis oil.

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Keywords: Municipal plastic waste; HDPE; LDPE; pyrolysis; energy recovery.

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1. Introduction

Municipal plastic waste (MPW) has a considerable share in the composition of Municipal solid waste (MSW) in both developed and developing countries as shown in Fig. 1 [1-5]. The plastic waste in developed nation would undergo well-established material recycling processes. For example, Japan has a great reputation in waste management system including source separation practice as well as reutilization of plastic waste such as bottle and packaging [6]. On the other hand, this behavior was not adopted in developing countries. Thus, plastic material that would have some values in term of material recycling and energy recovery was available at the transfer station and final disposal site. Without source separation practice, plastic waste at the site would be contaminated and difficult for material recycling. Therefore, energy recovery from plastic could be applied to bring back the value of the material left for disposal.

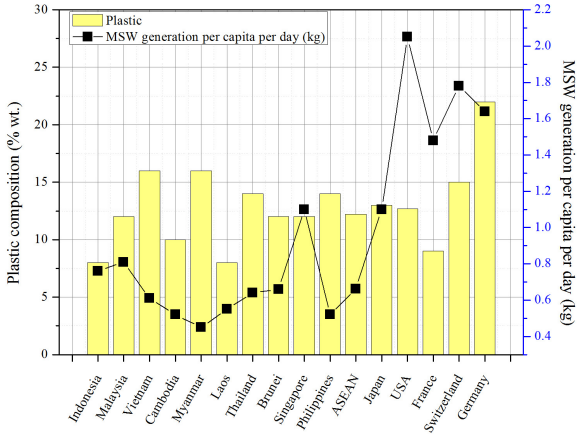

Fig. 1. Share of plastic waste in municipal solid waste of several countries with its waste generation per capita per day [1-5].

Incineration could recover energy from plastic waste by producing high pressure and temperature steam for power generation via steam turbine generator. However, it would need large amount of daily waste as well as a huge capital investment for construction work. This would not be feasible for small city, especially in developing countries where funding is tremendously difficult and public acceptance on incineration is poor. Thus, nowadays, pyrolysis technology gained a lot of attentions since it could convert plastic waste into oil that could be used as crude oil for further upgrading, distillation, or directly utilized with other conventional fossil fuels. This technology is adaptable at a community scale and requires significantly lower amount of budget compared to the incineration.

This paper focused on municipal plastic waste (MPW) composition at transfer station and energy recovery by pyrolysis. Firstly, composition study of MPW was performed at the transfer station so that the appropriate type of plastic could be chosen for the pyrolysis test. After obtaining the sample from the transfer station, pyrolysis of several types of MPW was done. The product oil was subjected to heating value analysis and analyzed by GC-MS. Product distribution was calculated to finally obtain energy recovery rate from the pyrolysis of plastic waste.

2. Material and methods

2.1. Sampling of municipal plastic waste

Sampling of municipal plastic waste (MPW) was done at the Nongkhaem transfer station in Bangkok, Thailand. Sampling sources was bulk municipal solid waste (MSW) from the day-to-day unloaded waste truck. The sampling process was done in both weekday and weekend to reduce the effect of consumption behavior. The classification of plastic type was performed according to the Resin Identification Code (RIC) system designed for material recycling and recovery by the Society of the Plastics Industry, namely, (1) Polyethylene terephthalate (PET), (2) High-density