P-7

Liquefaction of waste plastics by pyrolysis reactor of horizontal small batch plant

Zar Zar HLAING[1], Mariko ADACHI[1], Shin SUZUKI[1], and Hideki NAKAGOME[1]
Shoji KODAMA[2] and Masanobu KOBAYASHI[2]
Chiba University[1], Altis Co. Ltd[2]

Waste plastic mainly consists of polyethylene (PE), polypropylene (PP) and polystyrene (PS) with different polymer structure. Thus, recycling of waste plastic is highly encouraged. In this study, thermal decomposition of waste plastics including polyethylene (PE), polypropylene (PP), polystyrene (PS) was made using a designed batch plant that is an external heat type thermal decomposition batch type furnace capable of processing 500kg of waste plastic a day. The oil product yield of three kinds of waste plastics by thermal decomposition was compared and the trend of the recovery rate was analysed and function of lapse time of reaction.

Key Words: DTG analysis, liquefaction, (PE), (PP), (PS), thermal decomposition, fuel

1.Introduction

Transition to plastic materials from metals to reduce weight and economy is now one of the important strategies in many industries. Plastics are manufactured from petroleum reserves to higher energy, chemical energy conversion to include an option for waste plastic processing techniques. The mixed waste is particularly difficult to separate in practice, the use of suitable materials useful as the current shift to energy in a relatively simple compounds.This study is aimed at studying the influence of lapse time of reaction on formation rate product obtained from pyrolysis of waste plastic mixtures containing various plastic types at different temperatures, using a designed batch plant. Here, the characteristics of the liquid product are described by cumulative amount distribution, as a function of lapse time of reaction. After the reaction, the resulting oil recovery rates for various conditions were examined.

2.Experimental

2.1 Samples

The samples employed were PE, PP, PS and their mixtures. PE, PS and PP were pallet. The mixed plastic was actual waste plastic from food packaging and industrial waste such as films, packs, etc.

2.2 Experimental method

The process of oil recovery from waste plastic is shown in Figure 1. This small-sized waste plastic liquefaction plant is manufactured by MAEDA Seisakusho Co., Ltd. It is an external heat type batch type furnace and capable of processing 500kg of waste plastic a day. The sample is heated and decomposed in this device, separating into liquid product, the residue and gas. DTG(60) analysis is manufactured by SHIMADZU.

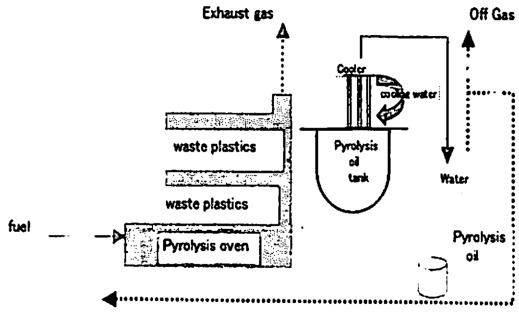

Fig. 1 The small-sized waste plastic liquefaction plant

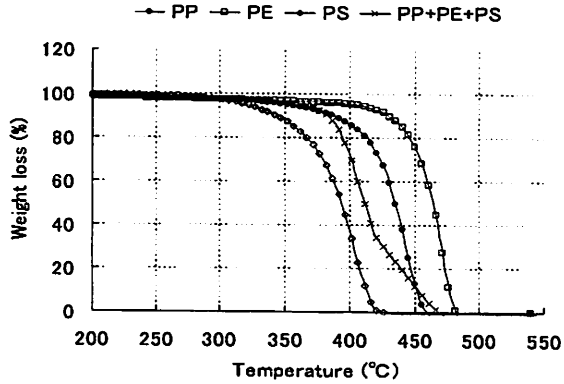

Fig. 2 TGA curves of Pellet plastics at a heating rate of 5 ℃/min under nitrogen stream.

3. Result and discussion

3.1 DTG (60) -analysis

The DTG curves of each polymer in general waste plastics show a similar behavior in a single step, but at different temperature ranges during thermal decomposition under the same analytical conditions. Shown Figure (2) PS degraded within a temperature range of 320- 425 ° C, while PP and PE degraded at higher temperatures of 380- 460 ° C and 400- 480 ° C, respectively. But, mixed cases degraded within a temperature range of 365- 470 ° C. The degradation temperatures at which the weight loss amounts to 50% were about 380° C for PS, 420 ° C for PP , 470 ° C for PE and 420 ° C for (PP+PS+PE) . Thus, the order of degradation temperature of waste thermoplastic by type of plastic was PS < PP < PP+PE+PS < PE. From these results, it can be expected that plastic mixtures of different compositions will result in different product characteristics. The mixed polymer pyrolysis at low temperature is relatively higher polymer decomposition temperature, the influence of the polymer from degrading towards lower temperatures, starting the decomposition temperature lower than distillate of monovalent.

3.2 The effect of 3P single &2P,3P mixed plastic

Figure 3 shows a graph of product yield of the three single material separately. In case of PP,PS and PE after thermal decomposition, more than 90% was collected as the liquid product. The liquid product of PP,PS,PE were 93%,94% and 95%. Figure (4,5) shows the product yield of 2P and 3P mixed.

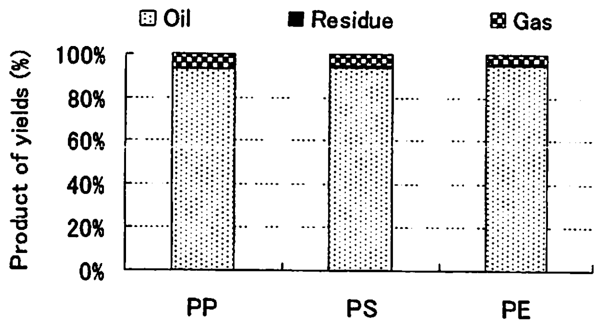

Fig. 3 The effect of 3P single unit of product of yield

In case of M-4 (PP: PS 6:4), M-5 (PE: PP 8:2), M-6 (PE: PS 4:6) and is the result of two thermal decomposition of mixed plastics. When calculated values are compared to the observed value, the additive rule relatively applies, although the residue increased and the liquid product decreased a little. However, for mixed waste plastic pyrolysis is lower than the measured value calculated either. In case of M-4 (PP: PS 6:4) and M-6 (PE: PS 4:6) the liquid product was 77% but M-6 residue is more than the M-4 and then the liquid product of M-5 of observed value was 82%.

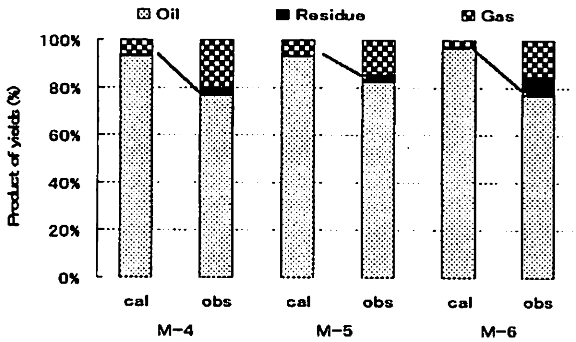

Fig. 4 The effect of 2P mixed of products yield

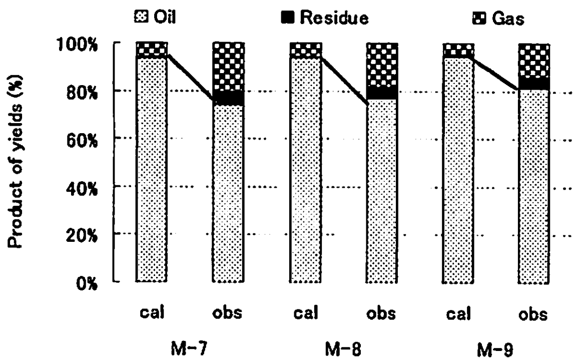

Fig. 5 The effect of 3P mixture on products yield

There is the similar trend in the experiment of mixtures of three plastics. However, in M-7 (PE:PP:PS 2:5:3) M-8(PE:PP:PS 3:4:4) and M-9(PE:PP:PS 7:2:1), the residue increased but the gas is half the calculated value and the liquid decreased. However, M-7 and M-8 is compared with the calculated value, the liquid product was 74% and 77 % and M-9 was 81%.As the whole, a liquid yield is lower than a calculated value, and the observed value has much residue. It is possible that the yield of the pure plastics used for the calculated value is too high as a reason. It is necessary to verify the difference between the reaction conditions at this time, and the reaction conditions of other experiments. Moreover, the product yield was found to be different depending on the type and proportion of mixed plastics. Let it be a future subject to carry out comparison examination of the reaction conditions experiments.

3.3 In the reactor of temperature& lapse time

Figure 6 and 7 show that to carry out comparison examination of the reaction conditions experiments. The reaction conditions of each experiment will be verified. It will search for the reaction conditions for the improvement in a liquid yield. When the reaction time is long at 400℃~499℃, the liquid yield is high and long at 500℃~599℃, the liquid yield is low.[1,2]

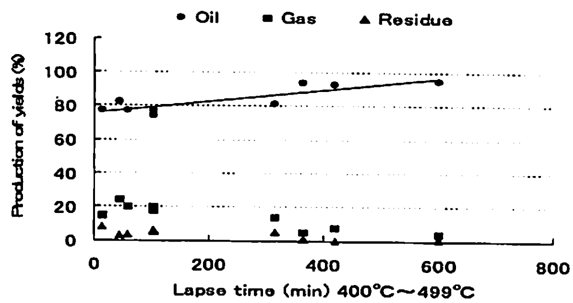

Fig. 6 In the reactor of temperature& lapse time 400~499℃

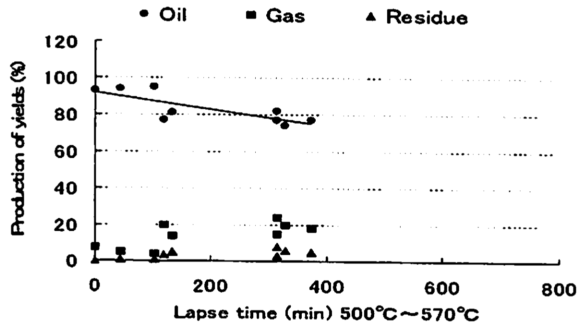

Fig. 7 In the reactor of temperature& lapse time 500~570℃

4. Conclusion

From DTG results, it can be expected that plastic mixtures of different compositions will result in different product characteristics. The product of yield is depending on the type of ingredients, mixing ratio, decomposition temperature, temperature control, lapse time .In the apparatus, if the atmosphere temperature in the reactor exceeds 500℃,the liquid yield will be low and there is a tendency which gas production increases. Therefore, it turned out that it is desirable to operate under 500℃. In the future work is the community to spread the technology more oil.

5.Refenence

(1) The14th National Symposium on power and Energy Systems (SPES 2009) F-214 ,P501-502

(2) The 5th International Symposium on Feedstock and Mechanical Recycling of Polymeric Materials (2009), P 52-57