1-13 Feasibility studies for the Feedstock Recycling of Automobile Shredder Residue (ASR)

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INTRODUCTION

Waste from automotive industry, particularly from end of life vehicles (ELV) has been identified as a priority waste stream. At the end of life, and after dismantling larger parts suitable for mechanical/material recycling, the remainder of the vehicle is shredded. After removal of the ferrous metal fraction, the remaining residue is known as Automotive Shredder Residue (ASR), a mixture of many different materials. Presently, the most of the waste plastic from the automotive industry are land filled, which is not desirable due to environmental problems and difficult to find suitable place. Feedstock recycling is a process, which breaks down polymers into petrochemical feedstock components from which they originate. In present investigation, we report the feedstock recycling method for bumpers, which is the heavy plastic portion in car in addition to the selected waste plastics such as PA6 (polyamide), MG53 (might be polyacetal) PC/PET (polycarbonate/polyethylene terephthalate) and industrial plastic waste such as polypropylene (PP).

EXPERIMENTAL

The five samples WB (Waste Bumper, Black in colour), PC/PET (polycarbonate with polyethylene terephthalate, white in colour), MG53 (black in colour), PA6 (Polyamide, white in colour), and industrial waste PP (grey in colour) were obtained from the ATOM Co. Ltd., Kurashiki, Japan. The thermal degradation of the above five types of waste automobile plastic samples was performed in a. glass reactor as shown Figure 1. Approximately, 10 g of plastic sample was loaded into the reactor. The nitrogen gas at a flow rate of 30 mL/min was used and held at 120^{0}C for 60 min to remove the physically adsorbed water from the plastic sample. The reactor temperature was increased to the degradation temperature (430^{0}C) at a heating rate of 3^{0}C/min. The analysis of degradation products was performed with

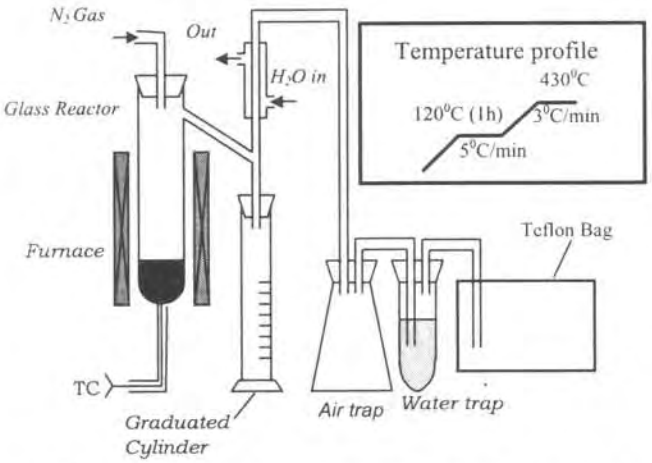

Figure 1: Schematic experimental setup for pyrolysis of automobile shredder residue (ASR)

gas chromatographs equipped with FID, AED, TCD and MSD.

RESULTS AND DISCUSSION

The pyrolysis of waste bumpers and other automobile plastic waste such as PP, PA6, PC/PET, and MG53 was performed under atmospheric pressure by batch operation process at 430^{0}C and the results are explained in the following sections.

Polypropylene (PP): The pyrolysis at 430^{0}C yield the liquid products about 70 wt%, gaseous products 16.6 wt% and residue was about 13 wt%. The average carbon number (Cnp) of liquid shows that 11.8 (Figure 2) and the density is 0.738 g/cc.

Polyamide (PA6): The pyrolysis of polyamide yielded the liquid products about 45 wt%, which are 25 wt% less than the PP. However, the gaseous products were less than 10 wt% and the residue is about 45 wt%. It might be due to the presence of various inorganic materials and some metals. The X-ray diffraction analysis of solid residue shows the presence of highly crystalline inorganic materials. The details of these

composition and source of the automobile waste was not provided from the sample supplier. We are not aware of the composition of inorganic material. However, the complete investigation about the detailed composition is in progress.

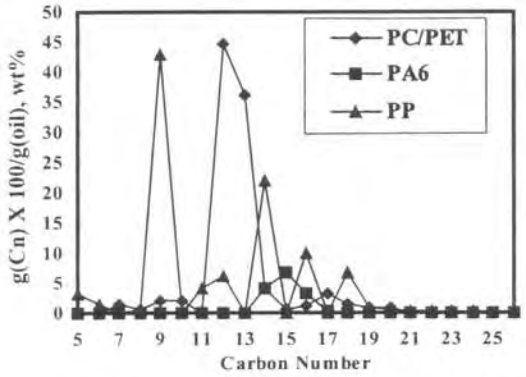

Figure 2: C-NP gram of liquid products obtained from PC/PET, PA6 and PP waste plastics at 430^{0}C

Polycarbonate/ polyethylene terephthalate (PC/PET): The pyrolysis of PC/PET yielded the less liquid products (26 wt%) than the other automobile waste plastics studied in this investigation. However, the GC/AED shows the formation of various oxygenated compounds n the liquid products.

MG53 : The pyrolysis of MG53 has not produced any liquid products. However, it produced the crystalline (white) compound. The GC/MS analysis and O-NP gram showed that the major compound is the butylated hydroxy toluene and the same compound also was observed in the PA6 degradation liquid products. The compound could not dissolve completely in organic solvents such as acetone, and tetrahydrofuran, etc.,

Waste bumpers: The pyrolysis of waste bumpers has been carried out at various temperatures such as 410, 430 and 450^{0}C using the experimental setup in Figure 1. It is well known from the automobile literature that the waste bumper is made up of polypropylene and also contained some inorganic additives. The gas chromatographic analysis shows that the carbon number of liquid products is in between the carbon numbers of gasoline and kerosene. However, we are not interested in the separation process, as it is not economical. The aim of this study is to send back to the oil refinery as a crude oil. The increase of pyrolysis temperature from 410 to 450^{0}C shows the negligible effect on the formation of liquid, gaseous and residue products. The C-NP gram of liquid products obtained at various pyrolysis temperatures was presented in Figure 3. The detailed analysis of pyrolysis products obtained at various temperatures and the applicability

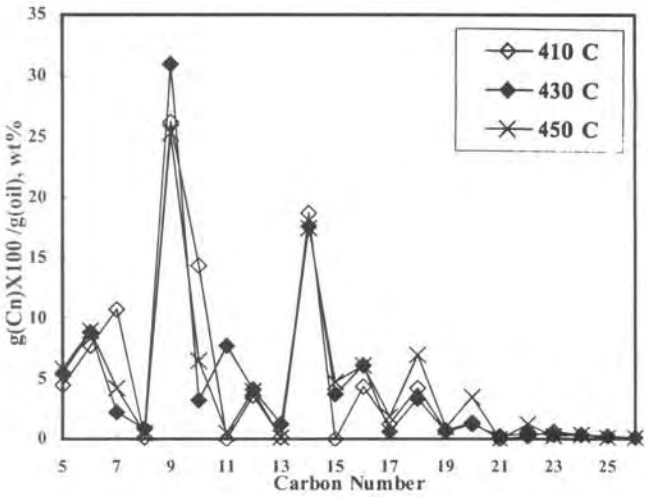

Figure 3: Effect of pyrolysis temperature on the C-NP gram of liquid products from WB

of residue as a solid fuel will be discussed during the presentation. Earlier, we have reported [1-2] on the liquefaction of real and model mixed waste plastics and the development of sorbents for the dechlorination.

CONCLUSIONS

The pyrolysis investigation on the several waste automobile waste plastics such as WB, PP, PA6, PC/PET shows that it is feasible to carryout the feedstock recycling and the liquid products can be sent back to refinery and the residue can be used as a solid fuel.

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