Combustion Properties of Polyethylene Added Iron Oxides

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The most of polyethylene (PE) waste in Japan is disposed by incineration. In such combustion, it has been well known that benzene is synthesized during the combustion of PE under the condition of insufficient O_2 concentration. The formation of benzene will possibly lead to the synthesis of dioxins via the occurrence of its precursors by chlorinating. The authors carried out the combustion experiments with PE and PE added iron oxide, goethite, in various contents, using the combustion apparatus of fixed bed semibatch type in a laboratory scale, and examined their combustion properties. The incineration tests of wastes contained in conventional PE refuse bags and PE refuse bags added 1wt% the iron oxide were also performed using the incinerator operating at Hiroshima University. As the results, it was confirmed that benzene was formed during combustion for PE, and was not formed for PE added iron oxide. Furthermore the suppression effect for dioxins formation in the case of using PE refuse bag added iron oxide was confirmed the results of the incineration tests. Based on the findings of this study, the authors design PE for environment benign products easily disposed by incineration.

Introduction

Although many studies with the thermal decomposition PE and other plastics[1,2,3,4] have been done, the most of the studies are focused on the production of oily hydrocarbons. Recently the formation of dioxins at the combustion of plastics is becoming a very serious problem for environmental pollution[5,6]. This study is composed of two kinds of combustion or incineration experiment, which are (I)the measurement of benzene formation at the combustion of PE and PE added iron oxide, using the combustion apparatus of fixed bed semibatch type in a laboratory scale[6] and (II)the measurement of dioxins formation at the incineration of the wastes contained in conventional PE refuse bags and PE refuse bags added 1wt% the iron oxide, using a commercial incinerator of batch type[7].

Materials and Methods

The PE used at experiment(I) is the lower density PE manufactured by Nippon Polychem.Co. (0.922g/cm^3). The properties of iron oxide, goethite used at both experiment(I) and experiment(II) are shown in Table 1. Fig.1 shows TEM picture

Table1 Properties of iron oxide

Molecular formula	α-FeO(OH)
Shape	Spindle
BET (m^2/g)	86.3
Moisture (%)	0.98
pH	8.1
Particle size (μm)	0.25

of the iron oxide. The PE refuse bags at experiment(Ⅱ) were the conventional type and special ones added 1wt% the iron oxide. Both experiments were carried out using the semibatch combustion apparatus of fixed bed in a laboratory scale and batch type incinerator operating at Hiroshima University, respectively.

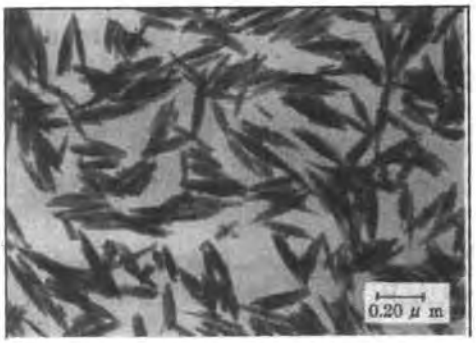
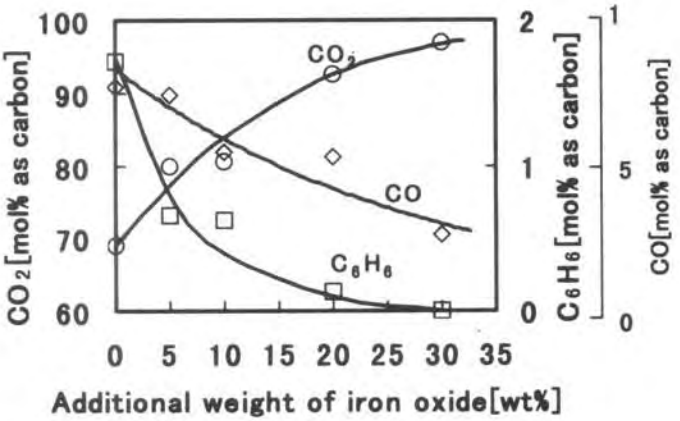


Fig.1 TEM picture of iron oxide

Results and Discussions

Fig.2 shows CO, CO_2 and C_6H_6 changes in exhausted gas at the combustion experiments of PE with additional weight of iron oxide. The quantity of benzene synthesized decreases by the increase of iron oxide quantity and CO_2 is increasing by the oxidation of CO based on the catalysis of the iron oxide[8].



(PE:2.5mmol as C_2H_2, 700℃ × 4min × $O_2$200ml/l)

Fig.1 Concentration change of CO,CO_2 and C_6H_6 in combustion gas with additional weight of iron oxide in PE

Table 2 shows the experimental results(Ⅱ) for the incineration of the wastes contained in conventional PE refuse bags and PE refuse bags added iron oxide at a batch type of commercial incinerator in Hiroshima University. While the dioxins concentration was 18～24ng-TEQ/Nm^3 for with use of the conventional PE bags, it decreased down to 3.2 ng-TEQ/Nm^3 in the case of using PE bags added iron oxide.

Table 2 Results of dioxins concentration at incineration experiments

Incineration of waste	Emission of dioxins
Contained in conventional PE refuse bags	18～24(ng-TEQ/Nm3)
Contained in PE refuse bag added iron oxide	3.2～14(ng-TEQ/Nm3)

Through experiments(Ⅰ) and (Ⅱ), it was confirmed that the PE added iron oxide can depress the benzene synthesis and dioxins formation at the combustion process.

Conclusions

The active iron oxide developed by the authors revealed notable catalytic functions for preventing benzene formation at PE combustion and dioxins formation at the incineration of waste contained PE refuse bags added the iron oxide.

Based on the findings of this study, the authors find their way successfully into practical applications for environment benign PE product goods such as refuse bags and shopping bags easily disposed by incineration.

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