Thermal Degradation of Mixed Plastics Containing Poly(vinyl chloride) by a Continuous Flow Stirred Tank Reactor

K. Murata*[1], Y. Hirano[2] and Y. Sakata[3]

[1]Japan Eco Environment Products, 1-1-18 Toranomon Minato-ku Tokyo 105-0001 Japan

[2]Mitsui Engineering & Shipbuilding Co., Ltd., 6-4 Tsukiji 5-chome Chuo-ku 104 Japan

[3]Faculty of Engineering, Okayama University, Okayama-CIty 700-8530 Japan

E-mail: muratakh@i-t-t.co.jp Fax: +81-3-3508-1734

Introduction

Thermal degradation of PVC containing Plastics was studied by using a continuous flow stirred tank reactor. In order to investigate the rate of thermal degradation and the chlorine balance of the products obtained by thermal degradation of PE containing 1wt% of PVC.

17.3-20.7% of the input Cl was recovered as the chlorine compound contained in liquid product, 0.9-1.6% in residue withdrawn from reactor bottom and the balance in gaseous product.

On the other hand, the total Cl content in the liquid product derived from PE/PVC1wt% was 1,100 ~1,300 ppm , of which ca.60% was organic chlorine compounds.

From AED-GC analysis, it was suggested that the organic chlorine compounds in liquid product were formed by the recombination of HCl gas and the olefins which were derived from thermal degradation of PE, in the gas phase of reactor.

Experimental

Fig.1 shows the experimental setup for thermal degradation of plastics.

PE (High –density polyethylene) containing PVC was fed into the reactor by using a extruder in the range of feed rate 0-1.5 kg/h. This reactor system can attain a steady state by the withdrawal of reactor content which contains the residual substance derived from PVC decomposition. The withdrawal rate of reactor content was fixed at 10% of feed rate of raw plastics throughout the experimenntal runs.

The analysis data of PE and PVC employed in this study are shown in Table 1.

Results and Discussion

Thermal degradation of a mixture of PE/PVC 1% was carried out at temperatures of 420,430,and 440 ℃, respectively.

Rate of thermal degradation(volatilization):

Fig.2 shows the rate of volatilization of PE/PVC1% as well as PE. The rate of

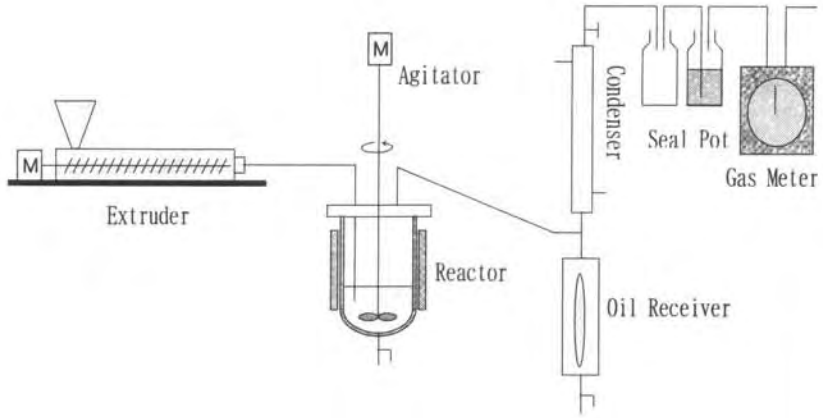

Fig.1 Experimental Setup

Table 1 Analysis Data of Plastics

Item	unit	PVC pellet	PE Pellet
Ash	wt%	0.20	0.04
Conradson Carbon	wt%	15.44	0.10
C	wt%	40.67	85.60
H	wt%	5.26	14.30
Cl	wt%	51.50	nil
O	wt%	2.37	nil
Higher Calorific Valu	cal/g	4990	11700

volatilization is defined by the following equation.

Rate of volatilization = production rate of (gas + liquid) / reactor content (1)

The rate of mixed plastics is slightly smaller than the rate of PE at lower degradation temperature.

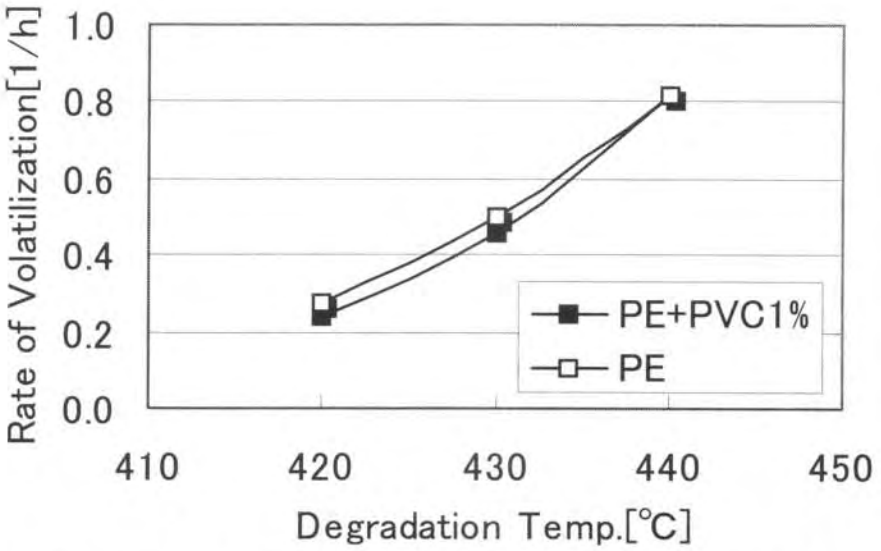

Fig. 2 Rate of Volatilization of PE/PVC1wt% and PE

Gaseous Product :

Fig. 3 shows the gaseous fraction in volatilized product of PE/PVC1wt% including HCl compared with PE. And carbon number distribution of gaseous product is shown in Fig.4.

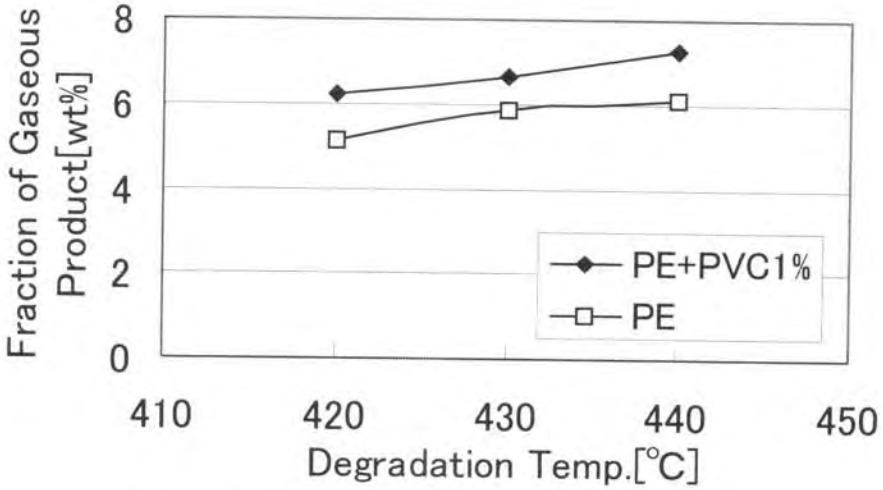

Fig.3 Fraction Yield of Gaseous Product

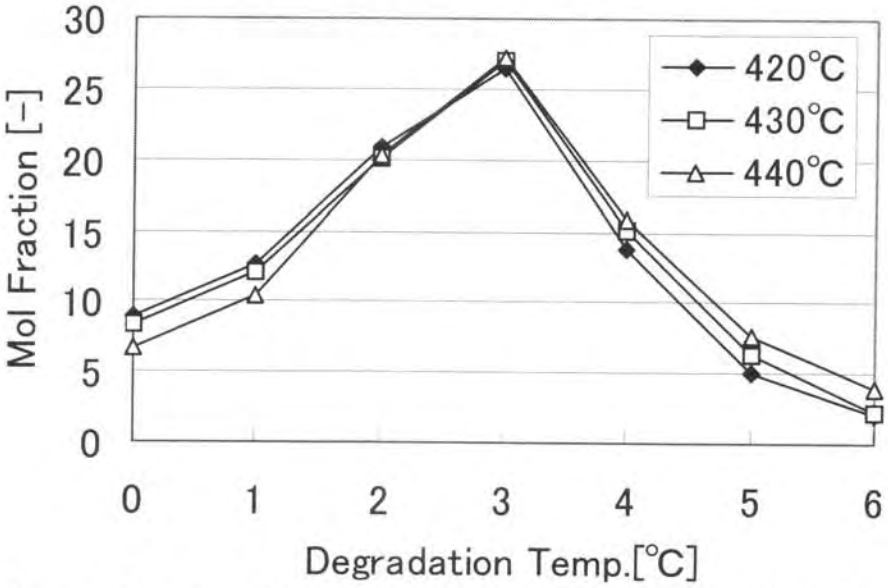

Fig.4 Carbon Number Distribution of Gaseous Products Excluding HCl

Liquid Product :

The carbon number distributions of the liquid products from PE/PVC1wt% are shown in Fig.5. The liquid products are distributed over wide range of carbon number (C4-C30), which is equivalent to boiling point ranges of 36 to 370℃.

Chlorine content:

Cl contents in liquid products and the boiling point distributions of organic chlorine compounds(Cl-Npgram) are shown in Fig.6 and Fig.7 ,respectivly.

From Fig.5,6 and 7, it could be concluded that the organic compound in liquid product is formed by recombination of HCl and olefin derived from PE decomposition.

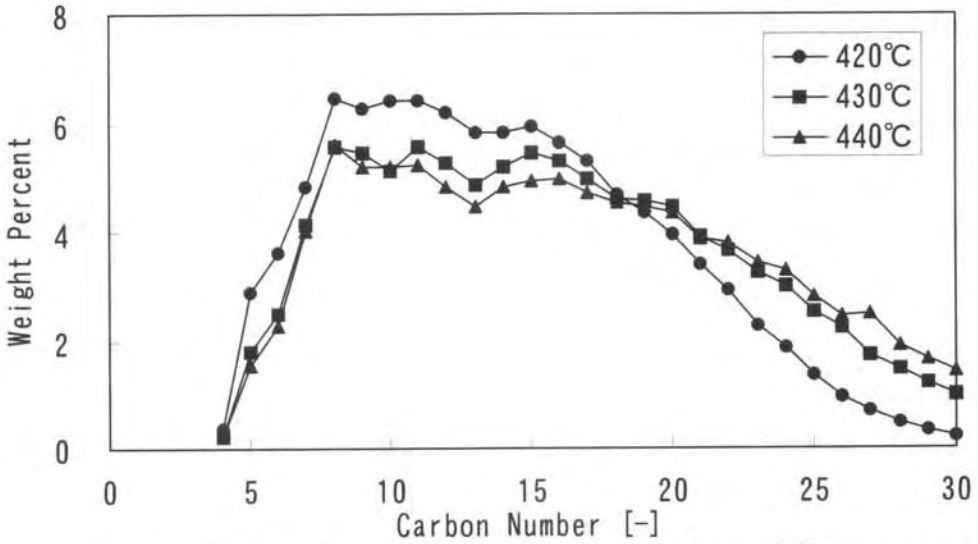

Fig.5 Carbon Number Distributions of Liquid Products

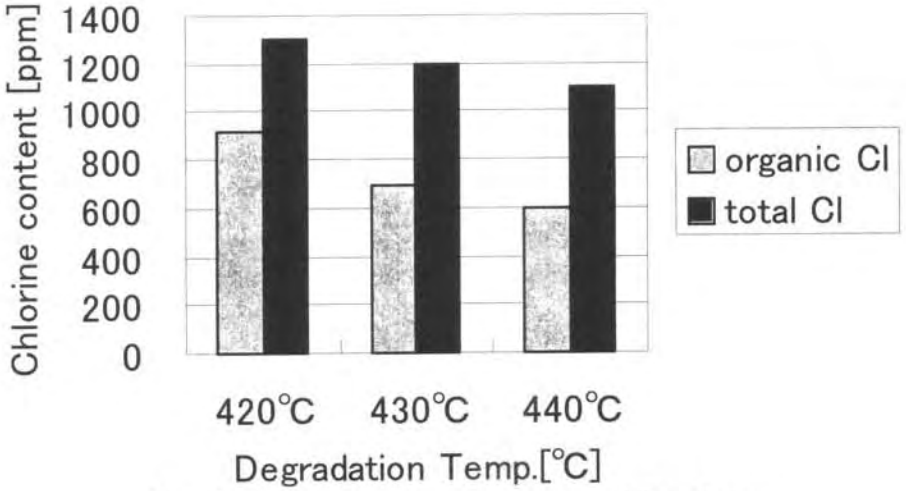

Fig.6 Chlorine Content in Liquid Product

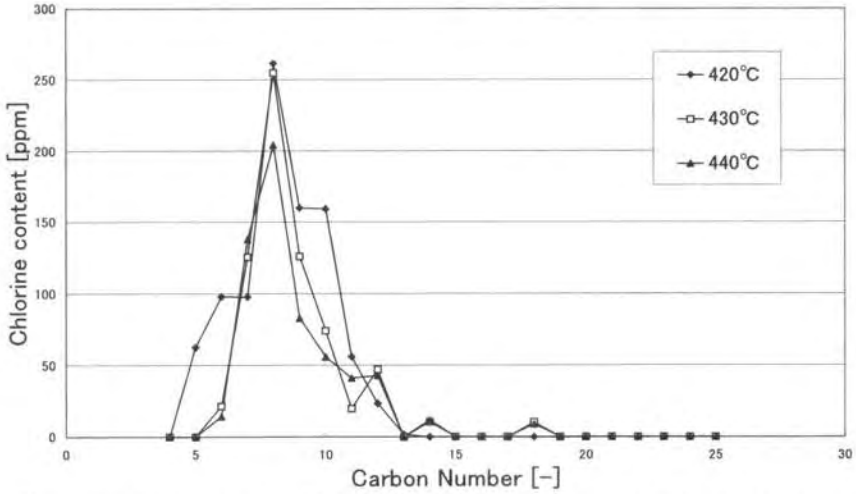

Fig.7 Distribution of Organic Chlorine Compound in Liquid Product (Cl-NPgram)

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