

Dechlorination of Mixed Plastics Containing PVC by a Circulating Degradative Extrusion Process

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The special type of extrusion process for mixed plastics containing polyvinylchloride (PVC) was examined. This process is characterized by the following process in which some amount of molten dechlorinated plastic from the tail of the extruder is returned back to the head in order to prevent corrosion, and the remainder is evacuated as a product. The degradation of plastic mixtures in which 3-20% of PVC was compounded to polyethylene (PE) or mixtures of PE, polystyrene (PS), and polypropylene (PP) were carried out under various conditions. Since plastic was introduced directly into the molten plastic with this process, a high degradation rate of the fed plastic was expected. The results indicate that more than 95% PVC was dechlorinated regardless of PVC content, and the PVC mixed plastics of PE, PS, and PP had higher dechlorination ratio than binary systems of PE and PVC. Raising the decomposition temperature also decreased the chlorine content in the plastic after extrusion.

Introduction

Recently, pyrolysis to petrochemical feedstock, RDF, and reduction in blast furnaces have received much attention in view of recycling techniques of waste plastic. PVC content in waste plastic as a contaminant is known to cause deterioration. Therefore, dechlorination of refused plastic is required. Some dechlorination processes using an extruder from a recycling point of view have been performed.[1,2] In this report, a unique degradative extrusion process with a throughput of 10 kg/hr for several types of mixed plastics containing PVC was examined.

Materials and Methods

Experimental Plant. For the experiments, the circulating extrusion process was employed (Fig.1). The extruder has a counter-rotating twin-screw system. Mixed plastics are fed into the head from the feed hopper and degradation occurs *via* exposure to the thermal work of molten plastic in the extruder heated with the hot oil jacket. A certain amount of molten dechlorinated plastic from the tail of the extruder is circulated back to the head in order

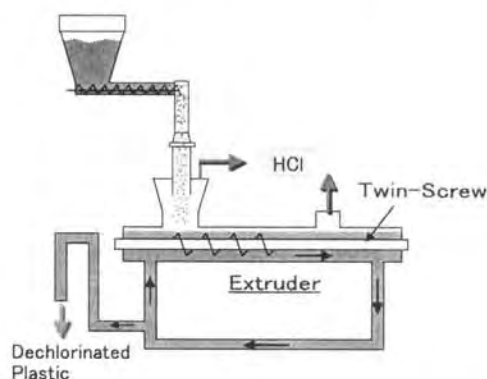


Figure 1 The circulating degradative extruder

to prevent corrosion of the extruder. The remainder is discharged as a product.

Materials and Conditions. Commercial PVC pellets consisting 94.2wt% of PVC were blended with other commercial pellets such as low-density PE, PE/PS mixture (66wt%PE, 34wt%PS), and PE/PP/PS mixture (50wt%PE, 33wt%PP, 17wt%PS). They were introduced respectively to the extruder at 6.6kg/hr in PE volume. The temperature of the heating oil was set at 330 or 340 °C. Rotational speeds of the screws were 60, 90, and 125 rpm.

Experimental. At first, PE was fed by rotating the screws and circulated. After outpouring the molten plastic, reaction temperature was raised to the appropriate level, the blended sample was fed.

Analysis. The dechlorinated plastics were pulverized in liquid N₂ and the powder was subjected to combustion analysis after drying for 3h at 90°C according to JIS-K2541 procedure. The chlorine content in the solution that had absorbed combustion gasses was determined by means of ion chromatography. We defined that chlorine content in the solution derived from organic chloride as organic chloride content in dechlorinated plastic.

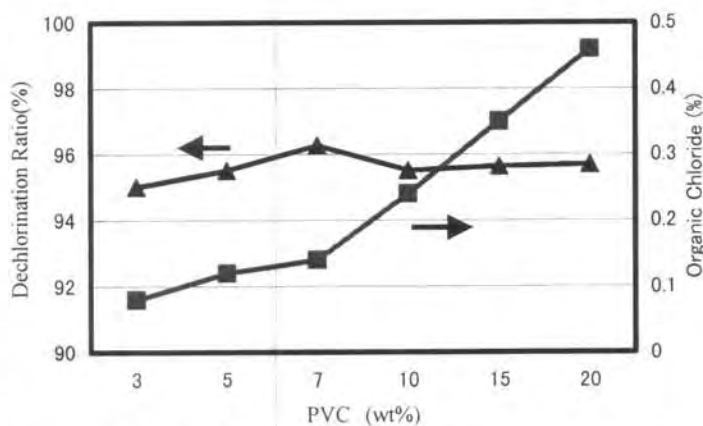


Figure 2 Ratio of dechlorination and content of organochlorine materials in dechlorinated plastic

Results and Discussions

Effect of PCV content. Fig.2 shows the variations of average dechlorination ratio and average residual organic chloride content. The result that more than a 95% degradation ratio of PVC was obtained regardless of PVC content indicates that PVC may be dechlorinated almost quantitatively in this process. The amounts of residual organic chloride increased in proportion to the PVC content in mixed plastic. This may be due to unreacted PVC or alternative organic compounds that were

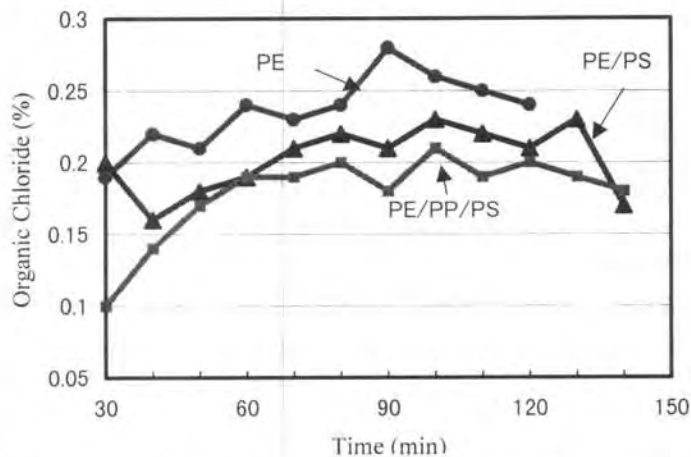


Figure 3 Effect of coexistent plastics for dechlorination

generated by reactions of chlorine radicals with additives in plastic or their degradation products. Organic chlorides such as chlorobenzene derivatives and alkyl chlorides were found and identified in the dechlorinated residues.

Effect of Coexistent Plastics. The effect of coexistent plastics for dechlorination other than PVC was investigated. The results are shown in Fig.3. The residual organic chloride content of dechlorinated binary systems of PE and PVC mixture were higher than those of PE/PS or PE/PP/PS and PVC mixtures. Those results indicate that there is some prominent effect of coexisting mixed plastics. This effect may be caused by radicals generated by decomposition of PS. Though it is reported that radical intermediates from the radical decomposition of PS and PVC stabilize in each other [3], the rapid degradation of PS by exposing fed plastic mixture to thermal work of molten plastic may accelerate degradation of PVC and decrease the residual chlorine content.

Effect of Temperature. The effect of temperature on dechlorination of PVC-PE/PP/PS mixture is shown in Fig.4. As can be seen in Fig.4, higher temperature evidently promotes dechlorination because amount of residual chloride decreased as the temperature increased.

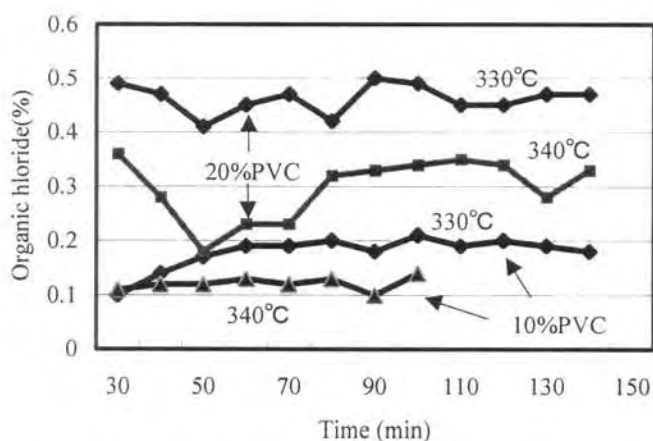


Figure 4 Effect of temperature on dechlorination of plastics blended with PVC

Conclusions

The dechlorination of plastic blended with PVC is considered to occur very rapidly in this process owing to the fact that when plastic was introduced directly into the molten plastic, its temperature rose at a substantial rate. More than a 95% dechlorination ratio was obtained regardless of PVC content in the fed plastics. Multicomponent systems like PVC mixtures with PE, PP, and PS had higher dechlorination rates than binary systems of PE and PVC. Raising the decomposition temperature also improved dechlorination in this extrusion system.

References

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