DE-CHLORINATION PROCESS DEVELOPMENT FOR THE PURPOSES OF BOTH MATERIAL AND THERMAL RECYCLING OF MUNICIPAL VINYL WASTE

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Abstract

In Korea, waste plastics including waste vinyl are the items of EPR(Expanded Producer Responsibility). Due to the high oil price, the waste plastics with bottle shape have been sold and recycled as high price. But the waste vinyl is difficult to recycle because of dirt and mixed other material such as papers and aluminum etc. In the course of recycling, PVC component can be inevitably included and make unfavorable products with high chlorine content. For the effective recycling of waste vinyl, the twin screw system with heat medium heating was used and is useful for the de-chlorination. Optimum temperature range for the de-chlorination was 310-350ºC. After the de-chlorination of waste vinyl, the melted samples were obtained and chipped for the analysis of chlorine and tensile strength. On the basis of chlorine concentration, the content of 1.4% of original sample was decreased up to 0.6%. The tensile strength of 5.2 MPa of original sample was increased up to 9.3 MPa.

Keywords: *De-chlorination, PVC, Twin Screw, Tensile Strength, Waste Vinyl*

1. Introduction

In Korea, the production amount of waste plastics in 2009 was 4.5 million tons. But the recycling ratio was low as less than 50%. Most of waste plastics discharged as a type of bottle have been easily recycled and can be used through the physical treatment of chipping and drying for the preparation of recycling products as an alternative of new polymer plastics.

On the other hand, the waste vinyl may be difficult for the effective recycling because of dirt and mixed other material. For the material recycling and thermal recycling by using waste vinyl, the melting process by heating may be necessary.

In the course of melting as about 250℃, the component of PVC can be decomposed and remained as micro-bubbles which can decreased the physical properties such as the tensile strength when the melted waste vinyl is used for the recycling products.

Also high content of the remained chlorine in the melted waste vinyl is limited for the use of refuse plastic fuel (RPF).

In Korea, according to the chlorine concentration in RPF the grade is classified to 4 levels. For the first level of RPF, the chlorine concentration should be less than 0.5%. Generally the chlorine concentration in waste vinyl is about 1.0-2.0%.

Without the de-chlorination from waste vinyl, it is difficult to use as RPF or the raw material with good quality for recycling products.

In this study, the waste vinyl of municipal waste was used as feed material for the de-chlorination experiment. The process with the twin screw type of reactor was used for effective de-chlorination and overcoming the transfer problem by the hard material such as metals and ceramics which can be inevitably included in waste vinyl.

To heat constantly and effectively, the reactor was controlled by the electric heating boiler with heat medium system.

In the course of de-chlorination, the vapor of hydrochloric acid was evacuated by vacuum pump and removed by knockout-port and condensing bottle controlled by low temperature.

For the investigation of optimum operation conditions, the remained concentration of hydrochloric acid and the tensile strength were analyzed.

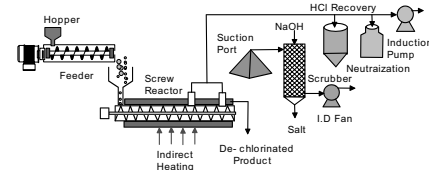

Fig.1 Process Diagram for De-chlorination of Waste Vinyl

2. Materials and Methods

In this study, the waste vinyl in municipal waste was used as feed material. This was sampled from the collection area of metropolitan city in Korea.

The concentration of hydrochloric acid of waste vinyl was 1.37%.

The waste vinyl was fed into the twin screw reactor as granule type. The granule type of waste vinyl was obtained from the crushing of melted waste vinyl made by recycling company.

The capacity of twin screw reactor is 20 kg/hr.

The hydrochloric gas is sucked to go through the recovery tank and to react NaOH solution by the induction pump.

The operation temperature of twin screw reactor is constantly controlled in the range of 310-350℃ by heat medium fluid of electric boiler.

Finally the de-chlorinated product as a melting type was obtained at the end of screw reactor.

In the course of operation, the discharged hydrochloric gas with the product was removed by the scrubber using NaOH solution.

The final de-chlorinated product was used for the analysis of tensile strength with the remained concentration of hydrochloric acid.

The measurement of tensile strength was followed to KSM3006 for the regulation of Korea Standard which can be used for the thermoplastic product.

3. Results and Discussion

One of effective controlling factors was heating temperature of reactor which can decompose PVC component and decrease the viscosity of melted waste vinyl to increase the mixing effect and the de-chlorination in the reactor.

The optimum de-chlorination temperature was 340-350ºC higher than 230ºC of theoretical decomposition temperature. On this experimental condition, the remained concentration of hydrochloric acid in final product was 0.6%.

The remained concentration of hydrochloric acid in the products was decreased on the increase of temperature.

The concentration of hydrochloric acid was changed from 1.37% of original sample to 0.6% of final product treated by 350ºC.

By these final products, the values of the tensile strength on the operation temperatures were compared with each other.

The value of 5.2 MPa for the original sample was changed up to the value of 9.4 MPa for the final product treated by 350ºC.

This indicates that the melted plastic with low concentration of hydrochloric acid in has higher tensile strength than that with high concentration.

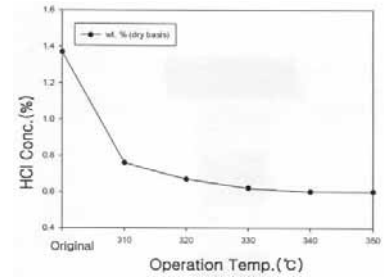

Fig. 2 De-chlorination Effects on the Operation Temperature

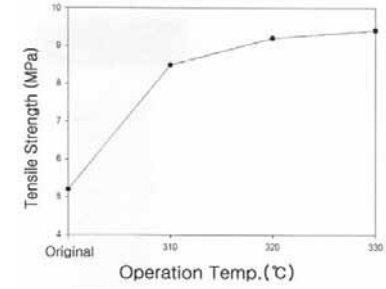

Figure 3 Comparisons of Values of Tensile Strength on the Operation Temperature

4. Conclusions

The waste vinyl with PVC component produced as a municipal waste can be de-chlorinated by the twin screw reactor with indirect heating.

According to the increase of operation temperature, the remained concentration can be decreased from 1.37% of original sample to 0.6% of product treated by 350ºC.

The values of tensile strength was increased from 5.2 MPa of original sample to 9.4 MPa on the same concentration of hydrochloric acid for final product treated by 350ºC.

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