DENITROGENATION OF ACRYLONITRILE-BUTADIENE-STYRENE COPOLYMER

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1. Introduction

Recycling of waste electric and electronic equipments (WEEE) polymers has drawn much attention recently. The conversion of waste plastics into chemical fuel or feedstock represents a sustainable way for the recovery of the polymeric waste. However, in the process of recycling of acrylonitrile–butadiene–styrene (ABS) copolymers, which is a widely used polymer in electric and electronic industry, thermal degradation will produce HCN, NO_X as well as complicated nitrogen-containing organic compounds that will not only cause environmental pollution but also cause the produced liquid to fail as fuel[1]. Therefore the denitrogenation of WEEE plastics is a must for this process. Hydrothermal methods[2]were adopted for denitrogenation, but the denitrogenation effects are still unsatisfying. Moreover, relative high temperatures and pressures are needed, which requires the use of expensive facilities. Therefore, the development of highly efficient denitrogenation of ABS under mild conditions is an area of considerable importance. In this paper, ABS is treated using poly (ethylene glycol) (PEG) as a phase-transfer catalyst. High denitrogenation efficiency has been obtained under mild reaction conditions.

2. Experimental

Alkaline denitrogenation of ABS was carried out at 160 °C for 2 h in a 60 mL stainless reactor equipped with a thermometer. In a typical experiment, 1 g NaOH was dissolved in 5 mL PEG600, and then added to the ABS solution of dioxane (ABS/DOA=1 g/25 mL). After reaction, the product was precipitated in acetic acid solution and separated, then washed with distilled water until pH=7, then dried under vacuum at 60 °C for 24 h before characterization. The chemical structure and the quantitative analysis of the products was characterized by FT-IR and Elemental analysis.

3. Results and Discussion

The enhancing effects of PEG on denitrogenation of ABS are clearly shown in Fig. 1. For ABS/DOA/NaOH system, the infrared spectrum of the product is similar to that of ABS, suggesting the conversion of nitrile group is very low with only NaOH at mild conditions. However, with the addition of PEG600, the strength of the –CN stretching band (2245 cm^{-1}) obviously decreases, at the same time new peaks assigned to $-CO-NH_2$ (1670 cm^{-1}) and -COOH (1705 cm^{-1}) appear, indicating a readily transformation of nitrile groups.

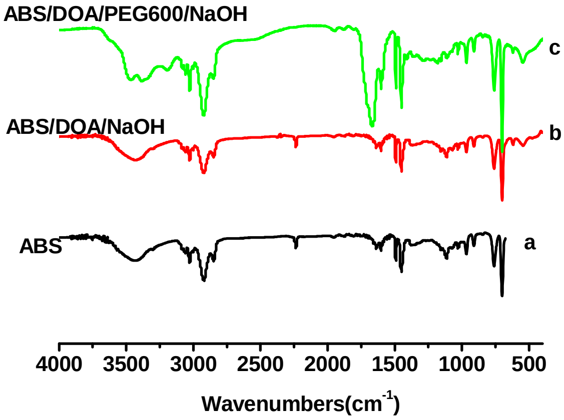

Fig.1 Infrared spectra of ABS and its alkaline degradation products

Fig. 2 shows the effect of reaction time on the alkaline hydrolysis of ABS. It can be seen that after reaction for 1 h, weak nitrile group (2242 cm^{-1}) still exists; after 2 h, nitrile group has been almost completely transferred to amide and carboxylate group. Moroever, the strength of amide group is higher than carboxylate group within 4 h, while the strength of carboxylate group is obviously stronger after reaction for 6 h, proving longer reaction time is beneficial to the complete hydrolysis of nitrile group.

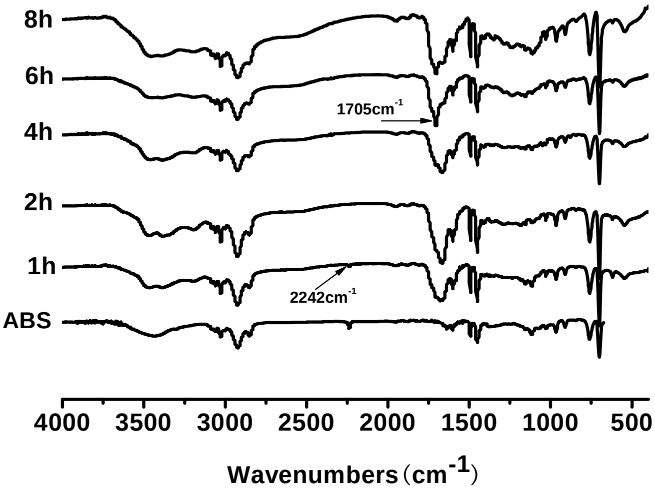

Fig.2 Infrared spectra of alkaline degradation products of ABS/DOA/NaOH/PEG600 under different reaction time

4. Conclusions

Acrylonitrile-butadiene-styrene (ABS) can be easily hydrolyzed using the ABS/DOA/PEG/NaOH system. PEG can obviously enhance the denitrogenation ability of ABS. Moreover, longer reaction time is beneficial to the complete hydrolysis of nitrile group.

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