
STUDIES ON THE CHEMICAL RECYCLING OF WASTES CONTAINING PVC, PVDC AND PPS

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Abstract

Pyrolysis process for waste plastics may be an alternative process to obtain chemicals and valuable liquid fuels from waste plastics. Although waste plastics such as PVC, PVDC and PPS are considered as valuable organic resources, they contain chlorine suggesting the production of chlorinated compounds in the course of the pyrolysis process. Production of such chlorinated compounds is very detrimental either in order to supply chemicals or to use them directly as fuels. It is considered that calcium hydroxide modified by organic compound is effective for improving the quality of products in pyrolysis process for polymeric materials because such modified calcium compounds are dispersed effectively into organic polymeric materials.

Keywords: Modified calcium compound, Pyrolysis, Wastes plastics, Chemical recycling, Chlorinated compounds

1. Introduction

Pyrolysis is an alternative process for recycling of waste plastics. By this technique valuable fuels and chemicals are obtained by means of thermal cracking of waste plastics. The pyrolysis process consists in heating the materials in an oxygen free atmosphere; the organic components of the materials are decomposed and generating liquid and gaseous products are evolved from the reactor while the inorganic materials remain unaltered in the reactor together with a carbonaceous solid formed in the process called as char. Pyrolysis is an especially appropriate recycling technique for waste plastics containing different plastics and other polymeric materials, since no separation operations are needed prior to the pyrolysis process. This confers the pyrolysis process an advantageous position with respect to mechanical recycling, which requires quite pure polymers to be successfully used.

On the other hand, the waste plastics such as polyvinyl chloride (PVC), polyvinylidene chloride (PVDC) and polyphenylenesulfide (PPS) contain chlorine. Therefore, chlorinated compounds should be produced in the pyrolysis liquids and this is very detrimental either in order to supply chemicals and liquids as fuels. Therefore, in the current process, the addition of alkali adsorbents is essential to avoid the production of chlorinated compounds.

It is suggested the occurrence of trapping in physical and/or chemical adsorption process [1]. However, this method is still inadequate because of un-sufficient dispersion of alkali adsorbent such as calcium hydroxide leading to incomplete dechlorination.

The objective of this study is to improve the effectiveness of alkali adsorbents. Usually calcium hydroxide ($\text{Ca}(\text{OH})_2$) has been used as alkali adsorbents of chlorinated compounds. Because it abounds in

amount of deposit and is cheap and least disruptive to the human body and the environment. In addition it is able to trap chlorinated compounds as calcium chloride (CaCl_2). However its affinity with organic compounds such as plastics is low and aggregates easily in polymer matrix. Therefore, its effectiveness is limited and needed too much amount. In this study calcium hydroxide reacted with organic carboxylic acid to improve on the performance as alkali adsorbents of chlorinated compounds as shown in Figure .1 [1].

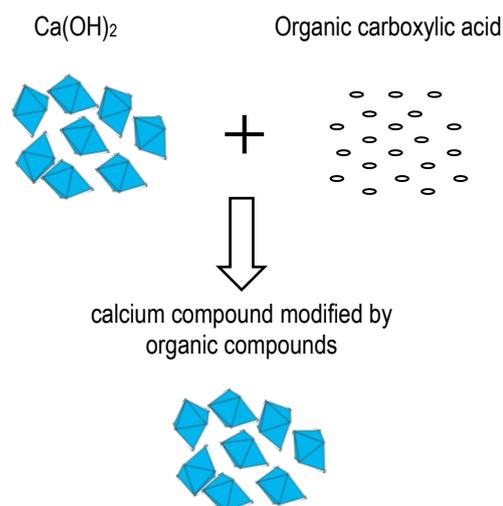


Figure 1 Preparation procedure of calcium compound modified by organic compounds in the reaction of calcium hydroxide with organic carboxylic acid.

2. Materials and Methods

2.1 Reaction of calcium hydroxide with organic carboxylic acid.

Calcium hydroxide was reacted with organic carboxylic acid in mixed solvent of water and acetonitrile. After the reaction, products were measured by thermogravimetry (TG) and scanning electron microscope (SEM) as shown in Figure 2.

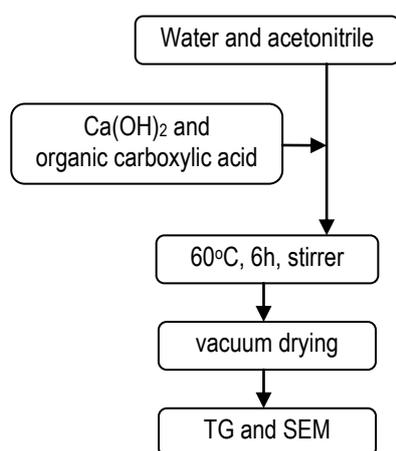


Figure 2 Reaction of calcium hydroxide with organic carboxylic acid.

2.2 Calcium compound modified by organic compounds expecting high affinity with plastics.

Calcium compound modified with organic compound or calcium hydroxide was added to polyvinyl alcohol (PVA) film and polystyrene (PS), polyethylene (PE) and polypropylene (PP) to make sure of the affinity of modified calcium with plastics.

3. Results and Discussion

3.1. The affinity of calcium compound modified by organic compound with PVA.

We have made sure the transparency of PVA film after adding calcium compound modified by organic compounds or calcium hydroxide itself as shown in Figure 3. As a result, PVA film adding calcium hydroxide itself was opacity. In comparison, PVA film adding calcium compound modified by organic compounds was transparency. Thus, it suggested the higher affinity of calcium compound modified by organic compounds with PVA than calcium hydroxide.

3.2. Addition of calcium compound modified by organic compounds or calcium hydroxide to PS.

Calcium compound modified by organic compounds or calcium hydroxide itself was added to PS, and measured by SEM and energy Dispersive X-ray Spectroscopy (EDX) of calcium as shown in Figure 4. As a result, PS

adding calcium hydroxide itself had the aggregate of calcium. In comparison, PS adding with calcium compound modified by organic compounds didn't have any aggregate of calcium. Thus, it is considered that calcium compound modified by organic compounds has higher affinity for PS than calcium hydroxide itself.

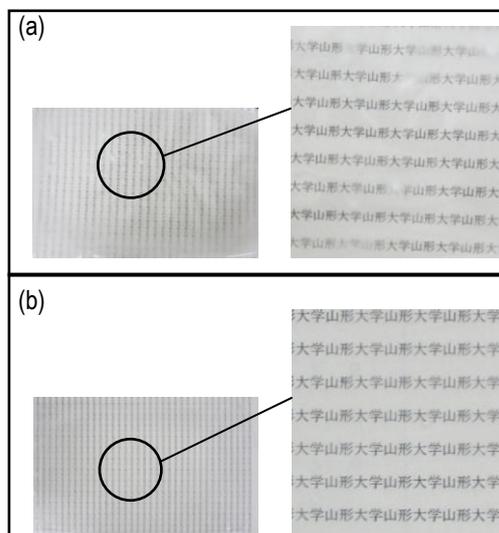


Figure 3 Transparency of PVA film with (a) calcium hydroxide (2 wt%) and (b) calcium compound modified by organic compounds.

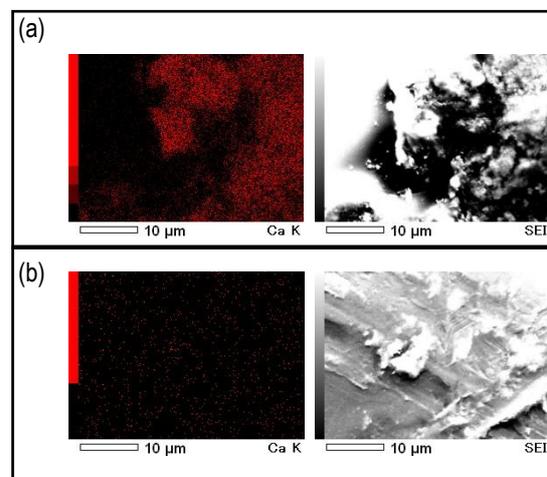


Figure 4 EDX (left) and SEM (right) images of (a) PS / calcium hydroxide and (b) PS / calcium compound modified by organic compounds.

4. Conclusions

Calcium compound modified by organic compounds was successfully prepared. Calcium compound modified by organic compounds had high affinity with plastics.

References

- [1] H-Tagaya, Bottom-up, Nanofabrication, ASP (2009) 283-300