Preparation and Properties of Zeolite/Brucite/Polypropylene Composite Fire Retardant Materials–cobalt

Xiaobo Zhang, Zejia Wang & Haiping Liu

Yanching institute of Technology, Sanhe, Hebei, China

ABSTRACT: In this paper, polypropylene (PP) as main material, magnesium hydroxide as flame retardant, effects of flame retardant synergist cobalt zeolite on flame retardant PP composite flame retardant properties, mechanical properties and thermal degradation behavior. The results show that, the reaction time is 3h, the reaction temperature is 400 °C, the loading is 7%, the flame-retardant properties of PP composites were improved obviously, the horizontal burning rate is 20.6mm/min, the limiting oxygen index reached 22.6%; little effect on the mechanical properties, tensile strength is up to 22.1MPa, the impact strength is 4.25KJ/m2; introducing cobalt zeolite change the thermal degradation process of magnesium hydroxide / PP system, decrease the thermal decomposition rate of PP composite, improve the thermal stability of the composites at high temperature.

1 INTRODUCTION

In recent years, with the continuous development of synthesis and processing technology of polypropylene, the mechanical properties of polypropylene materials have been greatly improved,

which are widely used in home appliances, automotive, construction and other industries; but because of the limited oxygen index of polypropylene (LoI) is only about 17, is a flammable polymer materials. With its wide application and brought the fire hazard and the risk of growing, which limits its applications. Magnesium environmentally friendly flame retardant by brucite preparation, has the advantages of high temperature resistance, (Zhu Fei, 2012) low smoke, non-toxic, environmentally friendly, (Sun ChenChen et al., 2011) in addition, there cerium oxide, zinc borate, aluminum, etc. have also been studied (Li Pingli et al., 2013), but because of the amount is large and the mechanical strength of products decrease, liquidity, poor processing performance. (Jiao C M et al. 2010, Bao Wenbo 2011, Li S L, 2010) Without affecting the mechanical properties of the composites to meet the ideal premise retardant effect, appropriate to add flame retardant synergist is currently a hot research. Study on cobalt and zeolite compound brucite flame retardant at this stage has not been reported in domestic and international research.
In this paper, cobalt nitrate and calcined zeolite prepared cobalt - zeolite synergistic agent, and the resulting synergistic agents and brucite flame retardants and processing of polypropylene blends prepared retardant polypropylene materials, Study the different processes conditions on the mechanical properties and flame retardant properties of flame retardant materials.

2 EXPERIMENTAL

2.1 Materials

Co(NO$_3$)$_2$•6H$_2$O was purchased from Tianjin Jinhuitaiya chemical reagent Co. Ltd.; Zeolite powder was purchased from Shanghai Jiuzhou Chemical Co., Ltd.; PP was purchased from Beijing Yanrenjie Chemical Co., Ltd.; Brucite was purchased from Tianjin Letai chemical reagent Co. Ltd..

2.2 Process

2.2.1 Preparation of cobalt - zeolite synergistic agent

The Co(NO$_3$)$_2$•6H$_2$O was dissolved in water, The zeolite was added with stirring the cobalt salt solution, stirred at room temperature for a certain period of time, the resulting zeolite suspension dried at 120 ℃ in a forced air oven, and then pulverized. The powder calcined three hours in a muffle furnace, and finally the resulting zeolite powder is ground, through 180 mesh sieve to obtain a cobalt - zeolite synergists.

2.2.2 Preparation of retardant composites

The preparation of cobalt - zeolite synergist, brucite and PP mixed get retardant polypropylene materials. The raw materials are mixed evenly, extrusion at 200 ℃, then pelletizing to obtain cobalt - zeolite / brucite / polypropylene flame retardant materials. Mechanical and flame retardant properties of spline were prepared at 215 ℃ 45MPa, and time 35s conditions using injection molding machine, then placed 24h at 23 ℃, respectively test the mechanical properties and flame retardant properties of spline.

2.3 Instrumental

Reference GB / T 1040--2006 test tensile properties (Shenzhen sans testing machine Co., Ltd.); referring to GB / T 1843--1996 impact test performance (Chengde Jinjian detection Instrument Co., Ltd.); reference GBT2406.2-2009 test LOI (Dongguan Kerui quality inspection instrument equipment Co., Ltd.); reference GB / T 8332-2008 test horizontal burning speed (Dongguan city Chino-E quality inspection equipment Co., Ltd.).TG-DTA were recorded with HCT-
2(Beijing Hengjiu scientific instruments), Temperature control in the 10/min to 600 degree cel- sius by using the TG-DTA test conditions, the nitrogen protection, gas flow rate is 10ml/min-100ml/min conditions. Particle size analysis was recorded with Mastersizer 2000(Malvern In- struments Ltd, UK).

3 RESULTS AND DISCUSSION

3.1 Effects of processing conditions on the combustion properties of flame retardant composite

3.1.1 Effect of reaction time

Cobalt nitrate in combination with zeolite, which binds the time will have some effect on the re- duction of performance. As can be seen from Figure 1, along with the reaction time of cobalt nitrate and zeolite growth, the burning rate of cobalt zeolite /PP / brucite composite decreases gradually. Until the reaction time was 3h, the reaction reached equilibrium; In this reaction time, the limit oxygen index of cobalt zeolite / brucite / PP composites reached the maximum. This time is the optimal reaction time of cobalt nitrate and zeolite.
3.1.2 Effect of reaction temperature

Zeolite catalyst reduction is relation with the amount of cobalt loading and firing temperature. When the cobalt nitrate and zeolite of different reaction temperature, different flame retardant synergist effect obtained. The same load with different cobalt content, the reduction degree is different by different calcination temperatures. Cobalt-zeolite low reaction temperature may not reach its catalytic effect, and the temperature is too high may cause the loss of catalyst activity, thus affecting the effect of flame retardant with the brucite flame. From the above chart shows, with the increase of the reaction temperature, the burning rate of cobalt zeolite /brucite /PP composites decreases first and then increases. When the reaction temperature reaches 400 °C, he burning rate of composite materials to reach the minimum, maximum limit the oxidation index.
3.1.3 Effect of loading

In the cobalt-zeolite synergistic agent, different cobalt content may also impact on its flame-retardant properties, because the loaded cobalt zeolite has excellent reducibility, when polypropylene combustion, cobalt oxide may be reduced to cobalt, the water produced in the reaction in the combustion temperature of the polypropylene will quickly absorb the combustion heat into steam, which reduces the temperature of combustion of polypropylene, so as to not only prevents polypropylene continue to burn, but also has a smoke suppression effect. Therefore, cobalt loading much may waste, and less likely to reach a good flame-retardant effect, thus affecting achieve flame-retardant effect with the brucite flame. The figure can be obtained from the optimum load capacity of 7%.
Figure 3. Effects of different load on the combustion properties of composite materials.

3.2 DTA-TG properties of flame retardant composites

The main degradation of pure PP occurred at 350-450 °C, and heat degradation at this temperature range is very quickly. After analyzing the results from thermal analysis, the addition of nano magnesium hydroxide and flame retardant synergistic agent in PP, the amount of thermal degradation residue at 600 °C still have the degradation residue solid, and decomposition temperature of magnesium hydroxide drop by about 340 °C to 220 °C, which shows adding synergist agent has accelerated the decomposition of magnesium hydroxide, reduced the rate of degradation of PP, played a role in coordinating fire retardant agent.
4 SUMMARY

1. The cobalt - zeolite synergistic agent can improve the flame retardant properties of PP. The optimal conditions were as follows: the reaction time was 3h, the reaction temperature was 400 °C, a loading was 7%. The flame retardant performances of PP composites under this condition has been significantly improved, the level of the burning rate and the limiting oxygen index can reach 20.6mm/min and 22.6%.

2. Co - zeolite synergists have little effect on the mechanical properties of the flame retardant composites. Under optimum conditions, the maximum tensile strength and impact strength can reach 22.1MPa and 4.25KJ/m2 respectively.

3. Due to the addition of cobalt - zeolite synergistic agent to accelerate the decomposition of magnesium hydroxide, it has good synergistic flame retardant effect with magnesium hydroxide.

REFERENCES


