Preparation and Properties of Water-disintegrable Polystyrene

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Abstract: The novel environmental friendly polystyrene blending materials were prepared via in-situ polymerization blending. The blends are composed of absorbent sodium polyacrylate (PAANa) particles and PS matrix. The resulting polystyrene blends and corresponding foamed products can disintegrate into powder under the action of water and the water-disintegrating products exhibit water and fertilizer retention capacity.

Key words: polystyrene; emulsion polymerization; sodium polyacrylate; in-situ polymerization blending
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Although the degradation of some environmental friendly polymers such as starch and cellulose under the action of the microorganism[1-3] is useful, degradation is not always necessary for many polymers. Disintegrating into smaller particles is enough for some application fields. Here, we found polystyrene blends in which water-absorbent particles of sodium polyacrylate were added can convert into hydrophilic powders when being contacting with water, which are called water-disintegrable polystyrene (WDPS). The detailed preparation of WDPS via in-situ polymerization blending and their water-disintegrable properties were discussed in this paper.

1 Experiments

1.1 Materials

Acrylic acid (AA), styrene (St), potassium persulfate (KPS), benzoperoxide (BPO), methylene-bis-acrylamide (MBAM), sodium hydroxide, cyclohexane, n-hexane and n-heptane are analytical degrade reagent and used without further purification. Kerosene oil, surfactant span-80 (SP-80), nonyl phenol ethoxylate (TX-10) and foaming agent n-pentane are used in available industrial degrade.

1.2 Preparation of WDPS through in-situ polymerization blend

The crosslinked sodium polyacrylate particles were obtained from emulsion polymerization with spna-80 and TX-10 as emulsifier.

Various molar ratios of styrene, particles of crosslinked sodium polyacrylate, initiator BPO (0.15% of St) and span-80 were stirred vigorously at 75℃ for about 3—4 hours hours. After that, the mixture was transfer into a sealed mould and polymerized for 2 days at 75℃ and the WDPS composed of sodium polyacrylate and PS was obtained. The PS blends were foamed with n-heptane as foaming agent.

2 Results and discussion

2.1 Water-disintegrable properties of WDPS

PS containing adequate water-absorbent polymer such as PAANa can disintegrate into powder-like products in the water. Figure 1 depicts typical water-disintegrating process of foamed WDPS containing 16% of water-absorbent PAANa particles. The blending materials became looser and looser once they were immersed into water, as shown in Figure 1(b) and Figure 1(c), and disintegrated into smaller aggregates and powders finally, as shown in Figure 1(d). Since the traditional PS materials are hydrophobic, which can not change in both volume and state under the action of moisture, the novel water-disintegrable property of WDPS materials derives from the particles of PAANa dispersing in the WDPS. The water absorbability and then swelling of water-absorbent PAANa evidently leads to the water-disintegrable property of WDPS.

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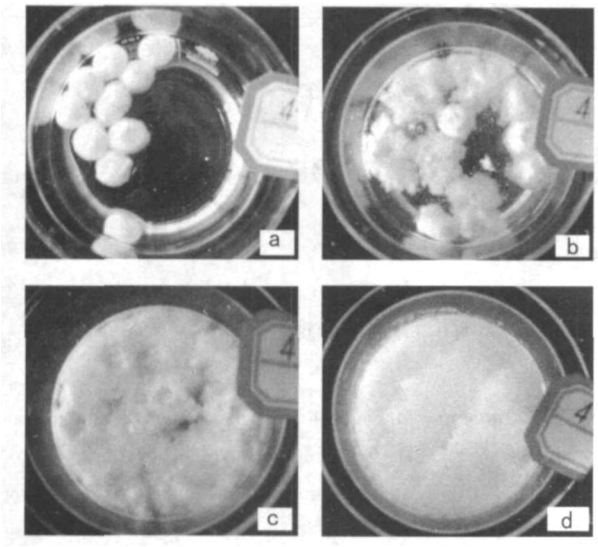

Fig. 1 Water-disintegrating process of foamed WDPS containing 16% PAANa after being immersed in de-ionized water for (a) 5 min, (b) 30 min, (c) 1 h and (d) 24 h.

In fact, the content of PAANa influences the water-disintegrable properties of WDPS dramatically. There was no any change after 24 hours for WDPS containing 7% of PAANa particles when it was immersed in de-ionized water, while the time to disintegrate for WDPS containing 11% of PAANa was only half an hour. Obviously, the water-disintegrating rate can be easily tuned and controllable through modifying the content of water-absorbent polymer particles for different request and application fields. In addition, the variety particle size, water absorbency and other factors of water-absorbent polymer dispersing in PS matrix can exert heavy influences on water-disintegrable property of WDPS, further research is performing in our group.

2.2 Performance of water-disintegrating products of WDPS

In order to investigate the water retention of the water-disintegrating products of WDPS, the compound soil containing 0.3% of water-disintegrating products was prepared and its influence on germination of Chinese cabbage "ShangHaiQing" seeds was studied. The contrasting experimental results of compound soil and blank soil showed that although the watering frequency is only once time per 2 days, which is lower than that of once a day for blank soil, the time of germination is 5 days and the germination rate is 64%, shorter and higher than that of blank soil 7 days and 45%, respectively. It is well known that the water-absorbent polymer is useful to preserving moisture and fertility[4-5], which is in accordance with our experimental results because there exist water-absorbent particles of PAANa in the water-disintegrating products. All of these show that the in-situ polymerization blending material WDPS is a kind of environmental friendly polystyrene material.

3 Conclusion

The successful preparation of water-disintegrable polystyrene via in-situ polymerization blending, in which the hydrophilic particles of PAANa and surfactant span-80 were added into styrene system before polymerization, was demonstrated. The resulting WDPS and foamed WDPS materials exhibit interesting water-disintegrable property and can disintegrate into powder which can improve water and fertilizer retention of soil.

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水崩解聚苯乙烯的制备及性能

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摘 要: 本研究通过原位聚合共混, 制备了一类新型环境友好的聚苯乙烯共混材料。该共混物由吸水聚合物聚丙烯酸钠分散在苯乙烯基体中形成。得到的聚苯乙烯共混物及发泡制品在水的作用下, 能够崩解为具有保水保肥能力的粉末, 展现出优异的环保用途。

关键词: 聚苯乙烯; 乳液聚合; 聚丙烯酸钠; 原位聚合共混
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