Effect of Modifiers on Injection Molding of Waste Polyethylene Drip Tape

Bin GUO* , Shou-Jun WU, De-Lan ZHU

College of Water Resources and Architectural Engineering, Northwest A&F University, Yangling Shaanxi, 712100, China

guo.bin999@163.com

*Corresponding author

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Abstract. In this work, effects of Ethylene-vinyl acetate copolymer (EVA) and Dicumyl peroxide (DCP) on injection molding of recycled polyethylene (PE) materials obtained from a waste disposable drip tape are studied. Under injected at 175-230℃ and 35-40 MPa, the recycled PE materials with EVA showed good injection moldability, while those with DCP showed poor injection moldability with DCP introduction increasing. Under injected at 135-145 ℃ and 50-60 MPa, the recycled PE materials with DCP can be well injection molded.

Introduction

Disposable drip tape made from blends of low density polyethylene (LDPE), high density polyethylene (HDPE) and linear low density polyethylene (LLDPE) is widely used in China due to its wide adaptability and relative lower cost. However, polyethylene is prone to deterioration in field applications[1],which in this case resulted in the deterioration of tensile strength and the elongation of the PE tapes at the break point. Research has demonstrated that the mechanical and physical properties of waste/virgin PE blends decreased with the introduction of PE waste. Therefore, modification is necessary for reproducing of waste PE materials.

There are many kinds of modification methods to improve the performance of recycling PE products. And it has been demonstrated that ethylene-vinyl acetate copolymer (EVA) and Dicumyl peroxide (DCP) were effective modifiers. It is reported that introduction of EVA can increase the elongation at the break and tensile strength for the LDPE/EVA blends, while a reverse trend for the HDPE/EVA[2,3]. And Introduction of 2 wt.% dicumyl peroxide (DCP) can simultaneously improve the tensile strength and elongation at break[4,5].

It has been revealed that the introduction of modifiers changes the melting point, viscosity and thermal stability of PE[2]. Therefore, it is necessary to study the effects of modifiers on injection molding of the recycled PE materials. In this paper, EVA and DCP were used as modifiers for the recycling of waste disposable drip tape. Effects of EVA and DCP on injection molding of the recycled materials are studied.

Experimental Procedure

The granulated waste PE was obtained from a post-consumer disposable drip tape which was used in NingXia GuYuan Agricultural Experimental Station for nine months. The as-received disposable drip tape was provided by Yangling QinChuan Water Saving and Irrigation Engineering Co. Ltd.

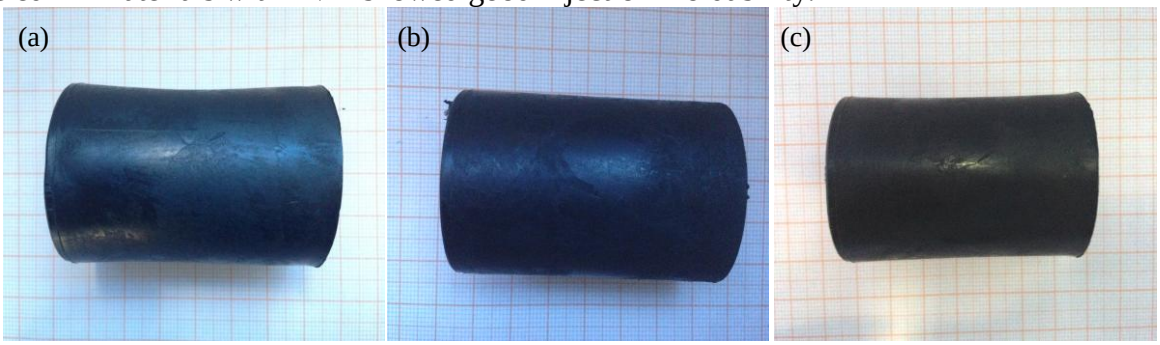
The modifier agents used were: Granular ethylene vinyl acetate (EVA) (ZE280L, VA content= 27.8 wt%, MFI = 2.2 g/10 min, Samsung, South Korea) and dicumyl peroxide (DCP) (Shanghai Hushi Laboratory Equipment CO., Ltd, China). Cylindrical samples were prepared by an injection molding machine (JPH-80, Guangdong Only Machinery Co., Ltd, GuangDong, China).

The injection was conducted at different injection temperatures and pressure. The temperature setting for the four sections of the injection molding machine cylinder was 175-230 ℃ and extrusion pressure was 35-45MPa for the first one. While them was 135-145 ℃ and 50-60MPa for another.

Results and Discussion

Effects of EVA on Injection Molding of the Recycled PE Material

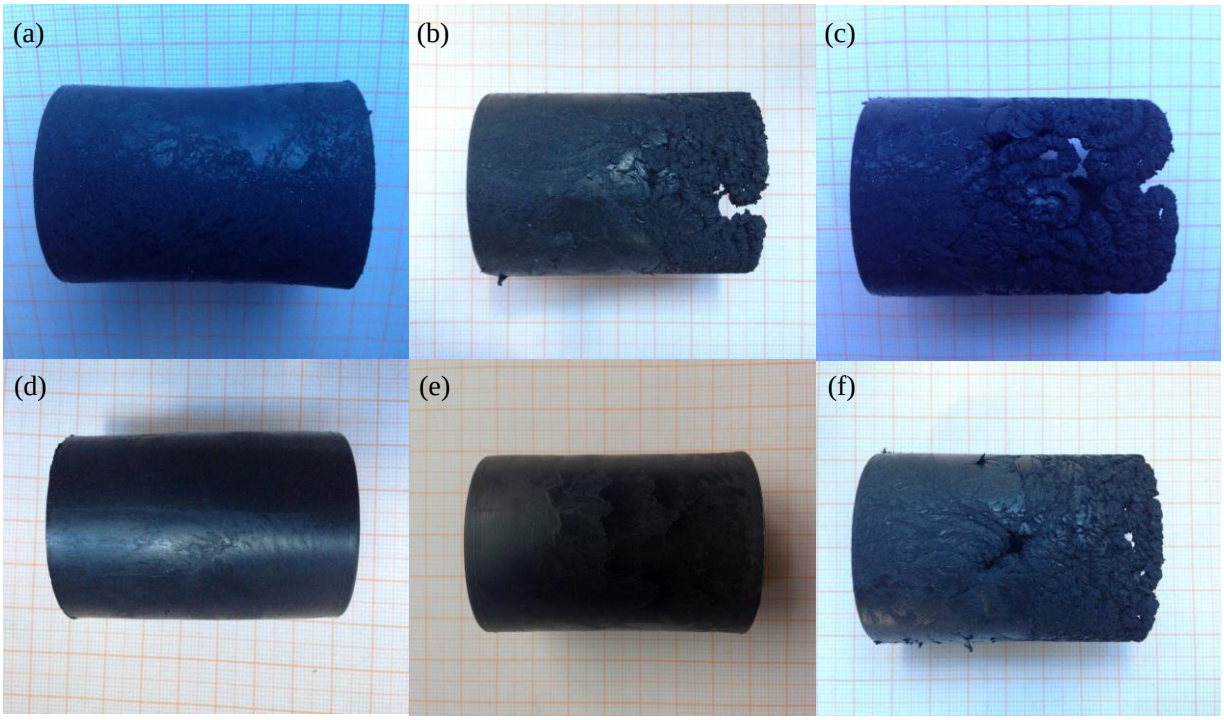
Fig.1 shows photographs of samples added with EVA. It seems that under injected at 175-230 ℃ and 35-40 MPa, the recycled PE materials with EVA showed good injection moldability. Introduction of EVA into PE decreases the melting temperature of PE phase, and increases the melting elasticity of the PE/EVA when EVA concentration increases [2]. And good compatibility between EVA and PE is favorable to reduce extrusion/injection deformation [6]. Therefore the the recycled PE materials with EVA showed good injection moldability.



(a)175-230 ℃, 35-40MPa, pure waste PE; (b)175-230 ℃, 35-40MPa, 6%EVA;(c) 175-230 ℃, 35-40MPa, 20%EVA

Fig.1 Photographs of samples added with EVA

Effects of DCP on Injection Molding of the Recycled PE Material



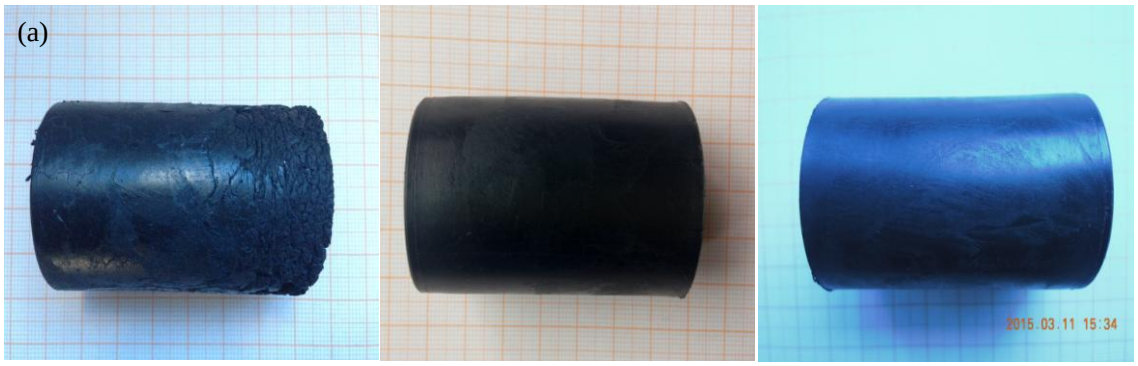
(a)175-230 ℃, 35-40MPa, 0.2%DCP; (b)175-230 ℃, 35-40MPa, 0.4%DCP;
(c)175-230 ℃, 35-40MPa, 0.6%DCP; (d) 135-145 ℃, 50-60MPa, 0.2%DCP;
(e) 135-145 ℃, 50-60MPa, 0.4%DCP; (f) 135-145 ℃, 50-60MPa, 0.6%DCP;

Fig. 2 Photographs of samples added with DCP

Fig.2 shows photographs of samples added with DCP. From Fig.2 (a) to (c), it can be observed that injection molding deteriorate with DCP concentration increases when the injection was conducted at 175-230 ℃ and 35-40 MPa. However, the PE/DCP showed improved injection moldability under 135-145 ℃ and 50-60MPa as shown in Fig.2 (d) to (f). Introduction of DCP into PE increases the melt viscosity and shear modulus of PE [3]. Therefore, the recycled PE materials with DCP showed poor injection moldability with DCP introduction increasing when the injection was conducted at 175-230 ℃ and 35-40 MPa, while improved injection moldability under 135-145 ℃ and 50-60MPa.

Effects of DCP/EVA on Injection Molding of the Recycled Material

Fig.3 shows photographs of samples added with DCP/EVA. It can be seen that EVA can offset the deterioration of the injection moldability resulted from DCP. And the blends can be well injection molded at 135-145 ℃ under 50-60MPa.



(a)175-230 ℃, 35-40MPa, 6%EVA+0.4%DCP; (b) 135-145 ℃, 50-60MPa, 6%EVA+0.4%DCP; (c) 135-145 ℃, 50-60MPa, 15%EVA+0.6%DCP

Fig.3 Photographs of samples added with DCP/EVA

Conclusion

Under injected at 175-230 ℃ and 35-40 MPa, the recycled PE materials with EVA showed good injection moldability, while those with DCP showed poor injection moldability with DCP introduction increasing. Under injected at 135-145 ℃ and 50-60 MPa, the recycled PE materials with DCP can be well injection molded.

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