COMPATIBILIZATION OF POSTCONSUMER PET/HDPE BLENDS.

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Abstract

Presently the large amount of disposable bottles makes it imperative to search for recycling or reuse methods of these materials, because they are not biodegradable. The mechanical properties of postconsumer polyethylene terephthalate (PET) and high density polyethylene (HDPE) blends at different composition with and without compatibilizer were studied. A binary blend (PET-HDPE 70/30% wt) was prepared on a twin-screw extruder at 200-280 ºC. Later ternary blends were prepared using as compatibilizer styrene-ethylene-butylene-styrene (SEBS) in different proportions from 0% to 30% (wt%).. The different properties were then analyzed using tensile strength and impact tests. The presence of HDPE in the binary blens showed an important decrease in mechanical properties. The addition of SEBS to the binary system PET / HDPE allowed us to recover some mechanical properties, as well as improving the processability of the blends.

Keywords: *PET,HDPE, blend, compatibilization*

1. Introduction

The recycling of plastic materials is a topic of particular interest in today's society. Plastics consumption has been a huge increase in recent years, especially since the 80's. Parallel to this increase in consumption, have been generating large amounts of waste.

Among the polymeric materials have attracted more interest in the recycling industry is the polyethylene terephthalate. This is reflected in the evolution of the consumption figures of recent times [1].

There is an important market in the supply of waste from PET bottles produced by injection-blowing process. Recover these waste by mechanical recycling is one of the most interesting lines of research at present [2].

Generally, the PET waste show contamination in the form of Polyethylene, which comes from the bottle caps. The incompatibility between the two materials results in a significant deterioration of mechanical properties [3].

The objective of this study is to characterize PET– HDPE blends and then to use SEBS as a compatibilizer to recover some of the mechanical properties.

2. Experimental

Materials

To study this type of system has been used a virgin PET manufactured by SABIC (BC-112) specifically for the manufacture of containers by injection blow molding process. The second system component is a high density polyethylene manufactured by BP (Rigidex® HD5211EA) specific for injection caps. As a compatibilizer, SEBS has been employed manufactured by API (Megol® SV, Applicazioni Plastiche Industriali, Italy).

Characterization

The preparation of the mixtures was carried out using a double screw extruder to ensure correct dispersion of the components in the blend. A co-rotation extruder Collin ZK 25 (Collin extrusions Ltd, Warwickshire, UK) with 25 mm diameter screw and a length – diameter ratio of 24 was used.

Test samples were obtained in a injection machine Mateu & Sole brand Meteor model 270/75.

3. Results and Discussion

PET-HDPE System

After a study of the preforms and caps on the market for the manufacture of packaging, it was decided to use as a maximum of 30% HDPE by weight.

Impact and tensile tests have been made to observe the evolution of the mechanical properties of the system as we add higher proportions of HDPE to PET.

Table 1. Mechanical properties of PET-HDPE blends.

	Tensile Strength, MPa	Elongation at break, %	Impact Strength, kJ m^{-2}
PET	58.51	146.4	3.94
HDPE	18.11	225.10	5.06
5% HDPE	53.54	100.94	2.44
10% HDPE	47.94	31.72	2.25
20% HDPE	39.78	3.40	1.19
30% HDPE	24.71	2.76	1.00

In this case, two phases appear in the blends, causing changes in mechanical properties, which depend largely

on the cohesion that have both phases together, as well as the weight ratio that exists between both polymers. Studying the evolution of the values of Tensile Strength, we saw that with the addition of HDPE, a decrease of values occurs until the value of 24.71 MPa for the blend with 30% of HDPE.

In the case of Elongation at break, adding 5% of HDPE, the values obtained are very similar to virgin PET, occurring a significant decrease in the values for higher charge ratios, reaching nearly to zero deformation for the blends of 20 and 30% of HDPE.

Finally, after analyzing the influence of the HDPE in the shock absorption capacity of the mixtures it was observed as the Impact Strength values obtained descend gradually as the proportion of HDPE is increased.

The general mechanical behavior observed in blends shows the typical behavior of systems formed by incompatible materials.

PET – HDPE – SEBS System

For this study the ternary blend of PET with 30% of HDPE is used, since it is the worst case can be found during the recycling of PET.

The component added to the system is a SEBS which is chemically compatible with much of the polar polymers including PET. The maximum proportion added to the binary system is 30% as the maximum percentage of minor component of the blend.

As in the previous section, Impact and tensile tests have been made to observe the evolution of the mechanical properties of the ternary system as different percentages of SEBS are added.

Table 2. Mechanical properties of Blends in function of SEBS content.

	Tensile Strength, MPa	Elongation at break, %	Impact Strength, kJ m^{-2}
0% SEBS	24.71	2.76	1.00
2.5% SEBS	30.95	3.41	1.19
5% SEBS	32.87	4.00	1.31
10% SEBS	34.60	4.53	1.75
20% SEBS	37.98	5.25	2.18
30% SEBS	44.52	6.16	2.69

Studying the evolution of the values of tensile strength, we found that with the addition of SEBS recover the original values of PET for the blend reached 30% of SEBS a value of 42.52 MPa.

In the case of elongation at break, we found that the values achieved without very significant, are clearly higher than the initial blend.

Finally, after studying the influence of SEBS on the shock absorption capacity of the mixtures, we observed that the impact strength values obtained are clearly higher than the initial blend, reaching for the mixture of 30% of SEBS, values very similar to those of PET.

4. Conclusions

The results obtained in this work show the incompatibility between the PET and HDPE, resulting in widespread loss in mechanical properties of the blends, especially in ductile mechanical properties.

The addition of SEBS allowed us a widespread recovery of mechanical properties compared to the initial materials. In particular, have largely recovered the values of tensile strength and impact energy in the blends with high content of SEBS.

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