MIXED HDPE/PP “SCRAP” COMPATIBILIZATION AND MODIFICATION - PRELIMINARY TESTING

INTRODUCTION

For mixed HDPE/PP scrap stream, the following end properties of the mixture were required:

HDPE-like material: MFI of 6-8±2 g/10min & Cold impact resistance 20%-30% better,
PP-like material: MFI of 12-20±2 g/10min & notched Izod of 13 kJ/m².

*Izod and Charpy notched impact strength usually differ by no more than around 0.5 kJ/m²

MATERIALS USED

For preliminary tests, we prepared a blend of HDPE/PP in ratio of 70/30.

<table>
<thead>
<tr>
<th>Polymer</th>
<th>% used in mixture</th>
<th>MFI [g/10 min]</th>
<th>Charpy Impact Strength @ 23°C [kJ/m²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDPE</td>
<td>70</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>PP</td>
<td>30</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>

Mixture of these two materials yielded:

- MFI (190°C, 2.16 kg): 6.0 g/10min
- MFI (230°C, 2.16 kg): 10.3 g/10min
- Charpy Impact Strength (4J, Notched): 10.8 kJ/m²

We prepared a special grade of GRAFTABOND™ ECO, to increase the mixture’s properties to desired values.
Material Report

TESTS PERFORMED

We performed MFI, tensile and Charpy tests for base material and compatibilized products. Mixtures were extruded on a laboratory scale extruder.

MFI of all mixtures was measured at 190°C and 230°C.

Charpy specimen were injection molded – Specimen size 1eA (notched type)

Charpy measurements were performed on Pendulum Charpy Impact Testing Machine.
RESULTS

HDPE-like Material

We prepared mixtures with 2% and 5% additive:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Unit</th>
<th>MIX HDPE/PP</th>
<th>+ 2% ECO</th>
<th>+ 5% ECO</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFI</td>
<td>ISO 1133</td>
<td>g/10 min</td>
<td>6.0</td>
<td>6.0</td>
<td>6.06</td>
</tr>
<tr>
<td>Charpy Impact Strength</td>
<td>ISO 179, Notched</td>
<td>kJ/m²</td>
<td>10.8±0.4</td>
<td>14.0±0.52</td>
<td>17.3±0.05</td>
</tr>
</tbody>
</table>

- MFI doesn’t change with % of GRAFTABOND ECO
- Charpy Impact Strength increased by 60% when adding 5% GRAFTABOND ECO

PP-like Material

For this variation, we added 5% of the same special GRAFTABOND ECO grade as for HDPE-like material, with 3.5-8.5% added rheology modifier GRAFTALEN SA – for regulating MFI of PP-like material.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Unit</th>
<th>MIX HDPE/PP</th>
<th>+ 5% ECO</th>
<th>+5% SA</th>
<th>+10% SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFI</td>
<td>ISO 1133</td>
<td>g/10 min</td>
<td>10.3</td>
<td>10.4</td>
<td>13.6</td>
<td>22.9</td>
</tr>
<tr>
<td>Charpy Impact Strength</td>
<td>ISO 179, Notched</td>
<td>kJ/m²</td>
<td>10.8±0.4</td>
<td>17.3±0.05</td>
<td>17.0±0.3</td>
<td>16.9±0.12</td>
</tr>
</tbody>
</table>
Material Report

*GRAFTALEN SA was added in addition to 5% GRAFTABOND ECO

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**SOLUTION**

Income mixed material HDPE/PP = 70/30 can be compatibilized with a special grade of GRAFTABOND™ ECO in two variations:

HDPE-like material – add 5% of GRAFTABOND ECO to the mixed material, to receive 60% better Charpy impact strength and unchanged MFI.

 HDPE-like → “Scrap” mix + 5% GRAFTABOND ECO

PP-like material – add 5% of GRAFTABOND ECO to mixed material, to increase Charpy impact strength by 60%. MFI remains at ~10 g/10 min.

To further increase MFI, we can provide rheology modifiers:

- Stearyl Alcohol based compound - GRAFTALEN SA,
- More expensive variant - GRAFTALLOY PDMS.

 PP-like → “Scrap” mix +5% GRAFTABOND ECO + optional: GRAFTALEN SA / GRAFTALLOY PDMS
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EXTRUSION PARAMETERS

*Zone 1 is first zone after feeder, zone 13 is last zone before die.*