I6003rp
Additive to Improve Recycled PVC

Product Properties & Processing Guidelines

Product Description

I6003rp is an effective bio-based polymeric additive for improving recycled PVC value and increasing its reuse in PVC compounds. It improves tensile toughness and tear resistance, provides plasticization, while not compromising clarity or UV stability. This product is ideal for converters who want to increase their scrap reuse rate and for compounders who want to upgrade the value of their recycle PVC product range.

Product Characteristics

- Improved Tensile Toughness
- Improved Tear Resistance
- Secondary plasticizer & Improved flow
- Transparency retention
- Inherently UV Resistant
- Resistant to Discoloration
- Renewable Content Certified >85% bio-based
- Secondary plasticizer & Improved flow

Typical Physical Properties

<table>
<thead>
<tr>
<th>Physical Form</th>
<th>pellets or powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellet size, mm</td>
<td>5-10mm</td>
</tr>
<tr>
<td>Mean Particle Size, Microns</td>
<td>350</td>
</tr>
<tr>
<td>Powder</td>
<td></td>
</tr>
<tr>
<td>Particulate Specific Gravity</td>
<td>1.24</td>
</tr>
<tr>
<td>Bulk Density</td>
<td>0.3-0.5 g/cc</td>
</tr>
<tr>
<td>Tg range, °C</td>
<td>-10 to 1</td>
</tr>
</tbody>
</table>

Improved Toughness and Tear Resistance

PVC recycle usage rates are often limited due to deterioration in physical property performance at loadings above a few %, while scrap generation can be significantly greater. Incorporating Metabolix polymeric additives with reuse of recycle scrap PVC or incorporating it into Repro PVC Compounds helps maintain toughness and tear properties at higher recycle usage rates.

Miscibility in PVC and Plasticization

The excellent inherent miscibility in PVC of Metabolix I6003rp additives enables improved mixing of recycle PVC and brings secondary plasticization with low migration and aging effects enabling reformulation to reduce plasticizer and impact modifier addition while maintaining physical properties.
I6003rp

Benefits and Results Tables

<table>
<thead>
<tr>
<th>I6003rp, %</th>
<th>0</th>
<th>10</th>
<th>15</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength, MPa</td>
<td>13.0</td>
<td>13.0</td>
<td>14.0</td>
<td>18.4</td>
</tr>
<tr>
<td>Elongation at break, %</td>
<td>101</td>
<td>146</td>
<td>155</td>
<td>211</td>
</tr>
<tr>
<td>Tensile toughness, J</td>
<td>0.8</td>
<td>1.0</td>
<td>1.1</td>
<td>1.8</td>
</tr>
<tr>
<td>Tear, N/mm</td>
<td>34.7</td>
<td>31.6</td>
<td>36.1</td>
<td>46.5</td>
</tr>
</tbody>
</table>

Example 1: medical regrind

Example 2: general purpose flexible regrind

Processing Improvements

The miscibility of I6003rp in PVC and similar shear rate/stress relationship supports viscosity matching, and promotes shear melting, thereby reducing the fusion time and improving heat stability. Processing can take place at lower temperatures with improvement in the extent and effectiveness of mixing.

Dry Blending

Metabolix polymeric modifiers are supplied in a form of solid granules or powders, which could be added at the dry blending or melting stage without any special handling. In the case when primary plasticizers must be used, I6003rp should be added in the mixing cycle after the plasticizer has been absorbed by the PVC resin and the mix temperature reduced to less than 150 °F (66 °C).

A typical mixing procedure to produce PVC-PHA dry blends in a high speed mixer or low speed ribbon blender is:

1. PVC resin and stabilizers are added to the mixer. If a primary plasticizer is required, it should be added when the stock temperature reaches 175 °F (70 °C).
2. Mixer speed is reduced and then liquid plasticizer is added. Speed is increased and mixing continues until all the plasticizer is absorbed and a “dry point” is reached. Fillers (if any) can be added at this stage as well. A typical dump temperature is 212 °F (100 °C).
3. The dry blend is then discharged into a cooling chamber and cooled to below 100 °F (38 °C). The I6003rp modifier can be added once the temperature is below 150 °F (66 °C).
4. Minor modification of these mixing procedures is possible within equipment and productivity constraints.

PVC Processing Guidelines
Fluxing

Melting is accomplished in one of three ways following the dry-blend process:

1. Single or twin screw extrusion of the dry blend followed by pelletization, cooling and packaging.
2. Banbury or Buss mixers, followed by a two roll milling, pelletization and packaging for future use.
3. Direct processing of the dry blend into finished product. Using an extrusion or injection molding process, fluxing can be achieved with the optimal L/D screw ratio of 20/1.

The temperature profile in an extruder is suggested as:

- Feed zone: 290 °F (143 °C)
- Zone 2: 302 °F (150 °C)
- Zone 3: 320 °F (160 °C)
- Die: 338 °F (170 °C)

Interruptions and Shutdown Procedure

The I6003rp modifier is susceptible to thermal degradation upon prolonged exposure to high temperatures. If the extruder is stopped for a considerable duration, it is recommended that the screw be kept turning at a slow rate (approximately 5 rpm) to continue purging the machine. The extruder can alternatively be purged with PVC without changing temperature set-points.

Moisture Content & Drying

The I6003rp modifier is supplied dry (<3000 ppm) in rubberized liners inside 1000 lb. Gaylord boxes. Under normal operating conditions, these pellets need not be dried further prior to extrusion. Partially used bags should be re-sealed after use to ensure that the moisture level in the pellets is maintained below 3000 ppm during storage. If necessary, drying at 80 °C for 4 hours using dehumidified air (dew point ~ -40 °C) should be sufficient to bring the moisture level to below 500 ppm.

Packaging

The i6003rp modifier is packaged in 20 kg bags and 1000 lb Gaylord boxes.

Safety Precautions

I6003rp is thermally sensitive and must be handled and processed with adequate ventilation and proper personal protective equipment. Temperatures above 200 °C (392 °F) or prolonged exposure to temperatures above 190 °C can result in considerable polymer degradation and the evolution of crotonic acid. Therefore, adequate ventilation should be provided where hot polymer may reside for long periods such as in leak areas, above the die, in screen changers, in vent ports, etc. As with most thermoplastics, exposure to harmful vapors and thermal burns from contact with molten polymer can be potential safety hazards. The I6003rp Material Safety Data Sheet provides additional handling and processing information and can be downloaded at www.metabolix.com.

**CAUTION: HEATING ABOVE RECOMMENDED PROCESSING TEMPERATURES WILL RESULT IN EXTENSIVE DEGRADATION AND POLYMER CHANGES THAT WILL AFFECT THE PROPERTIES OF THE MATERIAL.**
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