reFlex™ BioPlasticizers

PolyOne

reFlex™ 100
BioPlasticizer
as a Productivity Tool

A powerful, bio-derived, "accelerator" for vinyl plastisol and plastisol ink manufacturers
PolyOne’s bio-derived plasticizer technology can help you reach new customers, improve productivity, and grow your bottom line.

**reFlex™ 100 Solutions**

Companies who historically used fast gelling, high solvating plasticizers have been compelled by regulation or health and safety concerns to switch to alternate systems, most of which are not as fast or efficient. PolyOne’s reFlex 100 provides customers with a powerful formulation tool to better balance processing and product performance. PolyOne’s reFlex 100 bioplasticizer provides an exceptional, high solvating, fast fusing, bio-derived alternative for use with both phthalate and non-phthalate plasticizer systems, as described below.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Driven By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allows the incorporation of rapidly renewable content</td>
<td>Bio-Derived</td>
</tr>
<tr>
<td>Customers may be able to certify their products under the USDA BioPreferred® standard and potentially qualify for Federal Procurement Preference</td>
<td>Certified to 94% Renewable Content</td>
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<tr>
<td>Increased productivity and quality through reduced evacuation time and defect rates</td>
<td>Improved Air Release</td>
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<tr>
<td>Reduced usage levels</td>
<td>Greater Efficiency</td>
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<tr>
<td>Faster processing and reduced energy usage from lower gelation and fusion temperatures</td>
<td>Fast Gelation and Fusion</td>
</tr>
<tr>
<td>Easier material handling</td>
<td>Lower Paste Viscosity</td>
</tr>
<tr>
<td>Reduced levels of heat stabilizer and/or more robust performance</td>
<td>Imparts Excellent Thermal Stability</td>
</tr>
</tbody>
</table>
Test Formulations:
reflex™ 100 in Combination with Hexamoll® DINCH Non-Phthalate Plasticizer

Key Characteristics and Benefits
reflex 100:
- imparts excellent thermal stability eliminating the need for ESO in the formulation
- maintains excellent air release at all levels
- offers greater efficiency—less plasticizer is required to achieve equal hardness

Typical Properties
Gel Temperatures
reflex 100 progressively reduces the gel temperature with greater levels of substitution, and increases the gel rate as evidenced by the increasing slope of the plot.

Viscosity Stability
reflex 100 is effective in reducing paste viscosity even further than DINCH. It does not adversely affect viscosity stability until levels of 50% are approached.

Mechanical Properties
reflex 100 promotes early development of mechanical properties, but at equal loadings, exhibits lower tensile and higher elongation due to its lower durometer resulting from its greater efficiency. reflex 100 will generally provide similar mechanical properties at equal hardness.

Thermal Stability
reflex 100 progressively improves heat stability as the amount of reflex 100 is increased.
Test Formulations: reFlex™ 100 in Combination with Phthalate Plasticizers

Key Characteristics and Benefits
reFlex 100:
- imparts excellent thermal stability eliminating the need for epoxidized soybean oil (ESO) in the formulation
- maintains excellent air release at all levels
- offers greater efficiency—less plasticizer is required to achieve equal hardness

<table>
<thead>
<tr>
<th>Material</th>
<th>DNP</th>
<th>10%</th>
<th>25%</th>
<th>50%</th>
<th>DDP</th>
<th>10%</th>
<th>25%</th>
<th>50%</th>
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<tbody>
<tr>
<td>Geon 121AR Resin</td>
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<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
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<tr>
<td>DNP</td>
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<td>63.0</td>
<td>52.5</td>
<td>35.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>DDP</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>67.0</td>
<td>63.0</td>
<td>52.5</td>
<td>35.0</td>
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<tr>
<td>reFlex 100</td>
<td>0.0</td>
<td>7.0</td>
<td>17.8</td>
<td>35.0</td>
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<td>17.8</td>
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<tr>
<td>ESO</td>
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<td>0.0</td>
<td>0.0</td>
<td>3.0</td>
<td>0.0</td>
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<tr>
<td>Ba/Zn Stabilizer</td>
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<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Air Release: Excellent

Hardness (Shore A): 83 82 79 75

Typical Properties
Gel Temperatures
reFlex 100 decreases gel temperatures by as much as 15°C as the level of reFlex 100 is increased to 50% through substitution.

Viscosity Stability
reFlex 100 can be used at various levels to reduce paste viscosity without significantly affecting viscosity stability.

Mechanical Properties
reFlex 100 promotes early development of mechanical properties, but at equal loadings, exhibits lower tensile and higher elongation due to its lower durometer, which results from its greater efficiency. At equal hardness, reFlex 100 will generally provide similar mechanical properties.

Thermal Stability
reFlex 100 imparts excellent thermal stability, potentially allowing for the reduction/elimination of expensive vinyl stabilization additives.
**reFlex™ 100 Renewable Content**

**reFlex 100:**
- is primarily derived from rapidly renewable feedstocks and has been certified to the USDA BioPreferred™ standard to be 94% bio-derived; and,
- may allow customers to have their products certified to this standard at loadings as low as 20–25 phr, potentially qualifying them for the Federal Procurement Preference program.

**Who Will Benefit From This Technology?**

Customers who:
- are seeking a high solvating plasticizer to assist in formulation optimization
- have sacrificed productivity as a result of plasticizer selection/substitution
- value high levels of rapidly renewable content
- require a totally non-phthalate plasticizer system
- desire to have their products certified USDA BioPreferred

**Typical Applications**
- Resilient flooring
- Carpet backing
- Vinyl foams
- Plastisol inks
- General purpose plastisols