# Injection Molding of Vistamaxx™ Performance Polymer and Polypropylene Blends

## Technical Literature - TL00514

### Introduction

Vistamaxx performance polymer is a unique semi-crystalline copolymer of propylene and ethylene. The reduction of crystallinity is achieved by the introduction of amorphous regions in the polymer sequences of the propylene-based elastomer. The ethylene content (C2) ranges from 9% to 16% by weight in these grades. As a result, their physical properties performance generally falls between that of polypropylene (PP) and ethylene propylene (EP) rubber. This structure enables the formulation of a special semi-crystalline polyolefin morphology which provides:

- Softness and flexibility
- Elasticity
- Toughness and durability
- Colorability
- Excellent compatibility to PP.

Vistamaxx polymer grades bracket the range of crystallinity and flow useful in most compounding and thermoplastic blend applications. Some of the Vistamaxx polymer grades more commonly used are shown in the following table. More complete information is available on their respective datasheets.

**Typical Vistamaxx™ Performance Polymer Grades and Properties**

| Grade | Nominal | | |
|---|---|---|---|
| | Density [1] | MFR [2] | Ethylene, wt% [3] |
| 3000 | 0.873 | 8 | 11 |
| 6202 | 0.863 | 20 | 15 |
| 6102 | 0.862 | 3 | 16 |

[1] ASTM D1505, g/cm$^3$
[2] ExxonMobil Method, g/10 min (230°C/2.16 kg)
[3] ExxonMobil Method

With the excellent compatibility with PP, Vistamaxx polymer and PP can be mixed by dry blending in the machine hopper for injection molding. Certain mechanical properties of PP, such as impact resistance and physical properties like clarity and stress whitening, can be improved by using an optimized mix ratio.

### Material Selection

Blend Vistamaxx polymer with either a homopolymer PP (hPP) or random copolymer PP (RCP) for tailor-made PP properties. It is impractical to use 100% Vistamaxx polymer; in particular, the higher MFR grades are more difficult to injection mold due to the long crystallization and cooling time needed.

### Selection of Vistamaxx Performance Polymer

By selecting the correct Vistamaxx polymer grade, the desired PP property modification, like low temperature impact resistance, clarity and reduced flex modulus, can be achieved on the part. Vistamaxx polymer with higher C2 content is the right candidate to blend with hPP or RCP for low temperature and impact applications. However, if higher clarity and low haze properties of RCP or hPP need to be maintained in the mix, lower C2 grades in the Vistamaxx polymer product range are the right products to choose. In order to achieve a homogenous mix, select a Vistamaxx polymer grade with similar MFR for hPP or RCP to achieve good molding results.

Vistamaxx polymer can be used in all PP blends. They demonstrate ease of processing when using conventional plastics machinery. Vistamaxx polymer is compatible with most olefins and exhibits good adhesion to metallocene LLDPE and other polyolefins.

## Material Handling

### Storage

For material storage, we suggest:

- Retain in a cool, dry place
- Keep away from direct heat and open flames
- Avoid contact with solvents and other fluids
- Do not store in direct sunlight

See Vistamaxx polymer guidelines for storage and handling on our web site.

### Material Handling Before Molding

Vistamaxx performance polymer is supplied as free flowing pellets. Storage temperatures above 60°C combined with higher pressure from stacking can lead to pellet agglomeration. If this occurs, it is usually easy to break up the clumps by passing through a screened hopper or by tumbling. Generally pre-drying is not required for Vistamaxx polymer. It can be dry-blended with PP and directly fed into the injection molding machine hopper.

### Use of Regrind Material

The use of regrind material is recommended, especially with in-process regrind, runners and sprues. Use proper cleanout procedures to prevent cross-contamination with other polymers when using regrind. Keeping the regrind ratio consistent will result in a more stable process.

### Coloring

For product coloring, the use of a PP/PE based color masterbatch or pre-colored compound by melt blending is recommended. Either masterbatch or color concentrate should be of similar flow rate to disperse with the base polymer.

# Process

## Molding Temperatures for Vistamaxx Performance Polymer/PP

Best results are obtained when typical a Vistamaxx polymer/PP blend is molded at the following barrel temperatures:

**Typical Barrel Temperatures for Vistamaxx™ Performance Polymer**

| Parameter | Temperature | |
|---|---|---|
| | °C | °F |
| Barrel, rear | 160 to 230 | 320 to 440 |
| Barrel, front | 180 to 230 | 360 to 450 |
| Nozzle | 180 to 240 | 360 to 460 |
| Melt | 180 to 240 | 360 to 460 |
| Mold | <10 to 50 | <50 to120 |

Note: The higher the Vistamaxx polymer concentration, the lower the melt temperature needed.

## Injection Pressure

Resultant injection pressure depends largely on part size and geometry. First stage pressure should be high enough to fill 98% of the part to avoid shrinkage, voids and sink marks. Low to moderate injection pressure is recommended.

## Injection Time

Injection time plays a minor role in controlling warpage as compared to its role in managing and controlling shrinkage.

Note: This is part geometry specific.

## Injection Speed

Injection speed should be moderate to fast, depending on the part geometry. Thin wall parts tend to use fast injection speed.

## Hold Time / Packing Pressure

Allow sufficient pack pressure and time to ensure enough cooling in the gate area and part before ejecting the part. Low to moderate holding pressure is a good option.

## Back Pressure

Medium to high back pressure is necessary for dry blend and color mixing.

## Clamp Tonnage

Vistamaxx polymer requires a minimum of 3 tons/sq. inch of clamping force for the projected area of the molded article.

### Material Mixing

A good quality, properly sized gravimetric blender, which delivers an accurate and consistent dosage, is recommended. This will ensure the molding machine delivers a high quality melt stream.

### Mold Release

Generally parts made of Vistamaxx polymer/PP are easy to eject from a mold – they are soft and snappy in nature. Special care must be taken when molding very soft compounds to ensure ease of ejection; a combined air/mechanical assisted ejector system is recommended.

## Design Considerations

As expected, mold design when using Vistamaxx polymer remains identical to the basic methods and design principles used when designing molds for producing standard PP parts.

### Screw Design

Generally, a conventional polyolefinic screw having a compression ratio of 2.5:1 with a length to diameter ratio between 18:1 and 20:1 is sufficient for a wide variety of Vistamaxx polymer/PP blends.

### Runner Design

A balanced runner design should be used throughout the runner system. This allows each cavity to fill and pack equally, eliminating cavity-to-cavity variation. The runner size and shape should be identical, giving equal and even pressure drop from nozzle to gate. Cold slug wells are recommended to ensure the melt arrives at the gate in optimal condition.

### Hot Runner Processing

Ideally, a hot manifold or hot drop system should convey the melt from the machine barrel to the part cavity without affecting the melt in any way. Specifically, this would mean no change in temperature, with limited pressure loss to the material. Following the hot runner manufacturer's general design guidelines will minimize heat loss, pressure loss and, in general, result in a very controllable and reliable hot manifold system.

### Gate Design

Generally, gate types used in the molding of PP parts can be used for Vistamaxx polymer/PP blends.

### Venting Systems

A well designed vent system is necessary to ensure a stable process for the molding of good quality parts.

### Cavity Surface Finish

A matte or lightly textured surface finish is recommended when using high concentrations of Vistamaxx polymer (above 20%). A 27 to 30 VDI 3400 Ref. finish is recommended.

**Troubleshooting Guidelines - Ingredients Evaluated**

| Problem | Causes | Possible Solutions |
|---|---|---|
| Sink marks | • Part is under-filled and/or has excessive shrinkage in thicker sections | • Increase shot size<br>• Maintain adequate cushion<br>• Increase cavity or hold pressure<br>• Lower melt or mold temperature (if gate freeze-off too slow)<br>• Increase hold time<br>• Reduce fill rate<br>• Cool sink area faster<br>• Open gates<br>• Reducing the wall thickness of intersecting rib or boss<br>• Change improper gate locations or design |
| Voids | • Part is under-filled or has excessive shrinkage | • Need to complete mold fill (short shot)<br>• Maintain adequate cushion<br>• Add venting<br>• Change improper gate location<br>• Reduce injection rate<br>• Reduce part thickness (+6.0 mm [0.25"]) |
| Shrinkage | • Volume decreases as plastic cools and crystallizes<br>• Part is not fully packed out due to gates freezing off too soon or insufficient cooling time | • For cases of excessive shrinkage - increase cavity pressure and hold time<br>• For cases of oversized parts or not enough shrinkage - decrease cavity pressure<br>• Maintain adequate cushion<br>• Increase hold time<br>• Delay gate sealing to allow pack out (increase melt temperature)<br>• Reduce mold or melt temperature (gates not freezing off)<br>• Use a properly balanced cavity and core temperatures<br>• Increase runners or gate size<br>• Eliminate or reduce wall thickness variation (<25% change in thickness) |
| Poor weld line strength | • Convergence of flow fronts past an obstacle or merging flow fronts in multi-gated molds results in weak interfacial bond | • Increase peak cavity pressure (fill faster)<br>• Increase mold and melt temperatures<br>• Increase hold pressure and time<br>• Change gate location |
| Flash | • Insufficient clamp force<br>• Mold surface is defective<br>• Mold shutoff surfaces not seating properly | • Decrease peak cavity pressure (decrease fill rate and/or use profile injection)<br>• Decrease melt temperature<br>• Increase clamp force<br>• Clean mold surfaces<br>• Check mold surface for flatness<br>• Check integrity of mold shutoff |

| Problem | Causes | Possible Solutions |
|---|---|---|
| | | • Change gate location<br>• Use larger press |
| Burning | • Compressed air in the mold degrades resin | • Decrease peak cavity pressure (decrease fill rate and/or use profile injection)<br>• Clean vents<br>• Increase size or number of vents<br>• Reduce melt temperatures |
| Warp | • Non-uniform stress due to excessive orientation and/or shrinkage | • Part ejected too hot (increase cycle time)<br>• Mold at high temperatures, low pressures and moderate fill rates<br>• Decrease injection fill rate<br>• Properly balance core and cavity temperature<br>• Minimize molded-in stress due to low stock temperature and cold mold<br>• Minimize hot spots in mold<br>• Properly balance multiple gates<br>• Add more gating, if flow is too long<br>• Change gate location |
| Poor appearance (flow marks, low gloss, rough surface, jetting, orange peel, etc.) | • Flow front slips/sticks on mold surface, jets or pulsates | • Increase cavity pressure<br>• Increase fill speed and/or packing time<br>• Increase melt and/or mold temperature<br>• Cool more slowly<br>• Mold temperature non-uniform or too low<br>• Add sufficient lubrication (internal lubricant or on tool surface)<br>• Decrease/eliminate mold lubricant (*e.g.,* grease bleeding out of the mold)<br>• Clean and/or polish dirty mold surface<br>• Increase back pressure or use mixing elements for better pigment dispersion<br>• Increase venting<br>• Change gate location or design |
| Sticking in mold | • Over packing, excessive shrinkage or tool design causes physical attachment to the core or cavity | • Over packing, injection pressure too high-reduce<br>• For cases of under packing and excessive shrinkage, see solutions to Short Shot<br>• Reduce cycle time (sticking on cores)<br>• Increase cycle time (sticking in cavities)<br>• Add knockouts<br>• Remove undercuts<br>• Increase draft angles<br>• Polish cavity to remove surface irregularities in the mold<br>• For highly polished core surfaces (vacuum lock), polish to coarser finish, apply surface coating or increase venting |
| Gate blush, delamination or cracking at the gate | • Melt fracture | • Adjust injection speed (increase or decrease)<br>• Modify gate geometry (*e.g.,* gate too small, land too long)<br>• Add cold slug wells in the runners |

| Problem | Causes | Possible Solutions |
|---|---|---|
| | | • Increase melt and/or mold temperature |
| Black specks or discoloration | • Degradation | • Decrease melt temperature or residence time in barrel<br>• Improve venting<br>• Remove contamination<br>• Reduce screw RPM<br>• Reduce back pressure<br>• Reduce shear created by the use of a mixing screw |
| Short shots | • Under-filled part | • Increase shot size<br>• Increase cushion<br>• Increase fill speed, pack pressure and/or injection time<br>• Increase melt and/or mold temperature<br>• Remove plugged gates/runners or clean vents<br>• Inadequate melt flow rate (use higher MFR material)<br>• Increase gates, runners or vents |
| Splay | • Streaks on surface caused by volatiles such as moisture or degraded material | • Remove volatiles created by hot spot in manifold(check if manifold is functioning properly)<br>• Remove excessive moisture (dry resin)<br>• Reduce melt temperature |
| Gate stringing | • Plastic strings on parts located at gates formed during ejection | • Increase gate size (reduce orientation)<br>• Decrease melt temperature, increase cooling time<br>• Decrease drop tip temperature<br>• Increase mold opening speed (break strings upon ejection)<br>• Use valve gates |

**Contact your ExxonMobil Chemical representative for more information.**

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