

Section 1.0 – Scope

This processing guide applies to all of NTIC’s subcontractors and customers purchasing Natur-Tec® BF3002HT resin for production of injection molded cutlery.

Section 2.0 – Purpose

To provide Natur-Tec® customers with processing information for production of high quality bio-based and biodegradable injection-molded cutlery when utilizing the Natur-Tec® injection mold resin. This information is intended for use only as a guide for the injection molding of Natur-Tec® BF3002HT resin. Due to variations in different injection molding equipment, an experimental approach may be required to achieve desired results. Testing of the products molded from Natur-Tec® BF3002HT is also recommended to ensure user’s requirements are satisfied.

Section 3.0 – Storage & Safety Precautions

3.1: Safety and Handling Precautions

All safety precautions normally applied in the handling and processing of melted thermoplastics should be followed for Natur-Tec® injection molding resins. As with most thermoplastics, melt processing and variability in processing conditions may result in minor decomposition. Appropriate air testing should be completed to ensure that an acceptable Threshold Limit Value (TLV) of less than 5mg/m³ is maintained. The use of process area point source remediation measures such as monomer fume hoods or exhausts near melt processing equipment are typically recommended.

Natur-Tec® BF3002HT is considered non-regulated according to D.O.T. (U.S. Department of Transportation) shipping regulations. When handling Natur-Tec® BF3002HT resin at room temperature, avoid direct skin and eye contact along with conditions that promote dust formation. For further information, consult the Natur-Tec® BF3002HT MSDS. As with any melted thermoplastic waste, melted Natur-Tec® BF3002HT waste should be allowed to cool before being placed into any waste container to minimize fire risks.

3.2: Pellet Storage and Blending Recommendation

Natur-Tec® BF3002HT resins should be stored in an environment designed to minimize moisture uptake. Product should also be stored in a cool place at temperatures below 104°F (40°C). Product that is delivered in cartons or super sacks should be kept sealed until ready for loading into the blending and/or drying system. In the case of outside storage, if the product is supplied in boxes or other non-bulk containers, the unopened container should be brought into the extrusion production area and allowed to equilibrate for a minimum of 24 hours before opening to prevent excessive condensation.

3.3: Resin Properties

Typical properties for an injection molded part with Natur-Tec® BF3002HT resins are shown in the table below:

Physical Properties*			
Property	Unit	Test Method	Value
Specific Gravity	g/cm ³	ASTM D792	1.4 – 1.5
** Melt Flow Rate MFR 190°C, 2.16 kg	g/10 min	ASTM D1238	5 – 8
Molding Shrinkage	%	ASTM D955	Axial: 0.2 – 0.3 Lateral: < 0.1
Mechanical Properties*			
Property	Unit	Test Method	Value
Tensile Strength	MPa	ASTM D638	64
Elongation	%	ASTM D638	7
Flexural Strength	MPa	ASTM D790	108
Notched Izod Impact Strength	J/m	ASTM D256	8.7
Property	Unit	Test Method	Value
Heat Deflection Temperature (Un-annealed)	°C	ASTM D648	60
Heat Deflection Temperature (Annealed)	°C	ASTM D648	125

* Data obtained from annealed standard test bars molded with 50/50 blend of Natur-Tec® BM3002HT masterbatch and Ingeo™ 3001D.

** MFR determined from a 50/50 blend of Natur-Tec® BM3002HT masterbatch and Ingeo™ 3001D.

Section 4.0 – Injection Molding

4.1: Drying

Prior to molding, Natur-Tec® BF3002HT, check the moisture content. If it is above 0.1%, it is highly recommended to dry the resin in a dehumidifying dryer to get the moisture content below 0.1%. Natur-Tec® BF3002HT resin can be successfully dried using most standard drying systems. The resin should not be exposed to atmospheric conditions after drying. Keep the package sealed until ready to use and promptly dry and reseal any unused material. Typical Natur-Tec® BF3002HT drying conditions are 70 °C for 2 – 4 hours in a dehumidifying drier.

4.2: Melt Processing

Prior to introducing Natur-Tec® BF3002HT into any melt processing system, the system should be properly cleaned and purged to prevent any polymer cross-contamination. Ensure that the feeding & blending equipment are thoroughly cleaned and free of dust and contamination, taking extra note to thoroughly clean all potential hang-up areas such as elbow transitions and slide gates. The purging procedures below are recommended for optimal removal of other polymers.

4.2.1: Purge Procedure

- Purge with low melt flow rate general purpose polypropylene (PP) or polystyrene (PS) at normal operating temperatures. Purge 10 – 30 minutes as necessary. Let system empty as much as possible. Clean hopper thoroughly.
- Introduce a high melt flow PP (5 - 8 MFR) and change to recommended operating temperatures in Section 4.2.2 below.
- Purge 10-30 minutes as necessary. Let system empty as much as possible.
- Stop injection molding and completely clean all hoppers, elbow, slide gates, dryers, hopper loaders bins, hopper loader filters and material conveying lines of residual PP. Load Natur-Tec® BF3002HT into material handling system.
- Transition Natur-Tec® BF3002HT for 10-30 minutes as necessary.
- At the completion of the run, immediately purge all Natur-Tec® BF3002HT from the extrusion/molding system, using a moderate to low melt index PP or PS.

4.2.2: Typical Injection Molding Set up for Processing Natur-Tec® BF3002HT

Recommended Temperature Profile:

	Feed	Zone 1	Zone 2	Zone 3	Nozzle	Mold
Set Temperature °F (°C)	104 (40)	320 (160)	350 (176)	365 (185)	365 (185) - Short Nozzle 375 (190) – Long Nozzle	95 – 130 (25-30)

- **Note:** Do not raise the barrel temperature above 200 °C (392 °F) and maintain the temperature within ± 5 °F of set value to prevent degradation.

Recommended Pressure Set-up:	Injection Pressure: 50 bar at 20 L/t ratio; 70-80 bar at 60 L/t ratio; 140 bar at 100 L/t ratio Back Pressure: 5 – 10 bar Holding Pressure: 50 – 70% of injection pressure
Injection Conditions:	Injection Speed: Zone 1: 40 – 60 mm/s Zone 2: 15 – 20 Hold time: 1 sec
Extruder Speed:	80 – 100 rpm
Additional Notes:	Mold shrinkage of this material is low. Please choose a mold which is designed for low shrinkage material (such as PS). Using a mold which works for PE/PP may cause ejection problems. Try a smaller shot size in such a case.
Machine breakdown:	In case of breakdowns lasting longer than 5 minutes, remove BF3002HT resin from the hopper. Purge the extruder and re-start.

Section 5.0 – Process Steps for Annealing Cutlery made with BF3002HT

When cutlery molded with BF3002HT resin is to be used for high-heat applications, the cutlery has to be annealed (crystallized) in order to increase its heat resistance (see section 3.3). Cutlery that has not been annealed will have a lower heat resistance – up to 55°C only. Annealed cutlery will have heat resistance up to 125 °C.

Annealing can be done either during molding (in-mold annealing) or after molding (post-mold annealing). Following are the steps to anneal cutlery after molding (post-mold annealing):

1. Lay cutlery flat in a single layer on a heat resistant tray. Note it is important that the cutlery pieces do not overlap each other as the pieces soften slightly during the heating step of the annealing cycle; overlapping pieces would deform upon softening.
2. Place the cutlery-filled tray inside the oven preheated to 95°C and hold for 10min. If a conveyor oven is used, ensure the cutlery has 10min residence time in the heated section.
3. Temperature in the oven should be controlled within +/-5 °C
4. Cool annealed cutlery after removal from oven. Cutlery is then ready for packaging.

NB: The steps outlined above for annealing cutlery can also be applied to other products made from BF3002HT resin and that are to be used in high heat applications.

Note: The information provided herein is provided in good faith, but no warranties, express or implied, are provided with respect thereto. It is the responsibility of the users of Natur-Tec® resins to determine the proper conditions of use on their particular equipment and at their particular facilities.