

This bulletin is intended for use only as a tool to provide information and help address issues that may pertain to the preform design for Ingeo bottles. Since there are many factors to consider with preform and bottle development and manufacturing, an experimental approach may be needed.

Injection stretch-blow molded (ISBM) bottles made from Ingeo biopolymer, in a lot of respects, share the same attributes to bottles made from PET. They look and feel similar to each other with regard to clarity and toughness. Also, bottles made from these two different resins are made the same way. First, a preform is injection molded. Then, it is conditioned or reheated and with the use of a stretch rod, the preform is stretched and blow molded into the final bottle shape.

Despite the obvious similarities of Ingeo biopolymer and PET, there are some differences. The biggest one is processing temperature. Typical melt processing temperatures for Ingeo biopolymer range from 200-230°C vs. 270-290°C for PET. The glass transition temperature of Ingeo biopolymer is also about 15°C lower than typical bottle grade PET. This lower glass transition temperature means that an Ingeo preform requires a lower temperature for blowing than PET.

Ingeo biopolymer can be injection molded and blown using typical PET tooling and equipment. Depending on the bottle and machine type, usually using a preform initially designed for PET will work. For the most part, with just changes in some processing parameters like temperature and blow timing, a high quality Ingeo bottle can be made from a preform designed for PET. However, there is an opportunity for improved injection molding and bottle performance with optimized preform mold designs for Ingeo biopolymer.

Below are some recommendations that have been made with regard to typical stretch ratios for Ingeo biopolymer 7001D.

- Areal Stretch Ratio (Axial x Radial)**.....8-11
- Axial Stretch Ratio**.....2-3
- Radial Stretch Ratio**.....3-4

It has also been found that preforms with shorter, less abrupt neck transitions work well for Ingeo biopolymer. Preforms with transitions that are abrupt where the wall of the preform goes from thin to thick, are less forgiving when made from Ingeo biopolymer. In certain bottle or machine design incidences, preforms with a thinner end-cap may also help prevent material accumulating in the bottle's base. Depending upon the preform design, wall thickness, and machine design, reheat additives may be beneficial for improving the heating efficiency of preforms.

NatureWorks LLC has collaborated with Husky Injection Molding Systems and Plastic Technologies, Inc. for technical development purposes specifically related to Ingeo preforms and stretch blow molded bottles. The contacts at either of these companies can be used as a resource for one gaining experience with Ingeo biopolymer with regards to preform and bottle design considerations (see below). The bottle equipment manufacturer is also a good resource to collaborate with on any such product development project.

Plastic Technologies, Inc.  
1440 Timberwolf Drive  
Holland, OH 43528  
Phone: (419) 867-5400

Husky Injection Molding Systems  
500 Queen Street S.  
Bolton, Ontario, Canada L7E 5S5  
Phone: (905) 951-5000

## Safety and Handling Considerations

Material Safety Data (MSD) sheets for Ingeo biopolymers are available from NatureWorks LLC. MSD sheets are provided to help customers satisfy their own handling, safety, and disposal needs, and those that may be required by locally applicable health and safety regulations, such as OSHA (U.S.A.), MAK (Germany), or WHMIS (Canada). MSD sheets are updated regularly; therefore, please request and review the most current MSD sheets before handling or using any product.

The following comments apply only to Ingeo biopolymers; additives and processing aids used in fabrication and other materials used in finishing steps have their own safe-use profile and must be investigated separately.

## Hazards and Handling Precautions

Ingeo biopolymers have a very low degree of toxicity and, under normal conditions of use, should pose no unusual problems from incidental ingestion, or eye and skin contact. However, caution is advised when handling, storing, using, or disposing of these resins, and good housekeeping and controlling of dusts are necessary for safe handling of product. Workers should be protected from the possibility of contact with molten resin during fabrication. Handling and fabrication of resins can result in the generation of vapors and dusts that may cause irritation to eyes and the upper respiratory tract. In dusty atmospheres, use an approved dust respirator. Pellets or beads may present a slipping hazard. Good general ventilation of the polymer processing area is recommended. At temperatures exceeding the polymer melt temperature (typically 170°C), polymer can release fumes, which may contain fragments of the polymer, creating a potential to irritate eyes and mucous membranes. Good general ventilation should be sufficient for most conditions.

Local exhaust ventilation is recommended for melt operations. Use safety glasses if there is a potential for exposure to particles which could cause mechanical injury to the eye. If vapor exposure causes eye discomfort, use a full-face respirator. No other precautions other than clean, body-covering clothing should be needed for handling Ingeo biopolymers. Use gloves with insulation for thermal protection when exposure to the melt is localized.

## Combustibility

Ingeo biopolymers will burn. Clear to white smoke is produced when product burns. Toxic fumes are released under conditions of incomplete combustion. Do not permit dust to accumulate. Dust layers can be ignited by spontaneous combustion or other ignition sources. When suspended in air, dust can pose an explosion hazard. Firefighters should wear positive-pressure, self-contained breathing apparatuses and full protective equipment. Water or water fog is the preferred extinguishing medium. Foam, alcohol-resistant foam, carbon dioxide or dry chemicals may also be used. Soak thoroughly with water to cool and prevent re-ignition.

## Disposal

DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. For unused or uncontaminated material, the preferred options include recycling into the process or sending to an industrial composting facility, if available; otherwise, send to an incinerator or other thermal destruction device. For used or contaminated material, the disposal options remain the same, although additional evaluation is required. (For example, in the U.S.A., see 40 CFR, Part 261, "Identification and Listing of Hazardous Waste.") All disposal methods must be in compliance with Federal, State/Provincial, and local laws and regulations.

## Environmental Concerns

Generally speaking, lost pellets are not a problem in the environment except under unusual circumstances when they enter the marine environment. They are benign in terms of their physical environmental impact, but if ingested by waterfowl or aquatic life, they may mechanically cause adverse effects. Spills should be minimized, and they should be cleaned up when they happen. Plastics should not be discarded into the ocean or any other body of water.

## Product Stewardship

NatureWorks LLC has a fundamental duty to all those that make and use our products, and for the environment in which we live. This duty is the basis for our Product Stewardship philosophy, by which we assess the health and environmental information on our products and their intended use, then take appropriate steps to protect the environment and the health of our employees and the public.

## Customer Notice

NatureWorks LLC encourages its customers and potential users of its products to review their applications for such products from the standpoint of human health and environmental quality. To help ensure our products are not used in ways for which they were not intended or tested, our personnel will assist customers in dealing with ecological and product safety considerations. Your sales representative can arrange the proper contacts. NatureWorks LLC literature, including Material Safety Data sheets, should be consulted prior to the use of the company's products. These are available from your NatureWorks LLC representative.

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