
Bulletin on the use of Additives in NatureWorks PLA Bottles.

This bulletin is intended for use only as a tool to provide information and address issues that may pertain to the use of additives for NatureWorks PLA bottles.

Depending on end-use application, the use of additives for PLA ISBM bottle applications may be desired in order to improve the appearance of the bottle, increase productivity or ease of manufacture, or enhance a specific end-use property.

The items in this bulletin will provide some basic information on the use of additives with PLA. It will cover issues associated with the additive types, and how they are normally implemented.

Basic Additive Forms

Additives are usually added to the preform during the injection molding step. Typically, these additives are in two different forms, solid or liquid. The solid form is usually comprised of either a waxy prill or a master batch, where the carrier is the same material being used as the main resin in the preform - in this case NatureWorks PLA. Additives delivered in the liquid form are also available in the market place for PLA bottle applications. Liquid additives are usually delivered via a pump and mixer combination where the raw pellets mix with the additive before entering the feed section of the extruder.

Solid Additive Systems

Since PLA is not compatible with many other resins, it is very important to use PLA as the carrier in any solid masterbatch system. There have also been successes with additives that are in a prill form where the carrier comprised of a wax. It is recommended that experimentation on these prilled systems be done in order to make sure that it does not affect clarity, since this can be a sign of phase separation.

There are many different companies that are in the market of making additives for ISBM bottles. Many of these have the greatest experience with PET resin. However, as will be discussed later in this bulletin, there are also several beginning to gain knowledge for PLA bottle applications. Many of these additive manufacturers also make equipment to deliver the solid additives to the injection molder. This equipment is basically used to provide accurate letdown ratios and uniform mixing of the masterbatch with the main bottle resin itself. It is recommended to also use this equipment, if available, when running PLA preforms.

If addition equipment is not available for use with a PLA solid masterbatch, then the use of a “salt-and-pepper” blend of PLA and masterbatch will be necessary. It is very important when doing this type of blending that the masterbatch pellets are close to the same size as the PLA pellets. The bulk density of PLA pellets is about 44 lbs/ft³. If the pellet size of the masterbatch is significantly different, separation of the masterbatch and the main resin can result. This can lead to differences in appearance and performance from preform to preform.

Liquid Additives Systems

Liquid additives are also usually comprised of active ingredients along with an inert carrier. It is very imperative that the addition equipment recommended by the additive supplier is being used and to also that the instructions pertaining to letdown ratio are followed.

It is also very important with liquid systems that the carrier/additive combination does not promote screw slipping in the injection molder when used with PLA. Screw slipping will eventually result in inconsistent screw recovery times and, sometimes, a complete loss of feed.

Bulletin on the use of Additives in NatureWorks PLA Bottles.

Additive Types

The use of an additive for a PLA bottle usually is dependent on the end-use application. Different products have different requirements of the package for added protection and shelf-life.

Some basic additives for bottles made from NatureWorks PLA include:

- **Toner**
 - NatureWorks® PLA pellets have a slight yellow hue. To mask this yellowness, a toner may be used to produce a bottle that is clear and has high shelf appeal to the consumer. Toners may also be used to impart a different color to the bottle package.
- **Reheat Additive**
 - For two-stage ISBM processing, a reheat additive may be desirable in the preform in order to increase the rate of up heat while in the oven prior to blow molding.
- **UV Inhibitor**
 - Certain bottled products, like milk, are sensitive to UV light. The addition of a UV absorber or inhibitor to the preform might be needed for prolonged shelf-life.
- **Oxygen Absorber**
 - To protect products sensitive to oxygen, such as juice, an oxygen absorber can be introduced into the preform. Usually, these oxygen absorbers are active and work by means of a reaction. They work to prolong shelf-life as long as there is oxygen absorber left to react.
- **Slip/Process Aid**
 - To reduce the coefficient-of-friction (COF) on the PLA preforms and bottles, a slip additive or process aid might be used. The reduction of the COF can help reduce scuffing and scratching of bottles during processing, filling, and shipping.

Bulletin on the use of Additives in NatureWorks PLA Bottles.

Additive Companies

NatureWorks LLC is working with some major additive suppliers to the bottle market. Please contact one of these for added commercial or technical support. Some customers have also had success working with their traditional local additive suppliers. NatureWorks LLC makes no warranties or claims of suitability or availability of additives with suppliers, whether listed here or not. The companies listed are companies who NatureWorks LLC has worked with directly, in supply of additives for our work or customer's work.

North America (includes Canada)

Color Matrix

680 North Rocky River Dr.
Berea, OH 44017-1628
(216) 622-0100
www.colormatrix.com

Holland Colours Americas Inc.

1501 Progress Drive
Richmond, Indiana 4737
800-723-0329
www.hollandcolours.com

Americhem, Inc.

225 Broadway East
Cuyahoga Falls, OH 44221
800-228-347-6800

PolyOne

33587 Walker Road
PolyOne Center
Avon Lake, OH 44012
United States
866-765-9663
www.polyone.com

Sukano Polymers Corporation

295 Parkway East
Duncan, SC 29334
(864) 486-1478

Europe

Color Matrix Europe Ltd.

Commercial & Tech Center
269-273 Hastelweg
Eindhoven 5652 CV
The Netherlands
+31 402 916 524

Sukano Products Ltd.

Chaltenbodenstrasse 23
8834 Schindellegi
Switzerland
Tel: +41 44 786 99 35

Mexico

Color Matrix

680 North Rocky River Dr.
Berea, OH 44017-1628
(216) 622-0100
www.colormatrix.com

Holland Colours Mexicana S.A. de C.V.

Tezozomoc 4, Bodega 3
Col. Recursos Hidraulicos
Tultitlan, Estado de Mexico 54913
Tel. (+) 52-55- 58 94 36 41
Fax (+) 52-55- 58 94 42 55
E-mail: mexico@hollandcolours.com

PolyOne de Mexico S.A. de C.V.

Toluca
52-722-279-0200

Bulletin on the use of Additives in NatureWorks PLA Bottles.

Food Contact/FDA Concerns

Please note that it is the responsibility of both the manufacturers of finished food contact articles as well as the industrial food packers to make sure that their articles in actual use are in compliance with federal, regional, and local requirements and limitations. Any post addition of additives, colorants, or other adjuncts to NatureWorks LLC PLA resin requires that appropriate regulations be consulted for complete details on compliance to the appropriate norms. NatureWorks LLC makes no representation on the compliance of reference materials to regulatory requirements. NatureWorks LLC recommends that all manufacturers check with their colorant/additive supplier for correct compliance certification to appropriate legal and product stewardship requirements for appropriate geographical areas. We urge all of our customers to perform GMP (Good Manufacturing Procedures) when constructing a package so that it is suitable for the end use.

Safety and Handling Considerations

Material Safety Data (MSD) sheets for PLA polymers 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 PLA polymers; 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

PLA polymers 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

NOTICE: No freedom from any patent owned by NatureWorks LLC or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer's use and for ensuring that Customer's workplace and disposal practices are in compliance with applicable laws and other governmental enactments. NatureWorks LLC assumes no obligation or liability for the information in this document. **NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE ARE EXPRESSLY EXCLUDED.**

NOTICE REGARDING PROHIBITED USE RESTRICTIONS: NatureWorks LLC does not recommend any of its products, including samples, for use as: Components of, or packaging for, tobacco products; Components of products where the end product is intended for human or animal consumption; In any application that is intended for any internal contact with human body fluids or body tissues; As a critical component in any medical device that supports or sustains human life; In any product that is designed specifically for ingestion or internal use by pregnant women; and in any application designed specifically to promote or interfere with human reproduction.

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 PLA polymers. Use gloves with insulation for thermal protection when exposure to the melt is localized.

Combustibility

PLA polymers 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.

For additional information in the U.S. and Canada,
call toll-free 1-877-423-7659
In Europe, call 31-(0) 35-699-1344
In Japan, call 81-33-285-0824