

## Purpose

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To provide a guide to achieve consistent optimum product properties and performance from thermal bonded PLA batting. Since each customer has different types of equipment, process conditions should be adjusted to accomplish desired product performance. No specific machine settings are given, only desired parameters.

The following recommendations should be used as a general guideline. Proper adjustments should be made to fine-tune each special case.

### Fiber Conditioning

Fiber should be conditioned in operating area ideally at 75° F, 55% relative humidity for eight hours before processing. Low temperature and humidity, such as those experienced during the winter months, could cause excessive static generation which would cause processing problems. High temperature and/or humidity may cause sticking problems during garnetting. Temperature and humidity should be controlled in the processing area to eliminate static related problems.

### Line Preparation

Production line should be thoroughly cleaned before running PLA fibers to prevent contamination. Opening and blending equipment are especially critical because they can release contaminated materials slowly and sporadically throughout the production. Check all machine settings according to machine manufacturer's recommendation. Check accuracy of temperature gauges in oven to make sure they will not lead to overbonding of fibers.

### Equipment Requirements

#### opening and blending

Adequate opening equipment is required to separate fiber mat from the bale into small manageable fiber bundles. The capacity of opener must be at least equal to or greater than the rest of the production line capacity. The opener should operate at least 50%, and preferably 70-90%, of the time during the run to ensure good opening of fibers.

Because blending is required to mix low melt binder fibers with regular fibers in the case of thermal bonding products, a blending line with multiple hoppers/openers and independent weigh pans should be standard equipment. The blending accuracy should be within

+/-3% of desired level. The fibers should be combined on a common conveyor, fed to a picker or fine opener and air conveyed to the hopper of garnett or carding machine. In some cases, passing through a separate fine opener first is desired for better blending before feeding to the garnett or card.

## garnetting or carding

A garnett or card clothed with wire type and density suitable for the fiber denier is required. In general, low denier fiber requires finer gauge wire and higher wire density to be processed into uniform web for good quality products. For example, 100-200 wire points/inch<sup>2</sup> density can process 3-9 denier fiber adequately. 500-600 points/inch<sup>2</sup> wire density may be required to process fibers that are  $\geq 1$  dpf.

All moving rolls in garnett or card must be cleaned so fibers can be effectively separated into individual fibers to form uniform web. Damaged wires should be repaired so no holes will be formed in the web. Each roll speed and roll setting (clearances between rolls) should be adjusted according to equipment manufacturing recommendations, as improper settings could cause fiber neps and excessive variation in the web.

## cross-lapping

Either horizontal or camelback type cross-lapper is acceptable to carry web from garnett/card and build into multiple layers batting to meet the required weight. The cross-lapper speed must be adjustable to ensure that batting weight is consistent from side to side with variations no more than +/- 5% of the average weight. The movement of the cross-lapper must be such that the web will not be distorted to create thick and thin areas in the batting.

## thermal bonding oven

Must have a through air oven with air velocity adequately penetrating through the thickness of the batting. Adjustment may be required to ensure that hot air does not bypass the batting so adequate bonding can be achieved. The temperature control on the surface of the batting should be +/- 3° C of the desired temperature. No hot spots should exist in any part of the bonding area.

A cooling zone is required at the exit of the oven to reduce batting temperature to  $\leq 45^{\circ}$  C. Batting thickness will decrease if the batting temperature is too high before being wound up under pressure.

## windup area

Thermally bonded batting is easily compressed under high tension or high pressure. The resulting thickness is lower than expected. One should use great effort to wind up batting into roll with minimum tension or pressure.

Finished rolls should be protected from contamination by packaging material. Avoid using mechanical compression or vacuum packing on finished rolls to prevent permanent thickness loss of the batting.

## Processing PLA Fiber

### blending and recycling PLA battings

100% PLA fiber should be used to produce thermally bonded products unless exceptions are given in writing or based on special requirement. Waste battings with PLA fibers only are allowed to recycle back to production line by blending in no more than 10% by weight at any given time. The recycle waste PLA batting should be thoroughly separated and well blended with at least 90% virgin PLA fibers from bale. With more than 10% recycle batting, the final product performance will be significantly changed. In some cases, it may cause process problem such as deposits on garnett/card wires and poor bonding in oven. Also, short fibers and dust may be generated during the picking process, which can lead to potential skin/eye irritation if proper measures are not taken. No other waste battings with other types of fibers are allowed to blend with PLA.

## web and batting appearance

A uniform web without holes, neps or thick and thin spots is essential to give expected good final products. Good equipment maintenance, proper settings and proper web tension are essential to making a good web and final batting.

## binder fiber blend level

10-25% low melt PLA binder fiber is recommended to blend with regular PLA fibers depending on tensile strength and thickness requirements. In general, 18% is commonly used to provide adequate strength for subsequent finishing process and end use durability.

## thermal bonding

Because PLA melts at low temperature (165° C), which is close to the melting point of the binder fiber (110° C), the thermal bonding window is relatively narrow. Depending on tensile strength required for the final product, recommended bonding temperature on surface of the batting is 110-130° C. Temperature higher than 145° C can form harsh battings or curling fiber ends which can lead to batting layers sticking together due to “Velcro” effect. Running the temperatures above PLA’s melt point can pose a fire hazard both in the oven and after the batting has been stored if it has not been adequately cooled.

When PLA is melt processed, lactide can be generated. At the recommended bonding temperatures, lactide generation should not be an issue unless the ventilation on the oven is insufficient. The oven should have adequate ventilation to remove any fumes from the bonding area, maintaining lactide levels below 5mg/m<sup>3</sup>.

## product release limits

Each product should have a specification with acceptable limits to be used for product release. Basis weight, thickness, tensile strength and appearance are some of the properties to be checked. Release limits should not be too wide to cause inconsistent performance or too narrow to cause a significant negative impact on yield. For weight uniformity, the tolerance limits are:

+/-10% per ft<sup>2</sup> or 0.1 m<sup>2</sup> from average

+/-7.5% per yd<sup>2</sup> or m<sup>2</sup> from average,

+/-5% per roll of 30 yards or meters

No product should be released if any defect such as holes, high neps, thick and thin spots and/or contamination are present in the batting.

One should establish statistical data over a period of production runs to set the release limits on tensile strength and thickness. For these two properties, each converter should determine the critical level for each end use and set standard accordingly.

## Product Disclaimer

### safety and handling considerations

Material Safety Data Sheets (MSDS) for Ingeo fibers are available from NatureWorks LLC. MSDS 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 MAK (Germany), OSHA (U.S.A.), etc. MSDS sheets are updated regularly; therefore, please request and review the most current MSDS sheets before handling or using any product.

## handling

Ingeo fibers have a very low degree of toxicity and under normal conditions of use should pose no unusual problems from incidental ingestion. Eye contact with fibers should be avoided to prevent mechanical irritation to the eyes. 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 is required in such conditions to maintain an adequate work environment below established PEL (Personal Exposure Limit).

## 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 a composting facility if available; otherwise, send to an incinerator or other thermal destruction device. Disposal method must be in compliance with federal, state/provincial and local laws and regulations.

## environmental concerns

Generally speaking, lost fibers 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 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 health of our employees and the public. If you would like more assistance with the health and safety of our products please contact your NatureWorks representative.

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