

Needle-punching processing

Technical Bulletin 30904

Purpose

To provide general guidelines to achieve consistent optimum product property and performance when using PLA fiber in needle punch fabrics. Since each converter has different types of equipment, no specific machine settings are given, only desired parameters. Process conditions should be adjusted to accomplish desired product properties and performance. Proper adjustments should be made to fine-tune each process and equipment case by case.

Fiber Conditioning

It is recommended to keep the bales in the processing area, ideally at 75° F and 55% relative humidity for at least eight hours to come to equilibrium. At these conditions, the moisture and finish content on the surfaces of the fibers should provide trouble-free processing. If an imbalance occurs, either high static generation due to low moisture level, or fiber sticking to card wires due to high moisture level, processing problems often become an issue. Controlling temperature and humidity in the processing area is preferred to minimize potential 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 recommendations. Check accuracy of temperature gauges in oven (if oven is needed) to make sure they will not lead to overbonding of fibers.

Equipment Requirements

opening and blending

This is the first step to prepare the fibers for carding/garnetting and web formation. The objective is to break down the big pieces of matted down bundles from bale into small manageable size and feed to the

fine opener to further separate into individual fiber. Gentle opening either by single opener or multiple openers is the key for successful web formation. Defects can be generated in this step if aggressive opening is used. Depending on the degree of the opening, and the feed batt density to the card, the uniformity of the web is determined. Significant amount of unopened bundles will give high feed density resulting in heavier web weight at a given feed roll speed. The unopened bundles will also form thick spots (or cloudiness) in the web affecting the uniformity in weight distribution and appearance. If rat tails are formed in this step or previous steps, the defects such as neps or lumps will show up in the final product.

The capacity of the opener must be at least equal to or greater than the rest of the production line capacity. In general, the opener should function at least 50%, preferably 70-90% during the run to ensure good opening of fibers. If blending is required to mix different deniers or low melt binder fibers in case of thermal bonding (in addition to needle punch), a blending line with multiple hopper/opener each equipped with weigh pan should be standard equipment. The blending accuracy should be within +/- 3% of desired level.

These mixed fibers from a common conveyor are normally fed to a picker/feed and air conveyed to the feed hopper of garnett/card. In some cases, passing through a separate fine opener first is desired for better blending before feeding to garnett/card.

garnett/card

A garnett or card clothed with wire type and density suitable for the fiber dtex (denier) is required. In general, low dtex (denier) fiber requires fine wires and higher wire density to be processed into uniform web for good quality products. For example, 15.5-31 wire points/cm² (100-200 points/in²) density can process 3-10 dtex (3-9 denier) fiber adequately. Up to 77-93 points/cm² (500-600 points/in²) is required to process 1.1 or low dtex (1 denier or lower) fibers.

All moving rolls in garnett/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. Wrong setting could cause fiber neps and irregularities in the web.

cross-lapper

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 must have speed control so that batting weight is consistent from side to side with variation 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.

needle loom

Needle punch density must be adequate to provide final batting desired tensile and thickness. All needles should be cleaned so no fiber deposit or accumulation of entangled fibers on the base of needles (shank or intermediate section) occurs. Needles with entangled fiber deposits, if large enough, can punch holes in the batting. Replace all broken needles and needles with worn barbs from the needle board.

Needling can be accomplished by either one-sided needle loom (down stroke or upstroke) or double-sided needle loom, with or without preneedling (tacker). Production line speed could be adjusted to achieve required needling density for desired batting properties. Selection of needle size should be such that smooth uniform batting surfaces without large needle holes can be produced.

thermal bonding oven

For products requiring blending with binder fibers to increase batting tensile property and stability, a through air oven with air velocity adequately penetrating through the thickness of the batting should be used. Adjustment is required to make sure hot air will not bypass the batting so adequate bonding can be achieved. The temperature control on the surfaces of the batting should be within $\pm 3^{\circ}$ 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 so batting will not be wound up in temperature higher than 45^o C. If batting is wound up under pressure at high temperature, batting thickness will decrease.

windup area

Needle punched batting can be compressed under high tension or high pressure. The resulting thickness is lower than expected. One should not use excessive tension or pressure on windup rolls. Finished fabrics should be protected from contamination by packing material. Avoid using vacuum packing on finish rolls to prevent permanent thickness loss of the batting.

Processing PLA Fibers

fiber blends and batting recycling

100% PLA fiber should be used to produce needle punched 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 a given time (with 90% virgin PLA from bale). The recycle waste PLA batting should be thoroughly separated and well blended with at least 90% virgin PLA fibers.

Increasing the level of recycled batting beyond 10% recycle batting will significantly change the final product performance. In some cases, it may cause process problems such as deposits on garnett/card wires and poor bonding in oven. No other waste battings with other types of fibers are allowed to blend with PLA.

binder fiber blend level (if required)

In general, needlepunched fabrics provide adequate tensile strength for most end uses. In some cases, if increased tensile strength and fabric stability are required, binder fiber can be used. Depending on the tensile strength and thickness required, 10-20% low melt PLA binder fiber is recommended to blend with regular PLA fibers.

thermal bonding (if required)

Since PLA has a 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 final products, 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.

web/batting appearance

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

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 nonconsistent performance or too narrow to impact yield significantly. The tolerance limits for basis weight are:

+/-10% per ft² or 0.1m² from average, or

+/-7.5% per yd² or m² from average, or

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

Needle punch fabric manufacturers 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 OSHA (U.S.A.), MAK (Germany) or WHMIS (Canada). MSDS sheets are updated regularly; therefore, please request and review the most current MSDS sheets before handling or using any product. The following comments apply only to Ingeo fibers; 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 fibers have a very low degree of toxicity and under normal conditions of use should pose no unusual problems from incidental ingestion. In some cases, finishes used on the fibers which impart desirable end use performance enhancements may cause low levels of skin or eye irritation on prolonged contact. Workers should wear long sleeves and appropriate gloves for frequent contact with fibers. Eye contact with fibers should be avoided and proper hygiene practices used to prevent transferring fiber finishes to the eyes. Caution is advised when handling, storing, using or disposing of these fibers and good housekeeping and controlling of dusts is necessary for safe handling of product. In dusty atmospheres, use an approved dust respirator. At temperatures exceeding the polymer melt temperature (typically 170° C), polymer can release fumes which may contain fragments of the polymer. Fumes can be irritating. Good general ventilation is required in such conditions. Use safety glasses when handling fibers. If there is potential for exposure to particles which could cause mechanical injury to the

eye, wear chemical goggles. If vapor causes eye discomfort, use a full-face respirator. No other precautions other than clean, body-covering clothing should be needed for handling PLA fibers. Use gloves with insulation for thermal protection when needed. Additional protective equipment may be necessary due to special chemical addition, finishes or processing which may introduce additional hazards. The fiber user should evaluate such chemicals or processes on a case by case basis.

combustibility

PLA fibers will burn and, once ignited, may burn rapidly under the right conditions of heat and oxygen supply. Do not permit dust to accumulate. Spontaneous combustion or other ignition sources can ignite dust layers. When suspended in air, dust can pose an explosion hazard.

Clear to white smoke is produced when product burns. Toxic fumes are released under conditions of incomplete combustion. 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 reignition. Again, addition of chemicals, finishes or further processing of fibers may introduce additional hazards that must be evaluated by the customer on a case by case basis.

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. 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 or 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.

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