

Introduction

The sections that follow relate to the processing of 1.5dtex 38 mm Ingeo™ PLA fiber intended for conversion through the “cotton” or short staple spinning route. The fiber has been engineered specifically for ring spinning.

Fiber lengths other than 38 mm can be supplied (for example 51 mm) where fiber blend or machinery considerations are important. The information on machinery settings is appropriate for such fibers but some adjustments will be required for example, to roller spacing in order to accommodate the different fiber length. Additionally, roving twist, and possibly yarn twist, will need adjustment.

Blending, Opening and Cleaning

bale laydown

Bales of Ingeo PLA weigh approximately 250 kg each and should be used, where possible, sequentially according to bale and lot/merge number.

Adherence to the recommended safety procedures when opening bales is paramount. Suitable measures should be taken to protect operators when automatic systems are not in use. Bale wrappers should also be disposed of according to local conditions.

While Ingeo PLA fiber has significantly less bale to bale variation than cotton, as many bales as possible should be used in each laydown. This will ensure that fibers are thoroughly blended. Where continuous use of Ingeo PLA fiber is anticipated, programmed use of bales, from a range of deliveries, is recommended.

Ideally, fibers should be opened in a conditioned area to allow the surface fibers to equilibrate and to minimize the effects of condensation, particularly where bales have been stored in a cold area. Transport air should also be conditioned to ensure that the fibers arrive at the card containing the appropriate amount of moisture. Air conditions should be in the region of 23-25° C, 50-60% RH.

blending

Both manual and automated systems can be used. It is clear, however, that automated systems give better, more intimate and controlled blending. The open state of tufts of Ingeo PLA fiber makes for easy bale skimming, with low increments (2-3 mm per slice).

Sandwich-type blenders can be used for additional blending, particularly where manual feed systems are employed or where blends with other fibers are being used.

The use of Ingeo PLA fiber may necessitate adjustments to volumetric feeds since the fiber has good resilience and can be quite lofty on opening. Settings similar to those for polyester or polyamide are a good starting point.

Production rates will depend on the opening system installation. However, a slower controlled rate is preferable to large overfeeds and long stops. This gives a more consistent feed to openers and cards.

Because of the open nature of Ingeo PLA fiber, over trunking and excessive handling must be avoided to reduce the possibility of inserting nep and entangling fibers.

opening

The production of staple fibers made with Ingeo PLA ensures that the filaments are not entangled and that removal of foreign matter is not required. Hence minimal opening is required to separate the fiber tufts ready for carding. Waste removal is unnecessary and fiber extraction should be minimal.

Only one opening point is recommended, preferably a fully pinned beater. To avoid damage to the Ingeo PLA fibers, settings and speeds should be similar to those used for polyester or other man-made synthetics. Exact settings and speeds will vary from machine to machine according to the type.

(Note: Severe cotton opening systems must be avoided to prevent the deterioration of yarn quality.)

It should be remembered that each additional machine in the opening line will add nep and may even damage the fibers, leading to a reduction in yarn strength and an increase in yarn faults.

laps

To date, Ingeo PLA fiber has not been processed on lap forming machinery. It is anticipated that settings used for polyester or polyamide should be used as a starting point should this route be needed.

spraying

Ingeo PLA fibers are finished with additives which provide a balance of cohesion, lubrication and anti-static protection appropriate for the vast majority of mills. Sprays are not needed on any installation where carding and drawing equipment is less than 15 years old.

Before using oversprays please consult with NatureWorks Technical Services to ensure that these are really needed.

tinting

Tinting Ingeo PLA fiber is not recommended, though work is continuing to identify safe methods of application and removal.

Carding

The vast majority of short staple Ingeo PLA fiber used in yarn manufacture is carded using chute feeds and revolving flat cards.

chute feeding

Feed weights of between 500 and 900g are usual with card drafts from 100 to 160. In general, older cards will require lighter weights and lower drafts. Volumetric settings as for bulky synthetic fibers are likely to prove adequate.

card settings

Few changes to conventional card settings are required to achieve even webs. Card wire should be suitable for 1.7dtex and finer fibers. Fig. 2 shows combinations of wire types currently in commercial use. Wires designed for man-made fibers are essential to give the best performance and web quality. Aggressive cotton type wires and settings will cause too much fiber damage and must not be used.

| Fig. 2 Card Wire Types | | | |
|------------------------|-----------------|-------|-------------|
| | Points (/sq in) | Angle | Speed (rpm) |
| Taker-in | 40-60 | 90 | 650-750 |
| Cylinder | 640-800 | 70 | 300-400 |
| Doffer | 360-400 | 60-65 | Ñ |
| Flats | 380-420 | 75-85 | Ñ |

Full underscreens can be used since Ingeo PLA fibers do not need to be cleaned. Where mote knives are fitted, they should be adjusted to reduce fiber loss, either by reducing the opening before the mote knife or by opening the mote knife setting.

Flat strip removal can be carried out according to mill requirements. However, as Ingeo PLA fiber is very clean, only light strips need to be removed and these should be discarded.

Different cards, production rates and quality requirements may necessitate different settings, but many spinners have not needed to change the settings used for other synthetic fiber types of similar dtex and staple length.

Depending on card type and production rates, changes to the web and coiler tensions may be required (particularly for speeds above 100 m/min). Ingeo PLA fibers card and separate easily, and the webs have good cohesion.

Web removal systems which feature belts or some form of gathering improve carding efficiency, and allow high, stable production rates. For the best quality, however, the slowest carding rate compatible with mill balance is recommended to reduce imperfections and improve sliver consistency. The majority of mills process 1.5dtex 38 mm Ingeo PLA at between 25 and 35 kg/hr.

Sliver weights from 4 to 6 g/m are usual depending on card and wire limitations. Ingeo PLA is compatible with all autoleveling systems but, where possible, the compression of the sliver should be minimized to prevent the possibility of fibers self bonding, particularly where surfaces may be hot. This is also the case for calendar rollers in coilers—high calendar roll pressures are not required to achieve good can coiling and high can weights.

Sliver CV% depends on the feed and card type, but values of under 4% are usual. Nep counts should be extremely low, often zero, therefore testing is considered unnecessary.

Overall carding efficiencies should be the same as mill expectations, with low levels of waste and fly. Atmospheric conditions of 23-27° C and 50-55% RH are considered ideal.

Drawing

Ingeo PLA fiber processes easily at normal mill production rates and sliver weights and on all types of draw frames found currently in short staple mills. Final sliver quality is dependent on the type and age of the draw frame. Two passages of drawing are commonly used.

Normally 6 ends, but up to 8 ends, may be creeled per delivery, but care must be taken to ensure that edge and creel guides are carefully aligned to prevent overlapping of slivers. Excessive width should be avoided since this can lead to roller lapping and frayed sliver edges, particularly on second passage drawing.

Roller settings are less critical in the back drafting zone but a nip to nip setting of 48 mm has been found to give good performance. The front or main draft zone is more critical with a minimum nip setting of 42 mm.

Drafts depend on sliver weight requirements, but back zone drafts of 1.4 to 1.5 on both passages have given good results on a wide range of draw frames.

Tension drafts should be checked after the front roller to obtain the best regularity. Roller pressure after drafting should be low to prevent any bonding of fibers. For sliver monitoring systems using tongue and groove rollers, pressures should be reduced to a minimum where possible.

Some adjustment to coilers may be needed to ensure that coils are laid correctly in the can. Smaller coilers are more likely to need adjustment and in some cases different coiler plate surfaces may be needed.

Production speeds will depend on machinery type but, as with other fibers, the slowest possible speed commensurate with mill balance will give the best results. Speeds of 400 m/min are commonly used with sliver weights typically between 4 and 5 g/m, except for very coarse or very fine yarn counts. Resultant sliver regularities are around 2.5 CV.

Roving

In general, Ingeo PLA processes well on most roving frames, with low break rates and good regularities.

The roller settings should be chosen to suit a nominal 38 mm fiber. On older systems the rollers should be set as close as possible to 43 mm. With SKF PK1500 series drafting systems, the short cradle should be used in the main zone. The rear zone setting is less critical.

The choice of spacers in the main drafting zone will depend on the draft and roving weight, and should be confirmed by experiment. On SKF systems the use of a green or blue spacer is advised initially.

Front roll (floating) condensers are beneficial. The width should be chosen carefully to control the spread of fibers (9-12 mm spacing is normal).

Fig. 3 Initial Settings for PK1500 Series Drafting Systems on Roving Frames

| | |
|-------------------|--|
| Overall draft | Minimum 6, preferably 8-10 |
| Back zone draft | 1.15-1.20 |
| Back zone setting | 55-65 mm |
| Cradle type | Short |
| Spacer clip | <400 tex-black >400 tex green or blue |
| Condenser | 9-12 mm depending on count |
| Roller loading | High (red) |

Twist levels similar to those used for polyester or polyamide (e.g., around 0.8TM or AlphaM of 24).

Generally, roving spindle speeds of up to 1200 rpm are used, although better roving quality is achieved at lower speeds. Roving weights can vary from 400 to 800 tex depending on final yarn counts. Regularities should be good 4-4.5 CV% or better should be easily achieved.

Ring Spinning

introduction

In ring spinning, Ingeo PLA fibers produce yarns of high elongation, good regularity and few imperfections. Ring frame settings are chosen mainly to reduce yarn hairiness and the risk of glazing or melting the fiber, particularly when considering twist and traveler selection.

drafting

Back zone drafts should be between 1.12 and 1.20, although the roller setting is not critical on SKF type double apron drafting systems. For other systems, a close rear zone setting may improve yarn regularity. Roller settings should be as indicated in SKF manuals for synthetic fibers.

Main drafts should be higher than 15, and around 30 is the most common. Spacers and guides are chosen to suit the drafting system and yarn count.

Apron types recommended by the main manufacturers for short staple man-made fibers are usually acceptable, but they should not be mixed top and bottom.

Soft top rollers, as low as 65 Shore, will undoubtedly give the best yarn quality, but they are more susceptible to wear and damage. 70-75 Shore is an excellent compromise between quality and durability. Ingeo PLA has a low rate of roller lapping, and end break rates below 10/1000 spindle hours should be expected on modern machinery.

High roller pressure is commonly used for coarse counts and low drafts, but this is unnecessary for finer counts.

Fig. 4 Initial settings for PK200 Series Drafting System

| | |
|-------------------|---|
| Overall draft | Minimum 15, preferably 25 - 35 |
| Back zone draft | 1.12 - 1.20 |
| Back zone setting | 45 - 55 mm |
| Cradle type | OH132 |
| Spacer clip | <20 tex - yellow 20 - 50 tex - black - confirm by trial >50 tex - green |
| Roller loading | High (red) on coarse counts |

twist

Ingeo PLA yields reasonably strong yarns and only in exceptional cases will the twist level be chosen to give maximum strength. Usually an alphaM of 110 (3.6TF) or above is recommended for knit applications, with 116 (3.85TF) for woven applications, especially warps.

travelers

Yarns made with Ingeo PLA can be produced at rates similar to those for the majority of man-made fibers. A traveler speed of about 30 m/sec maximum (about 12,000 rpm on a 48 mm diameter ring) is typical for a 50-70 Nm (30-40 Ne) yarn.

The traveler weight is dependent on speed, tube size, lift, etc. but different weights can reduce hairiness. Traveler style will vary from mill to mill though usually drw (half round wide) types are used. Any traveler finish can be used and traveler wear is normal.

The low melting point of the fiber must also be kept in mind when considering the choice of traveler and actual production rates. New ring frames with programmed speed controls at the start and end of the spin cycle are clearly advantageous in this respect.

atmospheric conditions

Atmospheric conditions of 23-28° C and 45-50% RH give the best processing performance.

Air-jet Spinning

Ingeo PLA has been spun successfully on air-jet spinning machinery (specifically Murata MJS) during trials at the machinery manufacturer, though at this stage should be considered as still under development.

Rotor spinning

Ingeo PLA fiber has been spun for development purposes on OE (rotor) machinery, but as yet this route and the fiber for it are still under development.

Compact Spinning

This extension of ring spinning technology is growing and Ingeo PLA is being assessed currently through this process route. Initial trials indicate that there should be no difficulties on the commercial systems available for synthetic fibers.

Yarn Steaming

Steaming of fibers, including Ingeo PLA fiber, affects a number of fiber and yarn properties: fiber dye affinity and yarn twist liveliness particularly. The effects are variable, depending on the steaming conditions; therefore care should be exercised in the steaming operation.

Best practices for autoclaves should always be followed:

- dry (supersaturated) steam should always be used

- as high a vacuum as possible should be applied prior to steaming

- consistent conditions should be applied from lot to lot

- the autoclave should not be used cold

dye affinity

The dye affinity of almost all yarns is affected by subjecting the fiber to steam. The effect is variable depending on the conditions applied, especially by time and temperature. With Ingeo PLA, work in this area is still in progress. **Therefore steaming should only be carried out when it is necessary.**

Current recommendations are to use 60° C with a time of 20 mins to ensure good control from lot to lot.

Winding

The winding of yarns made with Ingeo PLA from ring tube can be carried out on any winder, including both manual and automatic and onto any package.

Care should be taken to minimize contact between the yarn and stationary objects to reduce abrasion on yarn.

Ingeo PLA yarns provide a firm package which does not slough easily, and normal package sizes can be produced. Some decrease in yarn tension may be needed to reduce the hardness of the package.

Winding speeds will be as normal for the mill, up to 1200 m/min. Slower winding speeds give better final yarn appearance.

clearing

Clearing will be as normal for other yarns of similar count and quality standards. On capacitive systems a “polyester” setting should be used. Stops for clearing should be in line with mill norms.

waxing

Conventional waxing systems and waxes can be used with no special precautions, though a lower melting point wax is generally preferred.

splicing

This area is critical to the performance in fabric making. Initial work has indicated no major concerns in splicing, with chambers and settings used for polyester being used as an initial guide.

The strength of the splice should be about 85% of the parent yarn strength (slightly higher for fine yarns and slightly less for coarse yarns). The minimum strength of the splice should be at least 60% of the parent yarn strength. Splices should be checked carefully for consistency.

Twisting (Folding)

Ingeo PLA can be twisted either in 100% form or with other yarns using any of the normal methods of twisting and folding.

Only limited work on folding has been done to date and particular care should be taken to ensure that the correct lubrication is used and the fiber surfaces are not damaged through excessive frictional heat.

Yarn Properties

The following ring spun yarn data is based on both commercial spinning and trials carried out by Ingeo PLA and will of course depend on age and type of machinery and overall production rates.

| 1.5dtex 38mm PLA Fiber-Ring Spun Yarn Properties-Cones | | | | |
|--|---------|-----------|-------------|-----------|
| Count (Ne) | 10 | 20 | 30 | 40 |
| Tenacity (cN/tex) | 19 - 20 | 18 - 19 | 16.5 - 18.5 | 14.5 - 16 |
| Elongation (%) | 30 - 32 | 28 - 30 | 25 - 27 | 24 - 26 |
| CV% (UT3/4) | 8 - 8.5 | 10.2 - 11 | 12 - 13 | 14 - 15 |
| Thins -50% | 0 | 0 | 0 - 1 | 5 - 25 |
| Thicks +50% | 1 - 2 | 2 - 4 | 10 - 15 | 25 - 40 |
| Neps +200% | 1 - 2 | 2 - 4 | 15 - 25 | 30 - 50 |

Ingeo Worldwide Offices

Amsterdam, Hong Kong, London, Milan, Minneapolis, New York and Tokyo



www.ingeofibers.com

Contact

1 800 66 INGEO (USA only)
+1 989 633 1746 (Worldwide)

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15305 Minnetonka Blvd., Minnetonka MN 55345
GSFIB034110305V2

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