TECHNICAL BULLETIN

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YARN REQUIREMENTS FOR KNITTING

INTRODUCTION

Before satisfactory knitting is possible, it is imperative that management, product development, and production personnel understand the importance of proper yarn management. Knitting efficiency, fabric quality, and product reproducibility are all dependent on yarn handling and storage. This technical bulletin explains the concept of proper yarn management as it relates to knitted fabric quality and machine efficiency. In this document, emphasis will be placed on defining needs. These include the following questions: What types of yarn packages are needed? Which type of shipping container is best? How should it be transported? What method should be used for identification and storage? Once yarn needs are defined, management must ensure that such yarns are ordered, stored, transported, staged, creeled, and properly knitted.

YARN PURCHASING CONSIDERATIONS

There are basic issues in any knitting operation that must be considered in terms of yarn purchasing. These issues are listed below and will be discussed in detail:

1. Yarn Quality, Costs, and Discounts
2. Yarn Availability
3. Yarn Packaging
4. Yarn Shipping and Handling
5. Yarn Storage
6. Supplier Reliability and Service
7. Yarn Return and Crediting
8. Inventory Requirements and Capability

1. Yarn Quality, Costs, and Discounts

Yarn quality in this respect refers to whether the yarns meet the minimum requirements of the knitter. The evenness, strength, elongation, and appearance of the yarn are of importance. Whether the yarn needs to be waxed or not is a consideration. How much yarn twist is needed is another issue. It is often possible that a given yarn count and twist multiple may be bought from several suppliers; however, the cost and quality may vary quite remarkably. Another important factor is that the yarn is not over specified causing the knitter to pay more for the yarn than is necessary. The smart purchasing officer will shop around for the quality needed at the best possible cost. Discounts may be offered by the spinner for large individual orders or for a long-term purchasing agreement. With any scenario, the management of quality is the critical purchasing consideration. In any case, yarn should be properly warehoused regardless of purchasing cost considerations.

2. Yarn Availability

Yarn should be purchased from reliable spinners who manufacture the needed yarn counts on a regular basis. This will best ensure consistent quality. However, there may occur times when availability of some counts becomes limited. In these instances and when warehouse space is to some degree limited, the knitter should purchase larger quantities of the counts in

jeopardy and warehouse them, while at the same time reducing the inventory of those counts that are more readily available. In any case, the choice of a given yarn count should be from the same supplier over a moderate to long period of time.

3. Yarn Packaging

Yarn packaging refers to the methods with which the yarn packages are wound, identified, protected, stored, or staged before shipping to the knitter and after receipt by the knitter. Yarn packages shipped to the knitter must be properly identified and put in a suitable container to prevent damage, soiling, and package disturbance. Mishandling can occur during transit, storage, staging, or creeling. When yarns are wound in the spinning facility onto paper or plastic cones, they must be protected at all times from contamination, drying out (dehumidified), and damage.

Yarn Package Configuration

With yarn packages to be used for knitting, it is very important for the package to be stable so that the yarn is able to freely unwind at a constant rate of tension without catching or sloughing-off of the package. After unwinding off the package, the yarn has a defined path it must follow over and through several devices that affect control and/or quality. The yarn may either move to a yarn-feeding system such as a storage feeder, or it may be used directly in the knitting needles by systems such as tape feeders. Also, stop motions and tension devices are in the yarn path to ensure quality.

There are many considerations as to package configuration. These include identification, wind, shape, weight, dimension, and density of the package. In addition, if during winding the yarn needs to be re-joined due to a break or the clearing of a defect, then the yarn will need to be re-joined by either splicing or knotting. Finally, each package must have a reserve tail of at least 8 to 10 inches in length.

Types of Yarn Joining

When a yarn breaks or is otherwise discontinuous, it must be repaired and joined back together. The way a yarn break is repaired is very important when specifying yarn packages. For ring-spun yarns, splicing is normally used to recombine the yarn at winding. In some cases at winding and normally at creeling or at the knitting machine, a “fisherman’s” knot or a “weaver’s” knot may be used to join the ends of the yarn together. For knitting purposes, a knot that is small, secure, and compact is preferred, because it generally creates fewer problems during knitting. As with all knots in knitting, it is important for the tails of the knot to be trimmed closely and carefully. Unfortunately, knitters tend to prefer “overhand” knots, which are not only larger, but also tend to have long tails. Today, some yarns are spliced, and although the yarn splice is smaller than a knot, the spliced area of the yarn is approximately 20-25% weaker than a well-tied knot. For cotton yarns, air splicing is the preferred method. Additional information on yarn joining can be found in Cotton Incorporated’s Technical Bulletin TRI 2007 - Weft Knitting Style Change-Over and Machine Setup Procedure.

Package Wind and Shape

Wind refers to the way in which the yarn is wrapped on the package so that package stability is ensured and yarn unwinding will be virtually trouble free. Packages may be wound with a tapered side (angled side), or they may have parallel-sided packages. Although a tapered package allows yarn removal with reduced and more consistent yarn tensions, package capacity and stability suffer. There are also different angles of wind for the taped package. The steeper the angle, the easier the yarn unwinds; however, the greater the chance for sloughing-off, latching, and damage to the package during handling. With straight-sided packages, package capacity increases, but yarn tension values during unwinding are highest and most inconsistent at three points: (1) when a straight-sided package is completely full, (2) when it is almost empty and ready for transfer, (3) and when the yarn is being unwound from the base of the package. Furthermore, with an increase in package dimensions of any type wind, problems with yarn unwinding and yarn tension difficulties increase. The tightness of the wind is also very important. In this respect, yarn that is wound under high tension will make a firm package. High tension winding can result in yarns with little elongation, which may tend to break because of the low elongation. Winding with low tension results in a soft package that can have outer layers that tangle during unwinding or sloughing-off the yarn.

Package Weight, Dimensions, and Density

Package weight, dimensions, and density are related in that for a package of a given set of dimensions (diameter and height), the higher the package weight the denser the package; therefore, there will be more yards of yarn on the package. Of course, if a package has more yards of yarn, there will be considerably fewer package transfers in knitting. Having more yards of yarn on the package can also be a bad characteristic. Will the package be so large that it will not fit into the machine creel? As indicated in the section Package Wind and Shape, a defective package that is too dense and has poor elongation or other shortcomings can result in many stops on the machine. If the package then has to be discarded, there will be a significant loss of material. If the package must be rewound, the effective uses of the yarn will be severely limited. It is for these reasons that some knitters specify the hardness of incoming packages at the base, middle, and upper portion of the packages and use a commercial compression device to check the package hardness. For satisfactory knitting, knitters should consider defining a range of package hardness values that is acceptable for one or more positions on the package. Hardness standards should be determined by the individual knitter due to knitting speeds and handling methods.

Yarn Package Protection

Some spinners place each yarn package into polyethylene bags, or they may wrap the yarns in tissue paper. The plastic bag is effective when it properly encloses the yarn to keep contamination from coming in contact with the surface of the yarn. Bags also help hold in the moisture from previous humidification of the yarn package. If polyethylene bags are used to wrap the individual package, make sure they fit the yarn package tightly enough to prevent the movement of yarn within the bag, which could result in the outer layers of yarn

sloughing-off the package. Do not remove the yarn package from the bags until the yarn is placed on a creel or a peg truck to be used in the knitting department.

In the past, paper wrappers used to be common in the industry but are not anymore. However, they may still be used to protect yarn packages. Tissue paper is normally used and will protect the yarn from contamination but will not prevent the package from losing bound water. In addition, paper bags are difficult at best to reuse. For these reasons, plastic bags are preferred.

Recently, the more common approach has been to put unwrapped yarn packages in cardboard containers for shipment or to place the yarns onto plastic trays that are stacked and shrink-wrapped in plastic for shipping.

Yarn Package Identification and Labeling

It is very important to have yarn packages clearly identified so that the proper yarn is used and yarn mixing is prevented. Therefore, packages must be properly labeled at all times with consistent methods. The labels on the packages must match and be on each package, carton, container, or pallet. Damaged or missing labels should be repaired or replaced. In some cases, the paper or plastic tube the yarn is wound upon may be marked by a solid color, a color tip or base, striping with color, or some other visual manner to identify the particular yarn. This may be done without a label inside the tube and is common in vertical spinning and knitting operations. A label inside the bottom of the tube may also be used with the color tagging. In either case, the color effect is used for quick, visual identification. However, there are a limited number of easily distinguishable colors thereby limiting the number of different yarns that can be marked in such a manner. If rewinding is required, identification of rewound packages is of paramount importance, because yarns that have been rewound will not dye the same after rewinding as before. Another form of identification is yarn "tinting." Various pastel shades can be applied to the yarn via a fugitive tint. The tinting is normally placed on the fiber in the spinning area. It is usually a means to distinguish blends, but can be used for different yarn counts or types.

Pointers for proper identification include:

- All packages and cartons must be properly labeled at all times. If the label becomes damaged or lost, it must be replaced.
- Identification labels should always be in the same position and right side up.
- The identification method should be consistent on all packages regardless of the identification system used. For example, if color-coded cones are used instead of labels, the color code must always be the same. If the colored paper cones are reused, the old label inside of the cone must be removed.
- If color-coded cones are used, they must be discarded when the color fades or becomes contaminated in any way.
- Extraneous writing should not be allowed.
- Yarn to be restocked to the warehouse should be properly labeled, repacked, and weighed. The carton must be resealed and identified.

- Assign responsibilities for identification and conduct regular audits.
- Use bar coding and tracking systems.
- Conduct regular audits.
- Report identification errors.
- Post identification guidelines.

Yarn Containers

Cardboard yarn containers may or may not be placed on wooden or plastic skids for transport and storage. Cardboard containers may be of different sizes, dimensions, and strengths, and they may hold a different number of packages. Furthermore, wrapped or unwrapped packages may be put into cardboard cartons. A typical carton will have several layers of yarn packages. Each layer of yarn should be separated by cardboard dividers, but this is not always the case. A properly wound yarn package will have the base and the tip of the tube extending beyond the yarn surfaces. These extensions prevent the separators from touching the base of the yarn on the package.

A more accepted method of packaging unwrapped yarn packages is to place them on tray packs. Tray packs are molded plastic trays that usually hold at least 25 packages of yarn with each package resting in its own molded depression or on a peg to form a layer. Up to six layers of yarn are stacked on top of each other with a molded tray divider between each layer and a molded tray on top of the last layer. There may or may not be plastic straps around the perimeter of the tray pack, which secures the layers as a unit. The entire assembly is then shrink wrapped with a layer of plastic that has suitable strength, clarity, and cost characteristics. The plastic wrap may be a complete encapsulation, or in some cases, due to fire department regulations, only the top and bottom segments are wrapped leaving the middle open. The bottom tray is also molded into a pallet configuration, which allows for easy transport by a forklift. These tray packs can be reused many times whereas cardboard cartons cannot. As a result, material cost for packaging and transport are reduced and disposal problems are eliminated.

The yarn container is of utmost importance in minimizing contamination and maintaining package integrity. All yarn containers must be properly labeled at all times with consistent methods. Extraneous writing on the outside of the boxes should not be allowed. During storage, all containers should be stored right side up with the label aligned in the same direction (towards the aisle).

Yarn packages should be placed into the container in a careful and orderly manner. Always place separators between all layers of yarn in the carton. Never throw or drop packages into the carton. Never jam extra packages into the container. Full occupancy of the carton will prevent the packages from shifting and moving in the carton during transport, which can cause damage to the package. If the capacity of the container is not maximized, then fill the void with Kraft paper, newspaper, or better yet, use a properly sized box. It is best to standardize the containers to dimensions that are designed around the size of the packages to be stored. Limit the weight of the container as well as the dimensions to prevent the use of unwieldy cartons. After packing, the yarn container should be properly strapped or taped for

shipment. Plastic strapping should be used instead of metal strapping. Metal strapping must be cut so that access to the box is achieved. Besides potential personal injury, the packages of yarn may also be cut by the sharp edge of a cut metal strap.

The integrity of the container must be maintained. Repair or replace damaged cardboard containers at the first sign of wear. Never cut access holes with a knife in cardboard containers or shrink wrapped pallets for acquiring packages for testing as damage may occur. Every time a yarn package has a cut, the machine will stop. As a result, efficiency will drop and defects can occur. Dispose of cartons with holes or tears unless these can be repaired. Should a carton become wet, it should be discarded.

4. Yarn Shipping and Handling

Yarn is usually shipped to knitting plants by truck and in some cases, by rail. Shipments may contain loose boxes, pallets, or containers. Furthermore, yarn shipping by truck is much more common than rail transport for knitting companies who request yarn to be shipped in smaller but more frequent shipments. Unfortunately, when shipping by truck or rail, high levels of heat build-up in trailers, containers, or rail cars during transport can affect yarn knittability because of loss of fiber moisture and the deteriorization of paraffin waxes, which will impact the frictional characteristics. Physical damage to the yarn package can occur during shipment because of poor handling of the container. In this context, damage can be due to careless loading or unloading of cartons and pallets and from container movement or shifting in transit. Another mishap in shipping can be the loss of labeling.

With respect to yarn receiving, a few simple guidelines can prevent mishandling. Schedule deliveries with suppliers. It is better to receive small, frequent deliveries whenever possible. Never accept damaged stock. Use a digital or an instant camera for damage documentation.

The warehouse docking area can be upgraded to reduce the chance for accidents and damage. Utilize loading dock bumpers to prevent damage to the trailer threshold and to prevent hard jarring of the trailer when it contacts the dock. Loading dock levelers will allow for a smooth transition from the trailer to the dock. Again, this will reduce hard impact to the containers and prevent damage to the yarn packages inside. Use plastic or wooden skids or pallets under cardboard containers. Always transport containers right side up. Make use of traffic mirrors in both the dock and storage areas.

Damage to yarn and yarn containers/cartons can occur due to common handling mistakes or omissions. These may occur due to carelessness, poor or no training, or understaffing. Care must be taken to minimize damage and loss. The means used to move the yarn containers or pallets have a big impact. Whenever possible, implement conveyors to unload trailers. If forklifts or tow motors are used, place safety first and not speed. Squeeze type lifts are not preferred. Forks that go under the pallet or tray should be used. Electrically powered lifts are preferred due to emissions and noise.

When moving yarn back and forth from storage to the knitting department or within the knitting area, use devices designed to move yarn and yarn containers. Use hand trucks or pin

trucks wherever prescribed by management policies. Use carts designed to handle the type of yarn packages ordered and received. In all cases, the transportation device is to be used to hold the yarn on the knitting floor; it should carry the same identification as the yarn. Do not hand carry yarn. Never drop yarn packages or containers. Do not throw the packages back into the storage container or jam them onto a pin truck. "Grocery carts" or wire mesh containers should never be used to store or transport loose packages of yarn. Yarns must only be moved into specified storage, staging, or knitting areas and not haphazardly around the knitting floor. Only designated personnel should be allowed to select, retrieve, or move yarn. Finally, yarns should only be released to knitting on an "as needed" basis.

5. Yarn Storage

Containers, pallets, or cartons must be properly stored. It is essential that the yarns be stored in a neat, secure, and dry area with easy access and retrieval. Some suggestions are as follows:

- Yarn containers should be stored in a well lit area with aisles and storage bins or racks properly designed and laid out for easy access. Yarn should be stored in well anchored racks with adequately spaced aisles. The aisle should be wide enough to accommodate forklifts without the chance of bumping the yarn containers or pallets. Lighting must be centered above the aisles. Aisles and passageways should be kept clear at all times. Each row of racks and each aisle should be clearly and simply marked for identification. It is best to number the aisles in a sequential manner, and each rack location should also be identified. Normally, aisles would have numbers, and rack bins or locations should have a letter. For example, a container would be found in aisle 4 and location A. Never stack boxes more than six feet to the top of the stack. (Follow yarn supplier guidelines.) Partially filled boxes should never be stored underneath full boxes.

- Never start a row of boxes or pallets against the wall, leave enough room to walk behind and between each row. Never store yarn containers near steam lines or in front of open air ducts, which could dry out the yarn. Always check for any water leaks that might develop from the ceiling and walls. Extremes of hot or cold temperatures and humidity in the warehouse should be eliminated. Yarn should normally be stored at 50-65% relative humidity and 75-85°F (23-29°C). Any yarn stored for over two months should be checked for moisture content and frictional properties before knitting. Never store yarn in metal buildings or in transfer truck trailers, due to the potential for excessive temperatures. Avoid direct contact of yarn containers with the walls of the building. Yarns containers should be kept off the floor. Yarns should be stored on pallets or in containment bins that can be lifted and moved by forklifts. Palletized plastic packs normally are made so that the yarn is several inches off the floor because of the bottom tray being designed as a pallet; however, cardboard containers must be placed on a pallet to prevent floor contact. Outside doors to the warehouse should be kept closed, especially during cold or humid conditions.

- When the yarns are first brought into the knitting area, the containers should be opened and the plastic bags removed to allow for the yarn to acclimate to the conditions on the knitting floor. Once conditioned, never leave containers opened and/or unstrapped. They

must be kept closed during shipping, handling, and storing in the knitting areas. Identify and report damage. Never mix yarn in the same container. This includes yarn of the same lot but different shipment dates. If possible, yarns of the same lot number should be stored together. Yarns of the same count should be stored together. Never store yarn packages loose or in bags within the storage area. Never store yarns in cloth buggies, fiberglass trucks, shopping carts, etc. Store returned or partially used yarns separately from the regular inventory. Yarns should never be mixed by supplier, lot, or shipment date. Yarns should never be left uncovered when in containers or pin trucks.

6. Supplier Reliability and Service

Once a decision to purchase yarn from a vendor is made based upon quality, cost, and availability, the spinner will be judged based upon the reliability of the shipments and consistent quality. As many knitters operate on just-in-time delivery throughout the knit product pipeline and offer more and more styles to customers, it is critical that yarn suppliers be chosen who can deliver on time. Eliminate problem suppliers and transportation companies.

7. Yarn Return and Crediting

Unfortunately, occasions will occur when a yarn does not meet expectations or performance. The knitter should be in communication and partnership with the spinner to let him know as soon as possible when yarn quality is not acceptable. This will allow for quick reaction by both parties to prevent financial hardship from striking both the knitter and the spinner. Similarly, when the fault of the defect is a result of poor yarn management or use by the knitter, the spinner should not be held accountable.

8. Inventory Requirements and Capability

Warehousing and storing procedures must be communicated to all warehouse staff and persons authorized to retrieve yarn. Storage and handling guidelines must be posted. Assign responsibilities and hold those employees accountable. Instructional courses in proper yarn handling should be taught. Enforce all regulations. All yarns should be FIFO (first in, first out) and therefore stored in a manner to facilitate FIFO. Schedule deliveries properly to prevent shortages or overages. Practice proper yarn handling and document all damages.

RESEARCH AND TECHNICAL SERVICES

Cotton Incorporated is a research and promotion company representing cotton worldwide. Through research and technical services, our company has the capability to develop, evaluate, and then commercialize the latest technology to benefit cotton.

- Agricultural research leads to improved agronomic practices, pest control, and fiber variants with properties required by the most modern textile processes and consumer preferences. Ginning development provides efficient and effective machines for preservation of fiber characteristics. Cottonseed value is enhanced with biotechnology research to improve nutritional qualities and expand the animal food market.

- Research in fiber quality leads to improved fiber testing methodology and seasonal fiber analyses to bring better value both to growers and then mill customers.

- Computerized fiber management techniques result from in-depth fiber processing research.

- Product Development and Implementation operates programs leading to the commercialization of new finishes and improved energy and water-conserving dyeing and finishing systems. New cotton fabrics are engineered -- wovens, circular knits, warp knits, and nonwovens -- that meet today's standards for performance.

- Technology Implementation provides comprehensive and customized professional assistance to the cotton industry and its customers -- textile mills and manufacturers.

- A fiber-to-yarn pilot spinning center allows full exploration of alternative methods of producing yarn for various products from cotton with specific fiber profiles.

- The Company operates its own dyeing and finishing laboratory, knitting laboratory, and a laboratory for physical testing of yarn, fabric, and fiber properties including High Volume Instrument testing capable of measuring micronaire, staple length, strength, uniformity, color, and trash content.

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