



# Thread Production

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## Introduction

Sewing thread has a variety of descriptions. We generally refer to it as, "two or more yarns twisted together to form a single strand in a plied or corded construction".

However, these days there are other 'Continuous Filament' constructions manufactured using technologies, like intermingling, texturing and air jet texturing which can produce a thread of a single ply construction.

Coats produces many different threads and this will be explained within this technical bulletin.

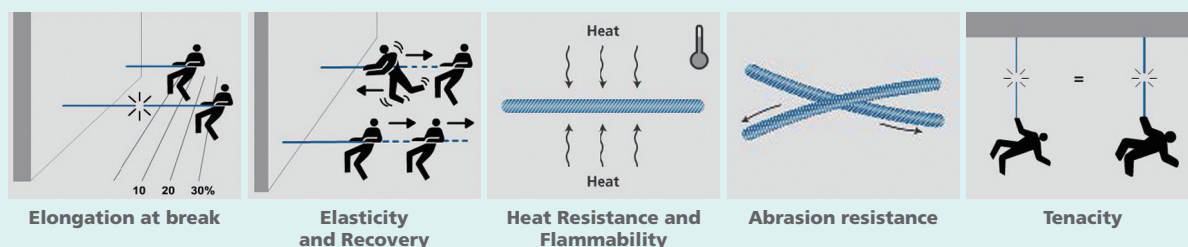
Most sewing threads today are based on synthetic materials, such as polyester or nylon, which have, to a large extent replaced the use of natural fibres like cotton and linen that used to be the material of choice.

Handicraft threads are still predominantly made out of cotton, especially when the handicraft work is done by hand. However, if the handicraft effect is being created by a machine, (as in the case of embroidery of logos), then synthetic threads are rapidly replacing cotton and rayon threads.

## Raw Materials

A few important characteristics of the fibres and filaments which are used for sewing threads are:

- Elongation at break
- Elasticity and recovery
- Heat resistance and flammability
- Abrasion resistance
- Tenacity, the strength for size of the thread



The finish is ultimately determined by the sewing performance and the lubricants used, but seam strength and seam durability is directly related to the properties mentioned above.

### Raw Materials: Polyester or Nylon

Polyester raw materials are initially produced using polymer chips or granules, which are then melted and fed under pressure through a device known as a spinneret.

A spinneret is a metal disc which contains holes. The molten polymer is extruded through the spinneret to form continuous filaments.

For the vast majority of sewing threads the holes in the spinneret are circular, but for high lustre filaments used to manufacture embroidery threads the spinneret profile is triangular producing trilobal filaments.

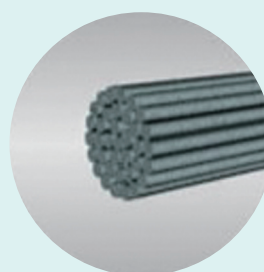
These filaments are then cooled and collected together to form a continuous filament yarn. This is one of the main components for making polyester based sewing threads. This process is known as **Melt spinning**.

The diameter of the filaments is determined by the size of the holes in the spinneret and the pressure of the pump.

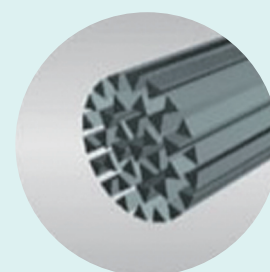
To obtain filaments suitable for the production of **Continuous Filament** and **Corespun** sewing threads, the yarns are individually drawn to orientate the molecular chains to produce particularly high tenacity filaments. The Filaments that are used for the production of sewing threads have a circular cross-section and a smooth surface, making them more lustrous than the natural fibres due to enhanced light reflectivity.

However, for special end uses such as machine embroidery - multi-lobal Polyester cross-sectional filaments are available which offer greater light reflectance values than circular cross-section filaments.

Coats produces a variety of different continuous filament threads with different physical characteristics which satisfy particular sectors of the sewing thread industry. The main continuous filament threads produced by Coats are made from Polyester or Polyamide.



Circular



Triangle

## ▪ Raw Materials: Polyester

This continuous filament polyester can also be used to produce polyester staple fibre. In order to do this we take a number of melt spun continuous filament yarns which are then brought together into a tow or rope-like structure. This rope like structure is then drawn or stretched to align the molecular chain thereby increasing the tenacity of the filament. It is then crimped, given a crinkle, to produce a better frictional surface.

The tow can then either be cut into a suitable regular staple length of around 38mm, in order to mimic the best quality cotton fibre to create Staple Spun yarns. Or it can be stretched broken to produce a longer, though more variable length fibre, and used to produce Tow Spun or Crag spun yarns.

For sewing threads high tenacity fibre is usually used. Despite their differing characteristics all synthetic threads must be properly lubricated if it is to perform properly at the sewing machine.

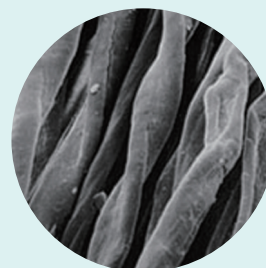
## ▪ Raw Materials: Cotton

Cotton is a natural fibre and is the fibre on which Coats originally built its worldwide business. Cotton is produced in many different grades.

For sewing threads, Coats selects from the world's long and extra-long staple cotton crops. The cotton fibres are carefully selected based on their grade, strength, length, fineness and maturity.

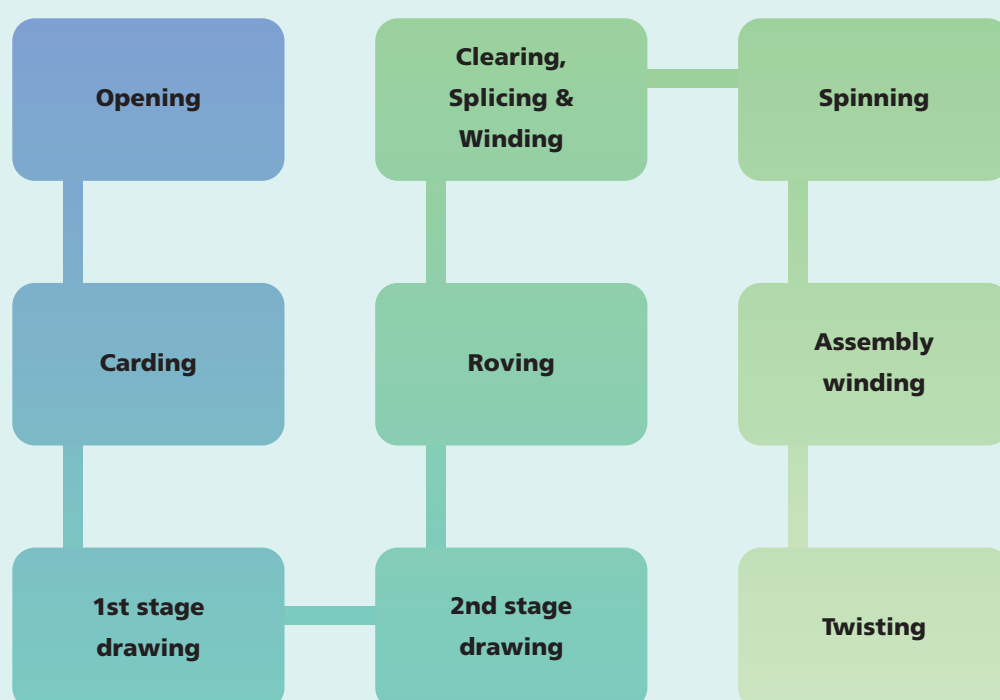
Under the microscope, cotton fibres have a flattened ribbon-like appearance with frequent convolutions. In a cross section of cotton you will notice that they look like collapsed, hollow tubes. These fibres are very fine having a typical diameter of 20 microns and a fibre length averaging approximately 38mm.

Although less common now as an industrial sewing thread, cotton is still dominant in the handicraft thread market.



## ▪ Spinning of Polyester Fibres

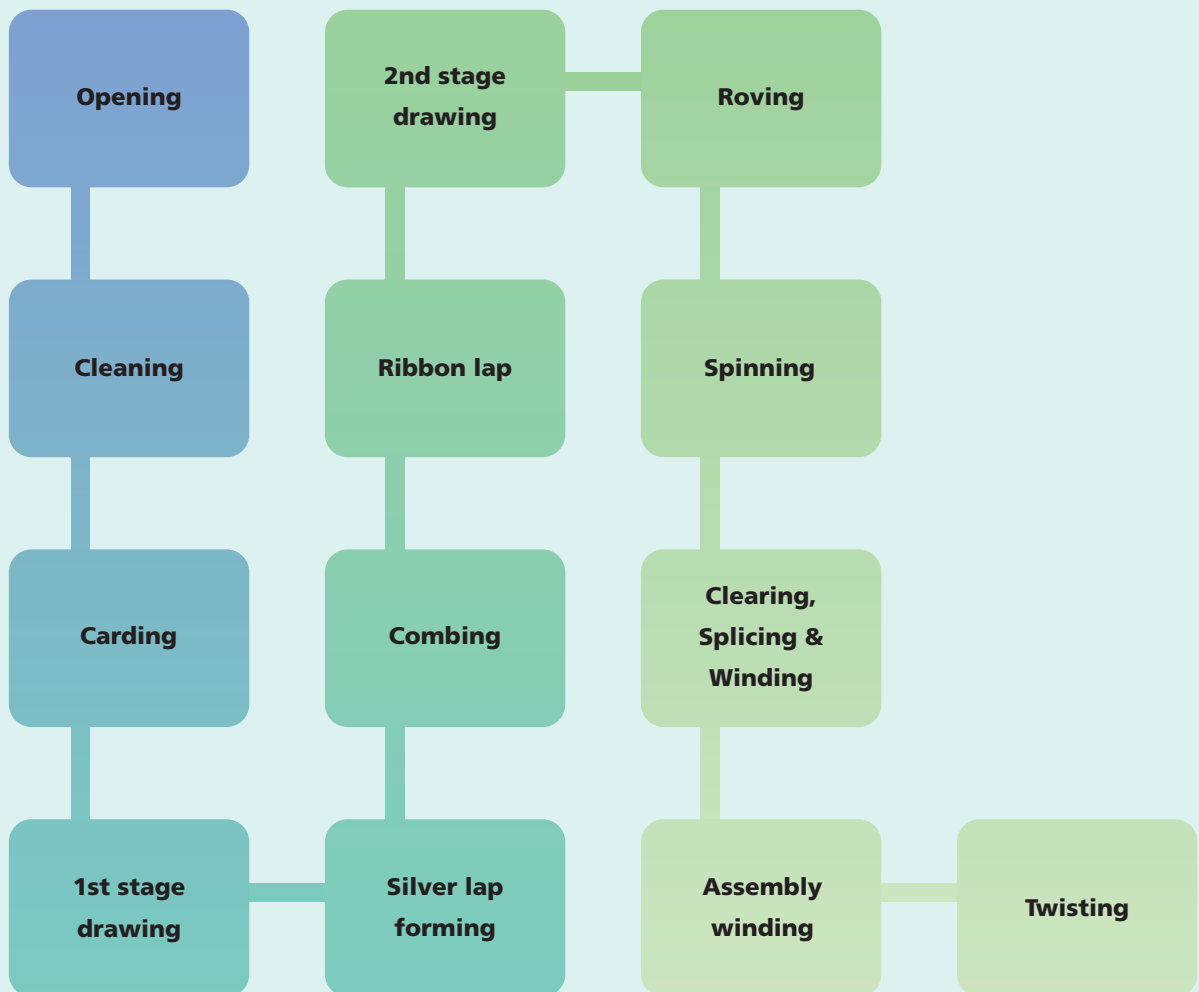
The process of manufacturing a spun polyester sewing thread includes the steps; Opening, Carding, 1st and 2nd stage Drawing, Roving, Splicing & Winding, Assembly Winding, and finally, Twisting.





## Spinning of Cotton Fibres

The process of manufacturing a cotton sewing thread includes the steps; Opening, Cleaning, Carding, 1st Stage Drawing, Sliver Lap Forming, Ribbon Lap forming, Combing, 2nd Stage Drawing, Roving, Spinning, Clearing / Splicing & Winding, Assembly Winding and Twisting.



## Spinning of Polyester and Cotton Fibres

### Opening:

This process is to open the bales of staple fibre and blend them together.

### Cleaning: Cotton ONLY

To remove the dirt, leaf and seed fragments that are mixed with the fibres.

### Carding:

The fibres in lap form are then passed to the **Cards**, which separate the individual fibres from each other and releases further quantities of impurities. The fibres are then brought together in a sliver or a tow, which is like a rope of fibre.



### 1st Stage Drawing:

Typically 6 or 8 slivers are combined and blended together, then drawn out using a drafting roller system to produce a single sliver similar in size to the single input sliver. This machine operates by having the pair of front rollers revolving faster than the back rollers.

### Sliver Lap Forming: Cotton ONLY

A number of slivers are presented to the **Sliver Lap** machine which aligns them side by side, draws them out. The fibres, now in sheet form, are rolled up into what is called a lap.



### Ribbon Lap Forming: Cotton ONLY

These laps are then presented to the **Ribbon / lap** machine where a number of laps are fed together on top of each other to another drafting system similar to the Sliver / lap machine. Again, the output from this machine is a lap, which is the input package for the combing machine.

These processes are designed to blend together the staple fibres, align them parallel to each other and enhance regularity.



### Combing: Cotton ONLY

The next stage of production presents the laps to the **Comber**, which combs the fibres as they are pulled from the lap. The function of combing is to remove short fibres and to lay the remaining long fibres parallel to each other. The production from the comber returns the fibre to a sliver form.



### Draw Frame - 2nd Stage Drawing:

After combing [Cotton ONLY], a number of slivers are again combined and passed through the **Post-comb draw frame** to help eliminate irregularities and to ensure that the fibres are properly placed parallel to each other. The sliver produced here is approximately the size of the input sliver but is still many times heavier than the yarns required for thread.

For polyester fibres the sliver lap, ribbon lap and post combed drawing processes are replaced by the two draw frame processes. This means that the process route is shorter in the preparation section.

### Roving:

The sliver from post-comb drawing of cotton or 2nd stage drawing of polyester are sent to the **Speed frame** where each individual sliver is presented to an individual set of drafting rollers and drawn down to a weight suitable for ring spinning. These machines, sometimes referred to as "slubbing" machines produce a finer version of a sliver which is known as a **Roving**. Because at this stage the number of fibres in the cross section is considerably reduced the roving is relatively weak. A slight twist is inserted into the roving to hold it together and facilitate the **Ring Spinning** process, as it is wound onto a bobbin.



### Ring Spinning:

The final stage of yarn production is done on the Ring spinning frame, where the **Roving** is drawn out to the required weight or thickness and the relatively high level of singling twist, required for both strength and balance in the completed thread is inserted.

This twist is normally in the "S" direction, though some threads have their singles twist in the "Z" direction. The drawing or drafting down is done by a series of rollers running at different speeds which draw the roving finer. After leaving the final drafting roller the singles twist is imparted creating a singles yarn. The resultant fine yarn is wound onto a ring tube.

If the staple fibre used was 100% cotton then the yarn is 100% staple spun cotton. If the staple fibre used was 100% polyester then the yarn is 100% staple spun polyester.





## Core Spinning

If the thread is to be a Corespun thread, then a pre-stabilised yarn of Continuous Filament Polyester is fed in at the back of the front rollers on the ring spinning frame, so that no stretching of the filament occurs, and the staple fibres in the roving form an outer sheath around the filament core.

If the staple fibre used was 100% cotton and the filament core is 100% polyester then the yarn is Polyester / Cotton corespun.

If the staple fibre used was 100% polyester and the filament core is 100% polyester then the yarn is Polyester / Polyester corespun, sometimes referred to as Poly / Poly.

## Schappe, Craq, or Tow Spun Polyester Threads

Spun synthetic yarns can also be produced directly from the tow of continuous filaments supplied by the filament producers by stretching it to breaking point. This is done on special machinery where the tow is passed between two sets of rollers running at different speeds, the second set being the faster. Each filament is broken before it reaches the second rollers but is carried through by its neighbours. This results in a more variable but longer length staple fibres, which are then drawn out and twisted into yarns through a series of drawing and combining operations for subsequent standard processing into finished sewing threads. Such yarns are known as Schappe, Craq, or Tow Spun yarns.

## Clearing, Splicing and Winding:

The package from the ring spinning frame weighs between 100 - 150 grams. The purpose of the Clearing, Splicing and Winding process after spinning, is to take the yarn from the ring tubes, pass them through electronic fault detectors (**Clearing**) to remove faults which may impede the sewing performance of the final thread. The ends of yarn are joined together (**Splicing**), either due to the removal of a fault or just to join the short lengths of yarn from the ring tubes to produce longer lengths. This process is called **Single End Winding**.

Once we have our "yarns" the next stage is to convert these into "grey" or "greige" thread.



## Assembly Winding:

The packages (or cheeses) of "cleared" yarn from Single End Winding are sent to the **Assembly Winding** process to prepare a suitable package for the twisting machines. This process simply assembles the required number of ends of single yarn for the eventual thread and lays them side-by-side under equal tension.



## Twisting of Spun and Corespun threads

All conventional sewing threads begin their construction cycle as simple yarns. As you've seen, spinning together relatively short fibres or twisting fine continuous filaments produces these basic yarns. Because of their fineness, these fibres and filaments have a large area of intimate contact with each other when held together with their axis parallel. This produces the coherence and strength combined with flexibility, which is essential in any good sewing thread, and it is the twist that is inserted in the basic yarns, usually in the "S" direction, which produces the consolidating force. This is referred to as the "Singling Twist".

The twist in the singling yarn is balanced by applying a twist in the opposite, usually "Z", direction when typically two, three or four yarns are combined to form a sewing thread. This is referred to as the "Finishing Twist".

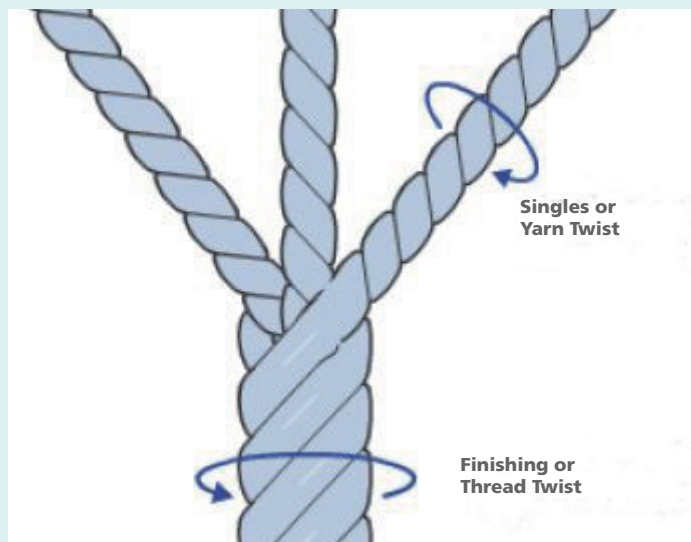




## Thread Manufacturing

Without the correct level of finishing twist, a conventional thread cannot be controlled during sewing. The individual plies would separate during their repeated passages through the needle and over the sewing machine control surfaces. Twist is therefore defined as the number of turns inserted per metre (or turns per inch) of the yarn or the thread produced.

If the twist is too low, then the yarns may untwist, fray and break, if it is too high then the resulting liveliness in the thread may cause snarling, looping, knots or spillage from the final package.



As you can see the term "S" or "Z" twist direction is derived from the diagonal of these letters following the direction of the twist. "S" twist is sometimes referred to as right twist and "Z" twist is sometimes referred to as left twist.

The continuous filament yarns shown at the beginning of this session can also be twisted to make continuous filament sewing threads. Continuous filament yarns can also be assembled in 2, 3, or 4 plies to create continuous filament polyester or nylon sewing threads. These include textured threads.

## Thread Types

A whole range of sewing threads can be produced from the few raw materials we've discussed today.

**Corespun** is the best general-purpose apparel sewing thread available in the market today. Corespun combines the strength and elongation characteristics of the Continuous Filament Core with the sewing performance and surface characteristics of the spun fibre threads.

The filament component is merged with the staple fibres in the yarn spinning operation. The filament takes up its position in the centre of the yarn with a protective sheath of staple fibres wrapped around it. These composite yarns are then twisted to form a plied thread.

The two main Corespun constructions are Polyester Filament Yarns covered and protected by Polyester fibres or Polyester Filament yarns covered and protected by Cotton fibres.

**Staple Spun Polyester** threads are manufactured from high tenacity staple fibres. A typical high tenacity fibre used for sewing thread would be 1.2 denier, which is a measure of the linear density and 38mm long with a tenacity of at least 7.5 grams per decitex. Some thread producers use a fibre length of 45mm or even 55mm depending on the machinery they have available. SSP threads are produced in a wide range of constructions and sizes, tex and ticket numbers, to accommodate most general sewing applications.

**Staple Spun Cotton** threads are generally from high-grade long staple fibres. These cotton threads are of three distinct types, Soft, Mercerised and Glace or Polished.

**Soft threads** receive no special treatment other than bleaching or dyeing and the application of a uniform, low friction lubricant.





**Mercerised threads** are treated under tension, in a solution of caustic soda which causes the fibres to swell and become rounder in the cross-section. This process enhances the lustre and increases the strength of the fibres. The dye affinity is also enhanced by this process.

**Glaze cotton threads** are produced from soft cotton threads by giving them a polishing treatment. This process applies a coating of starch to the surface of the thread, brushes the fibre ends into the body of the thread and dries them to form a smooth surface on the thread. The polishing process increases the strength of the thread by about 10% but more importantly this process protects the thread from abrasion during heavy-duty sewing operations. Glaze finishes are also applied to Polyester / Cotton cospun threads.

## Continuous Filament Threads

Coats produces a variety of different continuous filament threads with different physical characteristics which satisfy particular sectors of the sewing thread industry. The Continuous filament threads produced by Coats are made from Polyamide [nylon], Polyester and Rayon.

Continuous Filament threads are significantly stronger than their equivalent size in Cospun, SSP (Staple Spun Polyester) or Cotton.

Some varieties of Continuous Filament Threads are:

**Soft CF Thread** which is the simplest form. In the production of a continuous filament yarn the filaments are gathered from the spinneret into a continuous strand, each strand comprising a specific number of filaments dependant on the desired characteristics.

These strands are then combined and twisted conventionally into plied constructions similar to the post spinning processes used for spun threads.

These threads are used in sewing applications where the seam strength is particularly important such as footwear and fine leather goods.

Some of these threads are given an additional process called **Bonding**.

In this case, the threads are coated with a soluble resin like Nylon or Polyurethane for Continuous Filament Nylon and Polyester or Polyurethane for Continuous Filament Polyester.

After application, the resin is cured and dried which has the effect of holding the plies together. The application of the bonding agents also reduce the abrasion on the thread during the sewing operation.

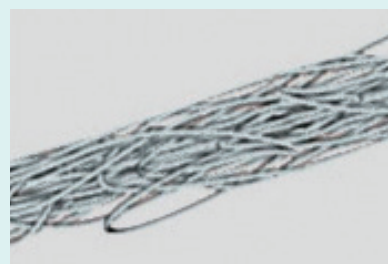
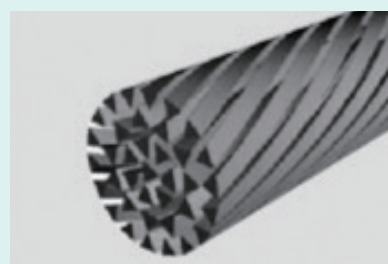
**Trilobal Polyester** is a specific type of Continuous Filament Polyester mainly used for embroidery thread.

Trilobal Polyester has been modified to maximise the lustre of the thread created by the individual filaments having a triangular cross section.

Continuous Filament threads are modified by further processing to produce what we now call **Textured threads**. These can be produced from Nylon (Textured nylon or TXN) or from Polyester (Textured Polyester or TXP).

These threads are designed to be bulkier and softer than the continuous filament twisted threads and can be produced in different ply constructions. The most common method of producing these threads is by false twisting. In this process, the filament yarn is subjected to heat, by contact or by convection, to soften the filaments. The yarn is then subjected to a rotational force which results in twist being inserted. As the thread exits the twisting zone of the machine, the twist is removed, but as the yarn is still in a thermoplastic condition the yarns memory retains some of the distortion imposed in the twisting zone. This process results in the individual filaments adopting a crimped shape giving a soft bulky thread with high stretch characteristics. They are most suitable as under threads in lightweight chainstitching, overlocking and coverseaming operations.

**Locked Filament Polyester** sewing threads are produced by a technique involving the heating and stretching of the continuous filaments. The filaments are entangled and heat treated to produce a consolidated thread. Locked Filament Polyester threads have many of the characteristics and the performance of threads produced by conventional spinning and twisting routes but the thread does have a different handle or feel to it.





## Wet Processing - Dye Package Winding

All synthetic threads, Polyester / Cotton Corespun threads and some 100% Cotton threads are wet processed on what are called **cheeses**. These cheeses are produced on the twisting frame or at a separate process called **cheesewinding for dyeing**.

The packages for dyeing are wound so that they are of a constant density and permeability to allow the dye liquor to be pumped evenly through the packages.



## Wet Processing - Carrier Loading

A **cheese dyeing kier** is used to dye sewing thread. The cheeses of grey thread are stacked onto the perforated hollow spindles of the dye machine carriers and compressed under controlled conditions to create a sealed column of thread of uniform density.



## Wet Processing - Dyeing

The lid of the dye kier is clamped shut. The dye liquor is pumped in under pressure and raised to the dyeing temperature.

The dye liquor flows through each thread package, alternately in-to-out and out-to-in at pre-set intervals. These cycles, together with the temperature, timing and the addition of all the other chemicals called for by the dye recipe for a specific shade, are regulated automatically by computer controls in modern dye kiers. This ensures even, level dyeing to precise standards.



When dyeing 100% cotton threads it is sometimes necessary to add **bleaching cycle** to the dye process in order to remove the natural colouring matters and chemical impurities in the Cotton fibres before they are dyed.

Different classes of dyestuffs are required for different substrates of sewing threads. Polyester is dyed using disperse dyestuffs at around 130°C whereas Cotton can be dyed with direct, reactive or vat dyestuffs usually at temperatures at below 100°C.

Polyester / cotton corespun threads contain two different components, unlike the sewing threads which are made from just one substrate, each component requires a different class of dyestuff and therefore the dyeing process is more complex and takes more time. The dyestuffs are selected to produce the same shade on both substrates and the two separate dye cycles are carried out consecutively in the same overall dyeing operation.

The dyed packages are then uniformly dried using **centrifuges** to extract excess moisture and then the cheeses are finally dried using **hot air drying** systems or **radio frequency dryers**.





## Wet Processing - Mercerising

Cotton threads are sometimes Mercerised. In this process, the Cotton fibres are impregnated with a caustic soda solution, which causes them to swell and in so doing, untwists their natural convolutions, before being stretched and the caustic solution washed out.

This produces a stronger, lustrous thread with an increased affinity for dye liquors. Mercerising is usually done in hank form and the dyeing process is also done in **hank dyeing machines**.

Before undergoing the mercerising process the grey 100% cotton thread is sometimes gassed or singed that is, run through a carefully controlled gas flame to remove extraneous fibres from the thread surface. This further enhances the lustre of the final product.



## Finishing - Lubrication

During sewing, considerable heat is generated at the needle of the sewing machine and an average temperature of 330 deg Celsius is common. This heat is generated through friction as the needle of the sewing machine punches its way through the layers of fabric being sewn. Both Polyester and Nylon threads will melt at temperatures below 300 deg Celsius. Most thread breaks that occur during sewing are caused by the synthetic thread melting in the needle eye when the sewing operation stops momentarily to change direction or while starting a new seam. They are not always caused by excessive thread tension.

To prevent thread damage at the needle eye and to help the passage of the thread through the thread path of the sewing machine, most threads are lubricated after dyeing. Most lubricants are combinations of **Paraffin Wax** that helps reduce friction and **Silicone** that promotes needle cooling. The lubricants can be applied at the dyeing kier, at a separate lubricant application process or more commonly at final winding. The Lubricant Content and the Friction Index helps ensure good sewing. The amount of lubricant applied is critical to successful sewing and the actual level of lubricant is carefully controlled.

## Finishing - Final Winding

After the lubricant and any special finishes have been applied, the thread is passed to **Final Winding** where the thread is wound onto the support (cone, vicone, tube etc) to the length that the customer requires. The type of support used will depend on the substrate of the thread being wound and the end use of the thread.





The final operation is **Finished Goods Packing**, where the product is labelled, wrapped and boxed prior to being sent to the warehouse for immediate despatch to the customer or for warehouse stock.



## Thread Sizing

The preferred method of sizing sewing thread for Coats Global Offer Products is the Tex System. Tex is the weight in grams of 1,000 metres of thread or yarn. The higher the number the coarser the thread.

An alternative sizing unit in common use for synthetic and synthetic blended threads is Metric Ticket. The metric ticket number is derived from taking the number 1,000 divided by the tex number multiplied by 3. The higher the number the finer the thread.

100% cotton threads still utilise the Ne [number] English Sizing System known as Cotton Count and Cotton Ticket number.

## Apparel Thread Conversion Table

Here is a useful apparel thread size conversion table. This includes the US ticketing system as well as Singer and Metric needle sizing.

Tex Size	US Ticket	Metric Ticket	Cotton Count	Singer Needle*	Metric Needle*
18	120, 100 / 80	160	60 / 2	9 - 11	65 - 75
21	100	140	-	9 - 11	65 - 75
24	100, 100 / 60	120	-	10 - 11	70 - 75
27, 30	70, 70 / 40	100	60 / 3	12 - 16	80 - 100
35	70	80	-	12 - 16	80 - 100
40	50, 60 / 36	75	40 / 3	14 - 16	90 - 100
45, 50	40	60	-	14 - 18	90 - 110
60	30, T-60	50	20 / 2	18 - 21	110 - 130
80	20, T-80	36, 40	20 / 3	19 - 22	120 - 140
105	T-100	30	12 / 3	21 - 23	130 - 160
120	16	25	-	22 - 24	140 - 180
150	12	18	-	24 - 26	180 - 230

\* Needle size recommendations are nominal and ultimately depend on the sewing application.



