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Handbook of Worsted Wool and Blended Suiting Process

R. S. Tomar

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Preface

Textile manufacturing process consists of sub-processes of spinning, weaving, dyeing, and chemical processing. Over the years, worsted wool has been a popular choice for men's trousers, pleated skirts for women, and both men's suits and sport jackets. Because worsted wool is so durable, it wells very well and also drapes easily, making it an ideal fabric for all sorts of garments. In this book all processes carried out up to grey fabric stage are explained with visual aids and the quality test procedures are mentioned.

Faults visible in fabric can be back traced to either of these processes. Hence fabric defects have been categorised as spinning, weaving, dyeing and processing faults and also as mending faults arising due to mistakes in the fault removal or mending process. The following treatise describes each fault along with possible causes of generation with visual aids wherever possible. Efforts have been made to cover various fabric faults along with remedial action and fabric swatches.

I am deeply indebted to Shri V. K. Gupta, Works Director, Raymond Ltd., Jalgaon and Shri S. K. Singhal, President – Textiles, Raymond Ltd., Textiles Division, for their valuable and kind support for making this effort successful. This information is based mostly on the knowledge acquired by experience and hard work.

Last but not the least, I am thankful to my dear colleagues, friends for their fruitful and innovative inputs, and my wife Madhubala and all my family members.

7th April, 2009

R. S. Tomar
B.Text., DBM, FIE, C.Eng., FTA
Head–Quality Assurance
Raymond Ltd.
Jalgaon, Maharashtra, India

Contents

1

Introduction to different fibres

1.1 What is wool?

Sheep skin, including the hair, was probably used long before the discovery of fibres that could be spun into yarns. Large areas of the United States are suitable for wool production but the maximum wool is produced from Merino sheep in Australia.

To provide the finest quality of wool, the sheep are inoculated against disease and given good nutritious diet to obtain the good quality of wool. The sheared wool from a living animal is called fleece or clip wool and that from the slaughtered animal hide is called pulled wool. The newly removed wool is raw wool of grease wool and contains 30–70% impurities such as dust, dirt, grease, vegetable matter and dried sweat. The wool is scoured to remove these impurities. Sorting is done to separate different qualities of wool. The best quality of wool is obtained from the shoulders and back of the sheep and the poorest wool is obtained from the lower legs. Fineness, colour, crimp, strength, length and elasticity are the characteristics that may vary with the breed of sheep.

1.2 Types of wool

The term 'wool' legally includes fibre from sheep, angora, cashmere goats, camel, alpaca, llama and vicuna.

(a) Virgin wool is the wool which has never been processed.
(b) Recycled wool or shoddy wool is obtained after scraps of woven or felted fabrics are shredded, sorted, cleaned, re-spun and woven.

Wool is widely used for a variety of apparels, carpets and rugs all over the world. The wool fibres trap air and form an insulating layer for the body thus making the wool a warm fibre. It is naturally a crease-resistant and absorbent fibre, making it comfortable to wear.

Care of wool is difficult because it has tendency to matt up. The scales present on the wool fibre entangle with each other forming into gook-like

structure. This causes the matting and thus shrinkage of wool. This property of matting is responsible for production of felts.

1.2.1 Speciality wool

(a) Mohair

Mohair is the fibre from Angora goat. It should not be confused with Angora rabbit. South Africa, Turkey and Texas (US) are the major producers. Mohair is very resistant and has fewer scales and no crimp.

(b) Cashmere

Cashmere is produced by a goat raised in India, Nepal, China and New Zealand. Cashmere is used for sweaters, coats, suits, jackets and blankets.

(c) Pashmina wool

Pashmina wool is obtained from Capra hircus goat. 'Pashm' as it is called by local people is very fine, soft and one of the most expensive fibres. It is used for making embroidered and woven shawls made in Kashmir, India. The goat is found in higher riches of Tibet.

(d) Camel hair

Camel hair is obtained from the two humped camels found in Turkey, China, and North Siberia. Camel hair is an excellent insulator. Camel's hair is often used as a blend with sheep's hair.

(e) Llama and Alpaca

Llama and Alpaca are Camelids from South America. The fibre obtained from them is 8–12 in. long and is known for softness, fineness and lustre. It has good draping characteristics and is liked by fashion designers.

(f) Vicuna and Guanaco

Vicuna and Guanaco belongs to camel family. Earlier they were killed for their hair but now this practice has been stopped as they are on the list of endangered species. The fibre obtained is short, lustrous and light cinnamon in colour and is one of the expensive fibres.

(g) Yak

Yak is a long-haired bovine found in Tibet and Central Asia. The fibre is obtained by combing and is blended with cashmere wool at times.

(h) Muskox

Muskox is found in Alaska. Qiviut is one of the finest natural fibres obtainable. Spinners claim that musk ox wool is eight times warmer than wool and extraordinarily lightweight. It doesn't scratch or shrink in hot water. It can be hand and machine washed in any mild detergent and will last for many years.

(i) Angora rabbit

Angora rabbit produces a soft luxurious fibre called Angora wool.

Merino sheep in Australia.

1.3 Basic quality parameters

In raw wool, the basic quality parameters are as follows:

(a) Fibre length
(b) Fibre diameter (measured in microns)
(c) Moisture
(d) Yield %

Wool is a natural fibre obtained from sheep. The fibre is from the fleece of the sheep or lamb, or hair from the Angora goat or Cashmere goat. Best of the available wool is the Merino wool. It is procured from Australia. It is available from 11.8–24.5μ.

1.4 Properties of wool

- It is a luxury fibre with an excellent feel and touch.
- It is soft and natural hand feel.
- It is wrinkle-resistant.
- It is light weight and durable.
- It absorbs moisture.
- It retains shape.
- It has a good drape and fall.

1.5 What is Super "X"?

The fibre quality ('Super X' or 'X') classification is allocated to a given product on the basis of the mean wool fibre diameter requirement as measured by Woolmark TM 24/IWTO 8 (Projection Microscope). 'Super X' claims must only be used on woven or knitted apparel products, yarn (including hand knitting yarn) or fabric with a minimum of 45% new wool, blended with silk and/or elastane.

1.6 Wool classification

'X' Value	Fibre diameter (μ or micron)
Super 64's	22.5
Super 70's	21
Super 80's	19.5
Super 90's	19
Super 100's	18.2

Super 110's	18
Super 120's	17.5
Super 130's	17
Super 140's	16.5
Super 160's	15.5
Super 170's	15
Super 180's	14.5
Super 190's	14
Super 200's	13.5
Super 210's	13
Super 220's	12.5
Super 230's	11.8
Super 240's	11.6

1.7 Dyeing wool / polyester and other fibres

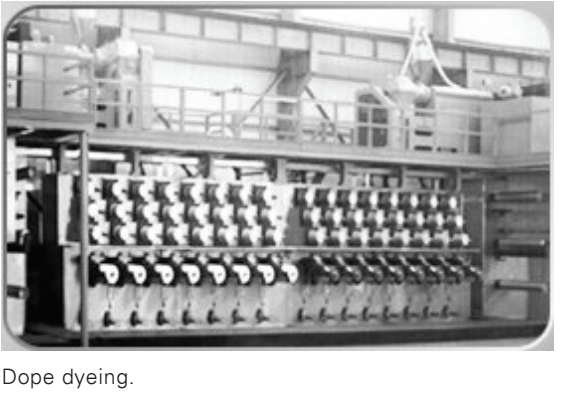
It is the process of colouring fibres, yarns or fabrics from which we can get solid shades, mélange (mixture).

There are different ways of dyeing. Some of them are:

(a) Dope dyeing
(b) Top dyeing
(c) Piece dyeing
(d) Yarn dyeing

(a) Dope dyeing

Mass coloration, spun-dyeing or dope dyeing may be defined as "a method of colouring manufactured fibres by incorporation of the colorant in the spinning composition before extrusion into filaments".



Dope dyeing.

(b) Top dyeing

It is a method for dyeing combed wool yarn, before spinning, by placing it in large vats and circulating dye liquor through the yarn at increased temperatures.

Top deying.

(c) Yarn dyeing

We use this form of dyeing for decoration shades. In this process use of auto colour dispenser avoids any lot-to-lot variation.

Yarn dyeing.

(d) Piece dyeing

In this process, the woven white fabric is dyed in desired colours by complete immersion, contrasted with yarn dyeing or raw stock dyeing.

- By this, it is possible to dye solid colours.
- It is possible to dye one component in the blend of different dyes taken up to get a mixture look.
- Quick dyeing method where the white fabric is ready and hence quick delivery.
- Desired quantity can be dyed.
- Finish of piece dyed fabric is smoother.
- Use of auto colour dispenser avoids any lot-to-lot variation.

Piece dyeing.

1.8 What is a product?

It is the "Fabric" engineered by using raw materials such as natural fibres or manmade fibres or combination of both with the help of latest technology.

The objectives of the world's most admired worsted suiting company are as follows:

- Product updation
- Technical updation
- Understanding the product to offer knowledge-based service

1.8.1 Special features required in product

- Comfortable as per weather condition
- Better handling and feel
- Light / Flexible

- Easy to maintain / Easy care
- Breathable
- Wrinkle free
- Crease retention
- Good shrinkage control
- Good colour fastness
- Good pilling resistance

1.9 Textile fibres and their description

Nos	Name	Fibre description
1	Wool	Fibre from sheep's or lambs' fleeces
2	Fibre obtained from alpaca, llama, camel, mohair, angora, vicuna, yak, guanaco, beaver, or otter	Hair of the following animals: alpaca, llama, camel, kashmir goat, angora goat, angora rabbit, vicuna and yak
3	Silk	Fibre obtained exclusively from silk-secreting insects
4	Cotton	Fibre obtained from the bolls of the cotton plant
5	Kapok	Fibre obtained from the kapok fruit
6	Flax	Fibre obtained from the bast of the flax plant
7	True hemp	Fibre obtained from the bast of hemp
8	Jute	Fibre obtained from the bast of Corchorus olitorius and of Corchorus capsularis.
9	Abaca (Manila hemp)	Fibre obtained from the sheating leaf of Musa textilis
10	Alfa	Fibre obtained from the leaves of Stipa tenacissima
11	Coir (coconut)	Fibre obtained from the fruit of Cocos nucifera
12	Broom	Fibre obtained from the bast of Cytisus scoparius and/or Spartium junceum
13	Ramie	Fibre obtained from the bast of Bohemeria nivea and Bohemeria tenacissima
14	Sisal	Fibre obtained from the leaves of Agave sisalana

15	Sunn	Fibre from the bast of Crotalaria juncea
16	Henequen	Fibre from the bast of Agave Fourcroydes
17	Maguey	Fibre from the bast of Agave Cantala
18	Acetate	Cellulose acetate fibre wherein less than 92% but at least 74% of hydroxyl groups are acetylated
19	Alginate	Fibre obtained from metallic salts of alginic acid
20	Cupro (cuprammonium rayon)	Regenerated cellulose fibre obtained by the cuprammonium process
21	Modal	A fibre of regenerated cellulose having a high breaking force and high wet modulus.
22	Protein	Fibre obtained from natural protein substances regenerated and stabilized through the action of chemical agents
23	Triacetate	Cellulose acetate fibre wherein at least 92% of the hydroxyl groups are acetylated
24	Viscose	Regenerated cellulose fibre obtained by the viscose process for filament and discontinuous fibre
25	Acrylic	Fibre formed of linear macromolecules comprising at least 85% (by mass) in the chain of the acrylonitrilic pattern
26	Chlorofibre	Fibre formed of linear macromolecules having in their chain more than 50% by mass of chlorinated vinyl or chlorinated vinylidene monomeric units
27	Fluorofibre	Fibre formed of linear macromolecules made from fluorocarbon aliphatic monomers
28	Modacrylic	Fibre formed of linear macromolecules having in their chain more than 50% and less than 85% (by mass) of the acrylonitrilic pattern
29	Polyamide or nylon	Fibre formed of linear macromolecules having in their chain the recurring amide functional group
30	Polyester	Fibre formed of linear macromolecules having in their chain at least 85% (by mass) of an ester of a diol and terephthalic acid
31	Polyethylene	Fibre formed of un-substituted aliphatic saturated hydrocarbon linear macromolecules
32	Polypropylene	Fibre formed of an aliphatic saturated hydrocarbon linear macromolecule where one carbon atom in two carriers a methyl side chain in an isotactic disposition and without further substitution
33	Polycarbamide	Fibre formed of linear macromolecules having in their chain the recurring ureylene (NH-CO-NH) functional group
34	Polyurethane	Fibre formed of linear macromolecules composed of chains with the recurring urethane functional group

35	Vinylal	Fibre formed of linear macromolecules whose chain is constituted by poly(vinyl alcohol) with differing levels of acetilization
36	Trivinyl	Fibre formed of acrylonitrile terpolymer, a chlorinated vynil monomer and a third vinyl monomer, none of which represents as much as 50% of the total mass
37	Elastodiene	Elastofibre composed of natural or synthetic polyisoprene, or composed of one or more dienes polymerized with or without one or more vinyl monomers, and which, when stretched to three times its original length and released, recovers rapidly and substantially to its initial length
38	Elastane	Elastofibre composed of at least 85% (by mass) of a segmented polyurethane, and which, when stretched to three times its original length and released, recovers rapidly and substantially to its initial length
39	Glass fibre	Fibre made of glass
40	Name corresponding to the material of which the fibres are composed, e.g. metal (metallic, metallized), asbestos, paper, followed or not by the word 'yarn' or 'fibre'	Fibres obtained from miscellaneous or new materials not listed above

1.10 Purpose of blending

Among the many reason for blending, achieving the improvements or variation in aesthetics performance and economics is the main.

(1) Aesthetics
  (a) Appearance
    (i) Colour
    (ii) Lustre
    (iii) Surface texture
    (iv) Cover
    (v) Drape
  (b) Hand and touch
    (i) Liveliness
    (ii) Fullness
    (iii) Firmness

(iv) Loftiness
(v) Dryness
(vi) Smoothness
(vii) Softness

(2) Performance
  (a) Functional (end use)
    (i) Wrinkle resistance
    (ii) Warmth and comfort
    (iii) Durability
    (iv) Fastness
  (b) Processing
    (i) Tailorability

(3) Economics
  (a) Fibre cost
    (i) Blend composition
  (b) Processing
    (i) Spinnability and weavability
    (ii) Dyeing and finishing

Polyester fibre is resilient and springy nature fibre, and has ability to bounce back to its original position in both wet and dry condition. Hence polyester has wider use in blend with natural fibres such as wool and cotton, which are sensitive to moisture. In addition, polyester fibres are thermoplastic which means that permanent pleats and creases can be imparted to fabric containing proper amounts of synthetic fibre.

1.11 Blending

It is a process of mixing two or more different fibres in desired percentage.

For example,

- 60% wool / 40% polyester
- 55% polyester / 45% wool
- 75% polyester / 25% wool
- 60% polyester / 20% wool / 20% linen

1.11.1 Types of basic blends

- All wool
- Wool rich
- Poly / wool
- Poly / viscose
- Wool and poly / wool in combination with speciality fibres –

Cashmere, Vicuna, Pashmina, Bamboo, Casein, Soyabean, Modal, Camel Hair, Silk, Linen and Lycra.

1.12 Introduction to fibres which blends with wool

1.12.1 Polyester

The first polyester fibre, Terylene, was produced in England. It was first introduced in the US by the DuPont under the name Dairon.

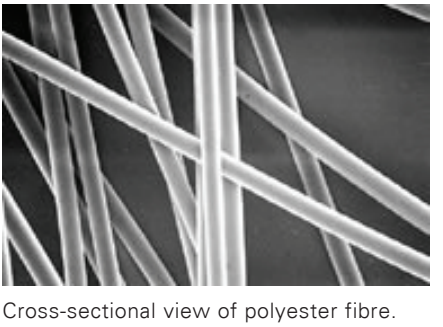
Polyester is produced by reacting dicarboxylic acid with dihydric alcohol. It is melted and passed through the spinnerette and retains the shape of the hole. Modified fibre has cross-sectional shape, is in-expensive and easy to produce.

Types of modified polyester fibres

- Benzoate polyester
- Flame-retardant polyester
- POY polyester

Polyester is widely used as a blend or otherwise in woven fabrics used for apparel and furnishing. Polyester knits well and is used for making knitted shirts and blouses. Polyester is used as a fiberfill (Polyfill) in pillows, quilts and padding. It is light in weight and more washable as compared to a cotton filling and had thus gained a lot of popularity. Non-woven polyester is used for making bandages and pads in the medical fields.

Polyester is easy to care as it can be washed in the washing machine using warm water. Hot water (120–140°F) causes wrinkling on the fabric. Polyester is oleophilic, i.e. it tends to attract oily soil making the fabric look dingy over a period of use. Soil-release finishes can solve this problem.



Cross-sectional view of polyester fibre.

Polyester is a form of manmade fibre. It is available in various deniers.

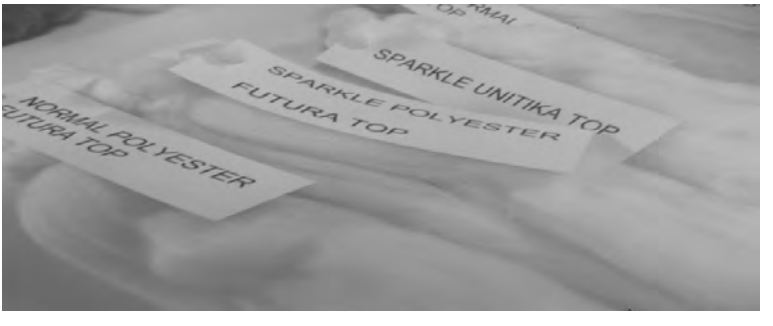
Finer the denier, more easy the handling and could be spun in finer yarn counts and could also be blended with wool, viscose and cotton in desired percentage.

Types of polyester

- Trilobal polyester
- Low pill polyester
- Normal polyester

Properties of polyester

- Strong, dimensionally stable material that absorbs very little water
- Improved wrinkle resistance
- Easy care and toughness
- Resistance to stretching
- It is procured from best sources



Varities of polyester.

1.12.2 Viscose

Rayon was the first regenerated cellulosic fibre. It is also called ‘artificial silk’. Regular rayon is called viscose rayon. Some rayon is made by using the cuprammonium process and is called the cupra rayon under the trade name Bemberg™.

Viscose rayon

The principal raw material for viscose rayon is wood pulp, cotton linters – and fibres of cotton that are too short to be spun into the yarn are also used.

The production process is as follows:

Wood pulp and cotton linters are processed with an alkaline solution until the cellulose is converted to soda cellulose. This is then treated with carbon disulphide and a product called sodium cellulose xanthate is formed. Xanthate is then treated with sodium hydroxide and is ready to go into the spinning tanks. Titanium dioxide, a delustering agent, is usually added in the spinning tanks to reduce the shine in the fibre.

Colour pigments are also added to the spinning solution before extrusion. This technique improves colour fastness properties.

High wet modulus rayon

This is often referred as HWM rayon. The strength and stability are equal to that of cotton. It can also be mercerized. It also wrinkles less as compared to regular rayon. HWM rayon is sold under brand names of Avril®, Zantrel®, Xena®.

Cuprammonium rayon

This type of rayon is manufactured by the Cuprammonium process, which is as follows. Cotton linters and wood pulp are bleached and dissolved in a solution of ammonia, copper sulphate and caustic soda. The resultant liquid is ready to be extended from the spinnerette. It is called cupra rayon and sold under the trade name Bemberg™.

Viscose fibre

Viscose fibre is the most common type of rayon. It is formed by the regeneration of cellulose from viscose by treatment with a solution of electrolytes (salts and acids). Neither a natural fibre nor a man-made one, it breathes like cotton but is much less sturdy. Versatile rayon is inexpensive and can be woven to feel like linen or wool. It is soft and drapeable but does wrinkle easily. It is available in various deniers in white and dyed shade. It can be blended with wool, polyester, and cotton.

Viscose fibre.

Properties of viscose are as follows:

- Most absorbent fibre in common use.
- Dries fast and resists shrinking.
- Pliable and soft with a good drape.
- Woven into fabrics that have the luxurious look of silk.
- Procured from Grasim Industries, Nagda, India.

Uses of rayon

Rayon is mostly used in woven fabric with polyester and wool, especially in apparel and furnishings. It is also used in non-woven fabrics where absorbency is important. It is also used as industrial wipes, bandages, diapers and sanitary napkins. It is blended with silk to make in-expensive silk sarees.

Rayon has a low wet strength thus care should be taken while washing. Rayon also has a tendency to shrink.

1.12.3 Silk

Silk is known as 'Queen of fibres', a title well-deserved by the virtue of its association with royalty. Silk is a natural protein fibre produced by the larvae of the silk moth. It is said to have been accidentally discovered in Chin and produced there for many years till China was discovered thus making the famous 'silk route'. Today china produces 54%, India 14% and Japan 11% of the world silk.

Sericulture (production)

Sericulture is the production of cultivated silk. Silk is produced by the larvae of several moths but Bombyx mori is the only one raised under controlled conditions to produce silk. The female silk moth (Bombyx mori) lays about 400–700 eggs. After the eggs are hatched, the larvae are fed on mulberry leaves. These look like caterpillars of size about 0.25" and are called silk worms. The larvae feed on the leaves for about 25–35 days and then become 3" long.

The silk worm attaches itself to a straw frame (manmade) and begins to secrete the silk fluid which hardens on contact with air. The larva moves its head in figure '8' patterns and constructs a cocoon around itself. These cocoons can be stored till they are unreeled. The fibre that the larva reels around itself to make the cocoon is coated with a gummy substance called sericin.

Different processes in silk manufacture

Reeling. Silk filaments are unwound from cocoons in a manufacturing plant called filature. Several cocoons are placed in a hot water to soften the gum. The insect inside it dies after that. These are then softly brushed to find the end of the filaments. The ends of the filaments are then reeled on to a wheel. A uniformity reeled silk is more expensive than the one with joints.

Throwing. It is the preparation of the raw silk for the loom by twisting and doubling it to the required strength and thickness.

Degumming. Sericin remains in the fibre during reeling and throwing. This has to be removed by boiling the silk in soap and water. This is important for furnishing and dying procedures.

Types of silk

Wild silk. The production is not controlled. The silk worm feeds on oak and cherry leaves. The filaments produced are less uniform in texture and colour.

Tussar silk. The cocoons are harvested after the moth has matured. The moth breaks open the cocoon to fly out, thus making the filament of silk break at various places. These short lengths are spun (twisted) to make a yarn. Tussar is a type of wild silk from India where the moths are feed on acacia leaves, a tree commonly found in central India.

Duppioni silk. Duppioni silk is another type of silk that results when two silk worms spin their cocoons together. The yarn is irregular in diameter with a thick and thin appearance. It is used in silk shautung.

Silk is sold by weight: 1 momme = 3.75 g. Other terms such as habutia and crepe describe the yarn and fabric structure.

Silk has a good drape lustre and texture. It is primarily used for apparel and furnishings. Silk is extremely versatile and is used to create a variety of fabrics from sheer chiffons to heavy brocades and velvets including the medium weight crepe. It can be woven as well as knitted.

It is used to make sarees, underwears, socks, shirts, gowns (evening), upholstery drapes and sheets. It is used in the medical field for surgical sutures and prosthetic arteries.

Properties of silk fibre

- It is a natural protein fibre
- It has a triangular shaped cross-section whose corners are rounded.
- It has a natural shine
- It has smooth, soft texture
- It is strongest of all the natural fibres

Silk fibre.

1.12.4 Nylon

Nylon was first introduced in 1938 by DuPont.

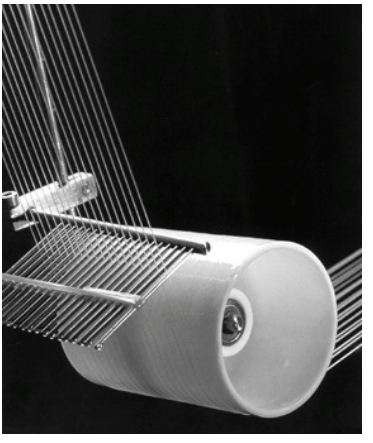
Nylon 6-6 is a polymer made from hexamethylene diamine and adipic acid. The two chemicals are combined to form the nylon salt which is melted and passed through the spinnerette to extrude the nylon filament. Well-known trade marks of nylon 6-6 are DuPont nylon, Antron®, Ultron® and Wellon®.

Nylon 6-6 is manufactured by the polymerization of caprolactum, melted and extruded. Trade marks are Caprolan®, Eureka, Shareen, Zefran® and Zeftron®.

Types of nylon

- Qiana nylon by DuPont
- Nylon-11
- Nylon 6-10

Nylon is a popular fabric for apparel and home furnishings. Due to its easy care feature, good dimensional stability and resiliency it has taken over the market in no time. Lingerie socks, swim wear, leotards, wind breakers and parkas are commonly made with nylon. Tufted carpets, draperies and upholstery of nylon perform well. Car interiors, parachutes, ropes, sporting goods, golf bags, umbrellas and tooth brushes are some of the industrial uses.



Drawing of nylon.

Properties of nylon

It is made from numerous strong and tough elastic synthetic polyamide materials.

It is round, smooth, and shiny filament fibre.

Its cross-sections can be either of

- Trilobal – to imitate silk
- Multilobal – to increase staple like appearance and hand

1.12.5 Linen

Linen or flax is a bast fibre. It is obtained from the stalk or stem of the plant linum usitatissimum. It is one of the oldest textile fibres. Today it is grown in Western Europe – Belgium, France, Italy, UK and Germany.

Manufacturing processes

Rippling. The stem for the fibre is pulled out by hand or machines while the roots are still intact or else the fibres get discoloured permanently. Stems are passed through special machines to remove seed pods.

Retting. To obtain fibres from the stalk, one must remove the outer woody portion – done by retting. When retting is done in fields (dew retting), stagnant ponds or pools (water retting or pool retting) where special enzymes or chemicals (sodium hydroxide) are added to the water, it is called chemical retting. This type of retting is much faster than any other type of retting.

Scutching. After the outer woody portion of the stems has rotted during retting, the stems are dried and passed through the metal rollers, which crush the woody portion, and the fibres are exposed.

Hackling or combing. The fibres are combed to remove any remaining woody portion and arrange them in a parallel fashion. This also helps in separating long and short fibres.

Spinning. The fibres are then drawn into yarns and spun.

Cottonising. This reduces the bast fibre to the length similar to that of cotton fibre. These cottonised fibres can be processed on equipment designed for cotton. All the bast fibres such as jute, flax, ramie and hemp can be cottonised.

Properties of linen fabric

- It is a made from the fibres of the flax plant.
- It gives coolness and comfort.
- It is pilling resistant.
- The presence of "slubs" or small knots that occur randomly along its length enhances the look.
- It is procured from Belgium and Spain.

1.12.6 Casein (Milk fibre)

The milk protein fibres are milk casein proteins, which can nourish and lubricate the skin.

Milk fibre was invented in 1930s in Italy and the US to compete wool. The fibre known as Aralac, Lanatil, Merinova all different brands for the same fibre are manufactured from milk casein.

- Milk fibre is a new synthetic fibre, which adopts milk protein as main material and high-technical process.
- Milk fibre provides comfort to human skin.
- It is anti-bacterial.
- It is procured from China.

Milk fibre.

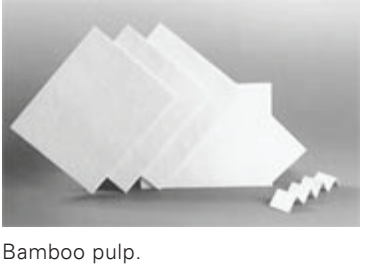
1.12.7 Bamboo Fibre

Bamboo fibre is a kind of regenerated cellulose fibre made from bamboo pulp through patented technology. It is featured with high tenacity and stability, strong durability and good spinnability. It is a kind of natural, green and environment-friendly textile raw material, which is biodegradable and can be blended with other materials such as cotton, hemp, silk, tencel, modal, polyester and spandex, etc.

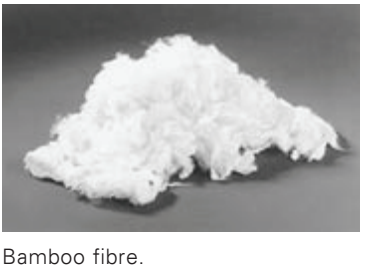
Properties of bamboo clothing

(a) They have excellent moisture absorption and permeability; comfortable to wear and leaves no perspiration; extremely cool in summer and warm in winter.
(b) They are anti-bacterial and bacteriostatic; make no harm to human skin.
(c) They are superior in anti-ultraviolet.
(d) They are soft, smooth and have good drapability.
(e) They have bright colour and special luster, good dyeing properties and colour fastness, give no toxic effect to human body.
(f) They have good durability and scratch resistance, and are free of hair bulbs.

Bamboo tree.



Bamboo pulp.



Bamboo fibre.

1.12.8 Lycra®

In 1958, DuPont introduced spandex. The first manufactured elastic fibre called Lycra®. Spandex is produced by DuPont under the trade name Lycra® and by Globe manufacturing company under the trade name Glospan® and Clearspan. Spandex is also known as elastane.

Production process

Spandex fibres are made by reacting polyether molecules with di-isocynate and polymerizing. The polymer solution may contain delustering agents, dye receptors, whiteners and lubricants. The polymer solution is then extended out through the spinnerette.

Spandex is seldom used alone in the fabrics. It is blended with nylon, cotton or other fibres to give stretch. It is resistant to dilute acids, alkalis, bleaches and dry cleaning solvents. It has a good resiliency and excellent elastic recovery. Spandex has a poor moisture absorption. It has superior aging resistance than rubber and resists soiling.

Properties of spandex

- Spandex or elastane is a synthetic fibre known for its exceptional elasticity.
- It is able to be stretched repetitively and still can recover original length.
- It is abrasion resistant.
- It is soft, smooth, and supple.
- It is very comfortable.
- It is procured from DuPont and Spandex, Bangkok

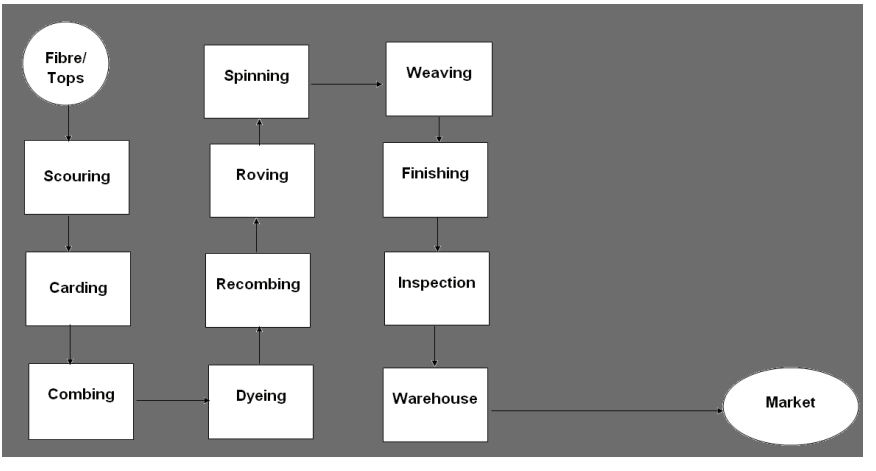
Uses of spandex

Spandex is used to support shape or mould the body or to keep the textiles from stretching out of shape. It is used primarily in knitted foundation garments, action wear, sports wear, lingerie and legging. It is also used in woven fabrics to give them stretch.

Spandex clothing.

2.1 Fibre to fabric process

Below is the process flow chart describing the process of conversion of fibre (raw material) to fabric (final product) through worsted processing.



Process flow diagram for wool material

Wool scouring (washing)
↓
Carding
↓
Gilling (3 passages)
↓
1st Combing
↓
1st Gilling
↓

2nd Gilling (For winding the material on bobbin for dyeing purposes)
↓
Top dyeing
↓
Back washing machine
↓
Gilling (2 passages)
↓
Blending done on gilling
↓
Gilling (3 passages)
↓
Re-combing
↓
Gilling (2 passages)
↓
Bump and press
↓
Receive the recombed blended tops in spinning dept.
↓
Planning of processing the tops in spinning section as per dyeing plan advice
↓
Tops bales are opened and tops are kept in open trolleys and kept for conditioning in tops conditioning room
↓
Gilling of tops is on 4–5 passages gilling
↓
Making of roves on roving machine
↓
Spinning of yarn on ring frame machine
↓
Steaming of single spun yarn
↓
Clearing of single yarn on autoconer winding machine
↓
Winding of two parallel yarns on ply winding machine
↓
Up-twisting of ply wound yarn on TFO machine
↓

Steaming of up twisted yarn
↓
Delivery of up twisted steamed yarn to yarn room after checking and weighing
↓
Weaving receives verbal information in advance regarding weaving plan
↓
Yarn room get warping order from PPD/SCM
↓
Yarn room arrange yarn quantity as per requirement on trolleys
↓
Yarn delivered on trolleys to warping department after checking steam lot, mark no., shade, etc.
↓
Warping section receives material from yarn room as per the instructions from PPD/SCM
↓
Carry out warping
↓
Healding and drawing-in
(Healding is the process of drawing of individual ends of warp beam sheet through drop wires, heald wires of heald shaft and reed dents)
↓
Weaving (sulzer)
(Weaving is the process of interlacement of warp and weft yarns and thus converted into fabric)
↓
Grey perching (Inspection of grey fabric against light for spinning or weaving fabric faults)
↓
Mending (It is the repair work process which is being done manually)

2.2 Objectives of the process

2.2.1 Scouring

The main purpose of scouring is to remove the impurities in wool like dust, dirt, perspiration and natural grease. This is very essential otherwise

further processes are impossible. The process of sequence is carried out in large machine called scouring train. This process is carried out in different ways.

(1) Emulsion scouring
(2) Solvent scouring (Normally used petroleum ether or carbon tetrachloride)

Normally in many industries emulsion scouring is used. The cleansing of wool by emulsion system is performed in sets of 4 scouring bowls. The washing set consists of a series of bowls separated from each other by pairs of revolving squeezing rollers. Heated water detergents are the scouring agents used and are assisted by the agitation of main combs and auxiliary combs moved by mechanical arrangements which propel the wool through the bowls. Heavy weight squeeze rollers at the delivery end of each bowl take out dirty water which passes into a side setting tank where a partial separation of grease and dirt take place, and liquor is being pumped back into the main bowl. Detergents normally used are Ahuralan TT100 or Nepco 1535. After the wool is delivered from last bowl it should be lofty and soft with a clean smell. The residual grease content is 0.35–0.45%.

Drying – Despite of using heavy weight squeeze rollers at the final delivery of wash bowls, the wool has 50% moisture which must be removed before further processing.

The temperature is kept in the bowls as mentioned below:

1st bowl	58–60°C
2nd bowl	55–58°C
3rd bowl	55–58°C
4th bowl	50–55°C

Water consumption per 1 kg of wool is 20 l, detergent consumed is 0.7% of scoured wool, and HP required is 120. For coarser wool, the machine has to set to run at high speed. Total yield is 67–72% of raw wool and consists of soil and clean waste.

2.3 Worsted carding

Wool, which is free from fat, suint and dirt, is subjected to a process called carding. Carding process is used in production of most staple yarn. In worsted industry the wool is always carded in the undyed state or dope dyed. If the thee ultimate fabric is required to be coloured, the dyeing can be carried out after combing, spinning or weaving.

Aims of worsted carding

(a) To disentangle the locks of scoured wool and separate the fibres, one from the other.
(b) To mix these individual fibre together intimately in more or less parallel formation.
(c) To remove from wool any vegetable matter left in wool after scouring.
(d) To form the carded fibres into an endless sliver of definite weight and deliver it into a tall cylindrical can.

Proper blending of material and checking up of moisture content in wool sample after scouring and before carding must be done. If moisture content is less or more than desired, alteration is necessary before it is fed to carding machine.

2.4 Back washing

After the carding process the wool in sliver form is given an additional wet cleansing treatment called back washing, in order to remove surface dirt released on pick up during the carding operation and to give the wool a better appearance. The back washing machine consists of 3 main parts.

(a) Two scouring tank with guide rollers, squeeze roller, water and steam pipes
(b) Drying machine
(c) A gill box

2.5 Combing

The carding machine disentangles the individual fibres in the mass of scoured wool and mixes them together in roughly parallel formation, but during the carding process many fibres break. The card sliver therefore consists of a variety of fibre length.

Objectives of combing process

(a) To remove the proportion of short fibres known as noil.
(b) To remove vegetable matter from wool, if any, and neps.
(c) To arrange the long fibres, which remain into a more or less parallel formation, and at the same time to assemble them into a continuous twist less rope-like band called comb sliver.
(d) To blend a number of sliver into a uniform combed sliver.
(e) The efficiency of previous scouring, dyeing, carding and gilling operations is reflected in the combing process, and it affects the

amount of fibre breakage and also proportions of top and noil produced.

2.6 Worsted spinning

In spinning department, re-combed blended tops are processed to convert to yarn form. Dyed and white spinning lines are separate as a precautionary measure to avoid from contamination during spinning operations. White yarn manufacturing has a separate white spinning line. This is to get contamination free white yarn of international quality. In spinning department, the re-combed tops, which are feed material for spinning department, are received according to production plan prepared by SCM department.

Spinning process has an objective to produce yarn with specific linear density, of good quality at reduced cost within specific time limit.

Objectives of worsted spinning

To carry out maximum level of production with higher utilization.
To obtain specified level of quality for customer (end user) satisfaction.
To do with minimum cost.

2.7 Warehouse and tops conditioning

In warehouse, re-combed tops in the form of compressed bales are stored. Those bales are covered with polypropylene woven flat sheet to protect materials. One bale has 8 packages, each of 18–22 kg. Generally, weight of 1 bale ranges from 225 to 250 kg. In a warehouse, arrangement of bales is most important to find out particular bales. Sometimes, some short lots

Tops sliver, kept in compressed bales, to be transported from other combing plants.

come to process, and then it becomes more critical to store all bales. As per requirement of shades, tops are opened. During opening of top lots, precaution should be carried out to avoid mixing of two different lots or similar shades.

Some times blends may be different and shades are same. There are variations in shades, so it is very essential to check lot no., blend, shade no., dyeing plan no., etc. to avoid mixing.

2.7.1 Tops conditioning

Tops are kept in open trolleys in conditioning room for obtaining the required moisture in the blended or 100% wool tops.

After opening the bales as per requirement, it is necessary to condition it. Hence tops are kept in trolleys in proper manner and allowed for conditioning for 24 h at a temperature of 29°C dry and 26°C wet bulb temperature at 80% humidity level. Humidifiers are installed to maintain the required humidity. After conditioning, the material recovers its desired level of moisture. This becomes important because it governs overall processing behaviour.

Tops conditioning system.

2.7.2 Raw materials specification with code system

The raw material is also given code nos., and as per code nos. for blend, shades, tint applied for white material etc., all visual management works.

Colour codes

In system, there are some blend codes which are denoted as

1st digit – proportion of blends

Mixture shade

- White / Yellow / Golden
- Blue
- Red
- Green
- Violet
- Orange
- Brown
- Black or Gray

2.7.3 Gilling

The principle of gill box is to make fibre straighten, uniform, unidirectional, and thus making sliver finer by reducing weight per unit length.

Gilling machine – NSC GC14.

Passage of material through the gill box machine

The input to this machine is in the form of re-combed tops. The sliver is passed over the creel and passed through the back roll, i.e. between the rubber cot roll and steel fluted roll, and then in between the fallers moves either by spiral gill screw or by chain. The fallers do a brushing over it. The fallers have pins which are of variable pin density and their use is as per the quality of material. The combing action of the fallers helps in parallelizing and straightening of fibres. Over the pins there is a brush which cleans the fibre flies accumulation.

The faller pins are very important for the quality of the sliver processed. There should not be any bent, broken or missing pin in the faller which can affect the evenness quality of the sliver.

Bent, broken or missing pins in the faller.

Working of gilling machine

After conditioning, gill box is the first machine used in the spinning line. Here the re-combed tops are given four subsequent passages so as to prepare final tops of required weight. The linear density is measured in the form of grams/meter. N. Schlumberger & Co. Ltd. is one of the manufacturers of this machine. The machine works with standard draft 4.1–11.9, and speed 400 rpm. The set length can be calculated by considering weight of feed tops.

Antistatic application is being done to avoid static current during processing of the material to run smoothly. Second passage of machine is normally kept on auto leveller.

The detailed specifications of gill box are

S. no.	Particulars		
1	Make of machine	N. Schlumberger and company (N.S.C.)	N. Schlumberger and company (N.S.C.)
2	Model of machine	GC 14	GN 6
3	Fallers fitted type	Chain type	Screw type
4	No. of fallers	2 × 72 = 144	2 × 36 = 72
5	Pin width	220 and 270	220
6	Working fallers	22	28
7	Pin projection (mm)	14	17.5
8	Pinned length (mm)	200	220
9	Input speed (mpm)	80	60–80
10	Diameter of drafting cylinder (mm)	30/62.5	30/62.5
11	Top roller diameter (mm)	80	80
12	Minimum heads 1 and 3	38/32	38/32
13	Pressure	200–400	200–400
14	STD draft	4.1–11.9	4.5–13.0
15	Reduced draft	3–8.8	Upto 8.65
16	Mechanical A/L limit	± 0–25 %	± 0–25 %
17	Maximum speed	400	400
18	Maximum load on material (g/m)	350	300
19	Compressed air consumption cubic (Nm/h)	7–8	7–8
20	Suction power (Nm/h)	2100	2000
21	Electrical power (KW)	7.5–9	7.5

Set length setting

Set length is adjusted for new lots. The set length can be calculated by consideration of weight of feed tops, number of doublings and wrappings. The set length is most important which can be used to reduce stoppages of next process.

Antistatic oil application

As the polyester is blended with wool, therefore static charges generation is more and polyester has only 0.4% moisture content, and during the process, working at high speed and with more static charge in material, the material flies may lead to frequent lapping trouble and cause problems

in the working of machine, resulting low production and deteriorating the quality of material. So to avoid all this, antistatic is sprayed on sliver at delivery end. If it is applied at rear end, then it may cause lapping of rollers and jamming of fallers. The application is usually done on 1st passage, if necessary. It has been observed that if oil application is done at previous stages, the working will be smooth and material get time to accommodate oil in it. The details of oil applications are given below:

- Antistatic oil used – cirrasol TF
- Concentration – 10%.

Selbana mixed with Katex is also used for better working performance. Emulsion-water is best emulsifier.

Percentage of antistatic oil applied on weight of tops is 0.15–0.2%. The size of orifice of spray pipe is 0.25 mm.

Tension setting adjustment

Tension adjustment is very important for the consideration of quality of delivered sliver. If the sliver is un-even or have cuts or higher U%, then input or output tension need to be adjusted. Tension checks should be done at coiler belt tension, coiler drive, and head coiler tension and back to head tension. The chain sprockets are given to adjust the tension level by shifting chain.

Auto-leveller setting

As per wrapping, if the draft is required to be changed, then only combination of A,B……H with 1……..8 nos. is adjusted in gear box. Practical changing of any gear is not required.

Pressure on tops rollers is manually adjusted in GN 6. If the main motor belt becomes loose, then the motor can be adjusted side way.

Can details

- Can sizes for gilling 1–3 = 700 × 1000 mm
- Can sizes for tri-coiler = 500 × 1000 mm

Can spring

Tension in can spring affects the false height level of sliver and leads to excessive stretch causing high count variation and brakes.

It has been seen that the auto leveller are functioning effectively at 2nd or 3rd passage of gilling.

The 3rd passage for auto leveller is justified if the tops are transported from the other units. Due to the criss-cross arrangement and disturb material layers, it is difficult at primary stages to do auto level. So compensation action carried out at finisher stages will be effective.

Also, it can be at 2nd level because if the material is at well auto-leveled condition, then further action of gilling will be very effective. Also, number of doubling at further reduces the short-term faults.

Thus it is seen that as compared to 3rd passage, the 2nd passage is more effective for auto leveller to function.

GV 20A.

Specifications of NSC GV 20 A:

No of deliveries	– 2 can of diameter 700 mm.
Drafting	– vertical drafting
Overhead creel capacity	– 8 cans of diameter 700 mm
Pinned field depth	– 190 mm
Faller chain pitch	– 9.525 mm
No. of fallers/heads	– 2 × 16 = 32
Draft cylinder	– diameter of 30/62.5 mm
Feed cylinder	– diameter of 50 mm
Pressure on feed cylinder	– 30 mm
Fixed nip distance	– 36 mm
Distance between feed cylinder and 1st working faller	– 100 mm
Faller pin length	– 85 mm
Flat pins size	– 18 × 24 (Std.) = 432
Pin length	– 0.5 in.

Projection inclination	–	0 degree = 4 mm
Std. draft range	–	4.5–13.1
Maximum delivery speed	–	500 rpm
Maximum input speed	–	85 rpm
Normal delivery weight	–	12 g/m
Motor with frequency inventor	–	11 KW at 1500 rpm
Suction motor	–	2.2 KW
Compressed air supply	–	6 bars
Compressed air consumption	–	1 Nm^3/h (avg)
Creel tension range	–	2.4–11.6%

Important points to remember

Ratch setting

It is the distance between consecutive roll pairs in a roller drawing system. To avoid breakages, it is necessary to set the ratch longer than the longest fiber, because a shorter ratch will break all fibres greater in length.

Visual management techniques

Code marking system

For specific identification of raw material (tops) colours, the code marking system is employed in the worsted plants. This is one unique feature of the system because without this system nothing can be planned on papers. The codes are given on the basis of blend proportions, shades, raw materials, count of yarn, fabric quality, trade name, etc.

Thus, at every stage of working this codification works to separate all materials to avoid mixing. It also helps to reduce contamination and mixing of shades/colours. It enhances quality improvement to even dying of piece dyeing, good work practices, reduction of wastes, easy to work and so on.

Colour codes

S. no.	Roving	Ring tubes
1	Yellow	Yellow
2	Green	Green
3	Pink	Pink
4	Sky blue	Sky blue
5	Dark blue	Dark blue
6	Brown	Brown
7	Orange	Orange

The specific cops at roving must have specific cops on ring frame. Thus, identification can be easy for particular count. The allocation of colour for counts, blends etc. should be as per need.

2.7.4 Roving frame

The roving frame is an intermediate machine between draw frame and ring frame. The main objective of this machine is to convert sliver in to thinner sliver for the convenience of subsequent processes. Here, the drafting of fibres is carried out so that the drafting load on ring frames can be reduced. The nominal twist is inserted to hold at the roving stage.

NSC BM–20 roving machine.

This gives advantage as compactness and easy material handling. This twist can be removed at ring frame. There are two different roving machine models available: BM20 and FM7N rubbing frame.

Working principle

The material is fed to the machine in the form of sliver from the cans. It is then passed over a roller which lies above the creel. Then it is passed over a roller. Further the sliver is passed between the roller mounted with cots and fluted roller. Then it is passed through 3 over 3 drafting system. The sliver is given draft to thin out from the back roll to front roll. It is then twisted from the nip of the front roll to the twist master eglets and further winded in the form of roving on the roving bobbin.

Specifications of rubbing frame

Machine make	–	NSC
Model of machine	–	FM7
No. of spindles	–	20
Delivery machine	–	20 × 2 = 40 rubbing strands
Delivery speed	–	150 rpm
Rubs/m	–	6
Delivery	–	double rove delivery type
Package builds	–	cheese type

Working principle

The roving strand delivered is twisted to hold material at lateral processes. This twist kept is very nominal as it has to break at ring frame. The difference in the rubber frame is that twist is imparted due to the rubbing of rove strand by rubbing aprons after drafting, and this gives lateral movement continuously to deliver and then winding on bobbin.

Stop motion

- Stop motion due to creel sliver break (photo sensor)
- Set length stop motion.
- Stop due to lapping.
- Stop at front side.

Quality checking at roving/rubber frame

At roving/rubbing frame special emphasis is given on the working and processing characteristics of material. Any problem is troubleshooted by

taking necessary actions via machine setting, adjustment, process parameters changes, etc.

The wrapping is checked against standard, and any deviation in wrapping is adjusted by changing the draft so as to get the required wrapping.

Precautions and recommendations in spinning preparatory:

- Tops should be stored in a room with 80% RH for conditioning.
- Draft on gill boxes should not be on higher side but should be in the range of 6.5–7.8 for better results.
- U% and spectrogram should be checked on all the passages of gill boxes not only for auto-leveller and final gilling and should be attended for mechanical reason if shows in spectrogram.
- Oil and anti-static spray should be applied on first gill box and the strength of solution should not be more than 15%.
- Measuring roller of 12 mm width on auto-leveller should be used.
- Inert test to be done on auto-leveller.
- Auto-leveller position once fixed should not be changed for same type of material.
- On GV-20 or FM 5P lower draft should be kept.
- Roving to be stored in conditioning room where RH is around 80%.
- Different spin plans for different types of material should not be used for working where as same spin plans to be used to avoid frequent changes on machines.
- Standardize work plans for different qualities (Adjustment should be minimum).
- Should avoid using two different make mounted top rollers on gill box in preparatory. Preferably Armstrong mounted top is better.
- Should follow some methods to study the periodic defects on machines. It is necessary to study the defects as per Pareto law and to analyse how the defects were being eliminated in the past.
- Should do coating on the surface of the rollers of various machines. Imported chemicals NIVITOL is recommended for better results to avoid lappings.

2.7.5 Ring frame

Main purpose of ring frame is to produce yarn of required count. Ring spinning basically in principal is drafting, twisting and winding only. The worsted material requires nothing special system to work. Some minor changes are required to make on ring frames, and the modern ring frames are self-equipped with attachments. Zinser ring frame is a latest state of art technology machine. In the high productive machines, generally the modifications are done in aprons, cradle sizes, lift and ring diameter, etc.

Ring frames.

Ring frame machine – Zinser RM 450.

(a) Spacer colour used

Count	*Colours of spacers*
24– 28	Beige colour/3.8 mm
Up to 60 Nm	Black colour/3.2 mm
Above 60 Nm	White colour/2.6 mm

(b) *Drafts* – The drafts can be set as per our requirement. Normally, all machine worked on combination of gears.

(c) *Twist setting* – The twist setting and direction of twist can be changed if required. Generally the direction is fixed but sometimes amount of twist varies as per the need.

(d) *Feed wrapping and delivery count* – Many times the feed wrapping

is changed so that the number of changes at ring frame is avoided. The draft will remain same and if feed wrapping varies, it gives very different count ranges.

(e) *Traveller change frequency* – 5 days.

In ring frame machine, the piecing is done side ways instead of below front roller. Because of the high skill of sider, there may be chance that the particular piecing will not catch by winding clearers. So for removing every fault in fancy trends, which is more important, side way piecing is done.

The marking on cops is done by chalk for avoiding shed mixing and for identification.

Drafting for reduction in weight per meter for required count and twisting for imparting strength by binding of fibres in required direction.

Ring frame is next to roving, as we feed roving on creel of ring frame machine and passes through 3/3 drafting system through back roller aprons and front roller and passes through from the nip of front roll to lappet guide and ring traveller and then wound on the ring tubes, which is mounted on revolving spindle. All the data of spindle speed, twist, draft and shade number with blend count, etc, are fed in the computerised system of the machine before start of the ring frame Zinser RM 450. The maximum spindle speed can be achieved is 12000 rpm. Yarn, like Siro, attachment can be fixed on Zinser machine to spun siro yarn.

2.7.6 Steaming

Steaming is done to set the twist which is imparted in ring frames to eliminate snarling effect. Following are the settings kept for single ring spun yarn for steaming.

Vacuum	–	85%
Temperature	–	84°C
Time	–	20 min.
Vacuum	–	75%

After yarn is steamed according to lot wise, single ring yarn doffs are stored for at least 8 h to cool and condition, then it is to be taken for winding. The time between steaming and winding is important so that yarn can retain moisture and get stabilised so that it can be suitable for winding.

Elgi Welker vapofix auto clave.

Precautions and recommendations in ring spinning

- One should not change Draft pinion if variation is there in count whereas it should be controlled at preparatory level and have standard feed material.
- Creel rods on spinning frames collect fibres due to rubbing of roving. These creel rods should be coated or covered with plastic or polythene strips.
- For partioning two ring frames, nylon net curtains should be used.
- Cloth of suction box should be washed periodically.
- Pneumafil tubes should be cleaned by boiling soap water not by hand brush otherwise inside surface smoothness will get damaged.
- Ring frames should have inverter drives especially where the drive is directly through V-grooved pulley.
- The top and bottom apron in the drafting zone of ring frame should be exactly one above the other.
- Traverse of the roving guides should not be stopped for fine counts where as the roving guides should be at centre and should have minimum traverse.
- Ring frames should be installed with travelling over head blowers on all machines.
- The Tube lights should be parallel to the spinning frames for better lighting and also for putting up curtains up to the bottom of ceiling. Tube lights should not be at 90° angle to the spinning frame.
- The ring frame partion curtain should be up to the bottom of false ceiling.
- Temperature inside the department should not be very high. Air conditioning should be effective as proper conditioning is very important.

- Yarn breakage in spinning should be studied and analysed, including fibre lapping on rollers.

2.7.7 Auto winding

Winding is the most important process in spinning system. The main objective of winding is to remove objectionable faults from single yarn to prepare fault-free yarn, which is achieved by clearing by electronic yarn clearers. The transferring of yarn from small packages to bigger packages is another objective of winding. The final bigger package is fault free.

An individual splicer is provided on each drum in which splicing is done at both the ends by pneumatic arrangements. The joint diameters are about 1.0–1.2 times of yarn diameter, where as strength is 80% to single yarn strength. Rate of splicing is at 30 splices/min. Air pressure required is 6.5–7 kg/cm^2 and 570 mm and thus knot-less yarn is achieved.

Oerlikon/Schlafhorst (Autoconer 338 Type RM).

Machine specifications of winding machine

S. no.	Particulars	Details
1	Make of machine	Schlafhorst (Autoconer)
2	Model of machine	338
3	Spindles per machine	60
4	Spindle per section	12
5	Individual splice head	Yes
6	Doffing	Manually
7	Creel capacity	6

Passage of material through machine

The bobbins are first kept in a magazine creel. The bobbin is selected one by one by the machine for winding on a hollow tube. The yarn first passes from the guide made of porcelain material. Then it passes through the cutter accompanied by the electronic yarn clearer. The sensor of the clearer is set for the following parameters of the yarn.

N – Neps
S – Slubs
L – Long thick place
T – Thin place
Cp – Count plus
Cm – Count minus
Ccp – Continuous count plus
Ccm – Continuous count minus

The sensor senses the fault and the cutter cuts it. Then it is sucked by the pneumafil tube. This suction fan sucks the end of the yarn left out after the yarn gets cut due to fault in it. Then the yarn gets spliced by taking both the ends and wounded on the cheese by the frictional winding drums. There is a travelling doffer, which takes out the full doff cheese after its completion. There is a conveyer belt moving at the bottom of the machine having vertical blocks to carry out the empty bobbins to the empty tube collection basket. One brush is also provided downwards which cleans the empties.

Precautions and recommendations in auto-winding

- All quality of Uster cleared yarn should be checked for Classimat yarn faults assessment.
- Finer counts to be run on 700/800 m/min. speed whereas courser counts to be run on 1000/1200 m/min. speed.

- Weft yarn used as single yarn should be run on closer yarn clearer settings.

2.7.8 Ply winding/assembly winding

In this winding, doubling of yarn is made by plying two single parallel yarns and are wounded on the parallel cheese, which is a feed package for twisting as per required order. Thus assembly winding is intermediate process where two parallel ends are wounded on small packages, which can fit into TFO'S pot that is of approx.1–1.2 kg.

If there is a single yarn in the plied yarn, it generates problems at further stages and can produce defective fabric. The good performance at ply winding gives better working at TFO. So parallel winding is also important process for TFO machine. The machine has two sides with electrical stop motion.

PS METTLER FMK-S Ply Winder.

Machine specifications of PLY winding machine

S. No.	Particulars	Details
1	Make of machine	PS METTLER
2	Model of machine	PS METTLER with auto length controller ALC-2000
3	Spindles per machine	120
4	No. of sides	2
5	Connected power (HP)	10
6	Transfer load (KVA)	1.2
7	Speed rpm (max.)	600

Maintenance schedule for ply winding machine

Machine cleaning	–	1 month
Cradle hole oiling	–	1 month
Starting handle lever oiling	–	1 month
Oil changing	–	6 months
Drum shaft bearing greacing	–	6 months
Can shaft bearing gresing	–	6 months

2.7.9 Two-for-one twisting (TFO)

Working principle

Twisting of the parallel wound double yarn can be done by the method of inserting two twists for one revolution of spindle. It is done to give twist as per requirement of direction for imparting strength to double yarns.

Working

This is a very important department next to assembly winding. It has four wheels A, B, C, D, which adjust the count of yarns as we should have A+B = C+D. It has a tangential belt which drives all the spindles of the TFO machine. Springs are of variable tension and two flyers arms placed 180° to each other.

As capsule contain a spring which differ as per yarns. The two flyers give twist to yarns and then it goes to groove bearing where we can adjust tension as per type of yarns. The feed is taken in pot. This spindle runs at 8000–9000 rpm.

TFO machine.

Machine specifications of TFO machine

S. No.	Particulars	Murata (Japan)	Prerna (Indian make)
1	Make of machine	Murata	Prerna
2	Model of machine	363	PRN 160 LW and PRN 160
3	Spindles per machine	120	120
4	Drum diameter (mm)	100	100
5	Disc diameter (mm)	180	170
6	Traverse	152	125
7	Maximum package diameter	160	150
8	Spindle diameter	Up to 1100	Up to 1500
9	Twist direction	“S” or “Z”	“S” or “Z”
10	Spindle pitch (mm)	255	255
11	Tensioners	Capsule type +	weight on brake disc
12	Bunch	By side wheel	By side serrated wheel

Generally Z over S or S over Z twist is inserted on double yarn but in rare cases Z over Z and S over S can also be twisted.

Precautions and recommendations in Two-for-One twisting

- Finner counts should be run on 7000 rpm speed whereas coarser counts should run on 8000–9000 rpm spindle speed.
- Yarn bunching should be of sufficient length i.e. 1.5–2.0 m. Bunch yarn should be removed after steaming. In case of coarse counts, such as 2/24 Nm or below, it should be locked by putting knots after breaking of the un-twisted bunch yarn otherwise it will be shown as bullets in the fabric.

General points to remember

- Single yarn after steaming should be taken for winding at least after 8 h.
- Air circulators should be removed as this causes contamination.

2.7.10 Steaming and conditioning

Yarn conditioning and setting should be done under high temperature and high pressure steaming to set the twist imparted in TFO machine for eliminating snarls in yarn.

The main objective is to set the twist temporarily which is imparted in TFO machine to eliminate snarling twist in the double yarn. Following are the settings to be kept for double yarn for steaming double cycle.

(a) Vacuum – 85%
(b) Temperature – 84°C
(c) Time – 20 min.

After the yarn is steamed, it is stored according to shade, count and lot wise for at least for 8 h so as to get cooled and conditioned.

2.7.11 Yarn delivery procedure

Yarn package checking in day light.

Yarn package checking in UV light.

Double yarn ready for delivery.

After double yarn steaming, yarn is not yet ready for delivery. Here are some specific steps that need to be followed up. After steaming, keep yarn for 8 h so that yarn can adjust with the actual dept conditioning. Then the upper layer of yarn from cheese is removed of about 1.5 m. Also bunches are removed from each and every package as this is either low twisted or parallel yarn.

Each yarn packages are checked for mixing of shades, blends, counts, etc. and also for shape, package hardness, softness, twist, bunch, 3- and 4-fold yarn. Then U-V light checking is also done in a dark room for white shade material for any type of mixing such as count, blend or twist, etc.

Finally, weighing of the material is done and is delivered to yarn room.

2.7.12 Tips for improvement (check points)

Spinning preparatory

- Before taking the material/shade on gill box machine, ensure that the machine is properly cleaned to avoid contamination.
- Proper instruction of the blend/shade/count should be given by the spinning personnel before running any new material.
- Checked the condition of fallers and rubber cots roll before starting any new material.
- Check whether the cans are perfectly cleaned and condition of can is ok.
- Wrapping should be properly checked and confirmed with the standard wrapping.
- Check whether sliver is being taken for Uster testing, gill boxes, GV-20 and roving.
- Check whether material cans are properly kept with the identification.
- Check whether piecening of sliver is properly done at the time of sliver breaks or material lapping.
- Temperature and humidity in the department should be checked.
- Roving and wrapping should be checked as per standard.
- Check whether storing of roving bobbins is done properly.
- Check whether condition of rubber cots of roving is ok.

Ring spinning

- Check the condition of rubber cots of ring frames.
- Check the counts checked at the time of starting of ring frame of ring single yarn.
- Check the Uster u% and imperfection of yarn.
- Check the mixing of similar yarn shades.

- Check the ring cops having single yarn bottom.
- Check the mixed colour empty tubes in bins.
- Check whether machine is properly cleaned. Fibres arrested in the roving creels area of previous shades material can cause contamination.
- Check the unsteamed and steamed yarn is kept in organized way.

Auto-coner winding

- Splice quality should be checked.
- Clean the yarn bottom after run out in winding.
- Confirm and check the yarn parameter settings before changing the material for counts and blends.
- Winding package should be checked for winding quality.

Assembly winding

- Check whether separators are in place for spindle to spindle to avoid 0.75-fold yarn.
- Check whether weight for yarn tension is equal for both side yarn path.
- Yarn passage should not abrade with metal friction
- Winding package quality should be checked.
- Similar shade mixing for other component should be checked.

Two-for-one twisting (TFO)

- Check whether bunching device is functioning properly.
- Check whether yarn waste is lapped on spindle.
- Check whether knotting done during yarn break or package is removed.
- Check whether mark no. is correct for the specified count and shade on the yarn package.
- Check whether bunch is being removed before delivery to yarn room.
- Yarn package should be properly checked for mark no., shade and mixed yarn etc. before delivering to yarn room.

Yarn room

- Yarn issued for warping should be as per piece tickets and mark no. should be confirmed for the shade.
- Out source yarn should be sent to QA Lab for checking of count and other test reports.
- Yarn should be stored in trolley to avoid yarn damage and to make easy search.

- Re-wound material should be examined for yarn mixing and wrong mark no. before it is taken for using for weft or storing in yarn room.
- Outsource yarn received should be checked for yarn package damage and for material handling.

2.7.13 Spinning accessories

Soldering of gill box faller pin strip.

Proper keeping of soldered fallers in tray.

De-mounting and mounting of cots roll.

Buffing machine.

Buffing time

As per the schedule given, the buffing of cots are carried out as per schedule. The function of this department is grinding, buffing and mounting of cots on arbours. The operations like cots diameter measurement and greasing are also performed. Firstly cots are checked for their size and hardness and if required corrective action has to be taken.

Greasing of the cots arbour.

Sorting of the cots according to their diameter.

Mounting and de-mounting machine for pneumatic cots.

Spindle-used oil sucking and fresh oil refilling machine.

House-keeping

Proper storing of the spindle oils.

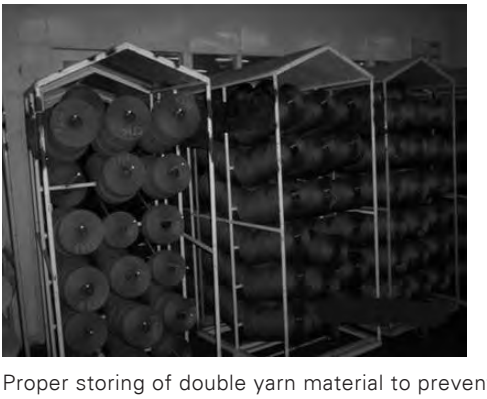
Proper house-keeping of the electric motors.

Proper house-keeping of gears (teeth wise).

Proper storing of empty roving bobbins (colour wise).

Proper storing of empty ring tubes (colour wise).

Proper storing of roving materials in trolleys to prevent spoilage of upper layers.



Proper storing of double yarn material to prevent spoilage of upper layers.

2.8 Weaving

The main objective of weaving department is to weave fault-free fabric of required length by keeping required production rate and maximum level of efficiency. The fabric is woven as per quality, specifications, weave, design effect, etc. specified by order and as per customer requirement. While doing so cost of fabric and quality of fabric are maintained at particular level.

2.8.1 Warp preparation

For worsted suiting fabric, the double twisted, medium count and better quality yarn is used. So there is no need for sizing. The preparatory machines itself improves performance of weaving. Thus it is seen that the quality of warp and weft gives the quality of weaving. Thus care is taken to improve quality at desired time limit with optimum level of quantity.

After receiving yarn from double yarn room and piece ticket (details of specification) from PPD/SCM, the first stage starts with weaving and warping. As mentioned earlier the suiting yarn requires double yarn that can withstand high stress and strain that developed at weaving stage. Thus sizing is dropped out and sectional warping is employed directly to prepare warp beam as weavers beam. The cheese of double yarn from yarn room is first kept in systematic manner so as to arrange on to creel side of warping machine.

The checking of number of bundles is carried out as per ticket. If any smaller packages are present then those are not allowed for creeling. Generally it has been seen that bigger packages at back side and smaller at selvedge or at front side are kept for the creeling of particular beams.

The yarns are guided through creel to head stock as per machine. On creel, it has to pass through pegs, guides, tensioners, stop motions and numbers of guiding position. Then it is taken through reed and sectional reed where width of section is decided. The pattern is decided and then creeling is done. As per piece ticket, twist, blend, colour, everything is seen while creeling and it appears as a result in individual section.

Then as per number of ends, number of sections is decided. The length of piece, beam length, everything is followed as per piece length. After preparing sections on drum, the beaming is carried out. Sometimes if beam length is smaller than knotting of two warp sheet, then it is done at warping only.

The preparation warp yarn is more demanding and complicating than that of the filling yarn. Each spot in a warp yarn must undergo several thousand cycles of various stress applied by weaving machine. Modern weaving machine has placed increase demands on warp preparation due to faster weaving speeds and use of insertion devices other than shuttle. Warp yarn must have uniform properties, which give sufficient strength to withstand stress and friction abrasion during weaving. The yarn on warp sheet must be parallel to each other with equal tension.

Benninger Bentronic warping machine.

In general terms, warping is a process of making a warp sheet of required warp ends from warp creel of yarn packages of the required length.

Warping machine can process all kinds of materials including coarse and fine filaments, staple yarns, monofilament, texture and smooth yarns, silk and all type of synthetic yarns. Warp beam is very much responsible for weaving good quality fabric and for high productivity on weaving machine.

The section beam is tapered at one end. Warp yarn is wound on the beam in section, starting with the tapered end of the beam. It is important that each section on the beam contains the same number of yarn. The same length of yarn is wound on each section which is measured by measuring roller. Warping speed is 500–800 m/min; however residual elongation will be reduced at high speed. The amount of yarn wound on the beam is proportional to the length of each section and the conical angle. The drum is made by synthetic resin bonded glass fibre. The roller starts measuring the build up of yarn with an electronic sensor. The maximum speed during winding of the beam depends on the necessary winding tension. Warping

speed of up to 600 m/min is possible. The warping speed is kept high for finer yarn quality.

The computer can also monitor the following automatic stops for predetermined length

Operating speed regulation of ±0.5% between warping and beaming.

Warping machine specification

Name of machine	Prashant Gamatex ESP-800	Prashant Gamatex E-800	Benninger Bentronic
Creel Capacity	544.00	480.00	480.00
For Selvedge	44.00	–	–
Machine speed (m/min)	600.00	600.00	800.00
Drum diameter (m)	0.83	0.83	1.00

Waxing

The waxing is carried out for better performance of the yarn at loom shed. The wax gives surface coating on yarn and avoids yarn bakes at loom sheds. The waxing compensates the thin places and avoids breaks. The wax is made up of 20% antistatic cirrasol TF oil, 10% polyethylene glycol (PEG) and 70% water as emulsifier.

Wax preparation arrangement.

The prepared wax can be applied on yarn as 1.5–2% on the basis of weight of material. The content of cirrasol TF oil is added more in winter season because PEG may get frozen in that season. Thus antistatic oil is increased in winter.

Tension parameters

Count	Tension (in grams)
2/102	16–32
2/80	18–36
2/24	40–80
2/56	30–60
2/70	20–40

Knots

During warping, fisherman's knot is put by hand knotter during changing the creel. The knot has high strength and it is easy to pass through dents and reed at warping.

Adjustments to be done

(a) *Width of warp*

The width of warp is adjusted as per beam space required. Generally on drum same width is kept like beam width. It is also seen that warp yarn has not been given any allowance as per as adjustment of widths is considered.

(b) *Section width*

It is required to set final width of beam. Section width is required for deciding actual gaps between the ends. It is calculated as reed or beam space divided by number of sections.

(c) *Cone height*

As per count, no. of ends, length of warp etc., cone height is set. This cone height decides how much traverse has to be given to beam during weaving and how much traverse to be given to the drum during warping.

(d) *Cross selvedge and plain selvedge*

The selvedge where ends are taken from creel at sideway as it crosses each other is called as cross selvedge. And in plain, direct selvedge is

formed. Generally, 65, 85, 80, and 78 ends are there in selvedge. For pattern beams, cross selvedge is put.

(e) Creeling

Creeling is done as per pattern, i.e. patterning as per bundle size and quantity of the warp material (kg) and accordingly number of packages is kept on creel.

Knotting machine

In some cases, warp pattern is same but the count of warp yarn and yarn shade vary; in such circumstances warp sheet yarns are knotted by the knotting machine on the beam itself. Hence, two different warp sheets are tied together called as end-to-end tying. Thus, beam contains two different types of yarns. This saves drawing and denting time.

Same concept is adopted in the loom shed where one beam is near to exhaust. Details of the used knotting machine are given below.

Name of machine	–	TODO warp tying machine (HIMAC)
Speed control	–	60–800 knots per minute
Number of needles	–	80
Time required for knotting	–	nearly one and a half hours.

Procedure

First take all the ends from both sides of beam, then remove lease from both beams. After that, leveling of ends is carried out. Then combing and dressing is performed.

Fix warp ends under tension and put on slits on ends so that they become tight enough for knotting. Carry out same procedure for new beams. Then cutting of excessive ends are done. Now put the knotter into action. Checking for first few knots are done so that it can be easily carried for the next beam. The gap between two ends should be there.

Many times end-to-end knotting is observed. The checking for knots and combing is then carried out. Then remove leases and rods, which have been put before working, and after this, final beam is ready to work. Higher beam knotting indicates higher utilization of men, machine and extra time for warping and thus beam drawing-in is reduced.

Warping faults

- Wrong mounting of creel
- Faulty tension creel

- Carry forward broken and missing ends
- Wrong denting
- Overlapping of sections
- Incorrect winding of beams and incorrect laying of leases
- Beam flanges and broken end at selvedge.

Drawing-in and denting

The objective of drawing-in and denting is to draw warp ends of weavers beam through drop wire, heald wire as per healding sheet number, and through the dents of the reed as per the denting order. Thus beams are ready to weave. In manual drawing-in stands, each consists of one drawer and one reacher with one helper. The drawing and denting is carried out as per plan on piece ticket. Every care is taken to avoid mistakes and thus avoids creation of defective fabrics.

Procedure

The drawing-in and denting details are written on the piece ticket. The denting is done afterwards. First they are mounted on the beams. Then leases are removed from beams. Then the tension is put on beam threads. Then lease rods are inserted.

While doing so the adjustment of reed, heald shaft and drop wires are carried out. The drop wires are of close-types. Jobber carries out the drawing and denting of selvedge ends on loom itself during beam gaiting.

2.8.2 Healding and drawing

It is the process of deciding to lift up which healds wire when to create required design. There are two types of healding: manual healding and drawing-in or auto-drawing-in.

Here the warp ends are passed through the healding wires and pins are dropped manually according to drafting plan. After healding denting is also done. The suitable reed for that plan is selected and denting of warp end through the reed is done.

But in manual healding, there are chances of mistake while drawing or denting. Manual healding is only preferred for straight draft or simple fancy draft. After drawing, the beam is ready for gaiting on loom. In manual healding 4000–5000 ends are drawn/shift.

Automatic drawing-in (Super Vega)

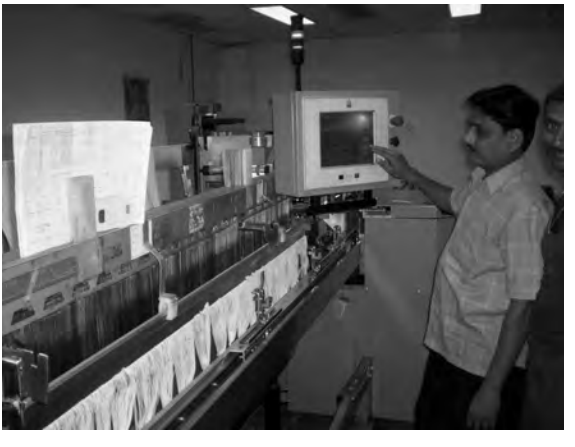
This is one of the advanced machine used for drawing-in all over the world.

Unlike manual healding, here only single end is used for healding and denting. Here drafting plan is feed on the screen and single end is drawn at dented automatically.

In this machine, there are no chances of mistakes being made in drafting order mechanically unless there is mistake in feeding the data on the screen. The yarn accumulator winds the yarn in advance to reduce the unwinding tension. From this accumulator, yarn is carried to yarn presenting device. Beside this there is a yarn hook which carries the yarn vertically up to the yarn catcher. This yarn catcher holds the yarn and gripper pulls the yarn to pass through drop pins, heald wire and reed. In yarn presenting box there is a cutter which cuts the yarn after the completion of one full cycle. In this way this process goes on till the required no. of warp ends are drawn and dented.

In this machine, there is a heald selecting device, heald separating device, heald pushing device and heald frame matching device. Each device has its own importance, and each device works at their scheduled time.

The speed limit of this machine is 82 ends/min. However it runs at the speed of 72–75 ends/min. In one shift 14000–15000 ends are drawn.



Automatic drawing-in machine.

2.8.3 Knotting

After healding is completed, this goes for knotting where the pattern of the original beam and this healded sheet is matched and then it is knotted with the help of knotting machine.

Knotting precautions

(1) After completing dressing of upper and lower beam ends, insert broken ends out of it into lease and confirm again.

(2) While dressing, do combing three to four times with the help of double reed.
(3) Confirm that both beam ends should have tension.
(4) Use proper needles.

Process of knotting.

2.8.4 Sulzer weaving machine

This filling insertion system produces good fabric quality with high economical efficiency and low energy consumption. A modified filler insertion system further reduces yarn loading.

Sulzer weaving machine.

Projectile weaving machine use a projectile equipped with a gripper to insert the filling yarn across the machine. The fine or coarser are securely gripped and inserted by the projectile, resulting in a wide variety of fabric, for simple staple goods through superior fashion cloth and for wide heavy industrial fabrics to complex jacquard clothes.

Weft yarn cover trolley.

Weft yarn should be stored in cover trolley to avoid from fibre contamination, dust and dirt.

Sulzer shed

The weaving department is the final stage where actual fabric is formed.

Machine specifications

Particulars	**PU**	**P7100**	**TW11**
Make	SULZER Ruti, Switzerland	SULZER Ruti, Switzerland	SULZER Ruti, Switzerland
Width	Single and double	Double	Single
Width specification (cm)	190 and 380	380	190
Reed space used (cm)	170 and 340	340	170
Reed specification used (cm)	170 × 2 and 170 × 2	170 × 2	170

(*Contd*.)

Particulars	PU	P7100	TW11
Dents per in.	16 and 21 PRO 7102	17 PRO 7102	17 PRO 7102
Loom speed (rpm)	300 and 260	260	275 and 255
Jacquard used	Elitex for border names	Elitex for border names	Elitex for border names
No. of ends used for selvedge	80–100 for 1 side and same for other	80–100 for 1 side and same for other	80–100 for 1 side and same for other
Dobby company	STAUBLI positive dobby	STAUBLI positive dobby	STAUBLI positive dobby
Dobby series	2400	2400	1430
Dobby type	KR 2 and KR 1	KR 2	KR 1
Dobby capacity	Upto 20 heald shaft capacity	Upto 20 heald shaft capacity	Upto 20 heald shaft capacity
Picking	Projectile picking principle	Projectile picking principle	Projectile picking principle
Beat up	Conjugated cam beat up positive impulse	Conjugated cam beat up positive impulse	Conjugated cam beat up positive impulse
Warp stop motion	Electrical WSM	Electrical WSM	Electrical WSM
Let off	Electrical with mechanical synchronization	Electro mechanical	Mechanical clutch type
Temples used	Ring temples	Ring temples	Ring temples
Take up drive	Positive take up with clutch tension type	Positive take up with clutch tension type	Positive take up with clutch tension type
No. of projectiles	12 and 18	18	12
Pick range	91–230 picks per in.	91–230 picks per in.	91–230 picks per in.

Types of projectiles used

The projectile used are of D1 and D2 type for all looms. The force of gripping is nearly 1800 gm for D1 and 1400 gm for D2. For count up to 2/100 Nm and for SIRO yarn, D1 is used. Average life of projectile is 2–2.5 years.

Torsion twisting angle and details of diameter:

Loom type	Torsion rod diameter	Angle of twist	Marking
DW PU	19	27	White
DW P7100	19	24	White
SW PU	19	19	White
TW11	19	18	Yellow

Selvedge type

Tuck-in-type selvedge is used for both ends in fabric and width size is 15 mm.

Temples type

Ring temples of 21 pins and 20 pins plain rings.

Weft accumulator

It is located at the weft feeding, between package and projectile entry. It has tensioning points and guiding points. These all accumulators are of rotary-guide types. The length of yarn of approx. 4–5 m is wound on the accumulator drum.

Healds used

Grobamextra – Feralfix – swiss

Box control signals

ETD – projectile trigger defective
TSD – sensor deflection
PNB – projectile not in place
PRP – projectile bounced back
TSA – projectile projecting switch
FTA – projectile drive play

Check list during beam gating

(1) Distance between selvedge gripper to reed SU and FA = 1 mm
(2) Telescopic shaft must be lateral play between picking and receiving housing.
(3) Temple ring must be free from waste.
(4) Temple cover hide must be of 75 mm.
(5) Selvedge must be drawn according to plan.
(6) Jacquard card must be according to piece ticket.
(7) Staggering must be done.
(8) Dobby card must be according to plan.
(9) Weft arrangement must be according to pattern.
(10) Projectile break must be set properly.
(11) Broken pickers of SU and SF must be checked.
(12) Crossing point of machine and jacquard must be checked.
(13) WSM must be checked.
(14) Oil level must be checked.

Sulzer light signal

Blue light blinking	–	warp thread breaks.
Yellow light	–	weft thread break and shut down via switch off buttons.
Yellow and red light	–	shut down via emergency button.
Yellow light permanent	–	specified length of fabric is attended.
Red light permanent	–	call for foremen (mechanical fault).
Red light blinking	–	electronic projectile detector or weft detector.

When machine is operated all signal lights are shut off.

Warp stop motion bars

Numbers of bars depends on single width looms or double width looms. The number of ends on fabric also governs the same. Generally 4, 5, 6 nos. of bars are used for low, medium, and higher dense fabric. It is necessary that the number of bars because all drawing-in through pins are done at drawing-in and denting time because of closed dropped wires used for end break stop motion.

The gripper projectile draws the filling yarn into the shed. Energy required for picking is built up by twisting a torsion rod. On release, the rod immediately returns two its initial position, smoothly accelerating the projectile by means of a picking lever. The projectile glides through the shed in a rake-shaped guide. Broken down in the receiving unit, projectile

is then conveyed to its original position by a transport device installed under the shed. At the completion of each pick, the weft is cut at each side about half inch beyond the edge of the fabric. These free ends are then tucked into the next shed by means of special tucking device and thus woven into the cloth to form strong and satisfactory selvedges. The only limitation imposed is being the provision of the small space required for the tucking between the individual fabrics. The sulzer loom can weave a wide range of weft yarn of adequate strength and good unwinding quality. Sulzer projectile weaving is employed for high speed continuous production, and once set should be operated on one fabric construction for as long as possible as preferably for several months.

Picking mechanism

The purpose of the picking mechanism is to accelerate the projectile to the picking point without shock.

Stop motions

It is the task of the stop motion to protect the individual elements of the machine, if movement is obstructed, and to switch the machine off. This is performed mechanically or electrically according to the type of fault. The stop motions are of two types:

- Warp stop motion
- Weft stop motion

(1) *Warp stop motion*

The warp of sheet is fed in the weaving process at a low speed and within a large number of the warp ends. Hence the checking of the continuity of the individual warp ends requires an essential different approach in the weft checking.

(2) *Weft stop motion*

On the single phase weaving machine, the weft thread is inserted individually but at high speed one after another. The weft continuity can be checked only when the picking fill warp width has been completed. Precautions and recommendations in weaving preparatory and weaving departments:

- Leasing reeds and V reeds appear to be rusted and may cause yarn abrasion and tension variation. This is suggested for the regular cleaning of the V reeds so that it should not have a rough surface or

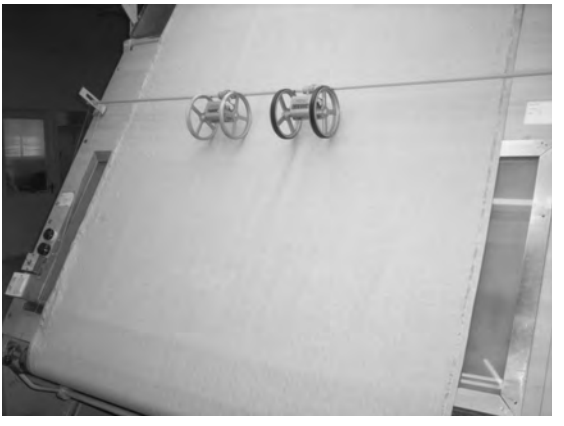
can use straight reed in place of V reed in front of the warping drum to reduce tension variation.

- Yarn room, where yarn is stored, is hot and dry in summer; moisture retention in yarn is affected. It is recommended that yarn room should be humidified for proper conditioning of yarn through out the year.
- For re-winding of warp/weft remnants, yarn should be wounded on single-headed winders fitted with slub catchers and splicer or knotters.
- In warping machine, pressure roller should be used at the time of beaming.
- Many tension adjustment rods in the creel appear to be rusted, and yarn breaking device is not in order. Regular cleaning is suggested of rods and breaking device for uniform yarn tension. Also, it is suggested to take care of the solder interruption button on the warping lease comb which tends to form grooves which undermines the yarn quality.
- Waxing to be done at beaming stage in warping. It is experienced that wool batching oil (Unipro-38) enhance the formation of rust on the machine. Hence we should do waxing with either PEG (Polyethylene Glycol) with antistat such as cirrasol TF in house preparation or Duro-wax (imported)
- We should go for electronic warp let off motion instead of mechanical let off motion in Sulzer projectile weaving machine for fine tuning and better control. This is very much essential for light weight, fine quality fabric.
- All four feeders should be used for weft insertion otherwise weft-wise bands may be seen in the fabric and proper weft mixing may not be done in the fabric.
- Temples are used as standard for all quality which we do get from temple abrasion marks on certain quality. It is suggested to use special type of shorter temples, i.e. MANEA Italic make with temple cover of anodised edges to prevent temple abrasion.
- For warping, warp yarn packages should be of equal length. This can be controlled if we have length measuring device equipped on ply-winding machine.
- In weaving shed, there should not be fluctuations in temperature and relative humidity. It must be constant.
- There should have quality-wise loom setting records to improve the quality and productivity.

2.8.5 Perching (Grey fabric inspection)

After the required piece length is doffed from the weaving machine, the grey fabric is examined on perching machine against light or with out light.

The fabric faults can be identified for the woven faults occurred during weaving or already in the yarn during spinning process. These faults are marked with soft chalked either with white chalked or blue chalked (made from blue superficial colour which can not give stains on the fabric and is washable). Hence corrective measures can be made immediately on the weaving machine or yarn can be taken for re-gauging for quality betterment.



Perching process.

2.8.6 Tips for improvements (check points)

Warping

- Material received from yarn room should be checked.
- Warp creel should be cleaned from warping machine before creeling the yarn packages.
- Proper warp tension and other norms should be followed.
- RT material to be kept separate for re-winding with proper label of identification.
- First section checking to be ensured for the arrangement of warp ends by the warping supervisor and weaving personnel.
- Wax application to be done properly.

Weaving

- Before loading warp beam on loom, machine should be cleaned thoroughly for avoiding fibre contamination.
- At the time of beam mounting on loom, the required loom setting should be done by the weaving personnel.
- At the start of loom, the beam gaiting strip which is taken out should be checked by the checker for quality norms like EPI, PPI, fabric

width, design as per sample and piece ticket, shade and fabric defects, etc. And only after confirming this machine should be switched on.
- Grey fabric after doff from loom should be checked immediately on grey perch for fabric faults (spinning or weaving), piece length and grey weight; if variation is found then it should be attended on priority basis.
- First piece doffs on loom should be checked on priority and then assessment must be routed through first piece checking cell.
- First-come, First-serve policy should be followed to deliver the perched pieces to grey mending department.

2.9 Mending

The main object of mending department is to assess the defect and to repair by filling the proper weft or warp yarn as per weave.

Working principle

The mender first takes grey piece and check the piece ticket at backside so that he gets ready to replace the faults. Then mender confirms about piece ticket. The details of piece no., quantity no., and mender no.; all things are put in register.

Process flow adopted for mending is as follows:

Material flow from grey perching to mending department – stored in mending department – selection of pieces done on priority basis and send to mending table – checked under light – faults were removed– mended pieces were checked – grey pieces were stored in warehouse.

Precaution and recommendation in grey mending:

- It is suggested that appropriate lighting is must for light weight suiting of fine counts. Particularly for dark shades. Light should be around 550–700 lux.
- While re-filling broken ends, floats, etc., we must tuck in 2–3 picks on either side for better mending quality.
- After re-filling a wrong end or relaxing a tight end, we should not use pincher rubber to even the tension on worked yarn. The tension should be evened out with the finger and not with the pincher rubber.
- After re-filling, a half inch length of yarn which is left out, protruding on either side, is cut during subsequent shearing in processing.
- While removing slough off / bunch yarn in the fabric, it is recommended that in such cases for easier yarn movement, it is better to wet the fabric and then needle the disturbed/distorted yarn.
- It is recommended that we should use at least two types of needle; one for coarse and medium counts and other for fine counts with a ball head.

2.9.1 Tips for improvement (check points)

Mending

- Pieces received from weaving are taken for mending the faults and should not be accumulated and if faults are found in the piece should be highlighted to the concern department personnel immediately.
- Rubber, pincher and water spray bottle should be checked time-to-time by menders and checkers.
- Filling work should be checked and confirmed by going on their table for design match and required tension after filling of the end or pick.
- Lighting intensity should be checked time to time.
- House keeping and cleanliness in department should be seen for maintaining up to the mark or to avoid soil and damage to the fabric.
- Mended piece ready to dispatch is to be re-checked for quality assessment of mending.

2.10 Introduction to yarn numbering system

Yarn numbering systems are used to denote the weight per unit length of a given yarn, which indicate the fineness or coarseness of the yarn. The prevalent system can be divided into two main groups.

(a) Direct system
(b) Indirect system

Direct system

In this system the length is fixed where as the weight varies. In this system the yarn diameter is directly proportional to the yarn numbers. The following are the most common units:

(i) tex – It is a unit to measure the linear mass density of fibres and is defined as the mass in grams per 1000 m, i.e. if 1000 m of yarn length weigh 10 g than the yarn is said to be 10 tex.
(ii) denier – It is defined as the mass in grams per 9000 m, i.e. if weight of 9000 m yarn length is 10 g than it is said to be 10 denier.
(iii) dtex – It is the mass in grams per 10,000 m.

Indirect system

In this system, weight is fixed and length is varying. This system has different units for yarns made of different fibres. Here the yarn diameter

is inversely proportional to the yarn count. The following are the most common units.

(1) British system (standard weight in pounds and length in yards)
   (a) *Cotton count* – It is defined as number of hanks of 840 yards in 1 lb. Under this system, the higher the number, the finer the yarn.
   (b) *Worsted count* – It is defined as number of hanks of 560 yards in 1 lb.
   (c) *Woollen count*
      (i) Run – defined as number of hanks of 1600 yards in 1 lb.
      (ii) Cut – defined as number of hanks of 300 yards in 1 lb.
      (iii) Yorkshire skein – defined as number of hanks of 256 yards in 1 lb.

(2) Metric system (standard weight in kilograms and length in meters)
   (a) Metric count – defined as number of hanks of 1000 m in 1 kg.
   (b) French cotton count – defined as number of hanks of 1000 m in 0.5 kg.

2.11 Count conversion formulae

From	English cotton count	French cotton count	Metric count
English cotton count (Ne)		Ne × 0.8467	Ne × 1.693
French cotton count (Nf)	Nf × 1.18	–	Nf × 2
Metric count (Nm)	Nm × 0.5905	Nm × 0.5	–
Tex (t)	590.5/t	500/t	1000/t
Denier (d)	5315/d	4500/d	9000/d
Worsted (w)	w × 0.6667	w × 0.5645	w × 1.129
Linen wet spun (L)	L × 0.3571	L × 0.3024	L × 0.6048

No. of fibres in the cross-section of yarn = 97,3000/count × μ^2, where

μ = diameter of yarn in microns

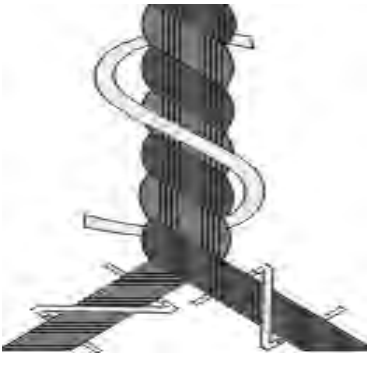
Fibre diameter (μ) = 11.9 $\sqrt{}$denier/specific gravity

Specific gravity of wool = 1.3042 g/cm^3

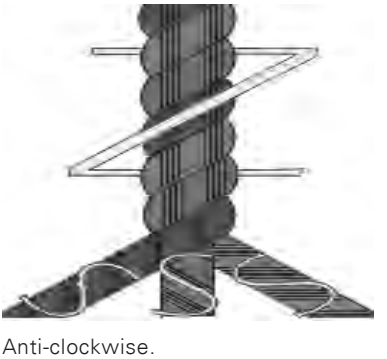
Specific gravity of polyester = 1.38 g/cm^3

2.12 Twist

- Twist is a diagonal arrangement (helical configuration) of the fibres in the yarn.
- It can be in both clockwise and anti-clockwise direction, which provides a variety of innovative effects.
- TPI (turns/inch) or TPM (turns/metre) is the number of turns along its axis per unit length given to the yarn while spinning or doubling.
- High twist – it refers to yarns that are manufactured with a relatively high number of turns per inch. This is done to increase the bouncy effect after finishing and make fabric more travel friendly.
- A 'normal' twisted yarn is made up of two single yarns, which are twisted along Z direction. The twisted yarn itself will be twisted in the S direction or vice versa.
- Grandrelle yarn – it is made of two different colours yarns twisted together to give visible or mood effect on the fabric. Similarly 2-/3-fold yarn can be produced which is typical for worsted industry.



Clockwise.



Anti-clockwise.

2.13 Supply chain management (SCM)

The objective of SCM in any field is to produce the particular components on time and to deliver on time. According to the sales order, components required for producing the required fabric; the warp and weft requirement of yarn shade wise, count wise, blend wise, twist wise has to be planned and issued; organising and executing should be proper and constant follow up should be done so that material is available in time for weaving the fabric and to achieve the committed target.

2.13.1 Objects of SCM

- Yarn procurement
- Inventory control
- Planning
- Optimal utilization of resources
- Co-ordination with marketing and sales
- MIS (management information system)
- Costing
- Outsourcing

3

Weaves and colour effects

3.1 Introduction

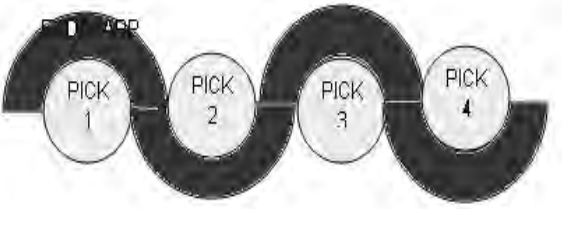
The process of forming a fabric on a loom by interlacing the warp and weft threads with each other is called weaving.

There are three basic weaves:

- Plain weave
- Twill weave (2/1 T and 2/2 T)
- Satin/Sateen

3.1.1 Plain weave

Plain weave is the simplest and most common weave; it is consequently inexpensive to produce. The warp and filling yarns alternately pass over and under each other, creating both horizontal and vertical surface intersect.



It is the simplest form of basic weave where one end is crossed over one pick. Crossing is reversed on each end/pick to form compact fabric.

- Variety in plain weave fabric is produced by using different thickness, texture, decos and varying closeness of warp and weft yarn.
- Widely used and accepted globally.
- Lightweight and durable fine fabrics can be produced with use of finer yarn.
- Colour contrast between warp and weft gives a mohair look.
- Flat, tight surface is conducive to printing and other finishes.

3.1.2 Twill weave

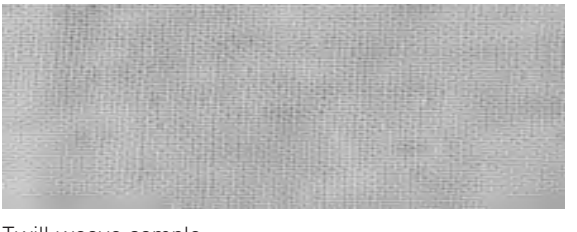
A distinct design in the form of diagonal is the characteristic of second basic weave called the twill. A change in direction of the diagonal line produces variations. Twill weave is created by passing the warp yarn over a number of filling yarns before going under one. The same pattern is repeated row after row, but each time repetition begins on the next warp yarn creating a diagonal weave that gives the cloth added strength and a diagonal surface interest.

Twill fabrics are frequently more tightly woven and will not get dirty as quickly as the plain weave. Twill weaves are therefore commonly used in men's suit in coat fabric and for work clothes, where strong construction is essential.

Types of twill weave

- 2 by 1 twill
- 2 by 2 twill
- 3 by 1 twill

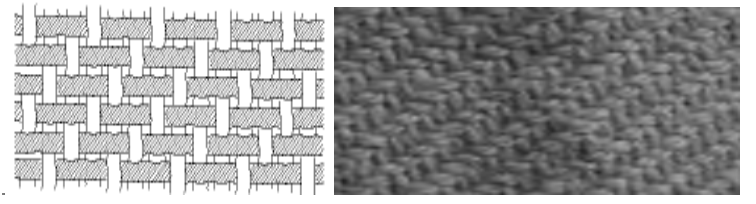
A type of weave made by varying the order of interlacing the yarns, so that diagonal lines are produced and repeat over three or more ends and pick on the face of the fabric. Any fibre can be woven in various types of twill weave. It is used in suiting fabrics globally. Weight of fabric varies as per yarn count and end use.

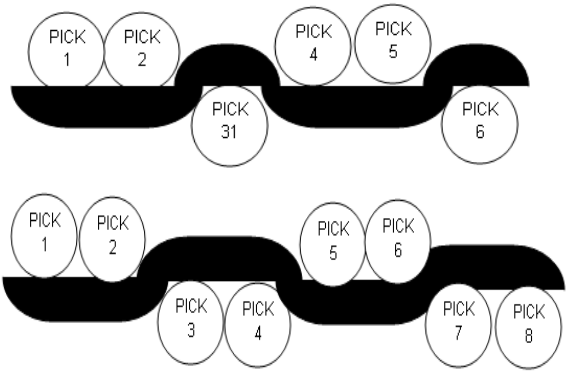


Twill weave sample.

Properties of twill weave

- It is durable and heavier.
- It is wrinkle resistant.
- It is resistant to soiling.
- The twill direction is defined as left or right hand or variation.
- It is pliable drape and hand.





3.1.3 Satin/Sateen weave

Satin weave is achieved by one warp yarn crossing over the most possible filling yarn, creating floats on the face side of the fabric. The floats give the fabric lustre and smoothness. It differs in appearance from the twill weave because the diagonal of the satin weave is not visible; it is purposely interrupted.

Satin cloth

Properties of Satin/Sateen

- Soft and smooth
- Excellent drape
- Floats hold up easily
- It is flat and lustrous with a smooth surface
- The surface slides easily for linings

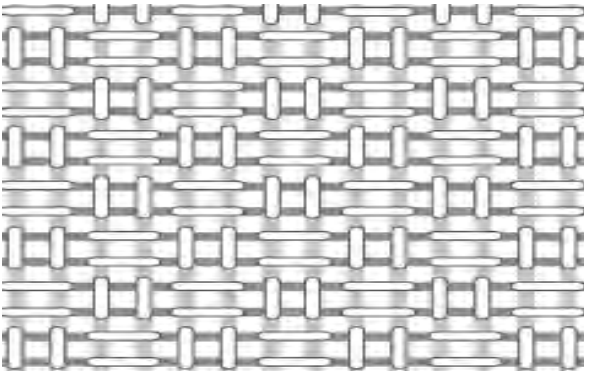
3.2 Special weaves

- Hopsack
- Birdseye
- Sharkskin (Pick-n-Pick)
- Herringbone
- Gabardine
- Cavalry twill

3.2.1 Hopsack weave

This is also known as basket weave in which two or more ends and picks are woven as one. This produces a rustic surface, especially if loosely woven.

This produces open fabric as compared to twill-based fabric.



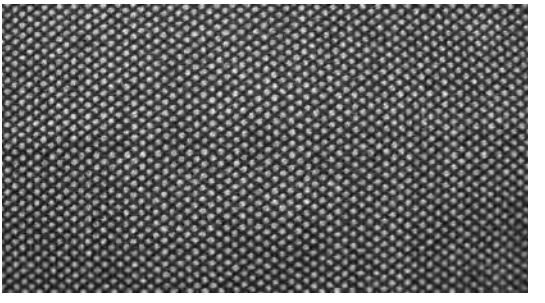
Sample of hopsack weave.

Properties of hopsack weave

- Usually basket or checkerboard pattern
- Contrasting colours are often used
- Handle is smooth and supple

3.2.2 Bird's eye effect

This weave makes a pattern of very small and uniform spots. The fabric is usually fine clear-finish worsted, and the design gives the appearance of small indentations.



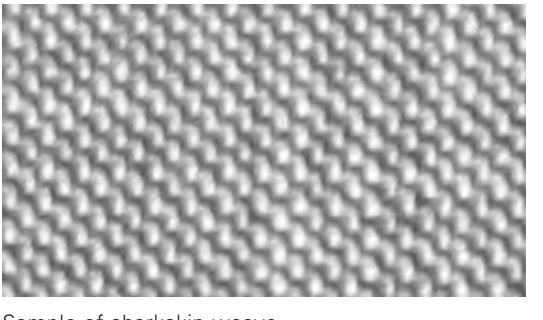
Sample of bird's eye weave.

Properties of bird's eye weave

- Smooth, clear finish.
- It has small diamond-shaped figures with a dot at the centre.
- More colour contrasts are used for jackets and less colour contrasts are used for trousers.

3.2.3 Sharkskin (Pick-n-Pick)

Sharkskin can be defined as a woven blend of smooth wool. More correctly, it is a smooth worsted fabric that often has a soft texture and a two-toned woven appearance to the worsted fabric.



Sample of sharkskin weave.

Properties of Sharkskin weave

- It has a very sleek, smooth, feel and appearance.

- It is fairly light in weight.
- It has a very substantial feel.
- It gives excellent wear and sheds dirt readily. It has many variations.

3.2.4 Herring bone

This is a broken twill weave in which the twill line reverses regularly forming zig zag Vs.

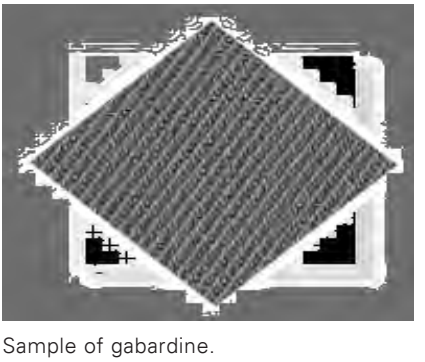
- It's also called as fishbone, feather or arrowhead twill.
- It can produce variety of effects by changing the twill base and colours.

Sample of herring bone.

3.2.5 Gabardine

A tightly woven durable twill with a distinct twill line. Commonly used in men's and women's trousers.

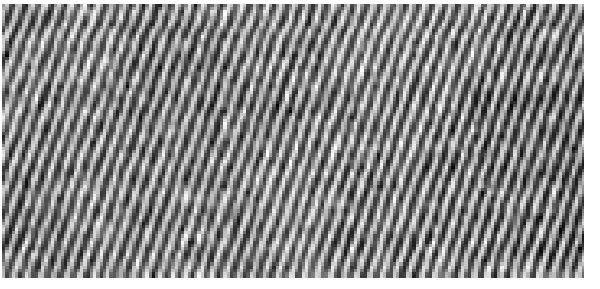
- End density considerably exceeds the pick density and so produces a twill line at a steep angle.
- A more pronounced twill is also known as a whipcord.
- The term 'gabardine' originates from the 16th century and was a name for a 'horseman's cloak'.



Sample of gabardine.

3.2.6 Cavalry twill

A firm and sturdy warp-faced fabric in which the weave has steep double twill lines separated by pronounced grooves formed by the weft. The term is derived from the fabrics once used for making riding breeches for military forces.



Sample of cavalry twill.

3.3 Weave and colour effects

In this chapter we discuss about the different check patterns and the colour effects that can be brought on clothes.

- Checks
- Stripes
- Dobby effects

3.4 Checks

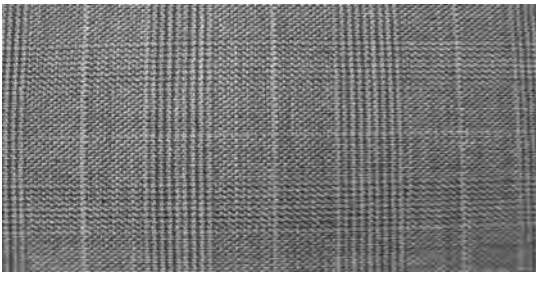
There are different check patterns depending upon the colour and weave used.

Following are the check patterns known globally:

- Prince of Wales check
- Glen check
- Shepherd check
- Hounds tooth check
- Tattersal (Window-Pane) check

3.4.1 Prince of Wales check

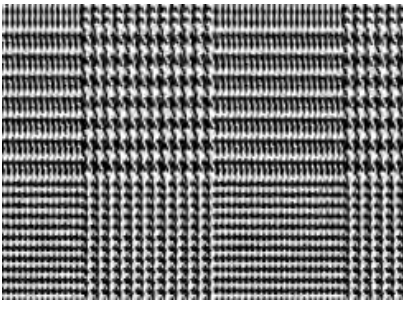
It is actually a very large check in bold red or brown on a cream ground with a grey over check. The base used mainly is Hopsack weave. Colour and size and can be modified as per requirement.



Sample of Prince of Wales check.

3.4.2 Glen check

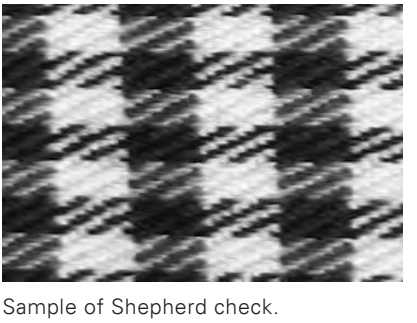
This check is one of the most common and forms the basis for numerous variations. The alternate blocks of colouring in warp and weft on a 2/2 twill produce panels of guard's check.



Sample of Glen check.

3.4.3 Shepherd check

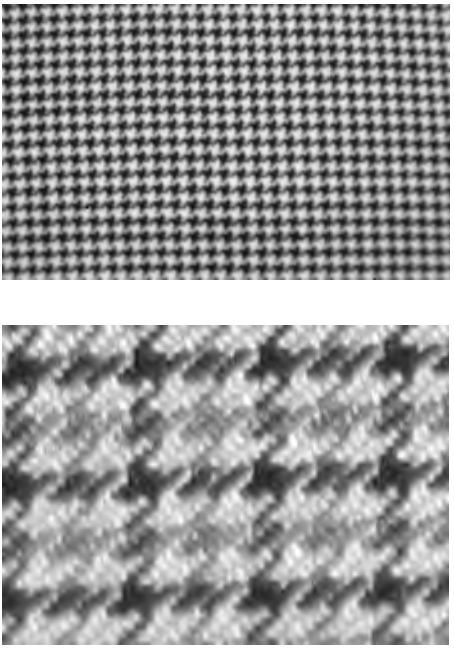
This is woven with a colour sequence of alternating five or more yarns and a 2/2 twill weave that causes the hounds tooth shape to be lost. Instead solid square-shaped blocks are produced where the colours intersect.



Sample of Shepherd check.

3.4.4 Hound's tooth check

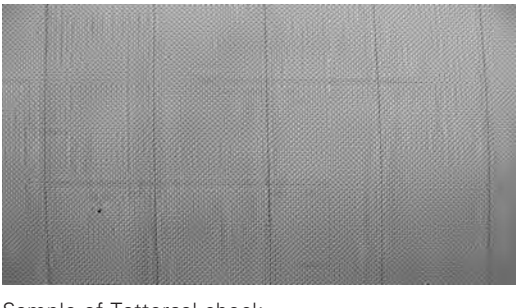
This weave is produced in a pattern of four light and four dark yarns in both warp and weft.



Samples of Hound's tooth check.

3.4.5 Tattersal (Window-Pane) check

It is a simple design that was originally a small scale version of horse blanket checks. The names comes from famous horse auction rooms in London, and the equestrian influence continues as the designs are still most commonly used for riding shirts.



Sample of Tattersal check.

3.5 Stripe

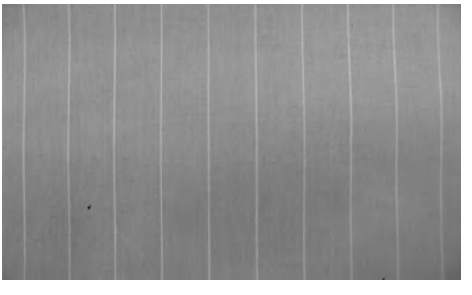
Stripe is a line or narrow band in a fabric produced by using different colour, weave or raw material.

As there are many ways of producing stripe effect but mainly two types are very popular:

- Pin striped
- Chalk striped

3.5.1 Pin striped

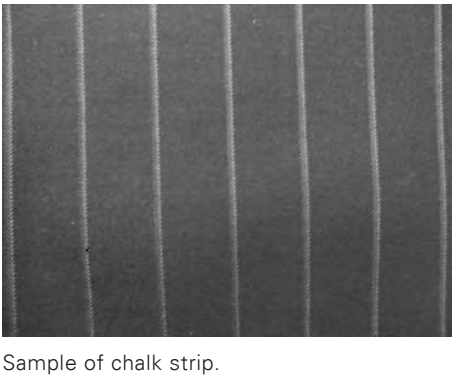
A pattern of very thin stripes running in parallel is pin stripes. The pinstriped suit has become associated with conservative business wear, although many designers now produce fashionable sharp pinstripes for younger more fashion-conscious suit wearers.



Sample of plain strip.

3.5.2 Chalk striped

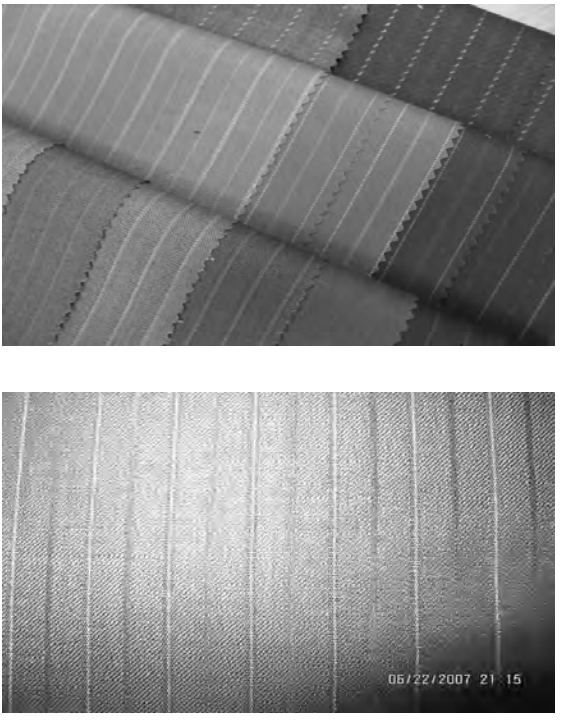
This stripe is usually more muted than a pinstripe. It has the effect of drawing a line on the blackboard with a chalk.



Sample of chalk strip.

3.6 Dobby effects

Different types of patterns can also be created by using dobby stripes or self-checks.



Samples of dobby effects.

4

Finishes

4.1 Introduction

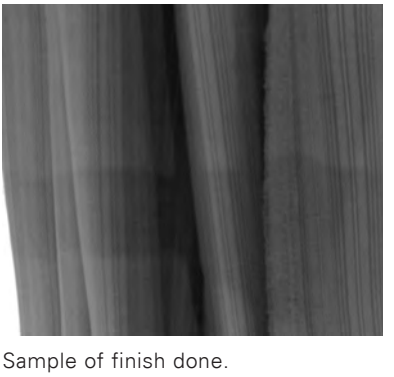
Chemical and other treatments are processed to modify the fabric to add more features.

A basic fabric should be:

- Smooth from both sides
- Pliable
- Rounder and bouncy
- Breathable
- Non-fibrous
- Lustrous

Common finishes are:

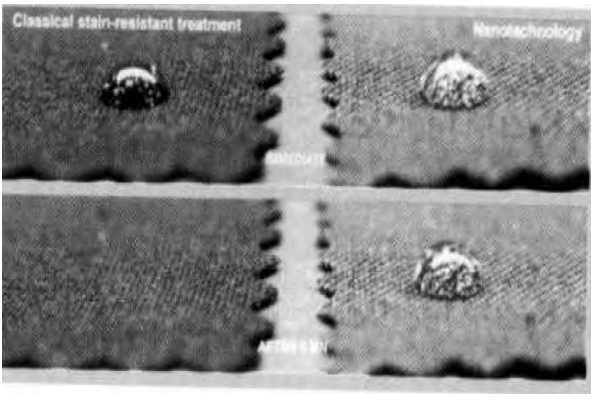
- Stain resistant / Nano / Teflon finish
- Machine washable finish
- Easy care finish
- Natural stretch finish
- Flannel finish
- Saxony finish
- Dolphin finish



Sample of finish done.

4.1.1 Stain resistant / Nano / Teflon finish

Fabric is combined with an extremely thin coating (Teflon) to make the fabric water repellent and stain resistant. This thought is studied from lotus leaves, which have a natural cleaning mechanism.



Sample of Teflon finish.

4.1.2 Machine washable finish / shrink control

Mainly wool or wool-rich fabric is subjected to mechanical action in the presence of moisture, i.e. during washing and/or tumble drying, the individual wool fibres start to shrink.

- Eventually, with prolonged mechanical action, the fibres become entangled and locked together causing the woollen fabric to shrink. This is called felting shrinkage.
- To prevent such shrinkage, special treatments are required that either mask the effects of the scales or completely restrict fibres moving relative to each other.
- Polyester / wool and polyester / viscose fabric have this property incorporated.

4.1.3 Easy care finish

The term ‘Total Easy Care’ describes the garment that can retain its appearance even after repeated machine washing and tumble drying. They can be worn immediately without having to spend a considerable amount of time restoring the garment to a pristine or ‘just pressed’ appearance.

- The main impediment to achieve garments with ‘Total Easy Care’ performance, in particular using pure wool, is that of shape retention

(i.e., maintaining sharp creases and seams after washing and tumble drying).

4.1.4 Natural stretch finish

This is a method of producing a dimensionally stable stretch fabric. Chemical treatment is given to impart stretch in the worsted fabric without using any elastic material.

4.1.5 Flannel finish

During finishing, surface fibre is developed so that the weave is partially or even completely obscured.

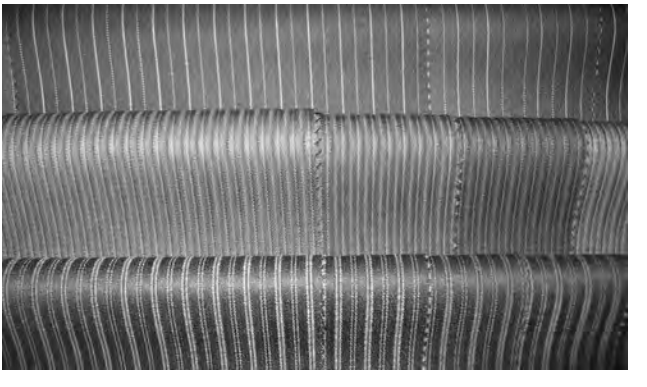
The nap is normally non-directional, and these fabrics are traditionally produced in white, or in wool-dyed mixtures.

4.1.6 Saxony finish

This finish is generally applied to worsted fabric. The cloth is stretched, napped, shorn short and then brushed and pressed.

4.1.7 Dolphin finish

Resin finish is a durable glaze. It withstands washing or dry cleaning. The wax and starch glaze washes out. It is produced by friction or glazing calendars.



4.2 Fabric/garment care

Following processes can be adapted to make the fabric perform better.

- Dry cleaning
- Wet cleaning
- Laundering
- Pressing or ironing

4.2.1 Dry cleaning

- Dry cleaning is a process which involves only solvents and no water for washing.

- Make sure the solvent is distilled to remove greases, oils, waxes and dyes. Poor solvent sometimes results in an objectionable odour in the garment and 'graying' of the white cloths.
- Before giving for dry-cleaning, inform the type of stains present on the garment. Pre-spotting helps to eliminate the stains which would otherwise be heat set after the garment is cleaned. Be an informed and fair customer to the dry-cleaners.

4.2.2 Wet cleaning

This uses water and makes the use of computer-controlled machines, soap, conditioners and finishers. However, until this process proves to be effective in replacing dry cleaning, consumer should be cautious with their 'dry-clean-only' garments.

*All wool fabrics must always be 'dry clean only' and detergent used should be mild and neutral.

4.2.3 Laundering

Laundering the garments is easier to control and even add life to it. Detergents should be well chosen as it usually contains wetting agents and emulsifiers. Using cold water is often more effective.

4.2.4 Pressing or ironing

- Pressing after cleaning is also considered important.
- Pressing linen and silk items require skilled professional presser.
- Linen can be pressed with high heat but should be pressed when damp.
- Silk requires lower temperature and it should be steam-ironed, better if a press cloth is used.
- Wool requires steam press and a moderate temperature.

5
Fabric defects

5.1 Introduction

Textile manufacturing process consists of the sub-processes of spinning, weaving, dyeing, and chemical processing. Faults visible in fabric can be back traced to either of these processes. Hence fabric defects have been categorized as spinning, weaving, dyeing and processing faults and also as mending faults which arise due to mistakes in the fault removal or mending process. Fabric defects are faults that would reduce the expected performance of a textile material.

They are classified as:

- Spinning defects
- Weaving defects
- Mending defects
- Dyeing defects
- Finishing defects

5.2 Spinning defects

Defects	Description
Cork screw	One yarn is straight and other one is twisted on it
Bullets	Zero-twisted or low-twisted double yarn
Bottoms	Yarn left over on the surface of the cop or cheese after winding
Count variation	There is difference in count compared to required count
3/4-fold yarn	Yarn containing 3- or 4-fold yarn
Griandrille bar	Use of wrong component in double yarn
Neps	Pinhead structure of clustered fibre mass which can not be opened
Slubs	Abnormal thick places of clustered fibre over a short length

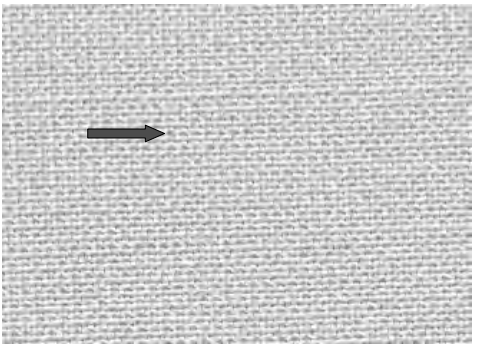
Spun in lint	Accumulated fly twisted with the yarn in spinning
Thick end	Diameter of warp end yarn is more than the normal yarn
Thick pick	Diameter of weft pick yarn is more than the normal yarn
Twist variation	Less twist or more than normal twist
Yarn mixing	Mix up yarn of different colour, count, twist direction, blend and shade
Knots	Joint of two broken ends of yarn
Oily yarn	Oil-stained yarn
Bad splicing	Improper knot less joint

5.3 Spinning faults

5.3.1 Bullets

Bullets are low-twisted double yarn seen weft wise in fabrics. Those are generally zero-twisted parallel yarns. Practical causes of faults on two-for-one twisting machine are:

1. Proper functioning of bunch motion is not there.
2. Incorrect yarn path through spindle.
3. Loose tensioners.
4. Capsule and spring working.
5. In-sufficient length of yarn as bunch.
6. Knot is not applied after removing the bunch yarn.



5.3.2 Twist variation

When the twist is done less or more than the required, it is called twist variation in the yarn. Loose/soft twist happens because of lower spindle speed.

The main causes are

1. Improper spindle speed on each spindle
2. Worn out bearings
3. Poor condition of brake shoe
4. Pressure of tension roller
5. Worn out bolster
6. Yarn lapping or waste lapped on spindle

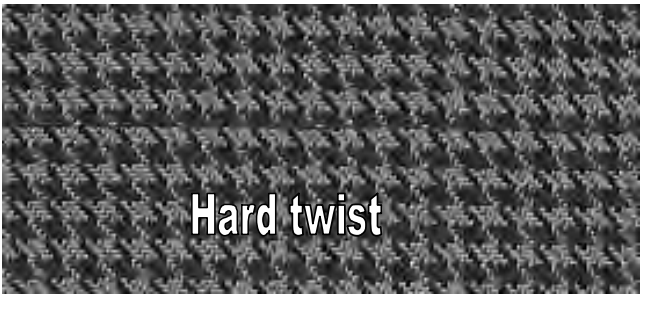
Hard twist happens because of low take-up speed.

The main causes are

1. Problem in freely movement of bobbin holder adopter
2. Cradle setting and its pressure
3. Friction ring
4. Winding tension
5. Yarn lapping over feed roller
6. Winding roller
7. Faulty and damaged bobbins. Such bobbins should be discarded.

General reasons are

1. Lapping on disc
2. Spindle and capsule working
3. Overfeed variation
4. Dial and overfeed tensions varies
5. Trolley knocks over brakes so place rails at bottom on floor
6. Scratches on drum



5.3.3 Bottom yarn

Remnant/Left-over yarns of different shades, counts, twist lappets onto bobbins give bottoms.

1. Remnant of ring frame cops.
2. Yarn used for lappets, during start of materials has to be of same shade/same count.
3. Remnant double yarn on two-for-one twister bobbins should be cleaned.
4. Red separator on ring frame to segregate different shades.
5. Lot change at auto-winding if cop is not changed.
6. Remnants yarn to be cleared from the ring bobbins and cheeses.

5.3.4 Cork screw

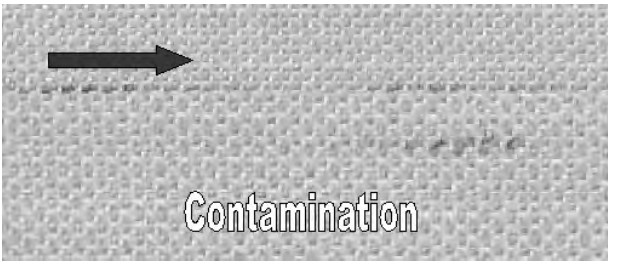
One yarn is straight and other one is twisted on it. It is caused due to deposition of fibres, foreign particles etc on yarn during spinning stage. Insufficient tension during TFO, different tension levels at parallel winding machine causes it. Yarn released during knotting at parallel winding causes screw of yarn over other yarn giving cork-screw effect.

5.3.5 Contamination

This is due to mixing of different shades of fibres, foreign materials, etc. during spinning stage. This causes visual objection in fabric. The causes of contamination depends on

1. Overall cleanliness of department
2. Cleaning of machine after every doff and lot change
3. Suction of drafting zones of gill boxes and rovings
4. Cleaning of scrapper and scrapper plate after every lot change of doff
5. Use of curtains for partition in ring frame and two-for-one to separate light and dark shades during running of machines
6. Overhead cleaners of plying, winding, machconer and ring frame
7. Not to run contrast shades side by side of machine, ring frame and TFO
8. Cover the material with polythene sheet to avoid fly and fluff accumulation

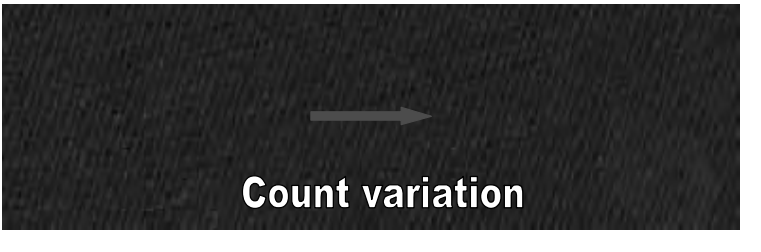
9. Do not use compressed air for cleaning machine
10. Use only vacuum cleaner
11. No common air conditioning for dyed spinning and white spinning sections because of common ducts for return and supply air
12. Prevent contamination due to packing material like poly propylene or jute bags etc.

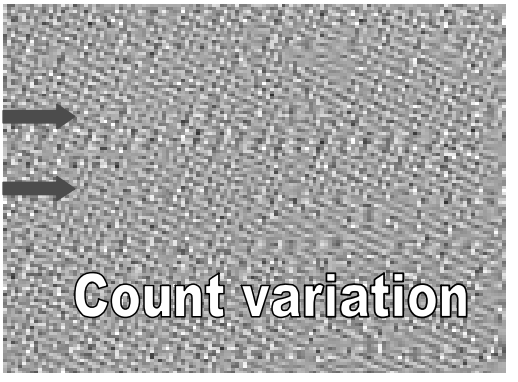


5.3.6 Count variation

It is the difference in count compared to required count. Fabric gives bad appearance and is characterised by variation in density. Steps to prevent it are:

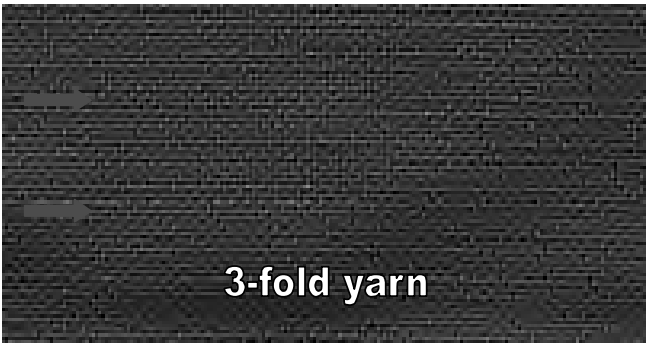
1. Regular check on wrapping from gill box to ring frames.
2. Correct piecening of silver or that portion should be removed from the delivered sliver.
3. During run out of material, extra care should be taken.
4. Auto-leveller setting should be checked for faults and materials of below standard. Uster value should be taken back for processing.
5. Check the top cots rollers' condition at gill boxes, roving and ring frame.
6. Check if tension at roving and ring frames varies. Barrels at roving should move freely.
7. Check the top arm pressure, spacer, condenser and drafting zone condition of spinning frame.





5.3.7 3- / 4-fold yarn

Higher package diameter causes slip of coil and generates such type of faults.



5.3.8 Neps

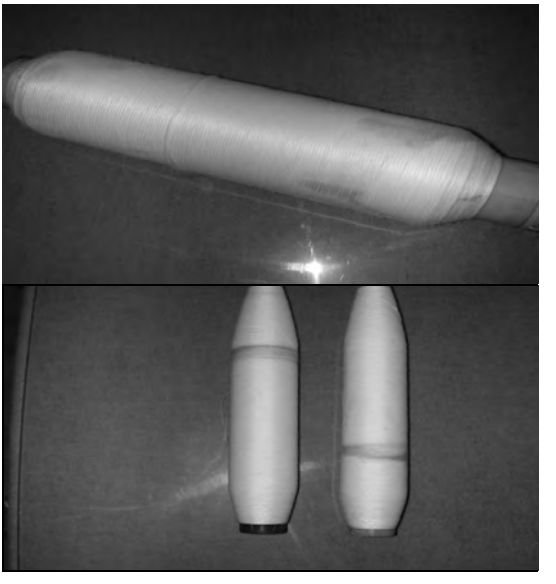
This is a pinhead-like structure of fibre mass of more than 3 mm size. This occurs because of poor carding of unopened fibres at back process. Metal surface in winding for yarn passage if not smooth may cause nep formation or can increase hairiness in yarn and can deteriorate yarn quality.

5.3.9 Oily yarn

Yarn stained with oil and grease due to poor handling, wrong work practices, work negligence, etc.

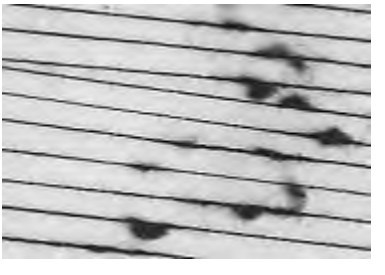
1. Excessive oil on ring frames.
2. If more oil is spread near bearings in drafting.

3. Yarn package or material spoiled due to fall on floor, which contain oil.
4. End breaks at ring frame not attended for a long duration by ring frame.



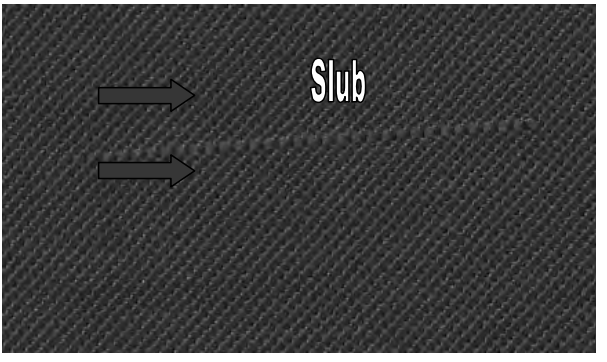
5.3.10 Spun in lint

Spun in lint is caused due to accumulated flies twisted with yarn.



5.3.11 Slubs

These are abnormal thick places over a short length of yarn. Lack of fibre control at each drafting stage also generates it. Also, lack of individualisation and parellisation at gilling causes slubs.



5.3.12 Snarled single

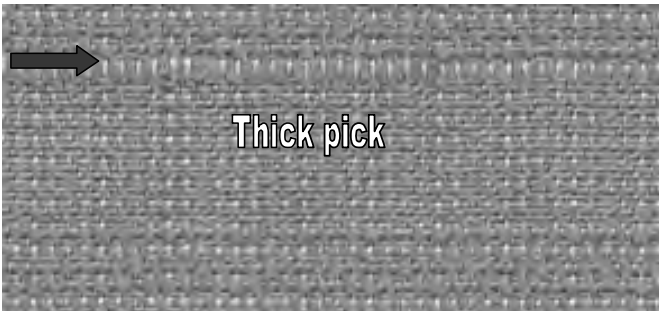
If one component of double yarn has different twist than the others, this causes snarling effect in that component of the double yarn. This is caused due to mixing up of low-steamed or un-steamed yarn, and variations in tension during winding at ply winding.

5.3.13 Thick end and thick picks

These are caused when diameter is more than the normal yarn.

Rove count, top roller (pressure and mechanical condition of machine parts)

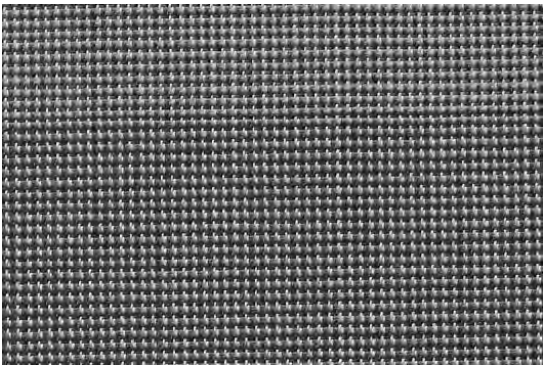
1. Piecening should be done at final gilling, and rove creel should be removed by roving operator.
2. Thick roving should be removed at roving and ring frame.
3. Ring cop having spinner's double yarn should be sorted out and cut.
4. Draft the top roller pressure condensers and spacers on ring frame and roving frame.
5. Regular checking should be done in yarn clearer on mach-coner.
6. Setting of Uster yarn clearers should be checked in every shift.



5.3.14 Yarn mixing

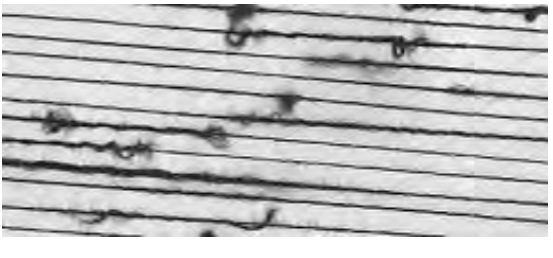
This happens when different colours, counts, twists, blends and shades are mixed up.

1. Material movement should be checked for lots, shades, blend, and count.
2. Check marking and labels given during each process.
3. Not to run similar shade side by side on ring frames.
4. All shades should be referred with standard shades.
5. Remove all remnant yarn from package.
6. Cutting of bottoms on cops.
7. Mixing of parallel winding and TFO double-twisted bobbins should be avoided.
8. Non-removable tails.
9. Wrong practices should be avoided.
10. Negligence of worker should be avoided at every stage.
11. Maintain proper house keeping at every stage of production.



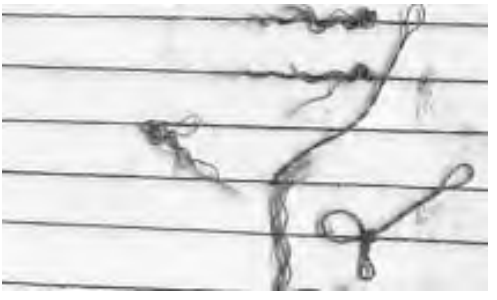
5.3.15 Bad splicing

Splice should be checked properly for strength and appearance as they can spoil the appearance of the fabric.



5.3.16 Yarn knots

It is a joint of two ends. The tail ends of the knot should be of equal length and about 8–10 mm in length and should be perfect and should not be moved to slip.



Steps to avoid poor hand knots

1. Avoid excess re-winding as it may lead to extra knots and may add to yarn hairiness also.
2. Smaller package at rewinding should be avoided to avoid mixing of similar shades.
3. Knot failure should be avoided by regular checking of knotting bills for knots quality.
4. Package quality for wound quality for package hardness should be checked at rewinding.
5. Use same quality of yarn for count, shade, blend and twist direction that is required for warping.

5.4 Weaving defects

Defects	*Description*
Broken warp end	After warp breaks, loom doesn't stop immediately; it runs 2–3 picks or some time more than this without broken warp end.
Broken pick	Weft way gap in fabric of 5–6 in. long at both ends is called small broken pick; where as if it is missing in full width than it is called full width broken picks.
Dobby mistake	Defects, such as shaft hold, design cut, wrong colour selection, related to dobby are called dobby mistakes.
Defective selvedge	Tails out, warp selvedge, loops, uneven, under

	tuck in, over tuck in, defect in monogram, curly selvedge are classified as defective selvedge.
Emery cuts	Fabric cuts (holes) due to emery.
Floats	Floats are of two types: warp and weft floats. Length of the warp or weft, which is not woven as per the fabric design, floats on the fabric 2–3 pick long at face or back.
Loose end	This happens because of less tension on particular warp end.
Loose pick	Less weft tension causes loose pick. The effect like stitches or weft loops observed on fabric.
Let-off bar	Irregular pick density in fabric but not at equal intervals.
Reed mark	Warp way gap on the fabric which is caused due to reed (mostly occurs due to damaged reed).
Shaft hold	Wrong lifting of healed shafts by dobby as per fabric design. These shafts are not lifted due to dobby mistake.
Starting mark	Uneven pick density observed on fabric when machine starts after attending warp breaks or weft breaks.
Section mark	Section-wise mark on fabric due to over-lapping of sections during warping.
Tight end	High tension on particular warp end compared to other warp end.
Temple mark	Mark on fabric, which is caused due to jamming of temple rings.
Wrong drawing	Wrong drawing of warp end which is not as per healding sheet or draft.
Wrong denting	Denting order is given on draft or on piece ticket. If we miss that order while drawing or denting the ends through reed, it is called wrong denting.
Wrong end	In warp and weft pattern ‘S’ twisted and ‘Z’ twisted ends exist. If we warp ‘Z’ twisted yarn in place of ‘S’ twisted yarn it is called wrong end.
Wrong end colour	In warp and weft, different shades are used and its sequence is given on piece ticket; if we miss that sequence then fault like wrong end colour will occur.
Slough off	Bunches of weft woven on fabric called slough off, mostly caused due to soft weft packages.

Loom stain	Greasy or oily or black dark stain that is observed in grey perch.
Pattern mistake	In some qualities warp pattern is printed on piece ticket and warping is carried out as per pattern. If warper makes mistake while creeling then fabric will be woven with wrong pattern called pattern mistake.
Wrong starting point	In dobby design, lifting order is given while making dobby card. If instead of 1st pick we start to punch from 2nd pick then it is called wrong starting point.
Loom damage	If fabric gets torn while weaving due to some reasons, it is called loom damage.
Wax streaks	Waxing is done during warp beaming to reduce hairiness and warp breakage on loom. Because of excess waxing warp and weft way, one can observe wax streaks on fabric.
Filamentation	In few qualities filament warp and weft used. While weaving due to abrasion, filaments of warp yarn gets open as it appears on fabric called filamentation.
Floating end	Single end continuously floating on the fabric.
Missing pick	After weft break, if weaver starts the machine without reversing the machine by one pick, then the defect observed is called as missing pick.
Missing end	One warp end is missing in the fabric.This missing end is created during breaking of warp end at creel at the time of ends winding on warping drum.
Wrong name selvedge	There are different name wording for name selvedges required as per quality numbers. If woven fabric contains any other name rather than printed name on piece ticket, it is called wrong name selvedge or wrong monogram wordings.
Broad / uneven selvedge	Tail of weft comes in fabric after tuck-in and more than 15 mm tuck in width is called broad selvedge; and at some places width of the selvedge varies, it is called uneven selvedge.
Floating selvedge	Monogram viscose end in name selvedge floats instead of binding called floating selvedge.
Bad tuck-in	Tail of weft protrudes on face or back of the selvedge is called bad tuck-in.

5.5 Weaving faults

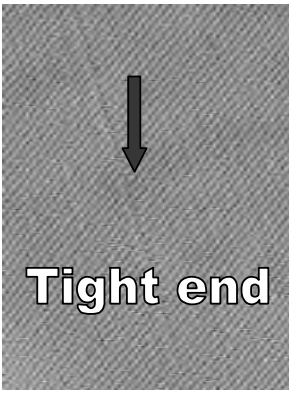
5.5.1 Tight ends

This fault occurs due to the following reasons:

1. Warping creel tension.
2. Variation in package unwinding tension.
3. Condition of warp stop motion at creel in warping.
4. End-to-end knotting had to be done in proper manner.
5. Loose bundles behind looms should be avoided.

In case if it is required then the ends must take two rounds over warp beam before it is taken for drawing in to heald wire and reed at the front of the loom.

6. Chaffing of ends due to knots or beads.
7. Trapping of ends in heald eye or reed.
8. Regular cleaning of reed.
9. Avoid cross-ends / missing end.
10. Weaver practice to attend work practices.
11. Knotting practice.
12. Hindrance in warp flow towards fabrics.



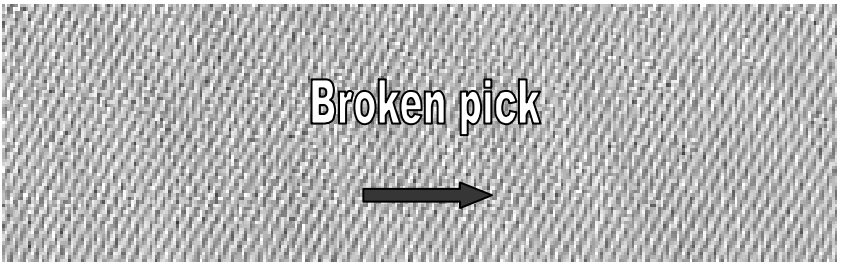
5.5.2 Broken pick

Weft way gap in fabric of one pick or more in full width of fabric or of smaller length at left side or right side of the fabric.

Check points for tension in weft, operator work practices, yarn quality are:

1. Weft tension.

2. Condition of projectile brake linings and their setting.
3. Conditioning of projectile, i.e. condition of gripper jaw or gripping force had reduced or not.
4. Condition of projectile feeder.
5. Length variation in projectile.
6. Thickness variation in projectile.
7. Projectile returned setting.
8. Projectile gripper opening and receiving side.
9. Selvedge gripper opening.
10. Play in telescopic shaft.
11. Dobby crossing point.
12. Jacquard crossing point.
13. Sley setting.
14. Dobby and jacquard chain tension.
15. Condition of projectile lifter and its cover plate settings.
16. Condition of cam driving shaft teeth.
17. Shed opening and staging.
18. Knocking at VSD.
19. Cutter action, timing.
20. Package separations etc.



5.5.3 Broken ends

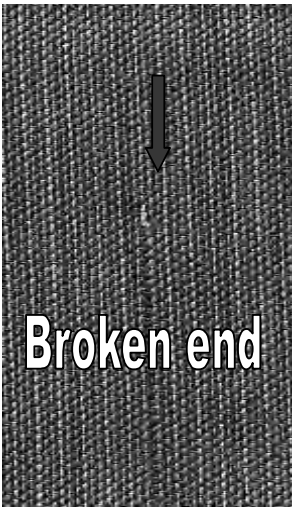
This occurs due to:

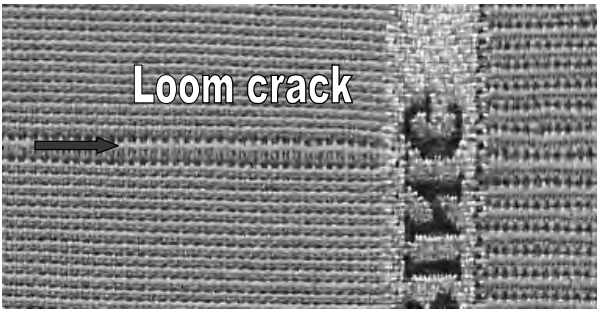
1. Poor condition of warp.
2. Warp breakage rate and shed staggering.
3. Staffing of ends due to bends and knots.
4. Fluff fibre dust accumulation at heald eye or reed.
5. Untimely cleaning.
6. Improper attachments to heald wires to heald frames.
7. Condition of contact bar and guide bar in warp stop motion.

5.5.4 Cracks

This occurs due to:

1. Loose beat up and work out bearing or cam action.
2. Faulty left-off start-ups.
3. Any non-adjustment of feel of cloth gives crack.
4. After maintenance if not adjustment of feel of cloth.
5. Negligence of worker during weft threading.
6. Clutch engagement of let-off generates cracks across width of fabric.



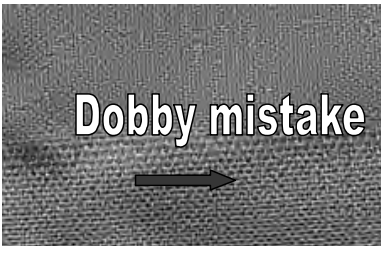


5.5.5 Dobby mistake

This is caused due to improper punch card, faulty jack and needle broken harness or faulty lifting of ends.

1. Working of heald shafts.

2. Condition of dobby card according to weft pattern provided to piece ticket (total information i.e. details of the yarn, weave and specification etc.)
3. Condition of dobby traction elements.
4. Pattern in dobby card according to weft pattern provided in piece ticket.
5. Dobby card cylinder setting.

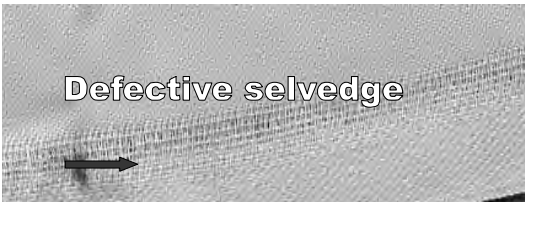


5.5.6 Faulty selvedge

Wrong drawing in denting, drawing in, selvedge end, jacquard working or punch card is faulty.

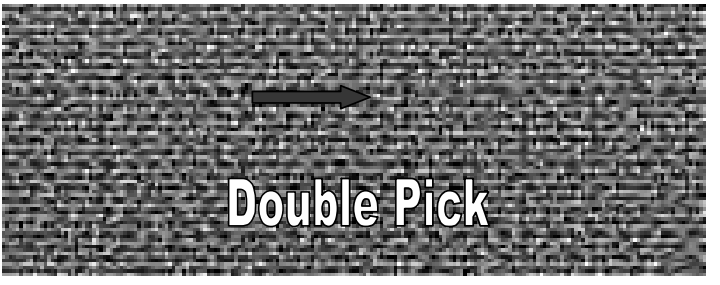
Check points are as follows:

1. Drawing of selvedge catching ends (through shaft and reed)
2. Condition of tucking needles.
3. Drawing of jacquard ends in ribbon selvedge.
4. Temple cover height.
5. Condition of selvedge gripper.
6. Accumulation of fly, fluffs dust at selvedge gripper foot.
7. Avoid less or more tuck in.
8. Selvedge binding should be perfect.
9. Missing ends at selvedges or jacquard ribbons.
10. Condition of temple rings.
11. Working of heald shafts carrying selvedge ends.
12. Projectile brake settings.
13. Beam flanges.



5.5.7 Double picks

Faulty pick finding, improper staggering of heald shafts, play in heald shaft connections etc.

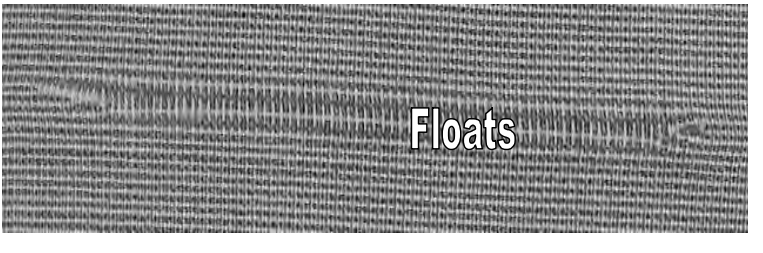


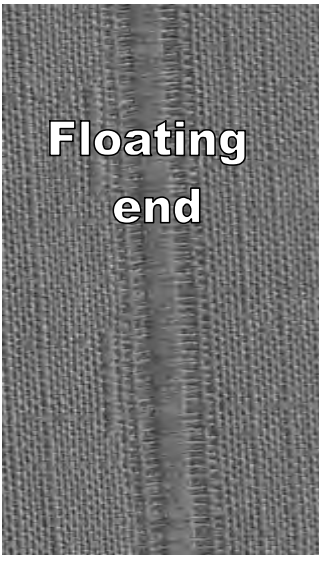
5.5.8 Emery cuts

Bad or worn out emery roller edges or surfaces, faulty winding width at every roller. Higher pressure or tension weaving generates emery cuts.

5.5.9 Floats and floating ends

1. Wax liquor pick up and its concentration at warping.
2. Shed openings.
3. Shed height and staggering.
4. Warp tension.
5. Avoid bead formation in warp.
6. Height of cloth supporting bracket.
7. Position of wip roller.
8. Condition of projectile guide.
9. Condition of temple ring.
10. End obstruction due to yarn knot, fluffs, yarn quality, warp break, shedding timings etc.
11. Heald wire broken or bent.





5.5.10 Loom damage

Because of workers negligence and excessive warp tension, some metallic pieces fell and stick on to emery causing damage to fabric, it is called loom damage.

5.5.11 Loom stains

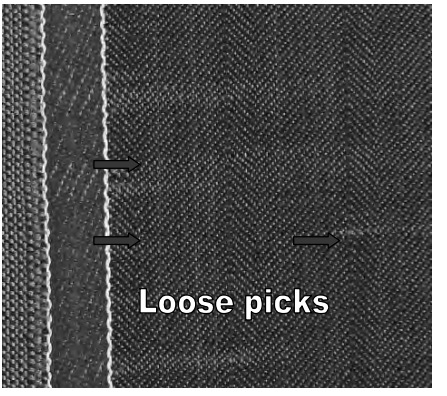
1. Leakage of oil from machine.
2. Leakage of oil from both side of telescopic shaft.
3. Accumulation of oily fluff / fibre dust at tuck-in needle at both side of machine.
4. Wastage embedded in sley coupling which leads damage of oil seal.

5.5.12 Loose ends

Lower yarn tension levels, variations in tension at warping creel and improper guiding of ends causes loose ends. Extra yarn package added at backside of weaving machine generates loose ends.

5.5.13 Loose picks

This occurs because of tension variation in weft package, improper working of compensator, improper working of tensioners at picking side, or if shoe brake at receiving side is worn out.



5.5.14 Let-off bar

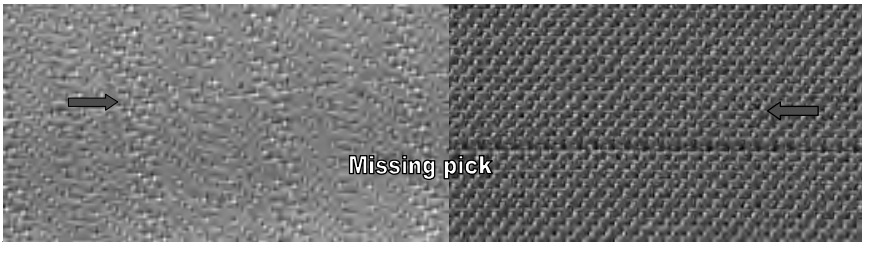
This may occurs due to clutch worn out, improper cloth roller pressure, beam bracket jammed, higher play in glass, vibration in whip rolls, exclusive play in regulation arms, or motor problems.

5.5.15 Loops

This occurs if warp entanglement is high, worker is negligent, temples are worn out, or shedding timings are not proper.

5.5.16 Missing pick

This occurs due to worker negligence, improper weft end-to-end knotting, malfunctioning of weft detector, or improper functioning of pick finding mechanism.



5.5.17 Oil stains

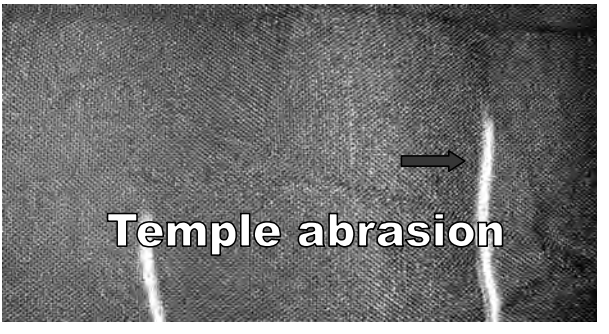
This occurs due to wrong work practice and wrong handling. Cleaning through vacuum should be preferred.

5.5.18 Pattern mistake

This occurs due to improper creeling at warping, improper drawing-in, denting, faulty weft selection, or knotting at wrong portion in loom.

5.5.19 Loom abrasion

This occurs when some metallic pieces fell and stick on to emery and pill out on fabric surface due to any abrasion on loom.

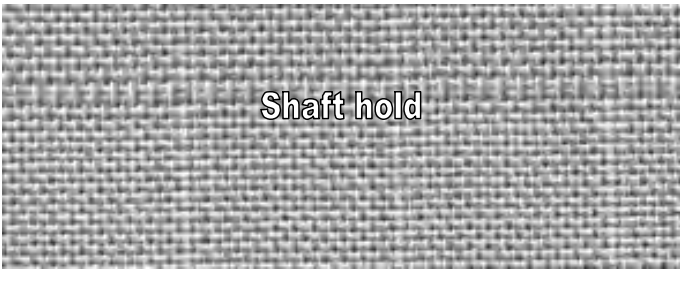


5.5.20 Reed marks

This occurs due to damaged reed surface, improper denting and wide dent spacing, non-opening of shed. Any problem related to reed generates reed marks.

5.5.21 Shaft hold

1. Condition of dobby card joint.
2. Any additional hole formation in card.
3. Dobby card cylinder setting.
4. Slip of card during its rotation.



5.5.22 Starting mark

This occurs due to mechanical faults in loom, improper stopping in loom in open shed condition, or excessive cloth release at loom stacking timing.

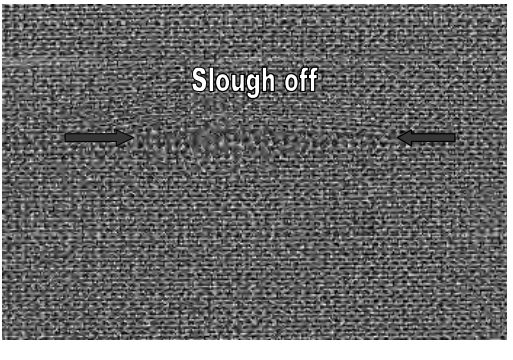
1. Play in sley or reed at 50 degrees machine position.
2. Eccentric take up roller bush and hexagonal stud.
3. Condition of take up timing.
4. Whip roller vibration.
5. Machine stopping point between 290–300 degrees.
6. Condition of main drive – brake band and its setting.
7. Working of free-wheeling device.
8. Let off mechanism.
9. Take up clutch pressure.
10. Slippage of cloth at emery roll or not.
11. Condition of both side emery pin and gun metal bushes.
12. Improper pick finding

5.5.23 Section mark

This occurs due to overall lapping of sections of excessive distance between two sections or improper traverse and cone height of section drum.

5.5.24 Slough-off

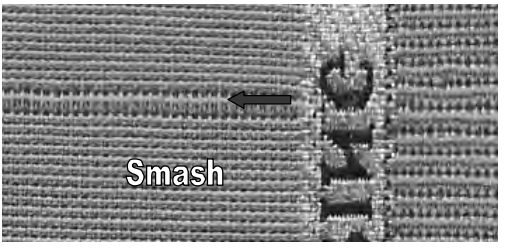
This occurs due to soft build packages, overfilled packages, low tension, package faults, faulty setting of accumulator, or non-working of tensioners or accumulators.



5.5.25 Smash

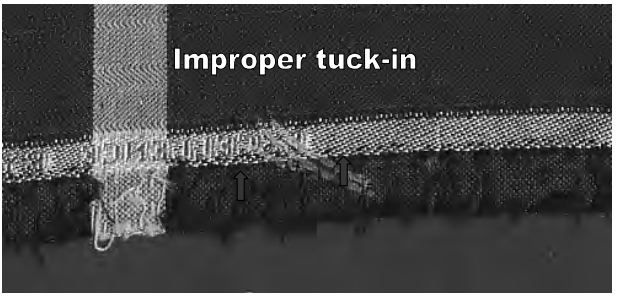
This occurs due to incorrect timing of shedding and picking sychronisation,

improper projectile checking, entanglement of warp end in heald zone, due to warp breakage, or sudden break down of loom parts.



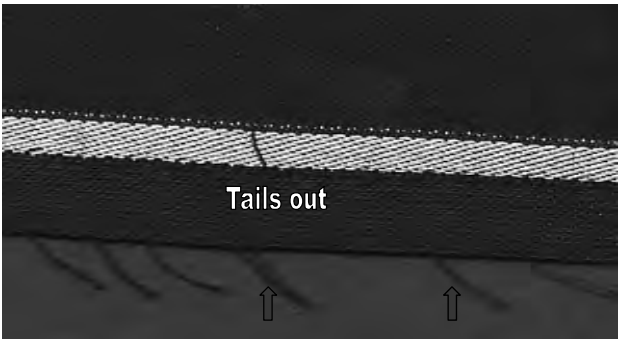
5.5.26 Tuck in

This occurs due to faulty settings of tuck-in needle, its entry timing and exit timing, and faulty break liner of projectile settings.



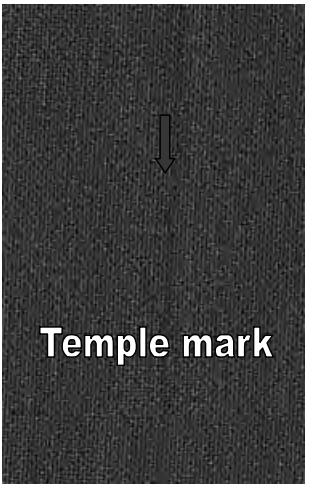
5.5.27 Tail outs

This occurs due to improper working of cutters on receiving side, timings of cutter and gripper cutter sharpness, freeness of working, etc. Trailing pick is also due to improper accumulator setting, blade sharpness and scissor setting.



5.5.28 Temple marks

This occurs due to incorrect setting of temple rollers, defective temples, wrong temples for fabrics. Sharpness of pins on higher side also gives temple mark; bends and poor condition of temples also causes temple marks.



5.5.29 Wrong drawing in / denting

1. Ends drawn with out looking to the draft.
2. Wrong work practices of workers.
3. Incorrect drawing hooks/denters.
4. Poor lighting conditions.

5.5.30 Wax streaks

This occurs due to:

1. At warping if wax licking roller movement is not proper.
2. Higher or lower intermediate speed of wax roller.
3. Stopping during beaming.
4. Wrong contact points of wax roller.
5. Improper viscosity of wax.
6. Flag, fluff on wax roller accumulation.
7. Beam and warp alignment.

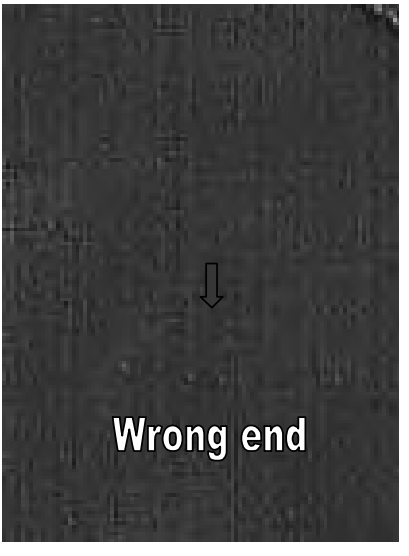
5.5.31 Woven lint

This occurs due to:

1. Poor house keeping.
2. Machine cleaning by air at the same time when other machines are also running.
3. Cleaning of jacquard, dobby, and other parts should be done outside the loom shed.

5.5.32 Wrong ends colour and of S & Z

These are created at warping when left uncheck.



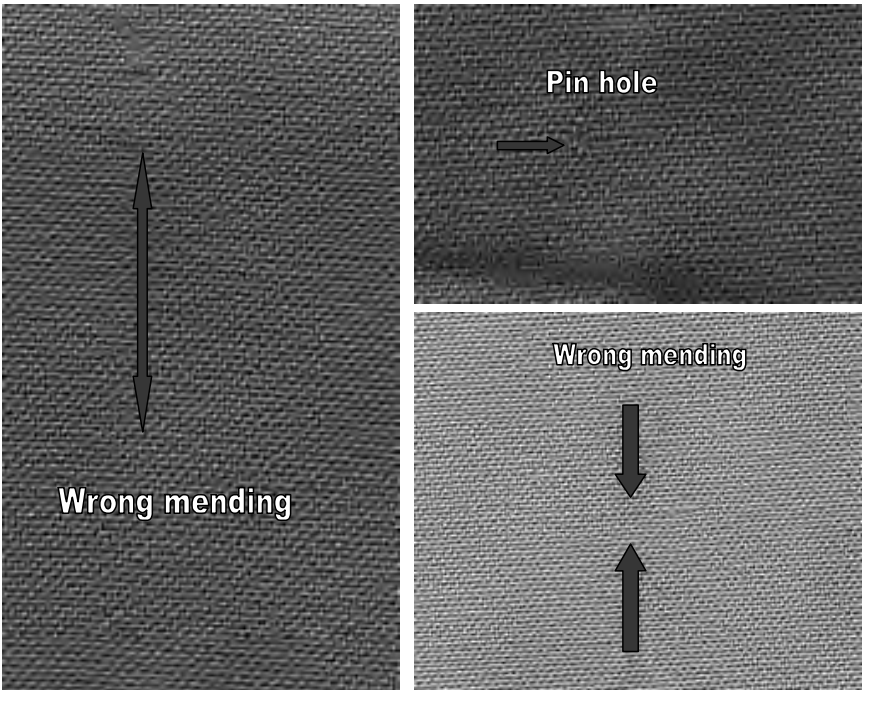
5.5.33 Wrong starting point

This occurs due to design break, faulty pick finding, faulty punch card, mal-functioning of dobby, improper joining of cards and faulty working of any machine parts.

5.6 Mending defects

Defects	*Description*
Double end	During mending repair if one extra end is not removed.
Double pick	During mending repair if one extra pick is not removed.
Loops	During mending repair if after filling end or pick is not properly relaxed.

Pin holes	During mending repair if knot on the side is relaxed un-evenly and in finishing after shearing this creates pin holes after shrinkage.
Un-mended	During mending repair if some thing is left un-noticed and not attended.
Tight pick	During mending repair if pick is filled tightly and not properly relaxed.
Tails out	During mending repair if tails are not properly cut / trim which are not interlaced in tuck-in.
Wrong mended	During mending repair if end or pick is not properly filled as per weave or not relaxed.
Pincher marks	During mending repair if end or pick is tightly relaxed creates abrasion also because of using hard quality rubber or sometimes relaxing directly with metal surface.
Trailing picks	These are extra tuck-in length more than 15 mm which interlace in the fabric body and not pulled properly and cut during mending repair work.
Mending soil mark	The grey fabric is directly kept on the floor or pushed from one place to other place – wipe out the soil/ dust of the floor.



Grey fabric should be avoided for keeping on the floor because of dust.

5.7 Dyeing defects

Defects	*Description*
Colour stain	Type of a stain occurring on the fabric due to colour.
Drain marks	Change in shade on the fold of the fabric.
End marks	The change in the shade at the end of the full length is called end mark.
Dyeing abrasion	White shining due to mechanical friction on the fabric is known as dyeing abrasion.
Listing marks	If shade is darker near selvedge than the surface of the fabric, it is known as listing mark.
Moire	When the surface of the fabric looks lighter and darker in circle form, it is called moire.
Oxidation marks	It is a type of stain observed in the vat-dyed fabric.
Patchy dyeing	When the shade of the fabric is found uneven, lighter or darker, it is called patchy dyeing.
Streakiness	If the solidity of the fabric looks poor, it is called streakiness.
Rope rub mark	Shining due to mechanical friction on the fabric is known as rope rub mark.
Dyeing creases	Coloured creases on the fabric.
Fabric damaged	Any type of damage, for e.g. holes, component damage, selvedge damage, etc.
White creases	Shining due to mechanical friction on the fabric is known as white creases. It is visible as a long line.

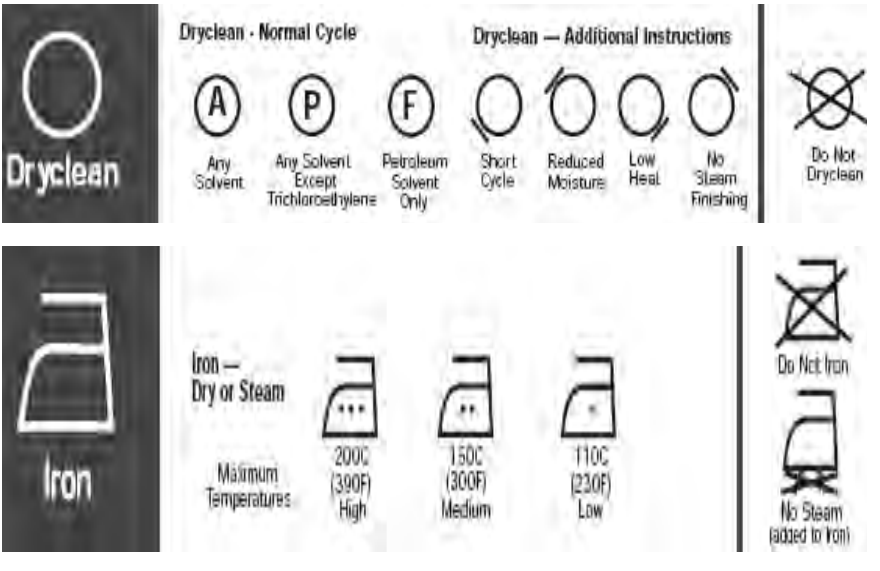
Centre to selvedge	Change in shade from centre to selvedge. (Shade of the fabric is not same in the centre as compared to the selvedge.)

5.8 Finishing defects

Defects	*Description*
Bowing	Weft becomes bow type or monogram of both the selvedge not in same line.
Chemical patches	Chemical stains observed on the fabric.
Drain marks	Colour migration.
Creases	Any fold.
Insect spots	Insects spots on fabric.
KD yellow	Fabric becomes yellow after KD TMT machine (from normal shade).
Moon marks	Moon type shape on the fabric selvedge or fabric selvedge is not straight.
Press marks	Weft-wise marking on uniform distance.
Rub marks	Abrasion or rubbing mainly from rope scouring or from NIKKI press.
Steam band	Improper binding of fabric on beam of KD TMT machine, strip near selvedge.
Processing damage	Any type of damage from shearing, stenter, NIKKI press or any machine.
Soiling marks	Any type of dust in fabric.
Colour contact	Other colour spot comes on fabric.
Singeing band	Improper burning of fibres from fabric surface due to fold in the fabric or problem in flame.
Stains	Any type of stains on fabric like oil, grease, etc.
Water marks	Water dropping mark on fabric.
Wrapper marks	Wrapper impression on fabric in KD TMT machine
End marks	Mark of fabric joint.
Abrasion (Fsg.)	Any type of abrasion from roll or any parts of machine.
Colour sublimation	Colour migration due to steam.
Shearing damage	Any type of damage from cutter of shearing.
Stenter damage	Damage due to pin or fabric entanglement from delivery side of machine.
Corino damage	Pin damage or fabric tear due to tension.
Nikki damage	Any particles goes in side the plate of machine may damage the fabric.

Scouring damage	Any type of damage due to scouring rolls or any other particles inside the machine.
Pilling	Balls formation on the fabric surface.
Shrinkage	Elongation on any machine may cause if fabric is wetted in hot detergent solution.
Rotary damage	Any damage due to any particles goes inside the machine.
Resin stain	Spots of resin chemical on fabric.
Yellow stain	Turmeric, oil, stains on fabric looks like yellow stain.
Steam patches	Uneven steaming in KD TMT machine and blowing.
Suction marks	Come from stenter cooling zone.
Doubly marks	Any fold creates doubly mark on machine.
Gun marks	Ring or impression of gun when we use during removing of stains.
Wrong pinning	Improper pinning on selvedge of fabric.
Dust marks	Any type of fibre deposit on fabric.
Fibrous / beads	Improper burning of fibres on fabric.
Short width	Fabric which is short in width.

5.9 Fabric care symbols



6

Testing procedures

6.1 Uster evenness testing procedure

Objective

Testing of sliver, roving, rubbing, GV-20 Sliver, single yarn and double yarn for unevenness (U%).

Sample quantity

(a) Sliver 50 m
  (i) For gill box tri-coiler – 3 × 40 m
  (ii) For G V 20 – 2 × 40 m
(b) 5 roving bobbins / machine – for BM-13 and 15 roving frame
(c) 4 rubbing bobbins (one bobbin having 2 deliveries) – for FM-7
(d) 10 single-yarn bobbins
(e) 5 double-yarn cheeses

Method of sample drawal

(a) Break sliver from delivery of gill box / GV-20 and collect 50 m of sliver directly from machine into plastic tub.
(b) Collect roving/rubbing bobbins directly from spindles of roving/ rubbing machine.
(c) Collect 10 ring bobbins directly from spindles of ring frame and get it steamed.
(d) Collect 5 double yarn cheeses directly from TFO machine and get it steamed.

Instrument used

Keisokki Eveness Tester Model KET-8011/B.

Testing condition

Material	Range of scale	Speed	Slot no	Test duration	Type of test
Top sliver	± 12.5%	8 m/min	1	5 min	Normal
Gill box sliver upto passage 3	± 12.5%	8 m/min	1	5 min	Normal
Gill box – Tri-coiler	± 12.5%	8 m/min	2	5 min	Normal
GV-20 Sliver	± 12.5%	8 m/min	2/3	5 min	Normal
Roving / Rubbing	± 12.5%	50 m/min	4	5 min	Normal
Yarn (6–47 Nm)	± 100%	400 m/min	6	1 min	Normal
(48 Nm and above)	± 100%	400 m/min	7	1 min	Normal
Double yarn (6–47 Nm)	± 100%	400 m/min	5	1 min	Normal
(48 Nm and above)	± 100%	400 m/min	6	1 min	Normal

For imperfection (Yarn only) Thin = –50%, Thick = +50%, Neps = +200%

Sequence of procedure

1. Clean the slots.
2. Click ‘Set up’ option on the computer screen. Choose the machine and count.
3. Feed the comments as to blend, shade, count, machine no, spindle no, etc.
4. Once the feeding is complete, a summary screen of the test to be performed will be shown. Check this screen for count and comments you had fed. If there’s any mismatch, go back and correct it by re-

feeding. Slot no. will be shown on screen, take the guide pointer to slot no. displayed. If parameters are correct, click OK.
5. Click 'Test' option.
6. A screen will be displayed having four different windows. First click 'Adjustment without material', if this adjustment is OK, then the pointer will come to zero position and certain value will be displayed giving message that 'Adjustment without material is over'.
7. After this pass the material needs to be tested through the respective slot; select the speed as per the test requirement. Then click 'Average value setting'. If this adjustment is OK, the pointer will come to zero position and certain value will be displayed giving message that 'Average value setting is over'.
8. Next click 'Start test' option, now the machine will start measuring the uneveness in the material after initial start up time of 8 s. Once the test gets start, diagram will be displayed on screen.
9. After stipulated time the test will over and two options will be displayed on screen. If the test is OK and satisfactory, click OK or else click Ignore.
10. Start next test and repeat procedure 9, till the given tests are over.
11. Once all the tests are completed, the main screen will be displayed. Click 'Result' option.
12. Various results option will be displayed on screen, choose batch printing and select Eveness testing and Spectograph (in case if required) and click print.
13. Printing process will start and results will be printed.
14. Enter the test result into Uster Eveness register and show the report to respective shift incharge.
15. In case if results are abnormal, get the corrected sample and repeat above procedure.

6.2 Tensile strength testing procedure

Objective

Testing strength and elongation of single and double yarn.

Sample quantity

(a) 10 single yarn bobbins
(b) 5 double yarn cheeses

Method of sample drawal

(a) Collect 10 single yarn ring bobbins directly from spindles of ring frames and get them steamed.

(b) Collect 5 double yarn cheeses directly from TFO machine and get them steamed.

Instrument used

Textechno STATIMAT ME.

Testing condition

Material	Gauge length	Time to break	No. of test
Single yarn	500 mm	20 ± 2 s	10 × 5 = 50
Double yarn	500 mm	20 ± 2 s	5 × 6 = 30

Sequence of procedure

1. Ensure air pressure to be of 5 bar or more.
2. Creel the bobbins/cheese on creel table.
3. Draw the ends and initialise the machine.
4. Select ‘File’ option displayed on computer screen.
5. Select ‘Group Parameter’ and click the yarn type to be tested: single or double yarn.
6. After this selection is done, feed the test details such as no. of packages and no. of test per package. Further, feed resultant count and sample details – blend, shade, count, lot no., remark, etc.
7. Click OK, once all this is fed.
8. Click ‘Close’ option of Group Parameter.
9. Click ‘File’ and select ‘Test Parameter’.
10. Choose test type as per type of sample and then press ‘Edit’.

11. Go to test speed window and feed the test speed, then choose headline and insert the yarn details in the label windows and click OK.
12. Click 'Close' of 'Test Parameter'.
13. Click testing order and insert the prepared group, click close window. Screen will show Force Elongation diagram, single value and package statistics.
14. Press 'UP' key of the machine panel. Test will start and results will be displayed on screen.
15. After completion of test, get the print out of the result.
16. Check the results against standard and initiate corrective action if results are out of acceptable limit.

6.3 Hairiness testing procedure

Objective

Testing of hairs/m of single and double yarn.

Sample quantity

(a) 10 single yarn bobbins
(b) 5 double yarn cheeses

Method of sample drawal

(a) Collect 10 single yarn ring bobbins directly from spindles of ring frame and get them steamed.
(b) Collect 5 double yarn cheeses directly from TFO machine and get them steamed.

Instrument used

Hairiness tester SDL Y098/6.

Testing condition

Material	Speed	Time	No. of test
Single yarn	50 m/min	1 min	10 × 1 = 10
Double yarn	50 m/min	1 min	5 × 2 = 10

Sequence of procedure

1. Double click 'Hairiness/Friction' icon on screen.
2. Further select 'File' from the main screen of Hairiness testing. Click 'New', this enables to go to database of Hairiness/Friction testing.
3. Select 'Hairiness' folder out of hairiness and friction options available.
4. Select 'Blend and count' folder of the material to be tested for hairiness.
5. After this selection, enter suitable file name containing shade and marking no. and then click 'Open'. This will create a file for the particular test to be carried out.
6. Click 'Test' window of the main screen and enter the sample details. In sample reference window enter the file name given above, where as in comment window enter the blend, shade, count, marking, etc, details of the yarn to be tested.
7. Then click OK.
8. Keep the Test speed as 60 and Test length as 50.
9. Thread the yarn to be tested for hairiness through the guides and measuring heads and leave the free end of yarn to suction outlet and click OK.
10. A new screen will be displayed having option of Start, Stop, Accept, Reject, Abort, etc on screen. Select 'Start' option. The machine will start running and will test the yarn for hairiness.
11. A running graph of hairs/m will be displayed on screen. As the length of 50 m is tested the machine will stop automatically. There is an option to reject the particular test if it is abnormal and re-testing can be done by selecting 'Start' option, same sample will be tested again.
12. Repeat steps 9 and 11 for each new bobbin till the given tests are over.
13. After the given tests are over, press 'Print'.
14. Select 'Table' option and printing of the test result will start printing.
15. Click 'Exit' option to come out of hairiness test.
16. Check the results against standard and initiate corrective actions if results are out of acceptable limit.

6.4 Classimat testing procedure

Objective

To measure numbers of faults (classwise) present in 100 km of single, auto-cleared and double yarn.

Sample quantity

(a) Single yarn bobbins having length of 100 km.
(b) 5 auto-cleared cheeses having length of 100 km.
(c) 5 double yarn cheeses having length of 100 km.

Method of sample drawal

(a) Collect sufficient number of steamed single-yarn ring bobbins so as to have yarn content more than 100 km on it.
(b) Collect 5 auto-cleared single yarn cheeses having yarn content of more than 100 km on it.
(c) Collect 5 double yarn steamed cheeses having yarn content of more than 100 km on it.

Instrument used

Premier Classidata 7000.

Testing condition

Material	Speed	Sample size	Type of material
Ring yarn	480 m/min	100 km	Poly:Wool / Poly:Viscose
Auto-cleared yarn	480 m/min	100 km	Poly:Wool / Poly:Viscose
Double yarn	480 m/min	50 km and more	Poly:Wool / Poly:Viscose

Sequence of procedure

1. After entering the username and password, Classimat test screen will be seen on computer screen.

2. Select the 'Test' icon from the menu bar. Further select 'New' icon from the given options.
3. Now a new screen will appear on screen.
4. Feed relevant yarn test details like count (Nm), type of material, package type, length in kms, no. of drums, speed in m/min, etc., into 'Test Detail' window.
5. Click the 'Remark' icon and feed relevant information regarding the sample into 'Remark' field.
6. Now click 'Cutmode' and 'Objectionable' field, select different fault classes as per requirement into different cutmodes. Give limit for objectionable fault depending upon the sample type – ring yarn, auto-clear, double yarn, etc**.**
7. After feeding all the above mentioned fields, click 'Finish' icon and then OK.
8. Now a class-wise fault window will appear on computer screen.
9. Click 'Start' icon which will appear on screen.
10. A message will be displayed on screen stating to clean all measuring slot. Clean all measuring slots and start the winding machine.
11. Thread all the yarns through the measuring slots on to the bobbin and start winding.
12. A new message will appear on screen stating 'Preparing for Classification'. This message will remain on screen for some time and will disappear automatically.
13. A new message will be displayed stating 'Classification started' and will disappear after few seconds.
14. Now the classification of yarn faults classwise will start and also length and weight monitoring will be done.
15. As soon as length of 100 km is reached, the test will automatically terminate and sensor will cut the running yarn.
16. Now click the 'Non-Cumulative' icon from fault window and then click 'Print' icon.
17. Check the results against the standard and initiate corrective actions if results are unexpected.

6.5 Re-gauging cuts/kg testing procedure

Objective

Testing of re-gauging cuts/kg of double yarn.

Sample quantity

(a) Minimum 2 fresh steamed double yarn cheeses.

Method of sample drawal

Collect minimum 2 fresh steamed double yarn cheeses.

Machine used

Padmatex Autoconer Winding machine

Testing condition

Material	–	Double yarn (Polywool/Polyviscose)
Count	–	Resultant count in Nm
Sensitivity	–	100
Reference length	–	2.0 cm
Material value	–	4.5 for polywool and polyviscose 6–7 for woolrich and 100% wool respectively
Speed	–	600–1000 m/min

Sequence of procedure

1. Do the setting of above mentioned testing condition parameters on the Uster panel board of the machine for the block on which study has to be carried out.
2. Mount the packages on the reserve peg and start the spindle.
3. Package will be taken to running position and its end will be picked by the lower arm and threaded through the sensor.
4. Wind this end onto empty bobbin and mount this bobbin between the adopters on the drum and start the spindle by pressing in the black button.
5. Carry out operation 2–4 for all the packages to be tested.
6. Lock the knotter by turning the knotter rod clockwise.
7. When any objectionable fault is sensed by sensor it will cut it and this will cause a yarn break. This stops the spindle.
8. Collect this faulty yarn part which is wound on bobbin by breaking it.
9. Start the knotter by turning it anticlockwise. It will knot the broken end and this starts the spindle.
10. As soon as spindle starts running, lock the knotter.
11. Wind all the yarn from test packages till it is exhausted. Collect all objectionable faults which are cut by sensor.
12. Weigh the winded packages and note the net yarn content of it by deducing tare bobbin weight out of total weight.
13. Calculate cuts/kg by dividing no. of cuts by weight of yarn (Kg).

14. Check the results against the standard and initiate the corrective action if results are out of acceptable limit.

6.6 Twist testing

Objective

Testing of twist/in. and its CV% of double yarn.

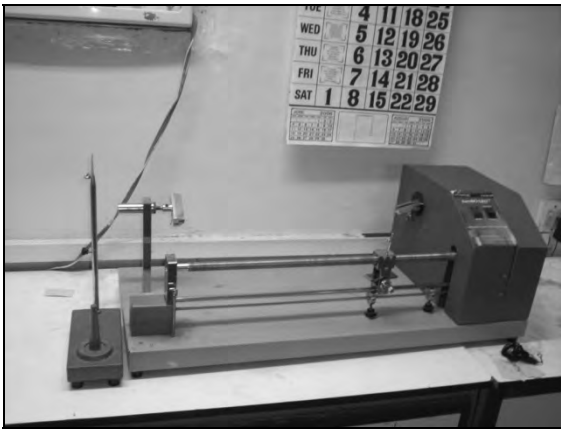
Sample quantity

(a) 5 steamed double yarn cheeses.

Method of sample drawal

(a) Collect minimum 2 fresh steamed double yarn cheeses.

Machine used



Star Micro Twist Tester STT 2401.

Testing condition

Material	–	Double yarn (Polywool/Polyviscose)
Count	–	Resultant count in Ne (English count)
Sample length	–	50 cm (20 in.)
Preset twist	–	5–8 twist/in. less than the standard twist/in. Twist direction – S or Z
Sample size	–	5 double yarn cheeses
No. of test	–	minimum: 5 × 6 = 30 and maximum: 5 × 10 = 50

Sequence of procedure

1. Start the main switch and machine switch.
2. Feed the above mentioned test parameter one by one through key board on control panel.
3. Mount the yarn sample, one end in fixed jaw and other end in rotating jaw.
4. Press 'Start' and then 'Enter' key. The rotating jaw will start to rotate and will continue to rotate till the preset twist value is untwisted.
5. Insert the needle between two components of yarn and move it towards rotating jaws as the twist is removed.
6. Press 'Jog' key slowly so that rotating jaw rotates and untwists the remaining yarn length.
7. Keep pressing 'Jog' key till the whole twist is untwisted and yarn becomes completely parallel. The needle inserted between two twisted yarn components touches the rotating jaw.
8. The twist/in. value will be displayed on screen.
9. Note this value in record sheet.
10. Mount next yarn sample and repeat steps 3–9, note the readings till the required tests as per testing condition are over.
11. Calculate the average T.P.I and its CV% of readings.
12. Enmark the minimum and maximum values from the obtained readings.
13. Check the results against the standard and initiate corrective action if results are unacceptable.

6.7 Count testing (count wrapping)

Objective

To find the average count of single yarn as well as double yarn (Count wrapping).

Material

(a) Single yarn
(b) Double yarn

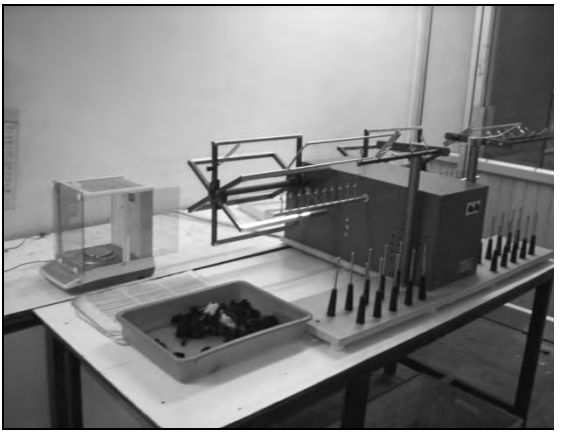
Sample size

(a) For single yarn – minimum 4 cops and maximum 8 cops.
(b) For double yarn – minimum 2 and maximum 5 double yarn cheese.

Method of drawal

Randomly select minimum 4 cops and maximum 8 cops for running shades. For double yarn, select 5 cheeses randomly from the given lot.

Instruments used



Wrap reel and electronic weighing balance.

Testing condition

Sample length	–	100 m
No of sample for single yarn	–	(a) Minimum 4 × 1 = 4 (b) Maximum 8 × 1 = 8
Double yarn	–	5 × 2 = 10

Sequence of procedure

1. Place the cops/cheese on the pegs of creel of wrapping machine.
2. Thread the yarn from each package through the guides and lock it to the screw on the wrapping barrel.
3. Press the 'Start' button and hold it for few seconds.
4. The wrapping drum will start rotating and will rotate till 100 m of length is wound on it.
5. After the required length is wound on the drum the machine will stop automatically.
6. Break the yarn near the screw, where it was wounded before starting the rounds.
7. Remove the leas one by one.

8. Weight the leas on electronic balance and note the weight in grams of each lea.
9. Calculate the count in Nm (Metric count) by using the below formulae
   Count (Nm) = Length in metres of yarn lea/Weight in grams of yarn lea
   For double yarn length = Length in metres of lea × 2 (as 2 ply yarn)
10. Calculate the Average Count (Nm) by taking average of given readings of each lot/machine.
11. Check the results against the standard and initiate corrective action if results are unacceptable.

6.8 Testing procedure for wrapping of sliver and roving/rubbing

Objective

To find wrapping of sliver and roving/rubbing.

Sample size

(a) For gill box and GV–20 sliver – 1 m of sliver for each delivery head.
(b) For roving – minimum 1 m × 4 readings for each lot.
(c) For rubbing – minimum 1 m × 2 readings for each lot.

Method of drawal

(a) For gill box and GV-20 sliver – Collect the sliver from each delivery head.
(b) For roving/rubbing – Collect the roving/rubbing strand from bobbins running on machine by stopping it.

Instrument used

Electronic weighing balance, dead weight, table enmarked with length of 1 m, scissors.

Sequence of procedure

(a) The sliver sample taken from the can is placed on wrapping table. Both the free ends folded are cut with scissors with reference to 1 m mark on wrapping table to get length of 1 m each. These lengths of sliver are weighted.

(b) Calculation – (Weight of sliver / Length in metres) = Wrapping in grams / metres.
(c) Minimum of 1 m of roving/rubbing strand unwound from the bobbins. However to get a sound average length may be increased to 2–4 times.
(d) Sample is laid on the wrapping table. After placing some dead weight on sample, both folded and free ends are cut with scissors with reference to 1 m mark on table to get length.
(e) Calculation = (Weight of roving / Length in metres) = Wrapping in grams/metres.
(f) Correct the machine draft by pinion adjustment if the wrapping falls outside the tolerance limit and recheck the sample again by following the above procedure.
(g) Record the wrapping in the Record book.
(h) Check the results against the standard and initiate the corrective actions if results are unacceptable.

6.9 Test procedure for calculating oil %

Objective

To find antistatic oil % of sliver and roving.

Sample quantity

About 10–15 g of sliver/roving collected randomly from different cans/ bobbins of same lot.

Method of drawal

Collect randomly sliver tufts from at least three different bobbins/cans of same lot, so as to make it 10–15 g and thoroughly mix these individual tufts and draw 2 g of sliver sample for oil testing.

Instrument used

Rapid oil extracting vessel, stainless steel plates, Methanol LR (Purity 99%), electronic weighing balance, hot plate, and measuring jar.

Sequence of procedure

(1) First clean the stainless steel plate with dry cloth and place it on weighing balance.
(2) Note weight of plate and record it. This is initial weight of plate.

(3) Take 2 g of sliver/roving sample to be tested by randomly picking it from thoroughly mixed sample.
(4) Place this 2 g of sliver/roving sample into the rapid extract vessel and fix its lower cap.
(5) Take 40 ml of Methanol LR into measuring jar.
(6) Place the stainless steel plate below the vessel pipe and pour Methanol from top of the pipe, so that it flows through the sample and gets collected in the pipe.
(7) Pour all 40 ml Methanol though sliver/roving sample and collect it in plate.
(8) Insert the pressing rod and press it so as to remove the residual methanol from the sample.
(9) Place the plate containing drained Methanol on hot plate.
(10) Keep the stainless steel plate on hot plate till methanol is fully evaporated.
(11) Remove the plate and keep in normal atmosphere for 15–20 min till it becomes cool.
(12) Weight the plate and note its weight in grams. This is the final weight.
(13) Calculate the antistatic oil% using the following formula.
Antistatic oil % = [(Final weight – Initial weight) / 2] × 100
(14) Check the results against the standard and initiate the corrective action if results are unacceptable.

6.10 Testing procedure for determining moisture

Objective

To determine the moisture content/regain from the given sample.

Sample quantity

(a) 50 g and above for sliver.
(b) 20 g and above for roving/rubbing strand.
(c) 5 g and above for yarn and fabric.

Method of sample drawal

Collect randomly sliver tufts from different bales/cans/area within a can. For roving/rubbing, collect it randomly from at least from 2 different bobbins or portion of single bobbin. For yarn collect the sample from at least 2 different bobbin or portions of single bobbin.

Instrument used

Moisture determination oven, desiccator, and electronic weighing balance.

Sequence of procedure

(1) Weight the sample whose moisture has to be determined. Note the reading, this will be the initial weight of sample.
(2) Put the weighted sample into cans of moisture determination oven.
(3) Set the temperature of oven at 100–110°C.
(4) Set the time in range of 30–45 min.
(5) Start the oven and heating will start. Switch on the fan.
(6) After heating is over, switch off the oven.
(7) Remove the can and transfer the sample into desiccator. Close its lid firmly so that sample doesn't come in contact with the atmosphere.
(8) Weigh this dry sample and note it. This is oven dry weight.
(9) Moisture content and moisture regain % can be calculated using the formula below

$$\text{Moisture content \%} = [(\text{Initial weight} - \text{Oven dry weight}) / \text{Initial weight}] \times 100$$

$$\text{Moisture regain \%} = [(\text{Initial weight} - \text{Oven dry weight}) / \text{Initial weight}] \times 100$$

(10) Check the results against the standard and initiate corrective action if results are unacceptable.

6.11 Method to conduct ring frame end breakage study

Objective

To conduct ring frame end breakage study.

Sample quantity

At least single side of a ring frame.

Method of sample drawal

Randomly choose the ring frame depending upon the count, blend or shade working on it; or for any special reference for which study has to be undertaken.

Accessories and instruments used

Ring frame end breakage study sheet, hygrometer, and time clock.

Sequence of procedure

(1) Before starting the study, note the processing and material details of the running machine like machine no., blend, shade, count, doff position and total no. of spindles installed. Note the starting time also.
(2) Note the dry and wet bulb reading from hygrometer installed in department.
(3) Note the idle no. of spindle of machine.
(4) Get all the broken ends attended from operator before starting the round.
(5) After all the ends are attended, take first round of whole machine or single side which is under study and note no. of broken ends – cause wise into the sheet against the breakage reason.
(6) Get the broken ends attended by the operator.
(7) Take second round after a gap of 15–20 min and note the reasons for broken end in same way as step 5.
(8) Repeat step 6.
(9) Further repeat steps 5 and 6.
(10) Minimum 2 rounds of whole machine or side under study to be taken.
(11) After a time span of 1 h, stop the study.
(12) Calculate the ring frame end breakage/100spdl/h as follows.

$$\text{Ring frame breaks/100 spdl/h} = (\text{Total breaks/no. of working spindles}) \times 100$$

where, no. of working spindles = Installed spindle – Idle spindles.

(13) Check the results against the standard and initiate the corrective action if results are unacceptable.

6.12 Method to conduct TFO end breakage study

Objective

To conduct TFO end breakage study.

Sample quantity

Minimum one single TFO machine.

Method of sample drawal

Randomly choose the TFO depending upon the count, blend or shade working on it; or for any special reference for which study has to be undertaken**.**

Accessories and instruments used

TFO end breakage study sheet, hygrometer, and time clock.

Sequence of procedure

(1) Before starting the study, note the processing and material details of the running machine like machine no., blend, shade, count, speed of machine, tension dial setting, front tension setting, capsule spring used and total no. of spindles installed. Note the starting time also.
(2) Note the dry and wet bulb reading from hygrometer installed in the department.
(3) Note the idle no. of spindle of machine.
(4) Get all the broken ends attended from operator before starting the round.
(5) After all ends are attended, take first round of whole machine or single side which is under study and note no. of broken ends – cause wise into the sheet against the breakage reason.
(6) Get the broken ends attended by the operator.
(7) Take second round after a gap of 15–20 minutes and note the reasons for broken end in same way as step 5.
(8) Repeat step 6.
(9) Further repeat step 5 and 6.
(10) Minimum 2 rounds of whole machine or side under study to be taken.
(11) After a time span of 1 h stop the study.

(12) Calculate TFO end breakage/100 spdl/h as follows.

$$\text{TFO breaks/100 spdl/h} = (\text{Total breaks/No. of working spindles}) \times 100$$

where, no. of working spindle = Installed spindle – Idle spindles.

(13) Check the results against standard and initiate the corrective action if results are out of acceptable limit.

6.13 Method to conduct loom operating study

Objective

To conduct loom operating study.

Sample quantity

Minimum one single loom and maximum eight looms (i.e. one line)

Method of sample drawal

Choose the loom/loom line depending upon the quality, weave, count, blend or shade working on it; or for any special reference for which study has to be undertaken.

Accessories and Instruments used

Loom operating study sheet, hygrometer, and time clock.

Sequence of procedure

(1) Before starting the study, note the processing and material details running of the loom like machine no., speed of loom, quality, name of operator, etc. Note the start timing also.
(2) Note the dry and wet bulb reading from hygrometer installed in the department.
(3) Note the clock readings of particular shift in which study is carried out before starting the study of loom / loom line. Note start clock reading of all looms under study. This is initial reading.
(4) Take first round of whole loom line or single loom which is under study and note any abnormality.
(5) Whenever loom stops due to breakage, go and observe the nature of break and its probable reason.
(6) Collect the broken part of yarn for reference sample.
(7) After ascerting the reason for breakage mark the cause into weaving study sheet.

(8) Observe the loom / loom line for 1 h and note the reasons for breakages – cause wise.
(9) If any loom is stopped for any other reason other than breakage, mention its total time for stoppage and reason in remark column of weaving study sheet.
(10) Note the clock reading of each loom after 1 h and note it. This is final reading.
(11) Mount the broken yarn cutting loom wise separately on the weaving study sheet.
(12) Calculate 100% picks as follows:

(Loom speed in rpm × 60) / 1000

(13) Calculate the total picks as follows:

(Final reading – Initial reading) / 10

(14) Calculate efficiency % as follows:

(Total picks / 100 % picks) × 100

(15) Calculate Average efficiency and Average picks taking average of all looms that were studied.
(16) Check the results against the standard and initiate the corrective action if results are unacceptable.

6.14 Method of cross-checking of beam gaiting strips

Objective

To weave defect-free fabric.

Sample quantity

All the new beam gaiting strip of 3 shifts.

Method of sample drawal

Not applicable

Accessories and instruments used

Glass table with under and over light arrangement.

Sequence of procedure

Check the following points:

(a) Selvedge and monograme
(b) Shade and pattern
(c) Wrong ends

(d) Double end
(e) Wrong drawing and wrong denting
(f) Reed mark
(g) Temple mark
(h) Loom abrasion
(i) Section Marks

6.15 Method of cross-checking of dyed strips

Objective

To weave defect-free fabric.

Sample quantity

Strip of all the pieces of white fabric.

Method of sample drawal

Not applicable

Accessories and instruments used

Glass table with under and over light arrangement.

Sequence of procedure

Check the following points:

(a) Loom abrasion
(b) Section marks
(c) Wrong ends
(d) Double end
(e) Wrong drawing and wrong denting
(f) Reed mark
(g) Temple mark
(h) Loom abrasion
(i) Section marks

6.16 Method of cross-checking of mended pieces

Objective

To despatch defect-free fabric.

Sample quantity

Full piece

Method of sample drawal

Randomly taken from mended and checked piece.

Accessories and instruments used

Mending table with under and over light arrangement.

Sequence of procedure

Cross-checking for mended work, e.g. wrong end, pulled knots, un-mended knots, thick end, loose end, tight end, filling work, pinholes and physical appearance of mended work.

References

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NSC GC14 Instructional Manual
NSC GV20 A Instructional Manual
NSC BM20 Instructional Manual
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Elgi Welkar vapofix Autoclave IM
Oerlikon/Schlafhorst (Autoconer 338 Type RM) IM
PS Mettler Ply winding IM
Murata TFO IM
Benninger Bentronic Warping m/c IM
Sulzer Weaving m/c IM
Raymond Textile presentation
Keisokki Eveness tester IM
Premier Classidata IM
SDL Hairiness tester IM
Textechno – Statimat ME IM

Index