WEAVING PREPARATION TECHNOLOGY

ABHISHEK PUBLICATIONS

WEAVING PREPARATION TECHNOLOGY

Dr. N.Gokarneshan M.Tech,Ph.D,MISTE
Principal,
NIFT TEA College of Knitwear Fashion
TIRUPPUR

ABHISHEK PUBLICATIONS
CHANDIGARH (INDIA)

IISBN: 978-81-8247-247-1

First Edition:2009
Published by:
Abhishek Publications
S.C.O. 57-59,Sector- 17 C
Chandigarh- 160017 (INDIA)
Ph. 0172-5003768, Fax: 0172-2707562
Email : abhpub@yahoo.com
Visit us at : www.abhishekpublications.com
Printed at: Shiva Offset, Navin Shahadra, Delhi

DEDICATED TO

MY BELOVED PARENTS

MY REVERED GURU SAGE RAMANA MAHARISHI

MY WIFE AND SON

AND

MY BELOVED STUDENTS

"This page is Intentionally Left Blank"

PREFACE

This book has been prepared considering the basic need of students of undergraduate and diploma courses in textile technology. The book in structured in a simple way. It is intended for the subject of weaving preparation, which forms the core in the prescribed curriculum of universities and polytechnics in India. Useful data are provided wherever necessary. As there are no text books on the subject that cover all the areas, namely, winding, warping and sizing, the book will be immensely useful for students and is therefore intended to be a basic book on the subject. The unique feature of the book is that it covers every aspect of the subject in a nutshell. Of course, there is always scope for improvement of the quality of the book. Therefore, suggestions from the readers are most certainly welcome. The preparation of the book has been possible not due to my sole effort alone. I wish to thank our beloved Chairman, Sri. Raja.M. Shanmugam, Vice chairmen, Sri. C.M.N. Muṛuganandam, and Sri. T. Thangaraj, for their moral support. I also wish to express my heartfelt gratitude to Prof. V.K. Kothari, of Indian Institute of Technology, New Delhi, for having kindly consented to go through the manuscript and give the foreword for the book. Prof. Kothari is a world renowned textile technologist and I therefore deem it a great privilege to include his valuable foreword in my book. I also wish to thank my mentor and guide, Prof. V.Subramaniam, for his encouragement and support. My special thanks should also go to my former

colleague, Mr. P.Dhanapal and technician Mr. Jaffer Sadiq for their timely assistance in the preparation of the manuscript. Last, but not the least, I thank all those who directly and indirectly helped me with the preparation of the manuscript. I welcome suggestions from the readers for improvement of the book.

Dr. N.Gokarneshan
Principal
NIFT TEA College of knitwear fashion
East of TEKIC, TEA Nagar,
Mudalipalayam
Tiruppur 641 606

FOREWORD

I am pleased to note that Dr. N.Gokarneshan has brought out yet another very useful book. In fact his earlier book on fabric structure and design has proved to be very useful for students of under graduate and diploma courses in textile technology, and therefore has served as a basic book on the subject. The subject of weaving preparation forms the core subject in the textile technology course. Not many books deal with the all the areas related to the subject. It would ideally meet the syllabi requirements of the one of the basic textile technology course. All the important stages of the weaving preparatory process are covered in this book. A number of illustrations are provided so as to give clarity to the reader. The book deals with the basic technological aspects involved at the various stages of yarn preparation, namely, winding, warping, sizing, and drawing in. It also highlights the modern developments in the concerned areas. Another interesting feature is the inclusion of micro denier yarns. The last few pages provide the latest industrial norms which would be very useful and informative to the students. All the chapters have been well organized and are sufficient at student level. The book besides being a basic book for textile technology course, will also serve as reference material for fashion/apparel/ costume design courses. As developments are taking place from time to time, the author needs to update the book accordingly. Also there is a good scope to improve the book regarding the presentation of its contents. I appreciate the efforts taken by the author in bringing out a much needed book on the subject and am sure that it will serve its purpose. I also wish him to write more such useful books that would benefit the student community.

Prof. V K Kothari
Department of Textile Technology
Indian Institute of Technology
New Delhi 110 106.

CONTENTS

PART I
WINDING

"This page is Intentionally Left Blank"

Chapter 1

FUNDAMENTAL ASPECTS OF WINDING

1.1 Introduction

The yarn from the spinning is not adequate in quantity and quality for weaving. It contains a number of imperfections in the form of thick places, thin places and slubs. These will pose problems in the subsequent process and ultimate hinder the cloth quality. Also the ring cop is small in size and needs to be converted into a bigger package. The winding process achieves the twin objectives of reducing the imperfections in the ring yarn as well as converting it into bibber package in the form of cone/cheese. Thus the ring cop which weighs about 60 - 80 grams is converted into a package of 1.5 to 2 kgs. Heavier packages of about 5kgs is used for synthetic textured yarns.

1.2 Classification of winding machines

The winding machines are classified into the following categories

Winding

- **Warp winding (cone/cheese)**
  - **Drum** → **Slow speed**
  - **Precision** → **High speed & super speed**
- **Weft winding (pirn/quill/filler)** → **Automatic (Autoconer)**

The conventional or slow speed machines (upright spindle winding machines) had a winding speed of about

300 meters/min. High speed machines worked at speeds of 600 - 800 meters/min and super speed machines worked at speeds of 1000 meters/min. Present day machines are automated and are known as autoconers. These machines run at speeds of more than 1500 meters/min and the latest machines are claimed to run at speeds of about 2000 meters/min.

A number of companies manufacture the latest autoconers. Out of these, the well known ones are the Schlarhorst, Murata and Veejay Savio.

1.3 Warp winding

Warp winding may be of contact or non contact types. The contact or the drum winding winds yarn on to a cone or cheese package by frictional contact with a drum. The non contact or the precision type of winding does not employ a drum and uses a traverse guide to traverse the yarn across the package. The object of the warp winding is to remove the yarn faults such as thick and thin places and slubs present in the supply package, namely the ring cop and also convert into a bigger package called the cheese or cone weighing about 1 -2 kgs.

1.4 Weft winding

It is also known as the filling or quill winding and is suitable as weft package for shuttle looms. The supply package may be ring cop or cheese/cone. Accordingly the type of winding may be direct or indirect. Unlike in warp winding, weft winding does not remove the yarn faults.

1.5 Parallel sided cheese package

In this type of winding the yarn speed is maintained constant. This package is suitable for open end spinning, texturising process, assembly winding, two for one twisters, and package dyeing. In case of using the cheese for package dyeing the yarn is wound on a perforated former (empty cheese). The lesser is the package density (hardness of package), the better is the dyeability. Minimum package density is attained at an angle of wind of 45°. The dyed packages are to be rewound into more compact package. For a cheese package the ratio diameter/traverse length is usually about 1.2 to 1.3 although larger diameter packages can be made. However, larger diameter packages are less stable and are prone to damage. Unwinding of the package is either by side or over end withdrawal.

1.6 Cone winding

Winding of packages in the form of cones is preferred due to the following reasons:

a) Unwinding of cones is done by over end withdrawal, and hence it gives a low and relatively uniform unwinding tension at high speeds.
b) Cones are considered to be stable package and enables easier handling without yarn sloughing off. (coming off loosely)
c) The size of the package is much larger than that of the ring cops and therefore it increases the productivity of subsequent machines by reducing the frequency of package change over time.
d) Yarn faults are removed from the ring cop.
e) Facilitates assembly winding (winding a number of component threads alongside each other)
f) Different yarn lots can be identified by using different coloured package formers.

Cones have gained more popularity than cheeses, since they can be made into larger packages than cheeses. In these packages, over end unwinding at high speeds does not affect the yarn tension considerably. The ratio of yarn diameter/traverse length is usually about 1.7 and the ratio of mean diameter/traverse length is 1.4, which is similar to that of cheeses.

1.7 Taper of cone

The conicity or the taper of cone is the angle between the central axis of the cone and the tapered face. In the case of high speed unwinding, balloon formation can take place and hence it is preferable to have low angled cones. The following angle of tapers are recommended for different purposes:

2°	- Shuttleless weaving
3°30′	- Continuous filament pineapple cones
4°20′	- Cones for warping
9°15′/9°30′	- Hosiery yarn for knitting

Cones built with constant taper are not suitable for knitting, since the speed of unwinding is low and no balloon is formed. Under such circumstances the yarn would rub on the surface of the cone giving high and uneven yarn unwinding tension. This is overcome by increasing the traverse rate towards the nose of the cone and thereby the taper of the cone is increased up to about 14° or 16° in a fully built package.

The nose part of the building package has lower surface speed than the drum and the base part has higher surface speed, during winding on drum. This problem is not present in the case of precision cone winding.

1.8 Types of yarn unwinding/withdrawal

There are two types of yarn unwinding from the package, namely, the side withdrawal and the over end withdrawal. In the case of side withdrawal, the package has to be rotated and this restricts the yarn speed. Also it causes creates problem of over running of cheeses if the unwinding is stopped suddenly. It also leads to increased tension as the package size decreases. The fact that the twist in the yarn remains unaffected in this type of yarn withdrawal is taken advantage of in the unwinding of flat yarns such as fancy threads, where variation in twist cannot be tolerated.

In the case of over end withdrawal, there is variation in twist, which depends upon the instantaneous diameter of the package. Thus the variation in twist increases as the package empties. The twist may get added to or subtracted from the existing yarn twist, depending on the direction of twist in the yarn and the direction of yarn withdrawal.

1.9 Angle of wind

This is the angle between the direction of the yarn lay on the package surface and any plane perpendicular to the package axis (fig1.1). In general, the greater the angle of wind, the better is the package. However, there is a maximum value of the angle beyond which yarn slippage will take place at reversals. In the case of drum winding the angle of wind does not change from inside to outside of the package, where as in the case of precision winding the angle of wind does change.

Angle inside the package *Angle outside the package*

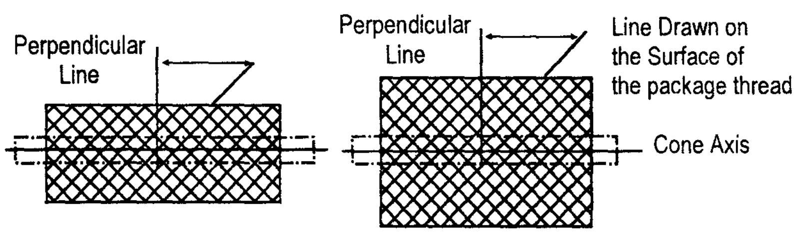


Figure 1.1 - Angle of wind

1.10 Wind and traverse ratio

The wind is the number of coils of yarn wound on per single traverse from one end of the package to the other.

The traverse ratio is the number of coils wound on per complete traverse cycle, and hence is twice the wind.

1.11 Package stability and density

Ideally in a winding package, the package density (hardness) should decrease from layer to layer, i.e from the start to end, as otherwise, the softer inner layers would be pushed away and results in bulging. The factors that influence the density of the package are yarn tension, pressure applied on the winding drum/package, and angle of wind. In the case of drum winding the hardness of the package is greatly influenced by the pressure between the package and the drum. In the case of precision winding the package hardness is mainly influenced by the yarn tension. Highly elastic yarns require lesser yarn tension/ drum pressure ratio so as to prevent subsequent yarn retraction causing increased pressure to develop on the inner layers. However, if this ratio is too low, yarn slough-off may take place. This is of particular importance in the case of continuous filament yarns. On the other hand a fault called 'cob-webbing' (cross threading) occurs when the traverse ratio used is too high. This fault can create high tensions or end breaks during unwinding.

1.12 Types of winds in cone/cheese winding

There are two types of winds generally used in cone and cheese winding, namely, 'Open wind' and 'Closed wind.'

1.12a Open wind

In this type, the succeeding coils are laid widely on the preceding coils of the package, to prevent diamonds or any pattern. Generally this type of winding is used for warping purposes. This wind is also called 'regular wind'. All the drum winding machines produce open wind package as shown in the figure1.2.

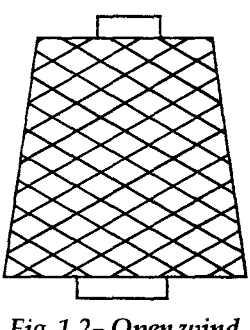


Fig. 1.2- Open wind

1.12 b Closed wind

When the successive series of winds are laid closely side by side, a very compact package is produced. This wind is called as 'closed wind'. This type of wind is used for sewing threads, synthetic filaments, etc. This wind is also known as 'universal wind' or 'diamond wind'. This is shown in the figure 1.3

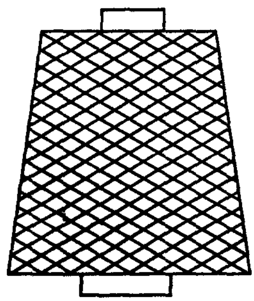


Figure 1.3 - Closed wind

Chapter 2

TECHNICAL ASPECTS OF THE WINDING PROCESS

2.1 Introduction

As winding forms the first stage of the weaving preparatory process, nevertheless, it becomes prudent to maintain good wound yarn quality, which would considerably influence the performance in subsequent processes such as warping, weaving and knitting. This could be achieved only if certain basic or fundamental criteria are fulfilled at various stages of the winding process. In this chapter the various requirements that are critical in determining the yarn quality at winding are discussed in the foregoing sections.

2.2 Basic requirements of yarn unwinding

The supply package in winding, which is the ring cop, plays a certain role in characteristics of the package wound. The build of the supply package should be such that it can permit over end unwinding at speeds above 1000 m/min. One of the important aspects to be considered is the 'backwind'. This should be as low as possible as other wise the productivity of the winding machine operator would be affected. The length of the back wind should not exceed 70 cms under any circumstances and backwind lengths of 40 cms are practically being achieved. During unwinding of the ring cop there is a great tension variation from full to empty package. This is due to increasing ballooning tension, which tends to increase the yarn friction. The inclusion of the balloon controller reduces the mean unwinding tension at any build position thereby reducing the variations in unwinding tension from full to empty supply package. The balloon controller restricts the balloon a certain distance above the nose of the ring cop.

The balloon breaker is effective in reducing the unwinding yarn tension up to about 70% of the ring cop build. Beyond this level the unwinding tension remains unaltered with or without the balloon breaker. This is due to the fact the unrestrained balloon transforms to that of a double balloon after about 70% of the ring cop has been unwound and this drastically reduces the winding tension.

Some of the well known types of supply package builds are the cop build, parallel or roving build, and combination build. The tension variation in the case of the second and third types is much higher as compared with the first type, namely, the cop build. Hence the cop build is being universally adopted.

2.3 Requirements of take up

The yarn from the supply package is taken up by two methods. One is by negative drive and the other is by positive drive. The first is applicable for drum driven machines and the second is applicable for spindle driven winders. The spindle driven method is, however, complicated and more expensive as compared with drum driven winders. The obvious advantage with the negative friction driven drum winders is that they are less complex comparatively and also traverse is done by means of the traverse grooves of the drum, enabling the yarn to be laid on to the package. No separate traversing mechanism is required. Hence these types of winders are most commonly used. In the case of drum winding the number of traverses will continuously decrease from empty to full cone package. In the case of spindle driven machines where separate traverse mechanism is used, the number of coils of yarn laid per traverse will remain constant from empty to full package. This is suitable for special cases, but drum driven machines are mostly preferred.

The nature of yarn slippage between package and drum depends on whether the yarn is wound on 'p' or 'q' type machines. In the case of a 'p' type winding machine (cone package nose at right side of drum), the package will be driven without slip about one third from the right end, i.e., the base. The length of the package from this point to the cone base will be subjected to positive slip, and the length between this point and the nose to negative slip. The converse happens in case of a 'q' type of machine. Reduction in the taper angle of the package considerably reduces the slip at the nose portion. The 'p' type machines are recommended for winding of Z twist yarns and 'q' type of machines are used for winding of S twist yarns, as otherwise package instability and slough off problems could occur.

The angle of wind of the package depends on the angle of the drum groove in relation to the axis of the drum. It also includes the angle between the yarn traversed from left to right and vice versa. The angle of wind generally used ranges between 30° and 55°. The package density attains a minimum value when the angle of wind is 90°, or in other words when the two sets of threads (from each traverse) are at right angles to one another. The air space between crossing yarns is maximum under such conditions. The recommended winding angle of package suitable for warping and unconventional weaving is about 30°. Increase in winding angle reduces the package density. Drums are available in scroll turns of 1.0, 1.5, 2.0, and 2.5. This relates the drum rotation and yarn traverse. In the case of a 1.0 scroll, the drum makes one complete rotation for one complete yarn traverse, thereby giving maximum winding angle and minimum density. Suitable combinations of scroll turns and traverse lengths will cater to warping, weaving, knitting and two for one twisting. A traverse of 125 mm with 2 scroll turns of drum will adequately meet the requirements of most preparatory and weaving applications. This is valid as long as the helical angle of the drum groove and yarn winding angle are constant. However, in the case of knitting applications, where package cones have concave noses and convex bases, accelerated package build is used. For instance, the empty cone tube could have a conicity of 5°57′ and becomes 11° when the package is full. The same drum can be used for winding of cheeses and cones up to a conicity of 6°. Special drums are to be used when the conicity increases beyond this value.

A major problem associated with winding is the pattern/ribbon formation which causes instability in packages during unwinding. This can be offset by modifying the lay of the yarn in the pattern zones of package and is generally done by causing controlled slippage between yarn package and drum, which is done mostly by intermittent reduction in speed of drum. To an extent the conical package has built in regulator. This is so because increase in package size changes the point of wind and thereby enables pattern breaking. However, in the case of cheese/ cylindrical package this is not so.

2.4 Requirements of yarn tensioning

It is evident that the stability of wound package (with required density) is largely determined by the yarn tension. With the conventional type of slub catchers, yarn tension played a major role in elimination of thin/weak places. This method posed its own problems for tension in excess of the required level adversely the yarn quality (loss of elongation). The extent of tension control of yarn in winding is dependent on the type of tensioner used. With the advent of newer types of tensioners and electronic clearers it has been possible to effectively control the yarn tension and thus maintain yarn quality.

2.5 Basic requirements of wound package

2.5 *a Warping*

Ideally in the case of direct/beam warping the yarn content in the package should be such that it reduces the creeling time to a minimum, and at the same time maintain uninterrupted production of the warping machine. Also the wound package should be able to unwind at high speeds of about 1000 m/min or even more. In order to get a package with high yarn content, a larger diameter with longer traverse length is necessary. This, however, imposes a higher tension on the yarn. The influence of the package diameter could be offset by increasing the package conicity or taper. A conicity of 5°57′ has been found to be suitable for knitting and pirn winding, and also for beam warping. Another advantage is that the problem of slough off is considerably reduced in the case of fine yarns. But in certain special applications a conicity of 4°20′ would be preferred. The main objective is that the end breakages at warping should be maintained at less than 1 per million meters of yarn.

2.5 *b Unconventional weaving*

Owing to the nature of weft insertion system in the different types of shuttleless weaving machines, serious constraints could be imposed on the wound package. A conicity of 4°20′ for cone or parallel cheese built on empty tube of 105 mm diameter would suit different types of yarns in all ranges of counts. The different systems of weft insertion in the case of shuttleless weaving machines would require a variety of combinations of traverse, conicity, and minimum diameter of core or cone shell to deal satisfactoily with a range of yarns of different frictional properties and linear densities.

The density of the wound package plays a crucial role and also large winding angles are unsuitable for shuttleless weaving machines. Winding drum with scroll turns of 2.5 is found to give the required package density and winding angle suitable for shuttleless weaving. Besides the package density and winding angle, yet another important aspect that needs consideration is the magazining efficiency. The magizining can be brought to nearly 100% by selection of appropriate magazining tail length. This could be possible on modern winding machines.

2.5 c *Knitting*

Unwinding of the wound yarn package at knitting does not present much of a problem. Earlier the package conicity of 9°15′was used in the knitting industry and this assisted in smooth functioning of the knitting elements. Nowadays, a conicity of 5°57′ (at empty package) with a full package conicity of 11° has become more popular in the knitting industry. This is attributed to the fact that there is massive slippage at the nose of 9°15′ cone during the initial stages of winding. It is necessary that wound packages to be used for knitting should be given waxing treatment. Proper care and caution is to be exercised during the waxing of yarns.

Chapter 3

TECHNICAL FEATURES OF A HIGH SPEED DRUM WINDING MACHINE

3.1 Introduction

In high speed winding the yarn is wound at a very high speed. The yarn used as supply package is in the form a ring bobbin or cop and this is converted in cones or cheeses weighing about 1.5 - 2 kgs. The winding speed may be about 1400 mpm. In general the high/super speed winding machines incorporate the following features.

a) Creel for holding supply packages
b) Thread guide and balloon breaker
c) Tensioner
d) Clearer or slub catcher
e) Winding drum
f) Bobbin cradle
g) Automatic thread stop motion
h) Full bobbin stop motion
i) Ribbon breaker or anti ribboning device
j) Driving arrangement

3.1 Supply creel

A creel or stand is fixed at the bottom of the machine in front and this accommodates ring cops which are used as supply packages. The capacity of the creel is equal to the number of winding drums in the machine. The creel carries holders in the form of pins or rods, upon which are mounted the ring cops. The supply packages (fig.3.1) are mounted such that unwinding of the yarn from them takes place from the nose portion (overhead unwinding).

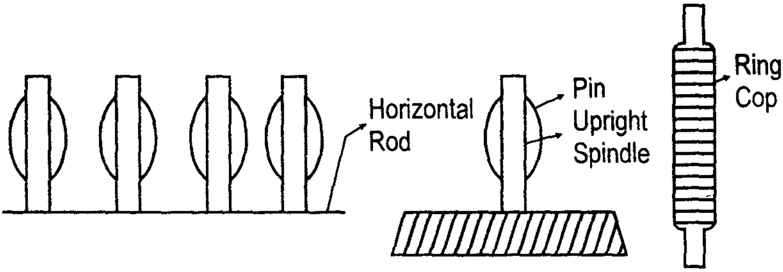


Figure 3.1 - Creel for holding supply packages

3.2 Thread guide and balloon breaker

The yarn after being unwound from the supply package is immediately made to pass through a metallic thread guide above it. The yarn passes to the other devices of the winding machine after passing through the thread guide. Different types of thread guides are used. Some of the well known ones are the roller guide, winding accelerator etc.

In the case of high/super speed winding machines, since the yarn is being unwound at high speeds, centrifugal tension is developed in the yarn. This causes the yarn to form a bulge, which is undesirable in two ways. Firstly this creates a great deal of tension in the unwound yarn and secondly a frictional force is developed between the surface of the unwound yarn and the supply package(ring cop). This causes abrasion at the yarn surface. Also there is a possibility of snarl or loop formation, when the yarn is unwound from the different parts of the supply package. All these result in yarn breakages leading to frequent stoppages of the machine.

The use of the balloon breaker obviates the aforementioned problems. The balloon breaker enables unwinding of the yarn from the supply package at very high speeds. Thus it prevents the damage to the yarn and thereby reducing the frequency of yarn breakages. In the absence of the balloon breaker the yarn will swing off completely from the upper portion of the ring cop in the form of a bow, while unwinding from the supply package (ring cop). The tension on the yarn is maintained at a constant level through out the build of the winding package, irrespective of the yarn being unwound from the base, middle or nose of the supply package.

A typical balloon breaker used on high/super speed winding machines is shown in figure 3.2.

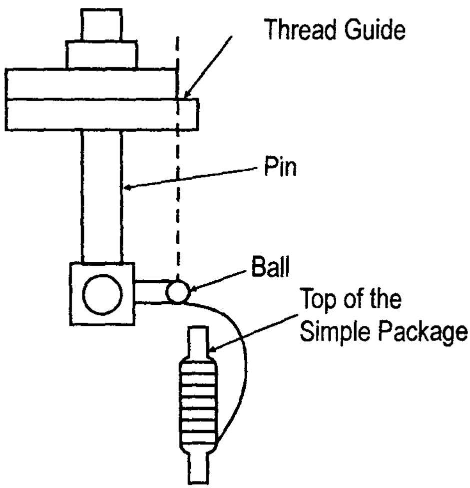


Figure 3.2 - Balloon breaker

As can be seen the yarn from the ring cop is made to pass through a small ball situated a little above the tip of the ring cop and below the thread guide. A pin is fitted on the supporting rod holding the ball in position.

With the commencement of the unwinding from the supply package, a balloon is formed between the point of unwinding and the thread guide due to the centrifugal force. However, with the use of the balloon breaker, the formation of the balloon will be broken due to the presence of the ball between the thread guide and the supply package. The unwound yarn turns around the ball, swings to and fro between the supply package and the supporting rod, thus preventing balloon formation.

Improved versions of the balloon breaker device are available. These may be in the form of circular, triangular and square tubes situated above the ring cop through which the yarn is threaded. Thus the use of the balloon breaker device improves the unwinding speed to a remarkable extent.

3.3 Tensioner

One of the most important aspect of winding is the control of the yarn tension. The tension device gives the required amount of tension to the yarn during winding. The tensioner serves a two fold purpose. Firstly it enables the weak place in the yarn to be removed and secondly it helps it controls the package density of the wound package and thereby ensures uniform density of the wound package. Besides, tensioners also help to remove the impurities adhering to the surface of the yarn.

The tension applied to the yarn during winding is almost uniform throughout the build of the wound package. It is least affected by the speed variations of the yarn, provided the tensioner functions properly.

There are different types of tensioners used in high/ super speed winding machines and they may be classified into the following categories :

i) Washer type tensioners
ii) Spinning disc or revolving type tensioners, &
iii) Gate or grid bar type tensioners.

3.3 a Washer type tensioner

In this type of tensioner (figure3.3.), two polished metal washers are held one over the other by a nut and spring. The yarn from the supply package passes between these washers and in the process is subjected to a tension due to the frictional resistance imparted to the yarn by the washer. Thus the weak places are cut off and are knotted/ spliced together again and the machine continues to run.

The level of yarn tension depends on the weight of the top washer. The heavier the top washer the greater is the yarn tension. The tension on the yarn may be increased or decreased by adding or removing more number of top washers. The washers are available in different colours and consist of holes. Using coloured washers, the amount of tension on the yarn can be varied according to the count and quality of the yarn. The tension obtained by this method is satisfactory for all practical purposes.

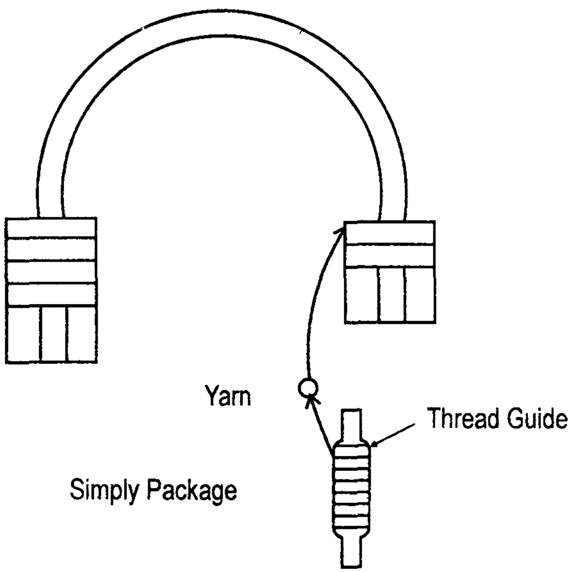


Figure 3.3 - Washer type tensioner

3.3 b Spinning disc or revolving type of tensioner

This type of tensioner consists of two highly polished metal cups placed one over the other and are mounted on a short spindle or shaft (figure3.4.). The two discs or cups are capable of revolving around their axis as the winding proceeds. The tension obtained is due to the frictional resistance imparted to the revolving cups by the yarn.

The tension to be given to the yarn depends upon the weight of the cups and varies with the count of the yarn. Heavier cups are used for coarser yarns while lighter cups are used for finer yarns.

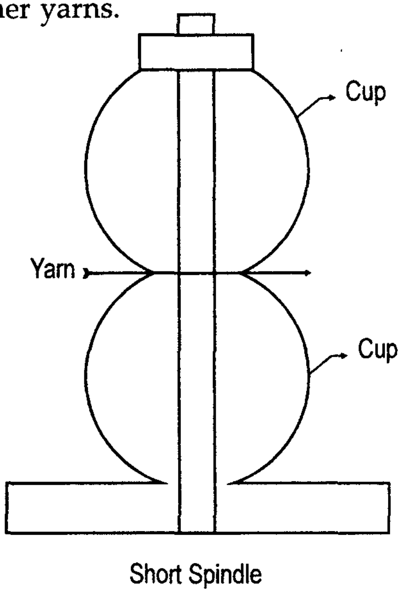


Figure 3.4 – Spinning disc tensioner

3.3 c Gate or grid bar type of tensioner

This type of tensioner (figure3.5.) usually consists of two vertical combs. One of these is stationery while the other is movable. The movable comb can be turned around its vertical axis. The yarn passes alternately to the right and left around the teeth on the stationery and movable combs respectively. The tension on the yarn can be increased or decreased by moving the movable combs farther or nearer to the stationery combs accordingly. This can be varied according to the requirements. A weight enables the distance to be adjusted.

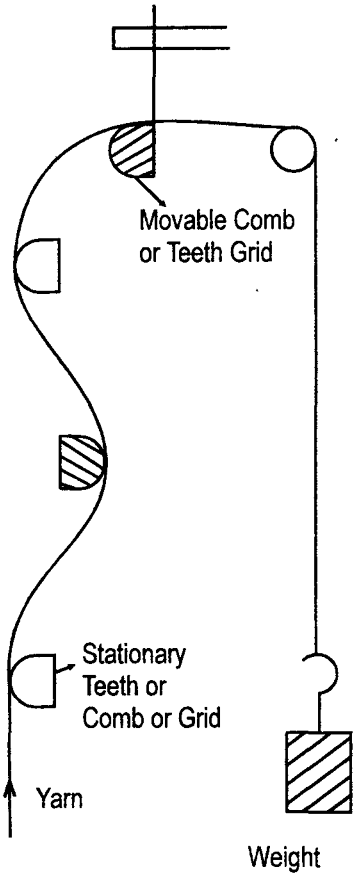


Figure 3.5 – Gate tensioner

3.3 d Factors governing choice of tensioners

A number of factors govern the choice of tensioning device. These are as follows:

a) It should be stable
b) It should not cause variations in twist
c) It must be capable of being easily threaded
d) It should be wear resistant
e) It should not cause tension variations
f) It should be dirt/stain free

g) It should be easily adjustable
i) It should enable easy cleaning
j) It must be economical
i) It should have a smooth surface

3.4 Guides

Yarn guides are necessary to control the yarn path during winding or unwinding. They are generally made of ceramic or steel material and are available in various shapes depending on the unwinding requirements. The yarn may unwind sideways or over end. In the former case, the unwinding may be smooth without any undue vibration. If, however, vibrations may be present or the unwinding is not smooth, yarn guides may be required to control the path of the yarn. In the latter case (over end unwinding) the yarn does not unwind along a fixed path but rotates. This rotation or circular motion of yarn is termed as 'ballooning'. The position of the yarn guide will influence the shape of the balloon, for a given size of package and yarn speed. It also influences the yarn tension. Hence the position of the yarn guide is an important aspect to be considered.

3.5 Slub catchers

These are also known as snick plates or yarn clearers. They are used to remove the yarn imperfections such as thick places, thin places and slubs. In case of conventional or mechanical type of clearers, thick places and slubs are removed and the tensioners remove the thin places. Thus in winding machines in which the conventional clearers are used the tensioners act partially as yarn clearers in that they remove the thin places. In case of modern clearers which are of the electronic type, the clearer removes all the three types of yarn imperfections and the tensioner only performs the function of ensuring compactness to the wound package. The details of the yarn clearers are discussed in subsequent chapter .

3.6 Winding drum

This is the most crucial part of the winding machine, on which the wound package is built. The winding drum performs the dual function of winding the yarn on to the package (cone or cheese) and traversing it longitudinally. Thus it builds the package diametrically and longitudinally. In other words it decides the dimensions of the full cheese or cone. The cylindrical drum consists of grooves cut helically on its circumference from one end to the other and vice versa. These grooves enable the yarn to be traversed. Thus the movement of the drum is described as 'rotary traverse'.

The drum supports and rotates the winding package the helical grooves in it traverse the yarn horizontally (right to left and vice versa) to the desired extent. It is possible to get parallel and conical winds on the packages by means of the drums. The design of the grooves, will, however, be different. In the case of the parallel winding the yarn is laid at an uniform rate from the cone base to tip, whereas in case of the conical winding the rate at which the yarn has to be laid is gradually reduced from the base of the cone to its tip.

The advantage of using the drum type of winding is that it requires no separate traversing mechanism and also it enables winding at high speeds without causing damage to the yarn.

The winding drum is normally made of bakelite and may be coated with chromium. It is mounted on a shaft usually made of iron and of a definite length. A number of such shafts are joined together across the width of the machine. The number of drums is decides the machine capacity. A winding machine may have drums on one or both sides. The shafts upon which the drums are mounted, are carried on ball bearings. This enables them to run at high speeds without generating frictional resistance. The diameter of the shaft is usually about 25 mm. The standard dimensions of a winding drum are 20 mm x 7.5 mm (dia. x length).

Each drum is driven by individual motors though the shafts upon which the drums are mounted. The motors have a special provision of breaking their cycle of rotation at regular intervals so as to alter the ratio between the rate of traverse and the rate of winding. This prevents patterning.

There are two types of drums used in winding machines. These are based upon the types of grooves and are as follows–

a) Intersecting type of grooves, and
b) Non intersecting type of grooves

In the drums with intersecting type of grooves (Fig.3.6), the grooves are cut from right to left side of the drum and intersect or cross one another. The grooves in this case are cut from one end to the other of the drum and have equal depth. Whereas in the case of the non intersecting type of grooved drums, the grooves are cut unequally from either sides of the drum. The grooves in this case do not intersect one another and also do not extend to the full width of the drum as in the former case.

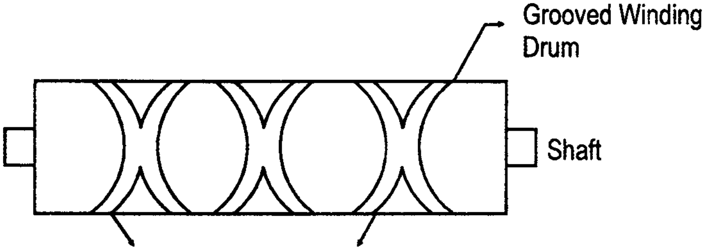


Figure 3.6 – Drum with intersecting grooves

The non intersecting grooved drums (Fig.3.7) have the advantage of eliminating the ribboning or patterning in the wound package. Hence no separate pattern breaking mechanism is required in this case. Whereas in the case of the intersecting grooved drums a separate anti patterning device is required to prevent pattern formation. Thus the non intersecting grooved drums permit winding to be carried out at higher speeds.

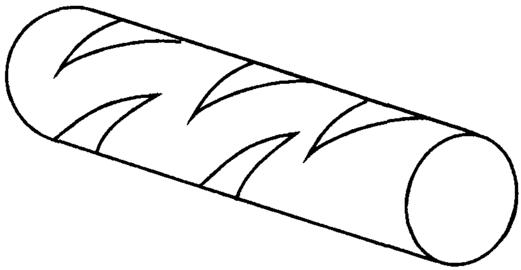


Figure 3.7 – Drum with non-intersecting grooves

3.7 Cone/cheese holder

This is also known as the bobbin cradle and acts as a support for the winding package which is in the form of a cone or cheese. The package is normally wound on metal or bakelite tubes or more commonly on paper cones. The bobbin cradle is a device that supports the wound package and enables it to be rotated at high speeds during winding. This device is connected to an automatic thread stop motion, which lifts the device off the winding drum in the event of thread breakage during winding. If the winding package is not lifted clear of the drum during a thread breakage, the broken end could possibly get embedded in the layers of the yarn in the package. This would make it difficult and time consuming for location of the broken end on the wound package. Also there is possibility of damage to the wound package. In the high speed winding machines, different types of arrangements are available for holding the cheeses or cones. The important types of cone/ cheese holders are

a) One arm cone holder

b) Two arm package cradle, and
c) Radial cheese holder

The one arm cone holder (Fig.3.8) can be used for building cones and runs on ball bearings with expanding rubber rings for plastic or paper cones of the following conicity : 3°30′, 4°20′, 5°57′, 9°57′. The cone shaped holder has a set of flat springs near its base in order to grip the card board or wooden cone from inside. It is used on Schweiter high speed cone winding machine.

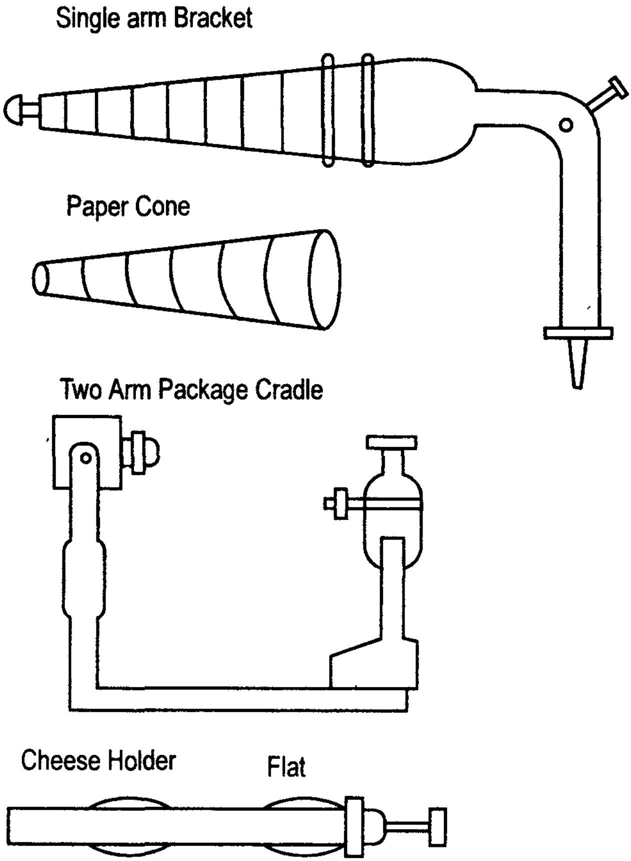


Figure 3.8 – Types of cone holders

The second type of the cradle is known as the two arm package cradle. It has pivots that rest in ball bearings and is used for conical paper cone, plastic cone, and wooden cone.

Another type of cheese holder consists mainly of two radial arms. The free ends of these arms hold the tube or cone. By the action of flat spring of the spindle, it grips firmly the inside of the tube or cone.

The radial arms are generally connected with the automatic thread stop motion and also with the automatic full bobbin stop motion. This type of bobbin cradle is used on schlafhorst high speed winding machine.

In all the above types of bobbin cradle, there is a knob attached to one of the arms of the bracket which enables the operative to put the cone out of or into contact with the winding drum for the purpose of doffing or restarting the machine. Some amount of pressure is exerted on the cone during its build up.

In order to effect a slow and gradual start, the cone holder is attached to a plunger through the holder cradle. The plunger dips in an oil bath. The arrangement prevents contact with the winding drum with the cone all of a sudden during restarting, as other wise it will cause unnecessary end breakages and increase the winder's work and reduce the output of the machine.

3.8 Automatic broken thread stop motion

Since the wound packages rotate at high speeds, it is necessary that stop devices be provided to stop winding in the event of thread breakage or exhaustion of supply package during winding. The stop motion should be able to immediately lift the particular cheese or cone out of contact with the winding drum in such an event.

If the cone or cheese is allowed to run on the winding drum, after thread breakage, the end of the broken thread will be embedded and lost in the layers of yarn on the packages. This would render it difficult for the winder to locate the broken end on the cone. Also the production of the particular cone will be affected due to the delay in locating and mending the embedded broken end. Further, the yarn on the cone will be damaged due to the same layer of yarn being constantly rubbed against the winding drum at such a high speed for that period.

The stop mechanism is operated through a cam that is carried on a cam shaft. The cam shaft extends though out the width of the machine. A cam is provided for each winding drum so as to actuate the broken thread stop motion.

An L shaped lever is housed and fulcrummed in the main lever. A cam roller or follower is fixed at the other end of the L shaped lifting lever. This follower is constantly in contact with the cam. The cam gives reciprocating motion to the L shaped lifting lever. A stop wire is connected to the stopping hook.

The yarn is usually threaded in such a way that it supports the stop wire under normal running conditions of the winding machine. Thus the stop wire is lifted when the yarn is under tension and the stopping hook is away from the lifting lever (under normal running conditions). The stopping hook is also connected to the main lever, so that in the event of a thread breakage, the stop wire loses its support and drops down and the stopping hook comes in the path of the lifting lever. The force given by the cam to the lifting lever is now utilised to lift the stopping hook and the lifting lever. The pawl of the lifting lever pushes away the ratchet bar from its position.

The ratchet bar is connected to the cone holder and the cone holder is also lifted up and the cone is made to lift away from the contact of the winding drum. Hence the winding stops.

To bring back the cone to the winding position on to the winding drum, the starting handle is used and lifted, then the top part of the starting handle slightly lifts the ratchet bar away from the pawl and the ratchet bar slips on the pawl. The cone comes in contact with the winding drum due to the weight of the cone holder.

3.9 Full package stop motion

As soon as the wound package has reached the preset or predetermined size, the full package stop motion automatically lifts it out of contact with the winding drum or shaft. This is necessary to obtain equal length of yarn on all the cones or cheeses of the particular set or lot as otherwise it causes problems in warping due to different cones in the warping creel exhausting at different times. The warping machine production and efficiency is adversely affected in such a case. Further, in the case of cheeses which are to be dyed in that form, it is necessary to have all the cheeses of particular size according to the spacing of the spindle which holds them in the cheese dyeing machine.

Instead of providing automatic stop motion some machines have diameter indicators which enable the winder in doffing packages of uniform diameter. Certain machines have a yarn length counter which measures the length of yarn by the number of drum rotations. Therefore the yarn length to be wound on a package can preset by the counter. This counter is coupled with the electric yarn break detector which checks the running yarn. The counter registers only the actual yarn being wound on to the package. Drum revolutions after a yarn break are not counted. Each counter controls 10 spindles. Therefore packages of 5 different kinds of yarn length can be wound at a time on one machine.

3.10 Ribbon breakers

These are also variously known as pattern breakers or anti-ribboning devices. The patterning is a defect that occurs during winding. Ribbons or patterns are formed when each additional layer of yarn is laid exactly in the same position of the previous layer on cone or cheese during winding. The pattern or ribbon so formed, is, however, neither visible to the naked eye nor has any adverse effect on the subsequent process for which the cone or cheese is intended. Also it will not be possible to obtain uniform dyeing or bleaching, since the flow and penetration of dye or bleach liquor will be adversely affected by the yarn where the ribbon is formed. It is therefore essential that the formation of ribbon has to be eliminated. There are three methods for doing this :

Method based on changing the speed of the winding drum

Method based on lifting intermittently the winding package from the winding drum

Method based on the use of non-intersecting grooves

3.10a Method based on changing the speed of the winding drum

The above anti-ribboning device in the high speed cone winding machine is electrical type. Here the speed of the winding drum is changed 40 times/minute by closing and opening of the electrical circuit of the driving motor (main motor) intermittently with the help of a special cam arrangement as shown in the figure. This method is very effective to prevent the ribbon formation and is widely used. Anti-ribboning device consists of main parts as a pilot motor, a cam, movable knob and fixed knob which is connected to the driving motor.

A typical device of this type is shown in fig.3.9 below

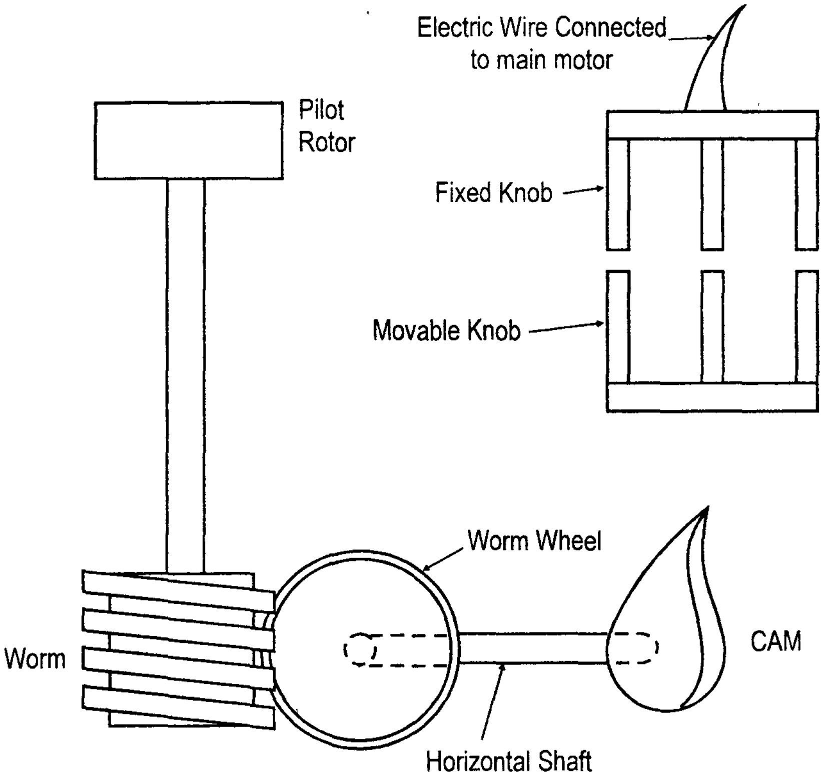


Figure 3.9 – Method of changing speed of winding drum

First the drive to the cam is given by the pilot motor through a worm and worm wheel gearing arrangement. The revolving motion of the cam is used to impart up and downward motion to a movable knob in order to make the movable knob in contact with the fixed knob during its upward movement. Thus, this type of intermittent contact between the movable knob and fixed knob with the help of the cam arrangement is helpful for closing and opening the electrical circuit of the driving motor. Thus this method of changing the speed of the winding drum helps in preventing the ribbon formation in the high speed cone winding machine. This method of breaking ribbons is applied on machine like Leesona, Rotoconer, Texmagg, Autoconer, Sachlafhorst, etc.

3.10 b Method based on lifting intermittently the winding package from the winding drum

In this method, the winding package is imparted a slight tilting movement intermittently. The slippage between the winding package and the drum, therefore vary constantly in relation to speed of the package to that of the drum and break the continuity of the cycle of winding. As a result no ribbon could be formed. This method works satisfactorily, but very frequent lifting of the winding package may tend to wear the moving parts. The power consumption is also more.

3.10 c Method based on the use of non-intersecting grooves

In this case the grooves are cut on the surface of the winding drum from the left to right and back again. But do not intersect at the crossing point. The grooves also terminate at points about one inch from turning corners of traverse on both ends. The depth of the two way grooves are also not equal.

The object of this is to facilitate the required amount of slippage between the winding package and the drag in order to break the continuity of the cycle of winding and thereby preventing formation of patterning.

This method eliminates unnecessary consumption of power or wearing of any parts of the machine.

3.11 Driving arrangement

The winding machine s are usually driven from individual motors, which transmits motion to the winding shaft through either reduction gears or three stage pulleys. Each side of the machine may have a separate motor, so that one may run independently of the other.. Push button control may be provided at one of the ends of the machine to start or stop. The individual motors are usually three phase motors provided with automatic arrangement for breaking the circuit at regular intervals in order to alter the periodicity. A three stage pulley enables speed variations to be made according to the type of material worked without the necessity of altering any gearing.

Chapter 4

PRECISION WINDERS

4.1 Introduction

The precision winders are also known as non contact type of winders. Unlike the drum winders where the drive is negative, in the case of precision winders, the drive is positive. The yarn is traversed across the width of the package by means of a reciprocating yarn traverse guide that is cam driven. A precise ratio is maintained between the spindle speed and the traverse speed. Hence the angle of wind decreases with increase in the size of package. These winders are available in different types, which are discussed in this chapter. Many precision winders have attachments for yarn lubrication and provision to produce different cone shapes. Certain machines are equipped with yarn overfeed devices to produce soft packages when required.

Precision winders have the following advantages over random or cross winding machines:

i) a higher and more uniform package density
ii) No patterning zones
iii) Outstanding winding-off performance
iv) Stable package build-up benefits further processing and facilitates high rewinding speeds
v) Precision winding with soft edges

4.2 Types of precision winders

The following are the types of precision winders:

a) Winders with constant spindle speed
b) Winders with constant surface speed
c) Winders with combination of both a & b.

4.2 a Constant spindle speed winders

In these types of machines, yarn speed is variable, resulting in increase of yarn tension and package density in the outer layers. Hence a means of tension compensation is necessary. The increase in yarn speed with size of the package, is, however, advantageous as it gives higher production.

4.2 b Constant surface speed winders

In these types of machines, the spindle speed decreases progressively at a rate that is determined by the count of the yarn being used.

4.2 c Combination type of winders

These machines combine both the above mentioned principles, namely, constant spindle speed and constant surface speed. The winding package is initially rotated until the yarn speed attains the necessary maximum level. The yarn speed then remains constant. The advantage of these machines is that the production rate is increased without utilising excessive spindle or yarn speeds.

4.3 Description of a precision winder

The main feature of precision winder is the spindle in which the package is mounted and it directly gets drive. The precision winder is one, in which there is a constant ratio between the speed of the spindle which carries the package being wound and the speed of the traversing mechanism.

This winder has the capacity for winding almost all types of yarn such as cotton, rayon, synthetic, spun rayon, linen etc. Besides, fineness and quality of the yarns do not offer any difficulty in winding on this machine. Even fine denier nylon can be wound on it without any practical difficulty. The types of wind that can be produced on this machine are close and open wind. The number of winds obtainable ranges from 40mm to 100 mm.

The passage of material through the important parts of the machine is shown in the figure 4.1.

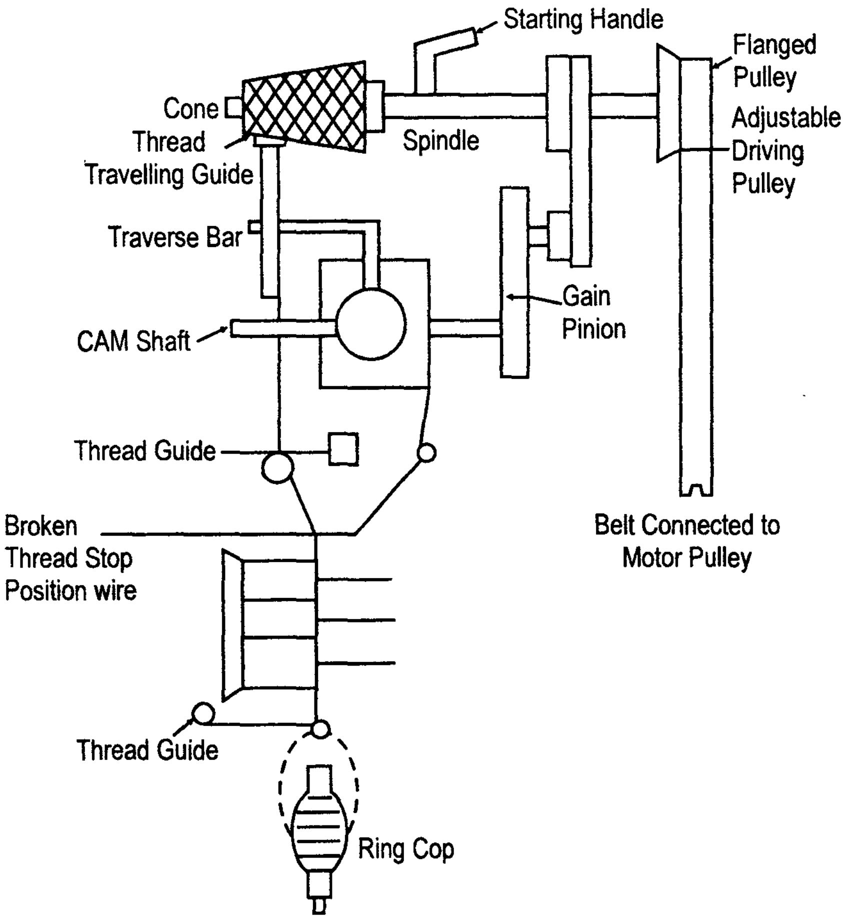


Figure 4.1 – Passage of yarn through a precision winder

The yarn from the supply package passes through the thread guide and on the gate type of tensioner. The tension of the running yarn is easily adjustable to suit the requirements. The machine is provided with a thread stop motion which stops it in the event of a yarn breakage or exhaustion of supply package. The yarn then passes to a traversing guide. The traverse guide consists of a steel roller plated with chromium, which is a hard metal. As such, it will prevent wear to a very great extent. The traverse bar to which the guide is attached, makes to and fro movement through a guide provided with self oiling arrangement. The important parts of the traverse motion are fully enclosed to prevent accumulation of dust and dirt which may affect its correct functioning. The cam is fully enclosed in an oil box to keep it lubricated all the time by the splash of the oil. The setting of the dog segment permits fine adjustments. The winding pressure can also be regulated with precision according to requirements. The tapering of the cone can be regulated to the desired extent by means of an indicator device provided on the machine. The winding speed of the machine can be adjusted from 200 to 400 meters/minute to suit yarns of different qualities and counts

For cotton the yarn speed is 400 m/min

For spun rayon the yarn speed is 400 m/min

For nylon the yarn speed is 350 m/min

The spindles are located in horizontal position and get their drive from the motor. The spindle rotates at a constant speed and hence the package will increase in diameter, so the yarn tension will also increase, which in turn will increase the elasticity of the yarn. To avoid this defect the tension of the yarn is reduced and the diameter of the package is increased.

The various arrangements described above enable the machine to wind yarns with different characteristics. Although it is specially designed for producing delicate man made fibres like nylon, terylene etc., the machine can be employed for fine cotton yarns where the conditions are favourable for its use.

4.4 Differences between precision and drum winding machines

The following are the important differences between drum and precision winders:

	Precision winders	Drum winders
1.	The winding package is directly driven by spindles.	The winding package is driven by surface contact with the drum
2.	As the diameter of the package increases its surface speed increases.	The surface speed remains constant irrespective of the diameter of the package.
3.	The number of winds does not change at any diameter of the package.	As the package increases in Diameter, the number of winds decreases.
4.	The angle of wind decreases as the package diameter of the package increases.	The angle of wind remains constant from initial package to full package.
5.	These winders are used to produce packages with closed wind.	These winders are used to produce package with open wind.

4.5 Prerequssites for obtaining assembley wound and dyehouse packages at high efficiency

In the recent times, there is a greater demand for dye package preparation in our country. The choice of a propeller or a yarn guide winding system does not have an influence on the most important part in dyeing which is the even density throughout the dye package. The choice for propeller or yarn guide is more influenced by the yarn type (cotton or filament) and yarn count and with cotton yarn whether grey or gassed yarn is used.

The winding density is the specific package weight in g/dm^3. The calculation is shown in Fig.4.2. In the dye package it is influenced by following parameters:

- Winding ratio (distance between the winding yarn layers)
- Yarn tension (yarn path, yarn speed)
- Contact pressure (back pressure)
- Moisture or lubrication (waxing, oiling) of the yarn

So in order to achieve the optimum dye package one should take proper influence on all the above mentioned variable parameters

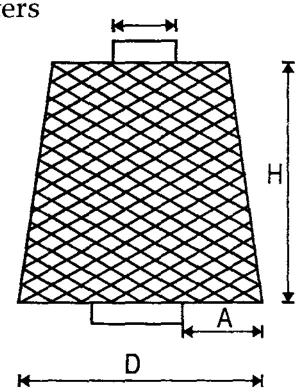


Figure 4.2 - Calculation of winding density

$$\text{Winding density} = \frac{G}{V} \; [g/dm^3]$$

Weight G = net weight [g]

= (package weight - empty tube weight)

$$\text{Volume V} = \frac{D+d}{2} \times 3.14 \times H \times A \; [dm^3]$$

A coarse and limited adjustment of the winding ratio is possible on precision winders having a common drive motor for propeller (blades) and package (see fig.4.3) means by changing the gears of the drive transmission on every spindle. The downside here is the proper stock keeping of the right gears and the required time for the changeover, which practically takes too long.

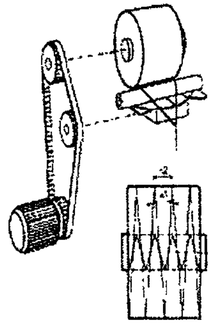


Figure 4.3 - Drive for propeller

Also due to the common drive the speed of the machine is limited. The better solution is a precision winder with independent drive for propeller and package, which allows the infinitely and precise package adjustment of the winding ratio from the machine terminal itself, either for each spindle individually or comfortably for the whole machine. The option for the precise setting of the winding ratio will also allow for a higher unwinding speed of the dyed package.

Winding ratio

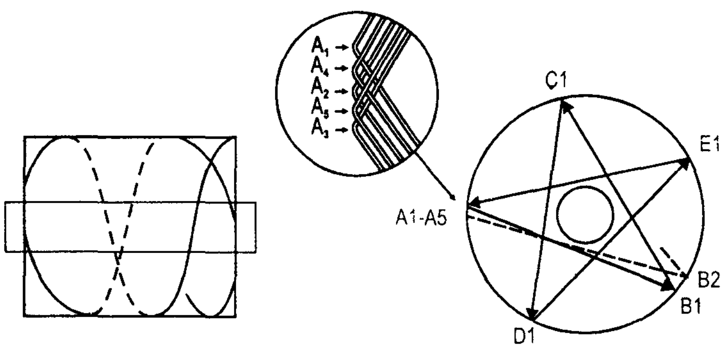


Figure 4.4 - Relationship between package rotation and propeller blade movement

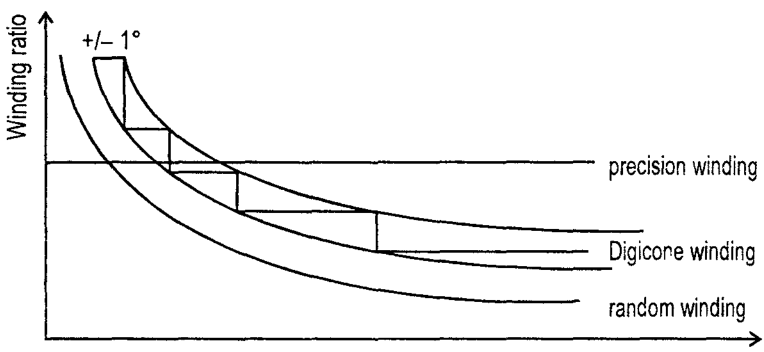
This important winding parameter defines the relationship between the package rotation and the propeller blade movement (Fig. 4.4)

Example : Winding ratio of 5.291

The digit in front of the point (5.xxx) has a considerable influence on the winding angle of the thread spirals and the maximum possible unwinding speed.

The first digit after the point(x.2xx) determines the crossing characters. On packages with high unwinding speeds the thread reversal points (A1-A5, B,C,D,E) must be as far apart as possible. Ideal crossing values are 4 & 6.

Using a machine with independent drive for propeller and package will provide an option for a further increase in homogeneity of the dye package by having the choice between precision winding and step precision winding or Digicone winding.



Here the package build- up is in layers, with each layer as precision winding. In certain time intervals the winding ratio is changed, so the crossing angle only changes slightly within a narrow range. To produce a high quality dye package this looks to be the optimum choice.

Chapter 5

KNOTTING AND SPLICING

5.1 Introduction

The principal objective of 'spinning', i.e., making a yarn out of a bunch of fibers is achieved as and when a cop is produced at the ring spinning process. The winding process serves to achieve additional objectives made necessary by the requirements of the subsequent processing stages.

The length of yarn in a ring bobbin is not adequate to run the warping process efficiently i.e., the warping machine has to stop frequently to change the cop in the creel. For efficient warping, long continuous lengths of yarn of the order of fifty thousand meters or more are required. The winding process therefore has the basic function of obtaining a larger package from several ring bobbins. This conversion process provides one with the possibility of cutting out unwanted and problematic objectionable faults. The process of removing such objectionable faults is called as yarn clearing.

It is important to note that, when such objectionable faults are cut out, to maintain continuity of the yarn in the wound package, the two ends have to be joined together by knotting or other means just as we join ends when a ring bobbin is exhausted. The quality of the knot is also important in terms of the performance of the yarn in subsequent processing stages. Of late, splicing of yarn ends has become quite popular and is gradually replacing knotting by way of its better appearance while at the same time retaining sufficient strength.

The efficiency with which the efficiency of yarn knotting and splicing are carried out, therefore, decides the success of deciding the objectives of the winding process.

5.2 Knotting

There are two main purposes of introducing knots during winding of yarns: Continuity knots, for continuity of the yarn and clearing knots to substitute the yarn faults during the yarn clearing. Continuity knots determined by the ring bobbin capacity are inevitable and these must go into the fabric. The introduction of a knot for clearing purposes, however,, is decided based on the end use and productivity considerations.

The cost of elimination, along with the cost of proportional failures in the fabric production machinery increases linearly with each knot inserted. It is therefore necessary to know the incidence of disturbing faults in the yarn before wasting time in applying clearing limits to a yarn. The comparison of parent and cleared yarn by the Classimat system will help in producing the required yarn and fabric quality at economical product cost.

A knot should satisfy the following requirements for efficient usage in textile industry:

a) be easy to tie,
b) have good resistance to slippage, and
c) be of a shape and size that gives it little chance of catching or jamming in the narrow openings, i.e. every knot must support the full weaving stress as it makes the journey from warp beam to cloth fell.

It is unfortunate that with just one of the commonly used knots (fig.5.1) it is difficult to meet all the above requirements satisfactorily. The tying of dog knot is simple and quick, but it is bulkier than weaver's or fishermen's knot. It is only suitable for creeling and these knots will not be incorporated into fabrics. Fishermen's knots are most popular but it is not at all convenient to tie by hand. They have a diameter 3 – 4 times that of the parent yarn and are popular for filaments, cottons, woollens, worsteds and blends.

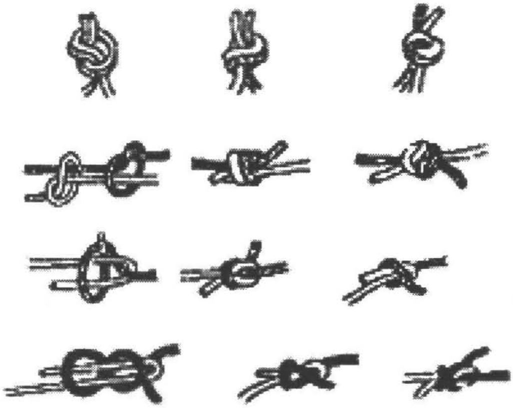


Fig.5.1 Types of yarn knots

Weaver's knots are most popular in the cotton industry and to some extent in worsted industry. The diameter of weaver's knot is 2 to 3 times that of the parent yarn. The weaver's knot may be single or double depending upon slippage property of yarn. It has been observed that the fisherman's knot, weaver's knot and dog knot rank in the decreasing order of resistance to slippage. These knots can be tied by hand or hand knotter or automatic mechanical knotter. Use of mechanical knotters also offers other advantages like uniformity of knot size and tail ends.

5.3 Factors determining the quality of knot

5.3 a Resistance to slippage

Most of the knot failures in down stream process is due to slippage only. Degree of slippage depends on fibre type, blend composition, yarn linear density, twist, number of ply and flexural rigidity etc.

5.3 b Size of the knot

A bigger knot causes serious obstruction as it passes through small path like heald eye, reed dent and knitting needle etc. It leads to uneven tension and results in end breakage in the process.

5.3 c Knot tail ends

In the practical weaving situation, initial knot tail lengths are commonly of a length where slippage to failure is dominated by one path i.e. by changing configuration. The tail length should basically be judged from the linear density and flexural rigidity. For yarn with lower linear density or lower flexural rigidity (or both), failure of knot begins at shorter initial tail lengths, and vice versa for yarns with greater linear density and flexural rigidity. The tail length should be about 5 - 10 mm in a weaver's knot and about 6 - 12 mm in a weaver's knot depending on knot slippage resistance.

Direction of tail also plays important role in knitting. Investigations have shown that under every knitting condition the end breakage due to a fisherman's knot is always more than that due to a weaver's knot. In weaver's knot both tails point in the same direction, whereas in the fisherman's knot the direction of the tails are opposite to each other. In a practical situation the thickness of a weaver's knot is that of the knot itself whereas the thickness of a fisherman's knot is the sum of the diameter of the yarn and the knot.

5.4 Splicing

A high degree of yarn quality is impossible through knot, as the knot itself is objectionable due to its physical dimension, appearance and problems during downstream processes. The knots are responsible for 30 to 60% of stoppages in weaving.

Splicing is the ultimate method to eliminate yarn faults and problems of knots and piecing. It is universally acceptable and functionally reliable. This is in spite of the fact that the tensile strength of the yarn with knot is superior to that of the yarn with splice.

Splicing is a technique of joining two yarn ends by intermingling the constituent fibres so that the joint is not significantly different in appearance and mechanical properties with respect to the parent yarn. The effectiveness of splicing is primarily dependent on the tensile strength and physical appearance.

Splicing satisfies the demand for knot free yarn joining: no thickening of the thread or only slight increase in its normal diameter (Fig. 5.2), no great mass variation, visibly unobjectionable, no mechanical obstruction, high breaking strength close to that of the basic yarn under static and dynamic loading, almost equal elasticity in the joint and basic yarn. No extraneous material is used and hence the dye affinity is unchanged at the joint. In addition, splicing enables a higher degree of yarn clearing to be obtained on the electronic yarn clearer.

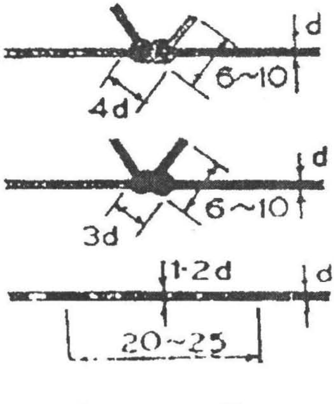


Figure 5.2 Relative size of knots and splice

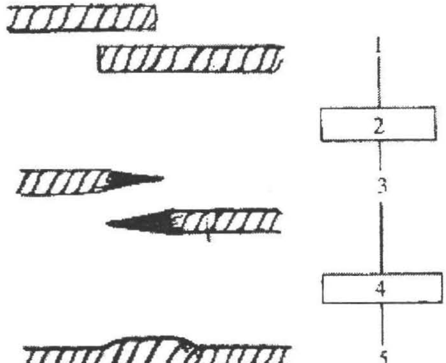
Splicing technology has grown so rapidly in the recent past that automatic knotters on modern high speed winding machine are a thing of the past. Many techniques for splicing have been developed such as electrostatic splicing, mechanical splicing and pneumatic splicing. Among them, pneumatic splicing is the most popular. Other methods have inherent drawbacks like limited fields of application, high cost of manufacturing, maintenance and operations, improper structure and properties of yarn produced.

5.5 Pneumatic splicing

The first generation of splicing systems operated with just one stage without proceeding to trimming. The yarn ends were fed into the splicing chamber and pieced together in one operation. Short fibres, highly twisted and fine yarns could not be joined satisfactorily with such method. Latest methods of splicing process consist of two operations. During the first stage, the ends are untwisted, to achieve a near parallel arrangement of fibers. In a second operation the prepared ends are laid and twisted together.

5.6 Principle of Pneumatic splicing

The splicing consists of untwisting and later retwisting two yarn ends using air blast, i.e., first the yarn is opened,



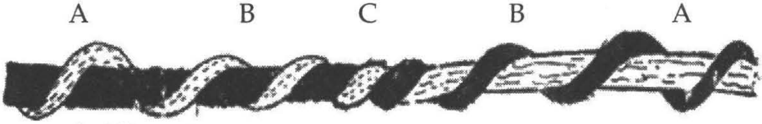
1 Cut Thread Ends
2 Preparation
3 Opened Thread Ends
4 Vortexing
5 Splice

Figure 5.3 Splicing operations

the fibres intermingled and later twisted in the same direction as that of the parent yarn. Splicing proceeds in two stages with two different air blasts of different intensity. The first air blast untwists and causes opening of the free ends. The untwisted fibres are then intermingled and twisted in the same direction as that of parent yarn by another air blast (Fig. 5.3)

5.7 Structure of splice

Analysis of the longitudinal and transverse sections revealed that the structure of the splice comprises of three distinct regions/elements brought by wrapping, twisting and tucking/intermingling. These are explained in detail below with reference to Fig. 5.4.



A. Wrapping
B. Twising
C. Tucking/Intermingling

Figure 5.4 Structure of splice

5.7a Wrapping

The tail end of each yarn strand is tapered and terminates with few fibres. The tail end makes a good wrapping of several turns and thus prevents fraying of the splice. The fibres of the twisting yarn embrace the body of the yarn and thus acts as a belt. This in turn gives appearance to the splice.

5.7b Twisting

The two yarn ends comprising the splice are twisted around the body of the yarn, each yarn strand twists on the body of the yarn on either side of the middle of the splice. The cross section of this region distinctly shows the fibres of the two yarn strands separately without any intermingling of the fibres.

5.7 c Tucking / intermingling

The middle portion of the splice is a region (2-5 mm) with no distinct order. The fibres from each yarn end intermingle in this splice zone just by tucking.

The studies on quantitative contribution of splice elements showed that intermingling/tucking contributes the most to the strength of splice (52%) followed by twisting (33%) and wrapping (about 15%). The lower strength of the splice is attributed to the lower packing coefficient of the splice zone.

Spliced yarn has a lower breaking elongation than normal yarn. Breaking elongation is mainly affected by intermingling. Wrapping and twisting provides mainly transverse forces. The absence of fibre migration gives lower breaking elongation to splice.

5.8 Effect of variables on the properties of the spliced yarn

Several studies have been conducted on the effect of various variables on the properties of spliced yarn.

5.8 a Effect of fibre properties and blend

Fibre properties such as torsional rigidity, breaking twist angle and coefficient of friction affect splice strength and appearance. The lower torsional rigidity and higher breaking twist angle permit better fibre intermingling. Higher coefficient of friction of fibres generates more inter fibre friction to give a more cohesive yarn. Thus, these properties of fibre contribute to better retention of splice strength. In blended yarn, usually the addition of polyester to other fibre blend like P/W, P/C both for ring and rotor spun yarn increases splice strength.

5.8 b Effect of yarn fineness

Several studies on cotton, polyester and wool have shown that coarser yarns have higher breaking strength but a moderate extension. The coarse yarn section contains more fibres and provides better fibre intermingling during pre-opening, hence the splice is stronger than that of finer yarns.

5.8 c Effect of yarn twist

An increase in the twist significantly increases the breaking load and elongation, even at higher pneumatic pressure. This could be due to better opening of the strands at higher pneumatic pressure. Splicing of twisted ply yarn is more complicated than single yarn due to the yarn structure having opposing twists in the single and doubled yarns. Twisted yarns also require a relatively longer time for complete opening of the yarn ends.

5.8 d Effect of different spinning methods

Yarn produced with different spinning methods exhibit different structure and properties. Therefore, these yarns show significant differences in the splice quality. The ring spun yarn lent best splicing but the potential of splicing is affected by the spinning conditions. The breaking strength percentage of ring spliced yarns to a parent yarn is 70 - 85% for cotton yarn. However, the breaking strength and extension of splice vary with fibre and yarn properties.

Rotor spun yarns, due to the presence of wrapper fibres, make it difficult to untwist and the disordered structure is less ideal for splicing. The breaking strength retention varies from 54% - 71% and is much lower compared to the splice of ring spun yarns. In case of friction spun yarns, the highest relative tensile strength obtained at the spliced joints can be above 80, but a number of splicing failures occurs due to unfavourable yarn structure.

The air jet spun yarn and the cover spun yarn are virtually impossible to splice. Only very low tensile strengths and elongation values can be attained due to the inadequate opening of the yarn ends during preparation of the splicing.

The coefficient of variation of these properties is also generally high.

5.8 e Effect of opening pressure

Studies on 25 tex, 50/50 polyester cotton ring spun yarn shows a rise in tensile strength upto a certain opening pressure. However, long opening time deteriorates the strength. An increase in pressure upto 5 bar caused release of fibre tufts and fibre loss from the yarn ends in P/C blend which is due to intensive opening, but beyond this pressure, drafting and twisting in opposite direction may also occur.

5.8 f Effect of splicing duration

With a given splicing length, when the splicing is extended for a long period of time, the breaking strength of the spliced yarn and also their strength retention over the normal value of the basic yarn increases because of increased cohesive force resulting from an increased number of wrapping coils in a given length. The effects are more pronounced at higher splicing lengths. It is desirable however, that splicing duration be as short as possible. The splicing duration alone has no conclusive effect on elongation properties of splice yarn. It has also been observed that, for maximum splice strength, different materials require different durations of blast. These are between 0.5 - 1.8 seconds.

5.8 g Effect of splicing length

Studies on splicing of flyer and wrap spun yarns spun with different materials, showed that regardless of the splicing material, the breaking strength and strength retention of both yarn types increase with splicing length because of the increased binding length of the two yarn ends. Elongation at break and retention of elongation of both flyer and wrap spun spliced yarns increase with the splice length. Compared with the splicing duration, the splicing length has more pronounced effect on the load elongation properties of the spliced yarn. It can therefore be stated that the splices made on longer lengths and for longer period of time have more uniform strength.

5.8 h Effect of type of splicing

The comparative studies on dry and wet splicing with water showed that the breaking load retention for wet spliced yarns are significantly greater than dry spliced yarns. In fact, wet splicing is more effective for yarn made from long staple fibres and for coarse yarn. This may be due to higher packing coefficient resulting from wet splicing.

5.8 i Effect of splicing chamber

The factors like method and mode of air supply and pressure along with type of prism affect the splicing quality. It was observed that irregular air pressure has advantages over constant pressure for better intermingling in the splicing chamber, which varies with different staple fibers, filament yarns, and yarns with S and Z twists. It is not possible to make a general comment regarding potential of the splicing chamber due to the multiplicity of factors influencing splicing.

5.9 Assessment of yarn splice quality

The two important characteristics of a splice are appearance and strength. Figure 5.5 shows the schematic diagram of a good and poor splice joint.

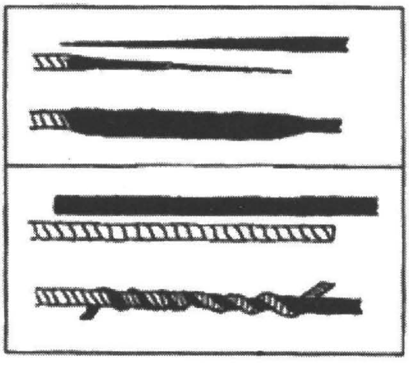


Figure 5.5 Appearance of good and poor splices

Although quality of splice can be assesses by methods like load elongation, work of rupture, % increase in diameter and evaluation of its performance in down stream processes etc., the appearance can be assessed either by simple visual assessment or by comparing with photograph of standard splice.

ATIRA has developed two sets of standards: one for the appearance - SAG (Splice Appearance Grades) and the other for strength - RSS (Retained splice strength) for judging the quality of a splice. Similar to yarn appearance grade boards, the appearance of a splice is also rated on a numerical scale by developing fiducial standards. These sets of boards contain splices of grades 1 to 7 according to its appearance. This rating of splice is referred as Splice Appearance Grade (SAG).

Retained splice strength (RSS) is the strength of splice, expressed relative to parent yarn strength and it gives an idea of proportion of parent yarn strength retained by the yarn after splicing. Splice breaking ratio (SBR) is introduced to characterise a splice for its RSS. The SBR is computed by expressing the number of breaks in the splice zone (splice $\pm$ 10 mm) as a percentage of the total tests. For computing SBR, the only thing required is to know if a spliced yarn has broken in the spliced zone or else where. It is noted that the lower the SBR, higher is the RSS, and better is the splicing quality. A splice with 40 SBR or lower can be considered as a good quality splice.

Thus the various possibilities available in the processes of knotting and splicing enables a spinner to provide just the yarn quality desired by the buyers at optimum cost for himself.

YARN CLEARING

6.1 Introduction

Yarn clearing is a crucial aspect in winding. The yarn faults such as thick places, thin places, and slubs are removed by clearers (slub catchers/snick plates). The conventional clearers are only able to remove the thick places and slubs and obviously require tensioner to remove the thin places. The modern electronic clearers are able to remove even the thin places and are thus much more efficient than their conventional counterparts. The different types of clearers, both conventional and the modern are discussed in this chapter.

6.2 Types of clearers

The yarn clearers in winding are of the following types :

Mechanical type

a) *Conventional fixed blade*
   Serrated blade

b) Electronic type
   Capacitance principle
   Photo electric principle

6.3 Mechanical type slub catcher

6.3 a Conventional fixed blade

One of the old type of clearers consists of a metal slit through which the yarn passes from the tensioner (Fig.6.1). Any imperfections in the yarn as mentioned above will be prevented from passing onward to the cheese or cone by this clearer. This type of clearer is nowadays rarely used on a high speed winding machine.

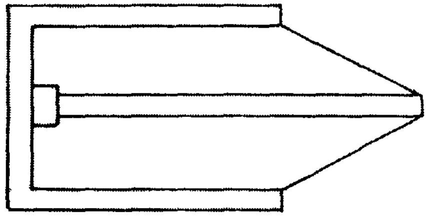


fig. 6.1 Conventional fixed blade

6.3 b Serrated closing blade

The most widely used form of slub catcher is the serrated blade type (Fig.6.2). The yarn is passed under the teeth of a serrated blade which arrests any imperfections such as big knots, snarls etc., present in the yarn and does not allow the yarn to pass through until these imperfections are corrected. The yarn instead of passing under one blade may be drawn between a pair of serrated blades to get more efficient result.

Adjustment of the space between the blades of the slub catcher can be made to suit yarns of different counts and qualities. When more efficient or severe action in removing big slubs and knots etc., are required, double slub catchers which have escaped the first slub catcher will be arrested by the second set.

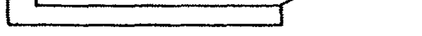


Figure 6.2 – Serrated blade type slub catcher

6.4 Electronic yarn clearer

6.4 a Capacitance type

In the electronic slub catcher, the measuring condenser is used for detecting the mass variations in the yarn. In this device (Fig. 6.3), the yarn during winding passes freely through the measuring condenser and detects a slub. The cutting arrangements are alerted. The cutting knife which is actuated by an electromagnet immediately cuts the yarn at that point.

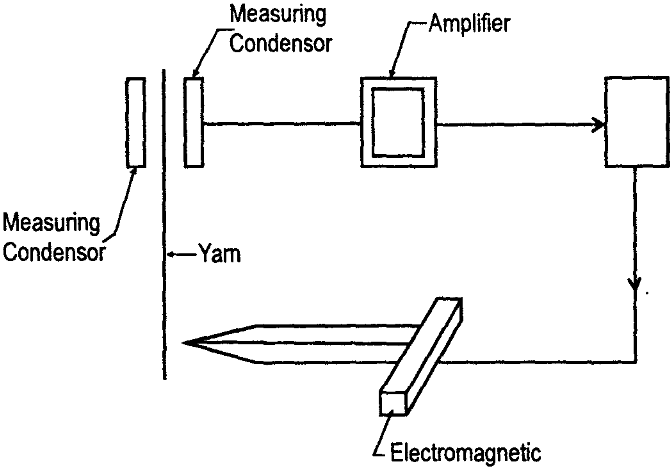


Figure 6.3 - Capacitance type electronic slub catcher

The slub which was arrested between the condenser and the cutting knife will be now removed and both ends of the yarn will be tied together by the knotting machine for winding to continue. The measuring condenser is very sensitive and efficient. The slub catcher can be adjusted to suit yarns of any quality.

6.4 b Photo-electric cell type

In this type, photo-electric cells are used for operating the devices. The optical scanning principle is used in photo electric cell clearer. The detector which scans the variations in the yarn diameter, may be made to allow minor slubs to pass freely through the device. But when the detector comes a large slub in the yarn, the cutting arrangements are put immediately into action. Each unit works independently.

6.5 Clearing efficiency of various slub catchers

The clearing efficiency of a yarn clearer is defined as its ability to remove the imperfections in the yarn

$$\text{Clearing efficiency} = \frac{\text{No. of faults removed}}{\text{Total no. of faults in the yarn}} \times 100$$

The clearing efficiency of -

Conventional blade type is	4 -6%
Serrated blade type is	16 - 30%
Electronic yarn clearer is	80 - 90%

Chapter 7

CLASSIFICATION OF YARN FAULTS

7.1 Introduction

Quality has become a very important term in today's context. In today's competitive market, there is an ever increasing demand for better quality fabric. This demands excellent yarn quality. Besides meeting the traditional quality standards the yarn has to meet the standards in respect of yarn faults, hairiness, lea count CV, etc. Hence yarn producers are faced with an uphill task of meeting the international market demands if they are to survive the stiff competition.

7.2 Yarn faults

The most important quality requirement is that the yarn should have very few faults especially the objectionable ones. Controlling the faults is critical not only from the point of view of garment appearance but also from the fabric quality requirement for automated cutting of fabric during garment production. It is becoming imperative to produce defect free 100 m or even longer lengths of fabric to meet this latter requirement. Therefore for export of yarn and fabric it is of utmost importance to control, monitor and remove faults to meet the desired standards. This is true for both weaving as well as knitting yarns. Short and long thick places and long thin places are yarn faults that are critical not only in determining the appearance of a fabric but also the process performance. Every one is familiar with thick faults like slubs that greatly detract from the fabric appearance and adversely affect the weaving performance.

Yarn fault is an event that occurs rarely, say once in several thousand metres, and therefore cannot be tested by the Uster Evenness Tester. One of the most popular instruments for testing yarn faults is the Uster Classimat; another one is the Classifault. These instruments classify thick and thin faults in to several categories basing them on their length and cross-sectional area or mass. The classes of faults tested by these instruments are given in Table A and B.

7.3 Indian Scenario

The best cotton yarns (from non-EOUs) are able to match the Uster 50% standards in 20s and 30s carded yarns but not in combed 40s to 80s yarns. However, the best values achieved by the EOUs, shown in brackets in Table 2 match even the Uster 5% standards in every respect including long thin and thick faults.

In blend yarns the Indian situation is still worse. No mill is able to achieve the Uster 25% level in respect of total and objectionable faults; only one mill is able to come near this standard. Regarding long thin faults, no mill is able to match even the Uster 75% level.

7.4 Systems of yarn fault classification

There are two systems of yarn fault classification, namely,

a) Classimat system, and
b) Classifault system

The classimat system is shown in figure 7.1 below

Cross - sectional increase/

Decrease	+ 400	A4	B4	C4	D4		
	+ 250	A3	B3	C3	D3		
	+ 150	A2	B2	C2	D2		
	+ 10	A1	B1	C1	D1		
mean yarn						F	G

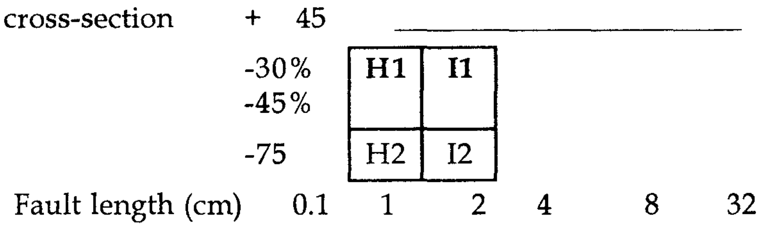


Figure 7.1 – Classimat system of fault classification

In this system of fault classification, the yarn faults are divided into length and thickness categories. The different classes of faults are A type, B type, C type, D type, F type, G type, H type and I type. Faults A to D types are divided into four levels and accordingly are known as A1, A2, A3, A4, B1..... B4, and so on. Faults H and I are known divided into two categories, namely H1 and H2, and I1 and I2. The faults A1, B1, C1, and D1 are known are those having a thickness of 100% of yarn diameter, and faults A2 .... D2 have thickness of 150% of yarn diameter, while faults A3 .... D3 have thickness of 250% of the yarn diameter and faults A4 ... D4 have a thickness of 400% of the yarn diameter. Faults F and G range between 45% to 100% the yarn diameter. While the faults A to G denote yarn faults that are thick and above the diameter of the yarn, faults H and I denote thin places, that is , lesser than the yarn diameter. The faults lengths of A class of faults range between 0.1 to 1 cm, while B class of faults range between 1 - 2 cms, C class of faults range between 2 - 4 cms, D class of faults range between 4 - 8 cms, and F and H class of faults range between 8 - 32 cms, while G and I class of faults are longer than 32 cms.

The classifault system is shown in figure 7.2

Cross sectional Increase/decrease							
+400%	A4	B4	C4	D4	E4		
+250%	A3	B3	C3	D3	E3		
+150%	A2	B2	C2	D2	E2		
+100%	A1	B1	C1	D1	E1		
+45%		F2		G2	H2	I2	J2
+30%		F1		G1	H1	I1	J1
Mean yarn 0%							
X- section -30%		K1		L1	H1		I1
-45%		K2		L2	H2		I2
-75%							
Fault length (cm)	0.1	1	2	4	8	9	25

Figure 7.2 – Classifault system of fault classification

The classifault is yet another system of yarn fault classification. In this system too the yarn faults are divided into length and thickness categories. Again the faults are divided into A , B , C , D , F, G , H, I, J and K types. Faults A to D types are divided into four levels and accordingly are known as A1, A2, A3, A4, B1..... B4, and so on. Faults H, I, J, K, and L are divided into two categories, namely H1 and H2, and I1 and I2 and so on. The faults A1, B1, C1, and D1 are known as those having a thickness of 100% of yarn diameter, and faults A2 .... D2 have thickness of 150% of yarn diameter, while faults A3 .... D3 have thickness of 250% of the yarn diameter and faults A4 ... D4 have a thickness of 400% of the yarn diameter. Faults F and G range between 45% to 100% the yarn diameter. While the faults A to J denote yarn faults that are thick and above the diameter of the yarn, faults H, I, K and L denote thin places, that is , lesser than the yarn diameter. Class A faults range between 0.1 to 1cm, class B, F and K faults range between 1 - 2 cms, class C faults range between 2 - 4 cms, faults D,G and L range between 4 - 8 cms, class E and H faults range between 8 - 9 cms, class I faults range between 9 - 25 cms, and class J and I faults are longer than 25 cms.

Chapter 8

TECHNOLOGICAL DEVELOPMENTS IN WINDING

8.1 Introduction

Though the basic principle of the winding process has remained unchanged, a good deal of developments have taken place in the winding machines during the recent years.

The recent developments in cross winding machines are towards higher output, improved package and yarn quality, tension control, easier attendance and maintenance, better environment and more and more automation. Preferred machine configuration is machine with single spindle design and machines with small spindle group. Large group winding machines are still being widely used in India , but these machines are obsolete for high speed weaving machines and manufacturing of these machines is being discontinued. It has become necessary to wind longer length of yarn onto package so as to suit the subsequent processes like warping, weaving and knitting. Ideally, it is expected that a wound package should be able to unwind itself easily at high speeds and also the yarn in the package should be free from objectionable faults such as thick and thin places. Also the number of knots/ splices should be kept at a minimal level.

8.2 New anti-patterning techniques

Generally today's autoconers are of the grooved drum type. Hence it is not easy to eliminate ribboning/patterning. Ribboning results in wound package of non-uniform density and also leads to uneven dyeing of yarn. Also, there will be problems in unwinding of the wound package.

During unwinding, coils of yarn will come off loosely (slough off), which causes end breakages in warping and weaving processes. Slough-off also causes damage to needles of knitting machine during knitting.

Hence pattern breaking mechanisms form an integral part of the modern automatic winding machines. Leading manufacturers of winding machines have introduced devices to avoid ribbon formation and enable formation of patternless wound packages. Some of the anti-patterning mechanisms made by various manufacturers are explained below.

8.2 a Schlarhorst Propack system

This system has been introduced in the Schlafhorst 338 model autoconer. A computer unit of the system constantly monitors and indicates the ratios between the drum and the package rotational speed as shown in Fig. 8.1.

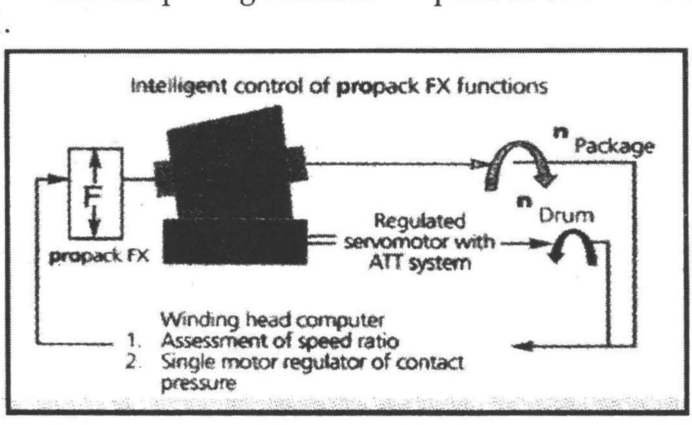


Figure 8.1 – Propack FX function

When the critical speed ratio required for patterning to occur, is almost attained, the propack system reduces the pressure on the cradle by a pre-determined amount. Thus the package runs at slower speed below the critical patterning speed till the package diameter is adjusted to a value above the pattern zone. Then the propack cradle antipatterning system is turned off.

8.2 b Muratec Semi conductor device

This system known, as TRIAC, is used for ribbon/ pattern breaking. A typical device is shown in Fig.8.2

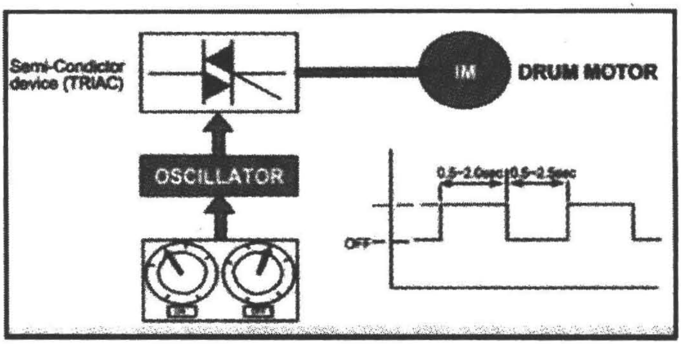


Figure 8.2 – Semi-conductor device

By means of dial setting for durations of switching the machine ON and OFF, the anti-patterning is effected. In this manner the cyclic change in drum speed is adjusted suitably. The attainment of critical speed ratios between the drum and winding package is thus prevented, due to acceleration and deceleration of both at a constant rate.

8.2 c Double pitch drum

The multiple grooves anti patterning mechanism is incorporated on 'PaC21' model of Murata automatic cone winding machine. The PaC21 monitor the critical parameters that cause ribboning and switch the yarn from one groove to another groove of the same drum to avoid patterning. Thus at the time of ribbon generating zones the jumping mechanism switch over the yarn from winding at 2W to 2.5W (Fig.8.3). It is recommended by the manufacturer that 'PaC21' automatic cone winding machine is applicable to all yarn types, count and winding shapes.

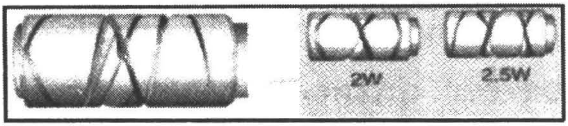


Figure 8.3 – Multi-groove drum

8.2 d Computer aided package (CAP)

It is an optional device on 'Orion' model Savio make of autoconer. The drum package diameter ratio is computer controlled. Each winding head computer controls the yarn deposited on the package and automatically intervenes with a servomotor to modify the drive ratio between package and the drum only at the critical diameter (Fig.8.4)

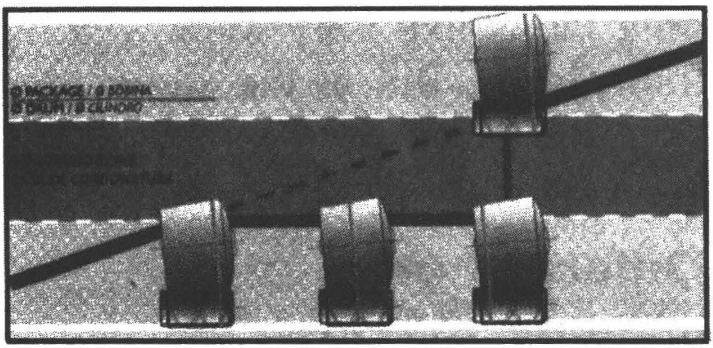


Figure 8.4 – Computer aided package

It is claimed that with CAP Orion winders produce perfect packages without patterns. Consequently, no unwinding speed limits are imposed in the subsequent processes of warping, knitting and dyeing.

8.2 e Precision winding with counter-rotating blades

In this system two counter rotating blades are used to avoid patterning. Such a system is incorporated in the "PSM-51' of SSM precision winder, and is shown in figure 8.5.

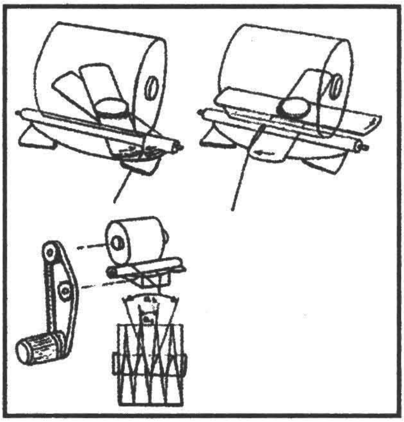


Figure 8.5 – Counter rotating blades for yarn traversing

The blades, additionally, help in yarn traversing and thus enable package build up. They rotate at constant speed and traverse the yarn alternately to wind it on the package smoothly and gently. The required density profile of the package is achieved by correct choice of the wind ratio that remains constant. The wind ratio prevents the number of coils per double traverse reaching a whole number effectively from empty to full package. Consequently no ribboning or patterning is produced on the package. The crossing angle becomes progressively narrower as the package diameter increases.

8.3 New techniques for reducing hairiness

One of the main problems associated with automatic winding machines is the increase in yarn hairiness. This is due to yarn abrading against the various machine parts. Interestingly enough, some machinery manufacturers have developed techniques to reduce the yarn hairiness on their machines. A noteworthy one is that developed by Murata automatic winder, in the model "Perla-A/D'. In this model, the hairiness reducing device is used in conjunction with a tension manager. This results in packages wound with less hairiness. The hairiness reducing device is placed just below the gate type of tensioner. Either air pressure or discs are used to apply pressure on the yarn that passes through the hairiness reducing device. This helps to wrap the hairs on the yarn and thus reduces protruding hairs from the yarn. This system is claimed to reduce only long hairiness. However, the feel characteristics of the yarn is not affected. Besides this, other advantages are also offered such as reduced stoppage of weaving machine due to engangled warp, 30% less pick up of size and less fly waste at subsequent process.

8.4 Tension control

Proper control of yarn tension is necessary for getting package of uniform density. Today's automatic winding machines have tension control devices that control the yarn tension uniformly right from the beginning to finish of the wound package, and also help to maintain lower levels of yarn tension. A number of such devices are produced by different machinery manufacturers, of which, a well known one is explained here as under.

Murata has developed a device that couples the balloon controller with tension manager. This balloon controller lowers over the supply bobbin to maintain even winding tension from the start to the end of winding. It permits winding of the package at high speed. A solenoid type of gate tensioner is used. The balloon controller maintains a constant balloon throughout the unwinding of the cops thereby maintaining a constant tension, as shown in figure 8.6.

The gate tensor imparts the necessary tension to the yarn simultaneously with the movement of the balloon controller and thus tension manager (balloon controller and gate tensor) controls the unwinding tension even at higher winding speed. This results in high productivity of the winding machine without affecting the yarn quality. The tension manager senses the yarn position on the ring

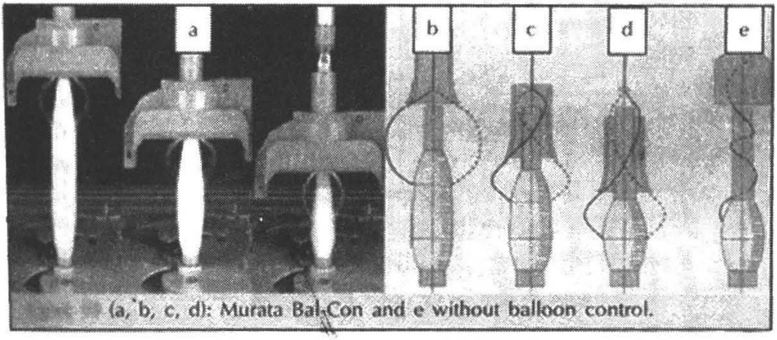


Figure 8.6 – Murata Balloon controller

bobbins and sends signal to computer. The computer in turn sends the command to solenoid of gate tensor to adjust the tension on yarn accordingly. Thus the winding tension is maintained constant. Other advantages claimed by the system are reduction of sloughing off and generation of hairiness.

8.5 Developments in splicing

Splicing has mostly replaced knotting, since the problem with knotting is that one fault is replaced by another worst fault due to the thickness and tails of knot. The different methods of splicing the yarn are mechanical, pneumatic/air, and water.

8.5 a Mechanical splicer – Twin splicer

In this system, the operation of untwisting-retwisting on the yarn is carried out between two self-compensating interfaced disks. Three adjustments are to be made on the twin splicer unit, i.e., untwisting-re-twisting-drafting. The presence of wax on the yarn, does not affect the characteristics of the splice. The unit is equipped with a dust protection cover; the cover is opened during splicing only.

The splicing operation is carried out as shown in figure 8.7.

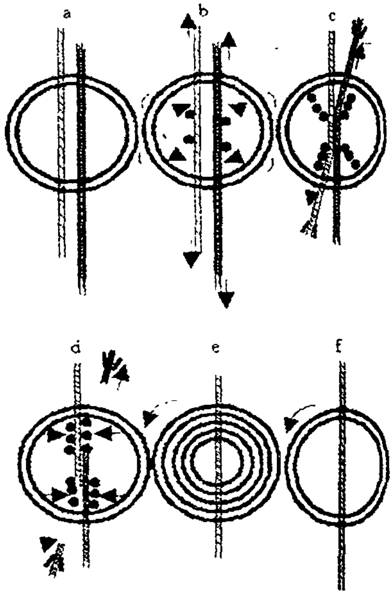


Figure 8.7 - Operating cycle of mechanical splicer

After the two ends of the broken threads have been introduced between the two discs, the threads are untwisted and drafted, the threads are brought together to create the centre and the excess yarn on the ends is unstrung, the yarn ends and the spliced yarn are then joined together and the yarn is re-twisted, the discs are then opened and the yarn gets spliced.

8.5 b Pneumatic splicer

The pneumatic splicing mechanism is shown in figure 8.8

Two ends of the yarn are kept parallel and face opposite direction. To condition the ends, the yarns are gripped and fibres are sucked from the exposed ends to taper them. Splicing is carried out after the two conditioned yarn ends are laid inside the splicing chamber so they are parallel, facing opposite directions and appropriately

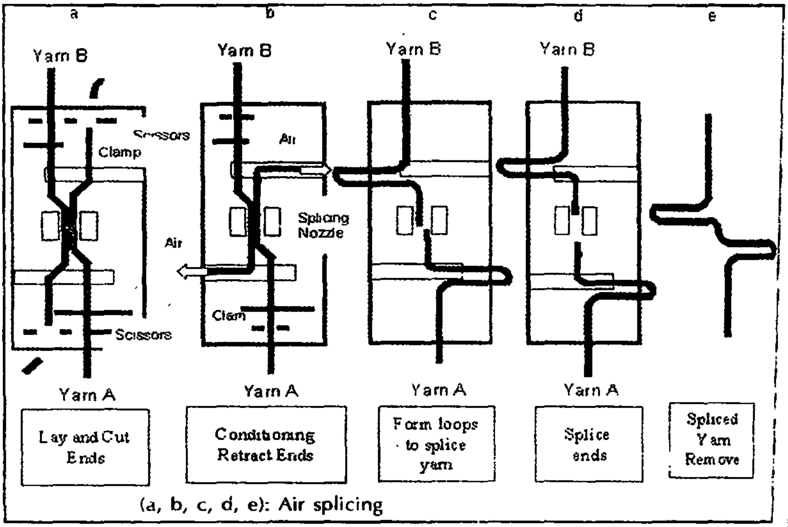


Figure 8.8 – Pneumatic splicing

spaced without the tips of the conditioned ends protruding. One way to do this is to withdraw loops of yarn. The splicing chamber of an air splicer is sometimes made in two parts that open to allow easy insertion of the yarn ends and then permit closure for the splicing phase of the operation. The two ends are spliced together by a rapidly rotating body of turbulent air inside the splicing chamber. The turbulence is induced by air that enters the cylindrical chamber tangentially. The air blast first intermingles the fibres and then causes the newly made joint to rotate to produce false twist. The yarn is then removed from the splicer and winding is recommenced.

8.5 c Aquasplicer

The special feature of aqua splicer is that air and water are used to splice a single and plied cotton yarns and blends by applying the appropriate mingling chamber. Mesdan is offering such types of splicers for all types of yarns.

8.6 Other significant developments

Besides the developments discussed previously, other interesting developments have also taken place in the winding machines. These are discussed below

8.6 a Auto reset device

The Murata automatic winder is equipped with a balloon quality control autoset device. The successive defects of yarn in a bobbin are sucked and taken away by yarn trap from the bobbin itself with the help of opening and closing motion of gate tensor. This reduces drum idle time when balloon quality control alarm comes and workload on the operator is also reduced.

8.6 b High speed auto doffing

Murata claims that their automatic winders are equipped with a very high-speed autodoffer whose doffing cycle time is only 9 seconds and travelling time is as fast as 60m/min. This contributes in the requirement of only one doffer per machine even for winding coarse counts below 20s Ne.

8.6 c Winding head control and drum drive

Schlafhorst supplies automatic winder that has direct-drive system for the drum, called as Auto Torque Transmission. This is combined with winding head control system. The drum ont eh autoconer sits directly on the shaft of the drive motor, thus ensuring that the winding head control system influences the drum in the manner that is a completely controlled and guaranteed direct transfer of the drive torque to tha package. This results in a smooth, gradual start-up, slip controlled acceleration, a high winding speed and improved anti-patterning.

8.6 d Flexible intelligent cycle and energy saving

Savio claims that with direct drive of the main moving parts like direct control of the grooved roller, suction nozzle, splicers, waxing units which, besides letting them work only for the time required, also avoids power waste caused by the interposition of mechanical components. Thus reduction in downtime during the splicing/bobbin changing cycle repetition is achieved by means of individual motorisation and control of each single function. Here movement of the package yarn suction nozzle, movement of the bobbin yarn suction nozzle and movement of the splicer in independent. So if one of the two suction nozzles fails to capture the yarn, it must repeat its cycle, while the other waits holding the yarn. The cycle is completed with the splice only when both nozzles have brought the two ends of yarn into position.

Chapter 9

MODERN AUTOMATIC CONE WINDING MACHINE (AUTOCONER)

9.1 Introduction

The textile industry has witnessed stringent requirements on quality and economic efficiency over a period of time and this has been subject to continuous change. Newer types of materials, suitable performance characteristics and fashion have assumed increasingly important role. Parallely growing with this is the importance of the yarn package winding as a quality filter in the textile production chain.

The factors such as conservation of the specific quality of the yarn, further optimization of the structure and build of the yarn packages and the production of yarn like spliced joints for gentle handling and undisturbed processing of yarn and packages in the production processes downstream of winding, are still considered vital in the yarn winding process. In addition to these, advanced monitoring and operating systems, proven automation solutions, energy and raw material saving technologies constitute the other performance features of the modern winding machines.

The autoconers provide the textile industry with mature, state-of -the-art technology capable of efficiently winding yarn for any specific application. Flexible and innovative modular technologies are the platform for textile technological progress and outstanding economic efficiency in automatic yarn package winding. In the automatic package winding, high performance functional units and intelligent closed-loop control systems form the integral part. High standards of quality and economy can thus be achieved in the modern winding machines due to the mature winding concepts.

9.2 Important features of the machine

There are several features of the autoconer. However the essential ones are being discussed. These are as follows:

a) Automated spinning bobbin feed
b) Linkage with the ring spinning machine
c) Yarn package rewinding with automatic feed package change
d) Manual filling of the feed bobbins into the feed magazines
e) Rewinding of manually creeled yarn packages
f) Rewinding of residual yarn packages
g) Predefined package density
h) Continuous online measuring of the yarn tension
i) Easy operation and maintenance
j) Highest accuracy and reproducibility of the yarn tension
k) Increase in productivity
l) Compensation of yarn tension variation
m) Flexible splicing principle

9.2 a Automated spinning bobbin feed

The spinning or ring cops coming from huge containers are fed into the material flow inside the machine over the flat circular bobbin conveyor. The bobbins are then automatically taken through the process relevant devices: the bobbin readying station for piece bobbins and tube stripper. Various systems, according to customers requirement, are available for removing the empty bobbin tubes. The standard equipment of the machine comprises an automatic yarn package doffer. Equipped with the multi-lot winding system(optional extra), the autoconer processes several yarn lots simultaneously.

9.2 b Linkage with the ring spinning machine

In a new version of the autoconer, the machine is directly linked with the ring spinning machine. A continuous transfer station (CTS) transfers the spinning bobbins gently onto the caddies of the winding machine. On the caddies, the bobbins are automatically carried through all process-relevant devices. The emptied bobbin tubes are returned to the ring spinning machine and, on their way back, also pass through the CTS. A yarn package doffer is included in the standard equipment. For online quality monitoring, the machine can be fitted with spindle identification system(SPID). This, however, is only an optional attachment and allows detection of faults occurring in the ring spinning machine at an early stage.

9.2 c Yarn package rewinding with automatic feed package change

In another type of autoconer the automatic rewinding of the yarn packages is done. The change of the feed packages in the supply creel is actuated by a change mechanism. The operator places the reserve feed package into an ergonomically favourable position in the winding unit. 1:1 rewinding, that is rewinding of one feed package into one take up package, is a special feature in this type of machine. Another typical application is "Peeling", a process in which a pre-defined length of yarn is wound off the feed package either at its beginning or its end.

9.2 d Manual filling of the feed bobbins into the feed magazines

On certain types of machines the spinning bobbins are placed by hand into the circular magazine pockets at each winding unit. For removing the emptied tubes after the winding process, two options are offered: the empty tube conveyor running the full length of the machine and carrying the empty tubes to a sorting table at the end of the machine, or the empty tube conveyor per machine section for depositing the empty tubes in a tube box at the end of each section. The full packages are also removed, and the empty package tubes put in place, by hand. Package doffer and full-package removal system are optional extras.

9.2 e Rewinding of manually creeled yarn packages

Rewinding of yarn packages is partly necessary after package dyeing for putting the packages into the required shape. Waxing of yarn that was not waxed in the preceding winding stage may be necessary for further processing. In a particular make of the autoconer, the operator places the package to be rewound into the supply creel and the finished take up packages are doffed and carried away by hand or doffed with an automatic package doffer (optional extra)

9.2 f Rewinding of residual yarn packages

In some machines facility for rewinding residual yarn packages is provided. The operator places the feed packages into a large capacity magazine much like the circular bobbin magazine. By rewinding residual packages, economic use can be made of valuable yarn resources, otherwise the yarn residues would go to the waste. Rewinding is possible for residual packages up to 115 mm in diameter.

The elements of the winding unit are arranged in an order that ensures optimum function of the process sequences. Very gentle handling of the yarn and a safe, controlled production process are the result. The winding unit can be flexibly and easily adapted to the specific textile production needs of a customer by selecting the winding components that are best suited for the given purpose.

9.2 g *Pre-defined package density*

With the measuring principle of the autotense, the Autoconer measures the yarn tension directly, as an absolute value of force. Outside factors have no influence on the measurement. The required yarn tension is set centrally at the informator and is secured as a closed-loop control circuit. This allows the production of yarn packages that are precisely tailored to the requirements the packages have to meet the production processes downstream of winding.

9.2 h *Continuous online measuring of the yarn tension*

The yarn tension sensor is located in the yarn path in a xone near the package where the yarn runs smoothly. It monitors the actual yarn tension in the area where the package arms. As the yarn is in constant contact with the sensor, there is continuous measuring of the yarn at each winding unit.

9.2 i *Easy operation and maintenance*

The operator sets the key parameters for the regulation of the yarn tension and for the electromagnetic yarn tension device centrally at the informator. A further factor ensuring high quality is the continuous auto-calibration of the system and its functional design. The need for operator intervention is reduced to a minimum.

9.2 j *Highest accuracy and reproducibility of the yarn tension*

Owing to the centralized setting of the yarn tension and all yarn tension devices, all values can be reproduced with exactitude. Utmost uniformity of the yarn tension from package to package is thus ensured. The high measuring sensitivity of the sensor and quick reaction and high precision of the yarn tension device guarantee precise adjustment of the yarn tension throughout the winding cycle.

9.2 k Increase in productivity

The autotense FX yarn tension regulator maintains the yarn tension at a constant level through out the spinning bobbin unwinding cycle, from the beginning to the end of the bobbin. The tension is adjusted to suit the characteristics of the yarn optimally. Tension-induced yarn breaks in the end zone of the spinning bobbins are avoided. The significantly higher winding speeds thus made possible help to boost productivity.

9.2 l Compensation of yarn tension variation

Direct and continuous real-time measuring of the actual yarn tension, a unique feature of the autoconer 338, provides the advantage that all unforeseeable variation in yarn tension can be recognised with great accuracy. Autotense FX compensates for variations in the yarn tension, such as the rise in yarn tension towards the end of a spinning bobbin and tension variations from deformed spinning bobbin and tension variations from deformed spinning bobbins, and adjusts the lower tension of the yarn coming fromt eh spinning bobbin during acceleration to normal speed, to the required level. The closed-loop control circuit connecting yarn sensor, winding unit computer and yarn tension device allows effective regulation of the yarn tension device immediately upon measuring, so that quick and correct adjustment to the pre-defined tension level is ensured.

9.2 m Flexible splicing principle

The Schlafhorst splicing technology stands out for the great flexibility of the splicers, covering a wide variety of applications, the reproducibility of the splicers and the simple operation and maintenance. The basic pneumatic principle of the system allows it to be optimally adapted to the requirements of any desired application with only slight modifications. With only few movements of the hand and a few additional components, the standard splicer can be converted into a thermo splicer, injection splicer or elasto splicer. All these variants are based on the principle of air splicing and their functionality is adapted to suit the specific requirements of the material to be spliced. Therefore the operation is simple, and as regards the main splicing parameters, uniform. The Schlafhorst splicing technology thus covers the wide range of different applications the textile industry has to meet.

9.2 n Systematic data analysis and targeted process control

The informator also takes care of the analysis of the data and the control of the process sequences and records the production and quality data. Error messages and alarm signals assist the machine operators in their work. A thermoprinter supplies printouts of data and reports. In addition, a variety of data can be stored in the PC-card via PC card drive and data and parameters transmitted to the informator.

Besides the above mentioned features, there others such as Clean environment for assuring high quality, economic and effective yarn clearing, cost effective yarn clearing

DEFECTS IN WOUND PACKAGES

10.1 Introduction

The main aspect of the quality of preparation in winding is the production of a fault free package that will unwind smoothly during warping. Some of these faults are caused by faulty machine settings while others are caused by incorrect work practice. Hence periodic checks on machine conditions, settings and proper supervision of operatives is necessary in order to minimize package faults. Some of the more commonly occurring package defects, their causes and remedies are discussed in this chapter.

10.2 Types of wound package defects

The following are the important defects that commonly occur in wound packages

10.2 a Stitches on cone

This defect is due to improper laying of ends onto the cone at reversal of yarn path. It causes more end breaks in the subsequent processes and also leads to excessive yarn waste.

Sources

i) Cone holders that are improperly set and are vibrating

ii) Tension brackets misaligned with winding drum

iii) Wrapping of coils of thread around the bottom of cone holder

iv) Traverse restrictors fixed at incorrect position

Corrective action

i) Overhauling of cone winders to be done time to time

ii) Setting of cone holder and alignment of tension brackets with the drum to be done regularly.

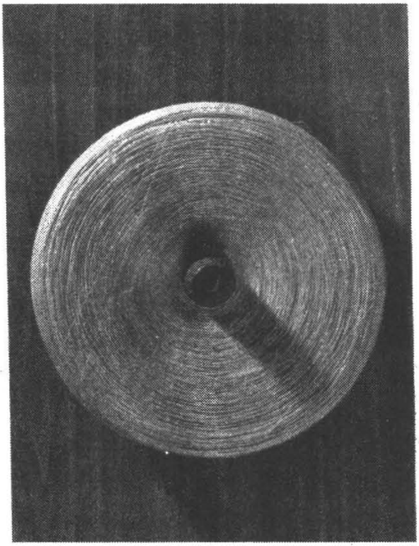


Fig. Stitching on Cone

10.2 b Ribboning or patterning

In this type of defect a ribbon like structure is formed on the circumference of the cone. It results in high level of slough off during unwinding, excessive yarn waste and uneven dye pick up in the case of dye packages

Sources

i) Restriction in the rotation of the winding spindle
ii) Improper setting of cone holders
iii) Cam switch set improperly
iv) Loading of lint the in the groove of builder cam

Corrective actions

i) Cone winders are to be overhauled periodically
ii) Anti patterning device is to be checked regularlyls
iii) Cone holders are to be properly lubricated so as to ensure their free movement.

10.2 c Soft package

It is caused due to abnormal softness of the structure of the package. In this case the overall density of the package is lower. It results in soft packings either at the base or at the nose of the cones.

Sources

i) The winding spindle is not properly aligned to the Improper alignment of winding spindle to winding drum

ii) The tension during unwinding is inadequate

iii) Loading of the cradle is insufficient

Corrective measures

i) The tension during unwinding is to be kept between 6-8% of single yarn strength

ii) The pressure at the cradle is to be maintained at required level.

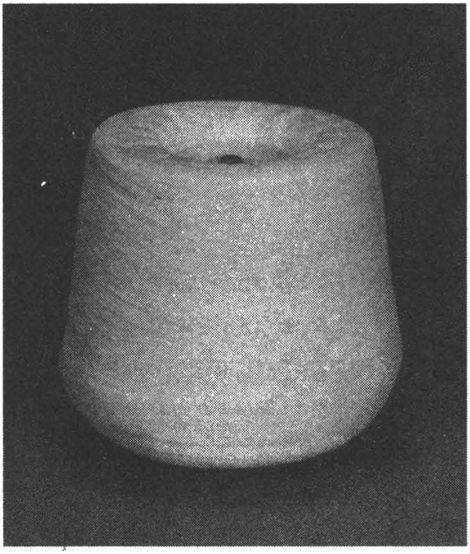


Fig. Soft Build Cone

10.2 d Bell shaped cone

In this type of defect, the cones are tightly built at centre and appear in the shape of a bell. Such a type of defect in the packages leads to excessive breaks during subsequent processes.

Sources

i) The tension of yarn is high during winding

ii) Improper setting of cone holders with winding drum

iii) Paper cones being damaged at the middle

Corrective measures

i) Cones are to be checked for quality during purchase

The tension during unwinding is to be kept at required level

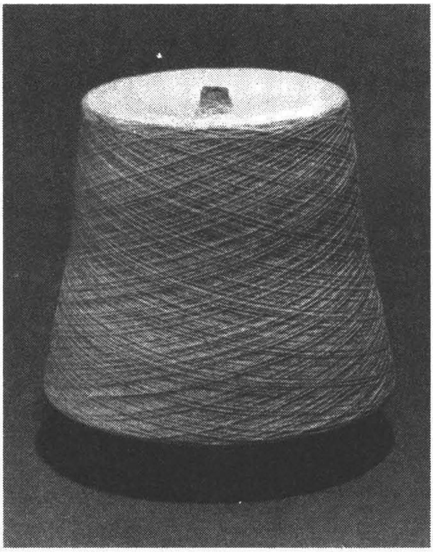


Fig. Bell shaped Cone

10.2 d Nose bulging

It results in bulging of bunches of yarn at the nose of the cones. This leads to slough off during warping.

Sources

i) Setting of cone holders to winding drum is incorrect
ii) Periodical inspection of settings in winding machines
iii) Tenters to be instructed to adopt correct work practices
iv) Avoiding use of damaged paper cones

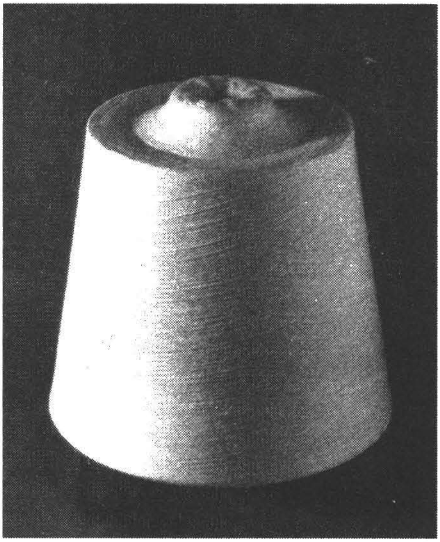


Fig. Nose bulging

10.2 d Collapsed cone

In this type of defect, the structure of the package itself gets collapsed. This kind of defect in the packages cause excessive breaks during warping and tend to generate a high level of hard waste.

Sources

i) Use of poor quality/damaged cones
ii) Poor system of material handling
iii) Maintaining non optimum unwinding tension

Corrective actions

i) Winding tenters to be trained on correct work practices
ii) Proper material handling devices such as cone transport trolleys to be used
iii) Cone inserts to be used for paper cones

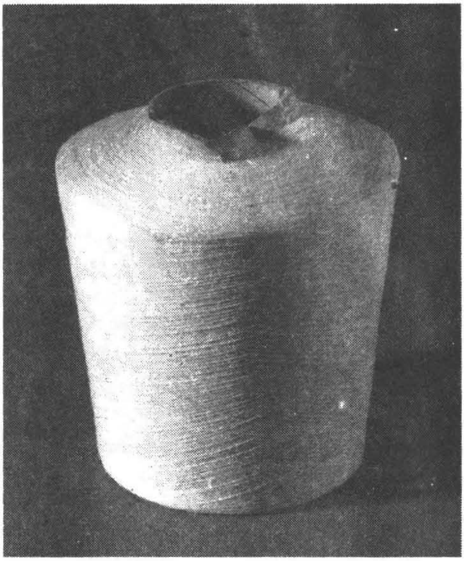


Fig. Collapsed cone

10.2 e Ring shaped cone

This defect results in the formation of ring shaped bulge across the cross section of the cone. It results in more end breaks in the subsequent processes and also causes slough off during unwinding.

Sources

i) Incorrect setting of cone holder
ii) Wrong placement of tensioners in the tensioning assembly
iii) Traverse of yarn affected due to defects in the grooves of the drum

Corrective measures

i) Due replacement of defective drums and stop motion wires to be ensured

ii) Periodic inspection of cone holder settings and tension assembly to be carried out

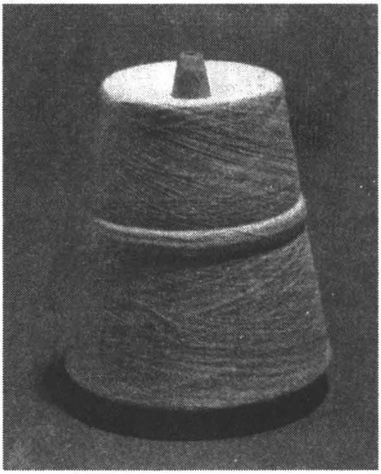


Fig. Ring shaped cone

Chapter 11

WINDING OF SYNTHETIC AND BLENDED YARNS

11.1 Introduction

Filament yarns are smooth, lustrous, with zero or some twist, (say producer twist of 10 - 15 tpm) which lacks fibre cohesion of the yarn, showing very poor abrasion resistance, leading to fraying of filaments or popularly known as "filamentation". This property calls for special attention and machinery to process them. This chapter deals with the problems encountered during winding of synthetic filament and spun blended yarns.

Normally, to avoid filamentation, the filament yarns are either twisted, sized or mingled also called aero-set or roto-set by forming nodes or nips in the yarn by compressed air using special nozzles.

11.2 Winding of synthetic filament yarns

The conventional winding machines having rotary traverse are not suitable for the filament yarns because of two main reasons viz.,

a) abrasion and damage to the filament yarn due to the surface drive to the package, and
b) the need of the higher yarn tension to keep the filament in the grooves of the winding drum which also can cause the filamentation.

Hence winding is carried out on spindle driven packages like precision coner, where the coils of yarn are laid exactly next to the previous coil precisely by adjusting the advancement of the package spindle in terms of the revolution by the term called "gain". The "gain" which depends upon the yarn diameter, the package diameter, and the angle of wind (complimentary) say d, D and the angle B respectively and expressed by gain = 2d / DcosB, the terms of the spindle revolutions. The "gain" can be adjusted by the change pinion on the machines. The packages prepared on the precision coners are absolutely ribbon free and hence ideal for filaments. There may be some tension variations due to the increase in its diameter, hence its surface speed or winding speed. However, on some machines there is a provision to keep it constant by decreasing the angular speed of the package, as its diameter increases. The precision coners are basically designed to suit the filament winding, offering pineapple shaped cones, ideal for filaments. The number of winds remain constant from inside to outside diameter which helps in (i) ideal take off, (ii)uniform package hardness and (iii) absence of patterning.

Gate type tensioner of ceramic guides (rods) should be used as otherwise with disc washer tensioner, the filamentation would occur due to friction due to the weight or spring of the tensioner. The main draw back of the gate type tensioners is that it may magnify the input tension variations due to its inability to respond to the tension fluctuations quickly because of high inertia mass of guides, frames and spring or dead weights, used to create torque on the frame carrying rods to apply the tension in the yarn. It follows Amonton's law of coil friction.

11.3 Weft winding

The filament yarn can be used as the weft with or without twist. Also textured and aeroset yarns can be used as the weft. Filament yarns without twist give better cover than those with twist. Aeroset filament yarns are superior to twistless yarns in respect of cover and surpass the twisted yarns in terms of workability. Textured yarns having higher bulk give superior cover as compared with those of aero set and twistless filament yarns. Though the highly twisted filament yarns give crisper feel, the snarling tendencies of these yarns is higher. The filament designated as 76/72/150 will give better cover than 76/36/150, but at the same time the latter yarn will perform better than the former in terms of yarn breaks and fraying tendency of filaments.

Another important aspect to be considered with the filament weft is that it is not suitable for lightly constructed fabrics, as it leads to fabric slip, since the warp/weft does not remain firmly interlaced and therefore can be easily pushed sideways by even with little disturbance. This tendency is greatly reduced by using textured filament yarn as filling material.

It is intriguing to note that fabrics woven with filament weft yarns appear more patchy and streaky than those woven with spun weft yarns. This is attributed to the fact that the very uniform filament weft throws onto the surface all the long and short term irregularities of the spun warp yarns and thus show higher level of patchiness and streaks in the warp direction.

11.3.1 Suitability of the supply packages

Twistless filament yarns are generally supplied either as pineapple shaped cones or large size roving type parallel tubes (Fig.). In the processing of these yarns the creel requires due consideration. The tension variations will be more during unwinding in the case of parallel tubes and hence pineapple cone shaped packages are recommended. The pineapple shaped cones are normally wound on texturising machines and are thus suitable to be used as weft supply packages for shuttleless weaving machines. Certain package defects such as patterning, tight spots and filamentation are to be avoided. The packages can directly be used as weft. Flat glass tube accumulators are recommended for twist lively yarns. The monomer may get deposited in the tube and hence should be periodically cleaned.

Precision wound packages are ideally suitable for shuttle less weaving machines. Typical specifications of the packages are shown in the table below:

Caterory of textured yarn	Shore hardness	Traverse	Core diameter
Fine yarn(40-85 deb)	45 - 55°	90 mm	90-110 mm
Coarse yarn (100-200 den)	45 - 55°	150 mm	90-110 mm
Flat fine yarns	65 - 70°	90 mm	90-110 mm

11.4 Winding of blended yarns

Blended yarns have a combination of properties, since two fibers of greatly differing properties are used. The most commonly used type of blended yarn is the polyester cotton blend. Though blended yarns have definite definite advantages over 100% cotton or synthetic yarns yet they pose problems in various stages of processing. For example, polyester cotton blended yarn have more bulkiness and hairiness. Also the hydrophobic nature of the polyester component gives rise to the problem of static charge generation during processing.

The following points are to be observed in the processing of blended yarns:

a) fusion of polyester fibers have to be avoided
b) yarn extensibility has to be preserved, and
c) reduction of yarn hairiness

11.4 a Important technical considerations

Of the various considerations, the winding speed is an important aspect. The speed of winding has to be reduced as compared to that used for 100% cotton yarn.

This reduces heat generation and thus prevents the fusion of the synthetic fibers. The reduction in speed also reduces the yarn tension during winding. This helps to preserve the yarn extensibility. Also by reducing tension variations in the blended yarn, problems associated with the dyeing can be reduced.

As already pointed in the previous section, blended yarns have more bulkiness and hairiness and hence wider slub catcher (20 - 25% higher) than those used for 100% cotton yarns is recommended. As polyester fibers have smooth surface, there is the problem of knot slippage during the winding and subsequent processes. Hence, good quality weaver's knots or fisherman's knots are recommended in mending the winding breaks.

Blended yarns also have high abrasion resistance and thus can cause cuts and grooves on the machine parts with which they come in contact with.

Chapter 12

WINDING OF SEWING THREADS

12.1 Introduction

A sewing thread is a strong, smooth, evenly spun, hard twisted and plied or cabled yarn treated with special finishing processes to make it abrasion resistant in its passage through the eye of needle, and through materials during seaming and stitching operation. It may be made from natural or man made fibres in either staple or filament form.

Sewing thread is considered to be the first textile material excavated. Archeologists concluded that the first sewing threads were made by cave men 25,000 years ago. Cavemen or junglemen prepared them by rubbing and twisting together either fur fibres from skin of animals or bast fibres. These were single twisted yarns having unbalanced and snarly structure making stitching very difficult. The difficulty was overcome by plying the single threads to balance the torque. Out of the natural fibres, cotton and silk were used for hand sewing. However, Issac Singer, who invented the sewing machine in 1850, brought about a considerable change in the field. Cotton thread was produced by Paudy and Patric Clark. The technology of Clark was further developed to a great extent by James Coat and became the leading sewing thread manufacturer as M/S J & P coats of Scotland. Calico mills commissioned India's first sewing thread plant in 1922 and introduced 100% polyester sewing thread in 1968. During pre-independence period M/S J & P Coats were manufacturing most of sewing thread in India for long period.

12.2 Types of sewing threads

Cotton sewing threads are most commonly used and still dominate the scene. In the last three decades the trend in garment manufacturing has been gradually shifting towards usage of synthetic and blended threads which have more durability, better recovery and colour fastness than the cotton threads. A broad classification of different types of sewing threads is shown in the flow chart (fig. 12.1)

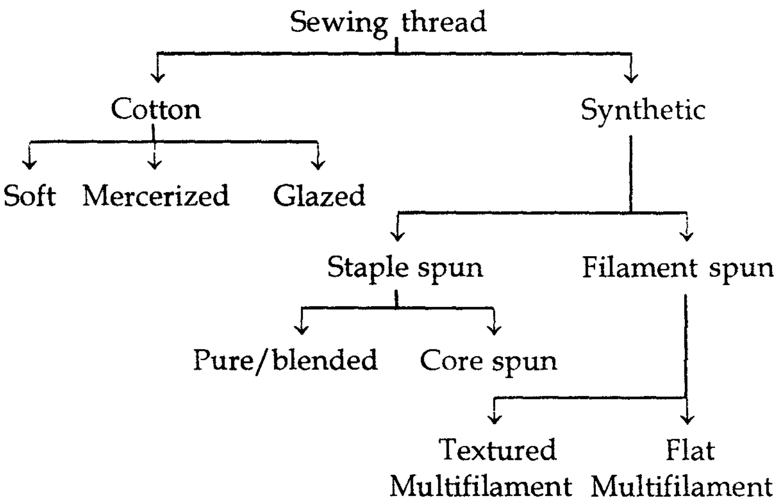


Figure 12.1 : Classification of sewing threads

12.3 Sequence of processes in sewing thread manufacturing

The following is the sequence of processes in the manufacture of sewing threads:

a) Yarn singeing
b) Hank to cone winding
c) Polishing

Cross winding and lubrication

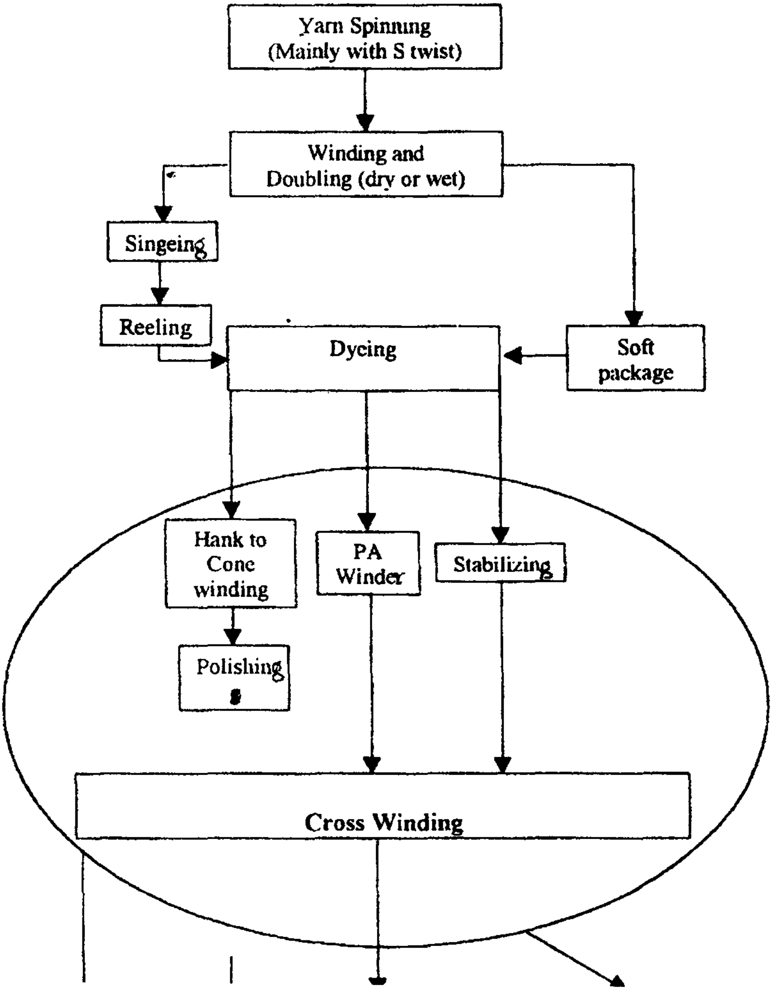


Figure 12.2 Flow chart showing sequence of process in manufacture of sewing threads

12.3 a Yarn singeing

Sewing thread must be singed to ensure that the projecting fibres do not interfere with downstream processing. Percentage of singeing can be varied by varying the yarn collection speed. Hair removal efficiency at singeing machine is normally 30 - 50%. Flame temperature is around 800°C.

The burner which is the heart of the machine serves to singe reliably the projecting fibres of yarn at high speed, without inflicting burns on yarn itself. There is a choice between the gas burner and the electric burner. Gas burners are widely used. The gas burner consumes about 55 gms of natural propane or butane gas per hour, depending on singeing rate and yarn type. It operates at a speed of 300 - 1200 m/min.

12.3 *b Hank to cone winding*

In this process, the yarn in the hank form is converted into cone of suitable weight. Waxing (except for polish quality) is carried out for reducing co-efficient of friction in sewing thread.

In newer models of these machines, twin rollers are placed in front of the winding head running at a fixed speed but proportional to the winding speed. The main functions of this unit are to eliminate unwanted tensions prior to yarn entering waxing unit. The speed of the machine ranges from 400-700 mpm, with possible traverse from 150-200 mm.

12.3 *c Polishing*

Objectives of this process are:

a) to obtain extraordinary smooth surface
b) to obtain round yarn cross-section
c) to increase the stiffness
d) to increase the tensile strength (7-10%)

Some threads for special end uses like leather industries, bag stitching, kite flying are treated with starch, softeners, whitener etc. on this machine. Cooked starch is mixed with other chemicals and different recipes are made for different qualities depending on the end uses.

12.3 d Cross winding and lubrication

Winding is carried out onto various types of sewing thread packages like cone, cop, tube, ball, vicone and spool. Threads are treated with special waxes for achieving best workability during sewing operation. Lick roller lubrication is applied on industrial sewing thread where thread has to run on high speed sewing machine; the basic ingredient in most of the lubricants is paraffin wax. Silicones are also used because of their stability to heat along with various other additives to give some special properties.

12.4 Geometry of packages

Threads are wound in various forms depending on their end uses. Small length spools are employed in retail store distribution, whereas somewhat larger spools are used to a limited extent in industrial applications. Some of the very fine soft threads are wound on cones, very coarse soft threads are in skein form, but the largest proportion by far is wound on the one headed tube with base or straight tubes. These packages in some instances are made on a weight basis; however, the larger percentage is made on a length basis. Ready-wound bobbins in a number of styles to accommodate the various sewing machines employed are also produced.

Cross winding threads are generally laid in with traverse ratios 1:6 (one double traverse = six spindle revolution) for finer counts and 1:4 for coarser counts. Following types of packages are used in sewing threads(with commonly used dimensions):

12.4 a Spool

Spools are small double flanged plastic or wooden bobbins with either tapered (so called Diabolo spools) or straight flanges. Mainly parallel winding (because side unwinding is easy) is carried out on spools although cross-winding is also possible on the spools. They contain relatively short length of 100-500 meter thread. The length of traverse on spool is 2.9/3.8 cm. The end uses are in upholstery, footwear, leather goods manufacturing, and in hand sewing operations.

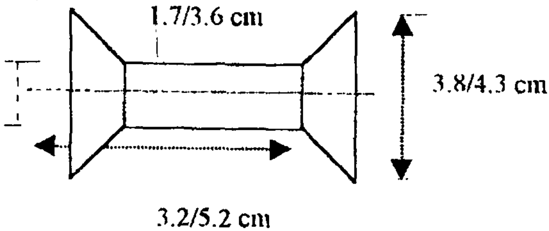


Figure 12.3 Dimensions of spool

12.4 b Cop

Cops are small flangeless spools, with precision cross winding. They are mostly made of paper and plastic. They are of two types, small cop, known as tube and medium cop known as a cop. The lack of flanges facilitates regular off winding on industrial sewing machines although their small diameter makes them less suitable for the machines with the faster thread take off. Smaller cops are popular in fashion trades, where a variety of shades are used and production runs are for any one colour or style of garments. The length of thread wound ranges from 100-2000 meters on a tube and 400-4000 meters on a cop. The length of traverse on a tube is 5 - 6.3 cms and on cop is 10 cms. The end uses are in kite flying, upholstery, ready made garment, tailoring, hosiery, umbrella and shoe stitching.

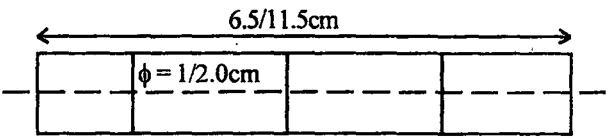


Figure 12.4 Dimensions of cop

12.4 c Cone

This is self supporting, cross wound conical package. It is easier to withdraw yarn over end from a cone than from a cheese and because of this, cone is more widely used. They contain relatively longer lengths of 1000 - 25000 meters with length of traverse ranging from 10 - 15 cms. They give trouble free thread unwinding at intermittent or continuous high speeds. Cones are the most economical packages for conventional sewing threads in situations where thread consumption is high and production runs are long. The end uses are in ready made garments, tailoring, hosiery, leather stitching, upholstery, shoe stitching, denim, embroidery, and kite flying.

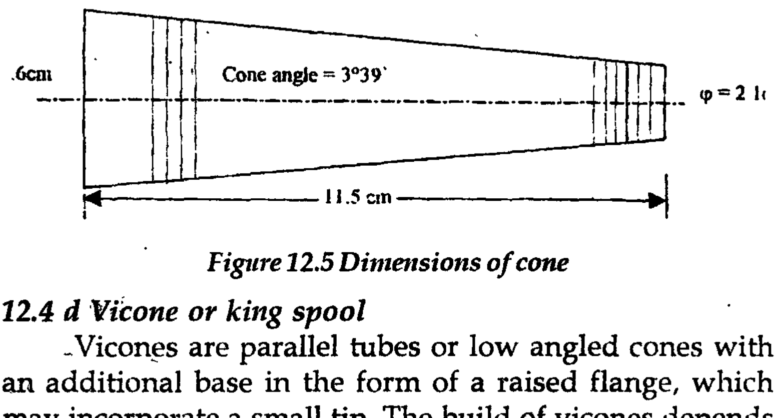


Figure 12.5 Dimensions of cone

12.4 d Vicone or king spool

Vicones are parallel tubes or low angled cones with an additional base in the form of a raised flange, which may incorporate a small tip. The build of vicones depends on the exact conformity of the taper with the angle of vicones base. Coarse yarns require a large traverse for the taper where as fine yarn require small one. They contain lengths of 1000 - 5000 m with length of traverse between 6.5 - 9.0 cms. The end uses are in embroidery, core-spun, and filament threads.

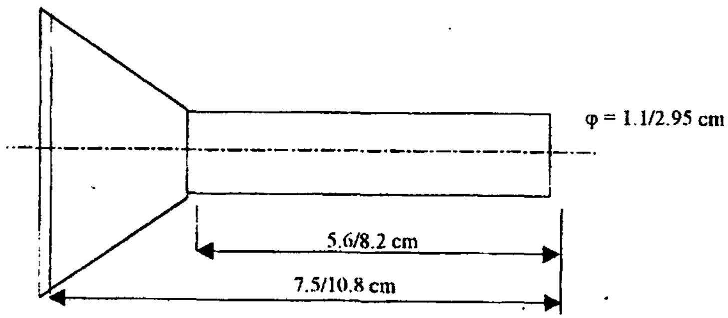


Figure 12.6 Dimensions of vicone or king spool

12.4 e Pre wound bobbin

Prewound bobbins are precision parallel wound thread packages designed to replace metal bobbins on a variety of lock stitch machines.

12.4 f Skein

A very small hank of small twisted plied thread (around 8 m) of coarse count, is parallel wound with the help of rotating flyer, which withdraws the thread from the supply package cone. End uses are in embroidery.

12.4 g Ball

It has a typical ball like structure, wound with four types of winding. They are rough base winding, form winding, surface layer winding, and circumference winding. The initial winding provides firmness at the base. Next winding process makes space for placing the identification ticket. The last stage of winding makes a hand over the ball, which retains its shape. An easy unwinding of thread is possible. End uses are in embroidery, fishing net and bag closing.

12.4 h Cocoon

Cocoons are self supporting i.e., center-less thread package specially designed for the insertion in the shuttle of multi-needle quilting and some types of embroidery machines.

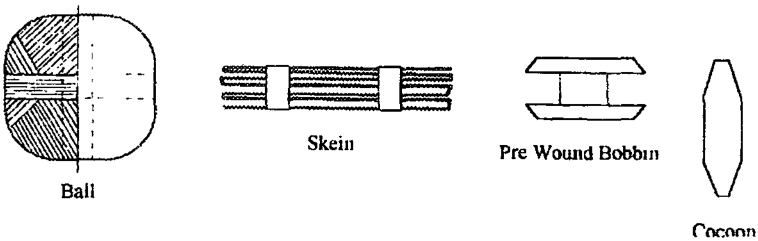


Figure 12.7 Different types of packages

Chapter 13

REQUIREMENTS OF WOUND PACKAGE FOR DYEING

13.1 Introduction

Package density is an important consideration with regard to dyeing in package form and this calls for proper care in the winding. If the wound packages tend to detective or have uneven density, there may be the possibility of uneven dyeing thus leading to shade variation. An unduly hard package can cause difficulties in dyeing due to improper penetration of the dye liquor into the layers of the wound package. On the contrary, a too soft package can create problems in the unwinding in the subsequent process and may require slowing down of the machine and also contribute to the percentage of hard waste.

Thus it is important that there is uniformity in the package density between and within packages. Package density variations causes shade variations in dyeing and ultimately affects the fabric appearance.

13.2 Measurement of package density

Normally the package density is expressed in terms of grams per cubic centimetre, which is calculated from the mass and volume of yarn on the package. These are in turn determined by measuring diameters of empty tube and full package, length of the package and its weight. This method can only be used in comparing package densities which are fairly uniform and is unsuitable in cases of variations of package densities. Also it is tedious and time consuming.

The densities of wound packages can be determined in terms of surface/shore hardness by suitable instruments.

The method involves penetration of a presser in the package surface under a known level of loading. The instruments are limited to determining the surface hardness of the package but do not indicate the variations inside the surface of the wound package. However, they have the advantage of ease of operation and less time consumption.

13.3 Factors influencing uniformity of package density

The following factors are considered to affect the uniformity of package density

a) **Winding tension**

It is influenced by the winding speed and tension weights as used on the tensioning devices. The winding tension determines the tightness with which the yarn is laid on to the package and thus the package density increases with increase in winding tension.

b) **Yarn count**

The count of the yarn determines the winding tension and spacing of the yarn layers on the package, provided the winding speed, tension weights and package size are considered to be constant. As the yarn count becomes finer, both the winding tension and spacing of yarn layers reduce correspondingly. A reduction in the yarn tension decreases the package density, while closer spacing of yarn layers in the package tends to increase the package density. However, the effect of the spacing of yarn layers overrides the effect of the yarn tension and thus higher package densities can be produced in finer counts of yarn.

c) **Pressure between package and winding drum**

In the case of conventional machines this is determined by dead weights on the cradle or spring loading. Increase in pressure leads to more compact yarn packages.

d) **Type of supply packages**–

In the case of ring cops, there are variations in density throughout the package, while in the case of wound packages, there is a fairly uniform density throughout the build of the package.

e) **Increase in package diameter**

In the case of surface driven packages, the number of winds decreases with build up of the package. This results in opening out the space between yarn layers and leads to lowering the package density. Thus the package density decreases with increase in its diameter. Studies have revealed that decrease in package density is more during initial stages of package build. Hence by using a bigger diameter sleeve and also by increasing the final diameter of the package by the same amount, the variation within a package will be much less.

f) **Yarn reversals on cross wound package**

The yarn is traversed from one end of the wound package to the other thus resulting in a number of yarn reversals at the edges of the package. The package density at the edges of the wound package is higher at the reversal points as compared with body of the package and hence the wound package tends to be harder at the edges. This is an inherent draw back of cross wound packages, but is overcome by causing a slight shift of the package or the drum during the running of the machine so as to change the reversal points at every traverse.

13.4 General measures to achieve package density suitable for dyeing

The following measures would ensure the required package density that would make it suitable for dyeing:

a) Reduction of winding speed and tension

b) Minimize undue variations in winding tension between drums of a machine thus enabling achievement of uniform density between packages.

c) Use of unwinding accelerator on winding machines is preferable in the case of polyester blended yarns in order to reduce variations in package density with a package.

Chapter 14

WINDING ON A TWO FOR ONE TWISTER FOR SPUN YARNS

14.1 Introduction

The process of twisting two or more single yarns is called as doubling or ply twisting. The yarn produced in the process is called as doubled yarn or plied yarn and the machines used for this purpose are called doubler, ply-twisters or Two-For-One Twisters. The main objectives of the ply-twisting are to improve the eveness, strength, lustre of the yarn and to obtain higher wear resistance, better fabric cover and handle of the fabrics.

Nowadays, Two-for -one (TFO) twisters are gaining worldwide acceptance in both staple and filament yarn twisting due to its following advantages. They facilitate production of long knot free yarn in a desired package which result in better efficiency in subsequent processes. Higher productivity per spindle, sometimes more than two times of traditional ring twisters is possible with these machines. Other features of these machines include reduction in man power and space requirements.

14.2 Present scenario of TFO

TFO Twisters are available to process yarns covering count range of Ne3/2 to Ne140/2. The mechanical spindle speed can be as high as 15,000 rpm (resultant speed 30,000 rpm). Although basic technology remains the same various improvements have been made with regard to energy saving, noise control, package quality and higher productivity etc.

14.3 Principle of twist insertion on Two-for-one twisters

The yarn receives two turns with one revolution of the spindle. The yarn receives its first turn (1) between the yarn brake and the exit port in the spindle rotor. The second turn (2) is imparted within the balloon between the spindle rotor and the balloon thread guide.

14.4 Geometry of packages

Geometry of final take-up package from Two-for-one twister is very important aspect as this package directly goes to the market or ready for use in the next process. Depending on the end use the package type may be cones having conicity of 5°57′, 4°20′ and 3°30′ or a cylindrical package.

The major decisive parameters of the take up package are:

a) Traverse length
b) The package diameter
c) Taper angle
d) Yarn crossing angle
e) Package weight
f) Density and hardness

For spun yarns depending on the yarn count and the requirements at end use stage, traverse length may vary between 152 mm to 254 mm, package diameter between 200 mm to 400 mm and weight between 1.5 kgs to 10 kgs. Soft dye package with uniform density can also be produced in the new generation machines.

14.5 Conditions for uniform winding

The winding unit in TFO consists of the following parts:

a) The winding drum and the traverse guide which precisely determine the laying of yarn onto the package.

b) The pre-take-up or over feed roller which reduces the take up tension to an appropriate value for the desired package density.

To obtain uniform winding of the take-up package, the following conditions are to be maintained in designing of the TFO twisting machine. The cradle which normally is a single bar or 3 bar type should be designed to accommodate the package size in length and diameter. Interfacial force (cradle pressure) between package and drum should be uniform throughout the package build up. Advanced package support system in modern TFO exerts continuously vibration free uniform pressure between package and drum. Centeringdisc or adopters which hold the package between the traverse guide and the yarn package sould be maintained as low as possible. At the traverse point yarn should reverse the motion in an angle as acute as possible.

14.6 On-line process monitoring and control

Day to day production process parameters and quality of the plied yarn are monitored and controlled through microprocessor based data information system. Renowned European manufacturers are providing electronic data monitoring system as a part of their machine.

The on-line monitoring system gives elaborate report on following aspects of production and quality: shiftwise production data and machine down time, spindle speed and winding speed, twist per metre or twist per inch. There is a possibility of interfacing a main computer with individual machines to check and store various process and production data. This type of central monitoring system can be kept in the spinning manager's cabin away from the winding department. Software can be developed as per the requirement of the individual mills to analyse the process and the quality data machinewise, shiftwise and spindlewise and it can be useful in increasing eh producitivity and quality.

14.7 Features of the new generation machines

With the new generation machines the space requirement has been substantially reduced. These machines need the space which is not greater than that of a ring twisting machine. They also have ergonomic advantages due to adaptable operating heights, for example from 1318 to 1586 mm. Effective spindle revolution up to 30,000 rpm depending on yarn count and spindle size is also possible.

Energy consumption is reduced by using optimised flat belt drive and by using energy saving rotors. Vibration and maintenance down time for lubrication are reduced by supporting the centre bearing spindle in the middle. Yarn quality is not affected by dust or soil. Noise level is reduced drastically by completely covering the spindle area. Electronically controlled pattern breaking device gives ribbon free package. It is possible to produce soft dye packages using the self threading deflection rollers adjustment (figure 14.1). Twist level on individual spindle can be monitored by attaching twist control unit.

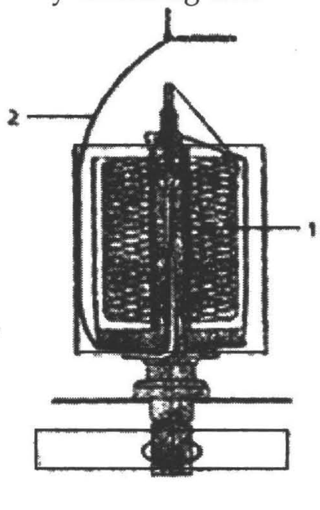


Figure 14.1

14.8 Pneumatic threading system

This system permits fully automatic threading without additional handling of spindles with and without balloon limiter (fig.14.2). It drastically reduces threading time up to 80% resulting in high productivity per operative per hour and reduced production costs. Since spindles with self cleaning yarn channel are used maintenance becomes easier. Moreover, no mechanical threading devices are needed with this system.

Operational details: Operation of the foot pedal stops the spindle rotor. As the pedal is pressed down further, the threading operation is initiated. The airflow opens the yarn tensioner automatically, allowing the yarns to be threaded though unhindered. The compressed air is guided through the hollow axle and sucks the yarns through the centre of the spindle into the rotor.

The yarns are then carried by the air stream up and around the spindle pot where they can be grasped by the operator. Once the threading operation has been completed, the tension capsule returns to its operating position. Thus no manual operations are necessary for opening and closing the tensioner. This positive-action method of operation means that, with such systems, operator errors are completely eliminated. And the automatic action of the system results in a substantial reduction in handling times.

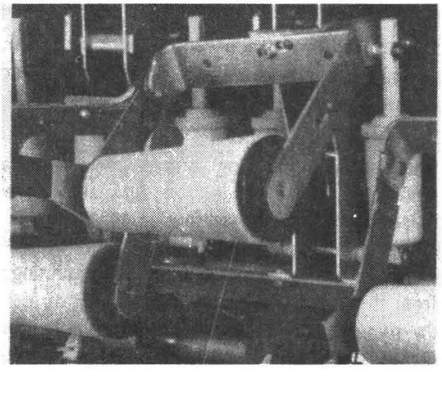


Fig. 14.2 Schematic of the Pneumatic Threading System

14.9 Cradle with take-up package lift off

The package cradle enables simple and rapid conversion to different package and tube dimensions (fig.14.3). The large traverse triangle ensures uniform take-up tension across the package surface. The friction roll ensures constant, slip free take-up package rotation, resulting in perfect package quality every time. Following a yarn break or feed package run out, the package is lifted from the drive roll after a timed delay in order to prevent package damage.

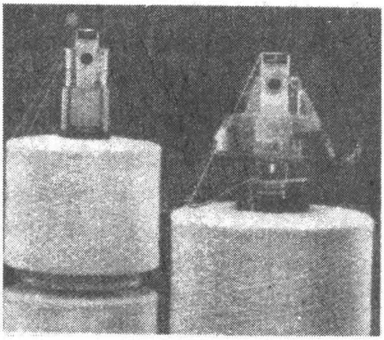


Fig. 14.3 Cradle with Take up Package Lift-Off

14.10 Yarn lubrication

The lubricant is continuously applied to the yarn directly during the twisting process (fig.14.4). Lubricated yarn offers improved running properties in subsequent processes like warping, weaving and knitting. The application of lubricant prevents wear, dust and fibre fly from developing. In this "in-line' system, the lubricant film remains on the surface of the yarn, enabling it to withstand the stresses of the processes which immediately follow. Thread driven waxing devices reduce the friction co-efficient of the twisted yarn in subsequent processes.

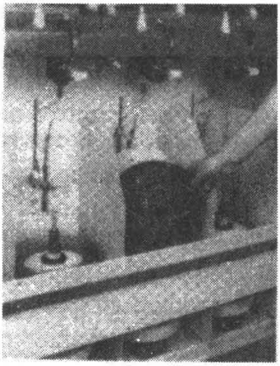


Fig. 14.4 Yarn lubrication System

14.11 Portable balloon limiter

Free-balloon spindles can be equipped with portable balloon limiters (fig.14.5). This results in lower energy consumption apart from widening the count range for coarser yarns.

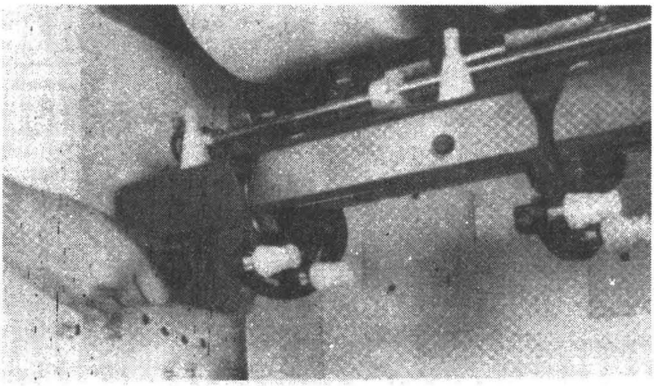


Fig. 14.5 Portable balloon limiter system

14.12 Breathing device

The breathing device reduces the winding density at the edges of the cross-wound twister package (fig.14.6). The device permits a marginal correction of the basic winding traverse by up to ± ½". The adjustment is performed from outside the gear box. With this ser up it is possible to produce soft package with uniform density (particularly for 100% polyester yarn) by gradually changing the traverse. This device is retrofittable. It is possible to change this gear box to normal cross winding at any time.

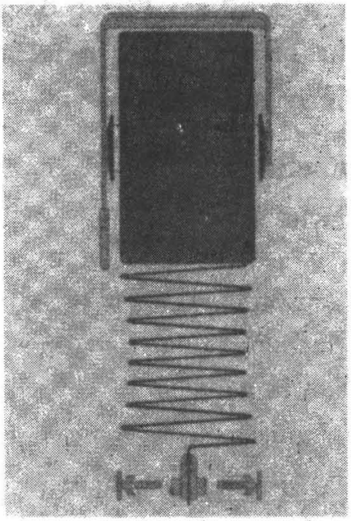


Fig. 14.6 Breathing device

Pneumatic yarn stop blocking system

In the event of a machine stoppage or power failure, the yarn stop feelers are pneumatically blocked in their working position. On machine restart, the yarn stop feelers are automatically released again after a time delay. This avoids yarn breaks as the machine accelerates.

14.13 Automation

Automation has been carried out in transportation of wound packages as well as the feed packages. Automatic transportation of wound packages through conveyor belt considerably reduces the manual handling times on long machines(fig.14.7). The ergonomically ideally positioned transport system in the middle of the machine serves also as an intermediate store for the cross wound packages. Package discharge can be continuous or intermittent. The circular creel transports the feed packages from the assembly winder to the individual TFO twister.

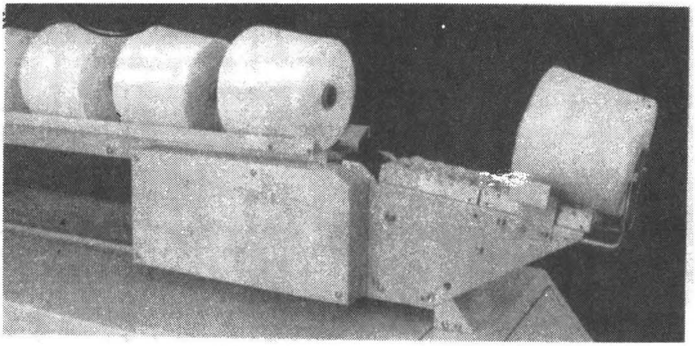


Fig. 14.7 Automation

14.14 Faults in packages

In TFO twisting defects can be encountered in the final yarn and package. Faults and the remedial actions to be taken against each faults are provided below.

14.15 Faults and remedies

Twist variation	Check tension of spindle drive belt and deflection of belt guide pulleys. Check whether the spindle brake is touching the whorl, clean and adjust. Check yarn pals around spindle, bearing housing. Remove excess wrapping around reserve disc.
Snarling	This type of problem is normally observed when two single end cheeses are used as feed package. Unwinding aids of various design and shapes are recommended to minimize the tension difference and snarling effect.
Hairiness	Check all the parts and yarn guides which come into contact with the yarn in its passage. It has been observed that coarse count carded yarn, if processed without

	balloon limiter leads to increased hairiness. Portable balloon limiter can be a solution. While processing synthetic fibres on TFO with balloon limiter, lubritwist is helpful in reducing hairiness.
Stitches	Uneven tension between take-up package, travers guide and pre take up roller and any disturbance in traverse mechanism or sometimes failure of anti-patterning create stitches on package. Check centralised anti-patterning device, thread guides and functioning of pre take up rollers.
Ribboning	Check working of anti-patterning device. Some times layer slough-off may occur if yarn stop motion does not work properly.
Deformed	Check cradle pressure, free rotation of adopters. Sometimes too soft and too hard package due to variation in winding tension creates deformed package.
Black ends	Clean spindle channel, capsules and reserve disc area. TFO with pneumatic threading will be helpful.

14.16 Techno economics

Two-for-one twisting process is advantageous over conventional ring twisting process in terms of reducing extra process of winding to obtain the final package. It minimises the space requirement and man power requirement.

Features	Economical advantage
Reduced machine width	30% saving in floor space requirement. Thus reduces the cost of building.

Special energy saving rotor and center bearing spindle	Increases the production speed by 10% and power consumption by 10-15%, thus saving money over the years.
'Volcojet' pneumatic threading	Reduces threading time and increases efficiency upto 15% depending on count

PART II
WARPING

"This page is Intentionally Left Blank"

Chapter 1

BEAM WARPING

1.1 Introduction

The warping process is intermediate between the winding and the sizing processes. It produces the warper beams that are combined together as a single weaver's beam in the next process of sizing. A warper beam may contain about 500-1000 warp ends. The direct or beam warping is suitable only for grey or monocoloured warps that require sizing. It involves only one operation, namely, warping and hence the speed and production are considerably higher than the sectional warping machine. Also the machine is suitable for longer runs as compared with the sectional warping machine. The warping machine consists of a creel, a headstock and control devices. The details of these vary according to the type of warper and they will be compared on this basis.

1.2 Creels

The creel is a stand for holding the supply packages in the form of wound packages. It enables to hold the supply packages in proper position for warping, and constitutes an important component of the warping machine. No individual type of creel can be suitable for all types of yarns, counts, set lengths and different applications. In other words no single type of creel can give the same beaming efficiency for different types or yarns or applications. Hence different types of creels are to be used for different purposes. The creels used in warping are of the following types:

a) V- creel
b) Rectangular creel
c) Truck creel

d) Continuous chain creel
e) Magazine creels
f) Automatic creels, and
g) Special creels

1.2a V- creel

As the name implies, this type of creel is V-shaped (fig 1.1). It consists of wooden pegs horizontally to hold the supply package. This is arranged so that the apex is in line with the centre of the machine. The arm of this V-shaped wooden frame diverges on both sides from its apex.

This arrangement enables the ends to be with drawn easily from the supply package without touching or getting entangled with one another during passing to the back reed of the head stock of the machine.

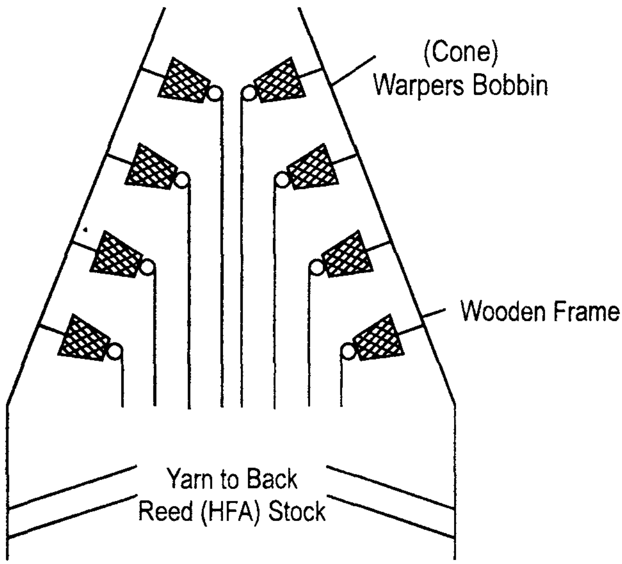


Fig. 1.1 V-Creel

1.2b Rectangular creel

This creel is rectangular in shape and hence its name (fig. 1.2). The frames are provided with pegs to hold supply packages horizontally. The frames can be increased to accommodate more number of supply packages and vice versa. Each frame consists of thread guides, indicator lamps etc. It is mostly used in the slow speed warping machine.

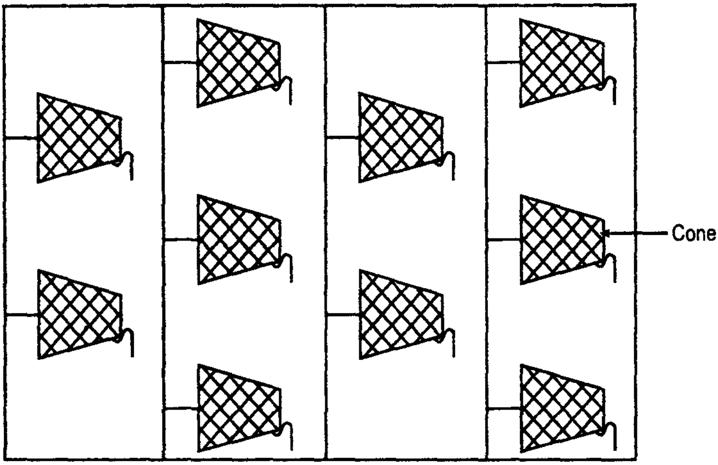


Fig 1.2 Rectangular Creel

1.2c Truck creel

This type of creel system is of varied types. This system utilises 'trucks' or mobile package carrier units. Each unit consists of a number of columns and tiers on either side and can be inserted on the axis of the creel frame to become a part of the creel. Tension units are positioned in relation to the packages, and the unit is movable. The numbers of columns and tiers on the trucks depend on the size of the package and the corresponding guage of the creel.

The trucks can be creeled at the winding machine and thereby minimize handling of the supply package, provided there are sufficient number of trucks. The system is not so cost effective as many trucks would be required. In some of the improved versions, a chain loading device pulls the trucks into the creel when replacement is required.

1.2d Continuous chain creel

This type of creel was evolved several years ago and was first used by Barber colman and co. The creel is in the form of two arms that form an acute angle with each other. These carry an endless chain that moves the columns of supply package holders and tension units into working position. It also moves the exhausted packages away from working position. Such a system enables creel changes to be effected in a very short time, say, 15 minutes. A creel is being transferred from the creeling position to the running position. Package holders may also carry remnants from the running position to the creeling position and are replaced by full packages for the next creel. The creel also has free space to accommodate storage of packages/ creel trolleys.

1.2e Magazine creel

This type of creel is provided with arrangements to hold reserve package (fig 1.3). The tail end of the running package is knotted with the starting end of the reserve

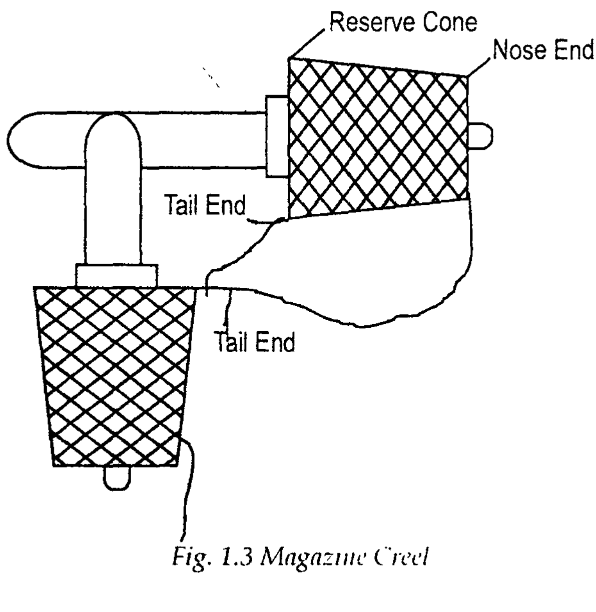


Fig. 1.3 Magazine Creel

package. This enables the continuous working of machine without stoppage for replacing the exhausted package with a new one. The dimension of the creel and floor space required are comparatively more than other types of creel. The creel is usually V-shaped.

1.2f *Automatic creel*

This is a more sophisticated type of creel and is currently being used in modern warping machines. It is basically a truck creel with automatic chain loading and unloading and is designed to reduce the creel change time. One important feature is the threading of yarn. The yarn is threaded by an operative, from the supply package simultaneously through tension device and break detector and then gathers all the warp ends from one tension column and twists them together before locating them in a holder on the threading truck. As the thread is pushed forward it automatically threads and separates the ends according to creel tiers and columns. The main advantage of this system is that it provides the shortest creel change time compared with other creel systems. The creel carriage stands at the back side of the creel, and is released when the supply packages are almost exhausted. As the carriage moves along the creel every end is cut between package and tension device, the 'live end' being secured in a clamp. When the knotter carriage reaches the front of the creel, the operative operates the chain conveyor and removes the creel trucks from the creel. The creel trucks are designed with special pegs with clamps at their extremities so that when each cone is loaded the end is located in the clamp. This precludes of the use of closed end cone shells. The knotter carriage has a separate knotter head for each tier on each side of the creel, so a six tier creel will have twelve knotter heads on the knotter carriage. When the full creel teucks are correctly assembled by the conveyor chain, the knotter carriage ties one column on each side simultaneously.

This type of creel also includes other interesting features. One of these is a tension unit that is set to a minimum tension on each end of a column at the back of the creel and this tension is matched on every end on the front column of the creel. All the intermediate columns are then calibrated by a scale so that all ends have equal tension as they reach the head stock. Once the basic setting has been made, uniform simultaneous adjustments can be made to all the ends by a single handwheel. A travelling blower keeps the tension units and yarn packages free from 'fly' and a dust suction unit with stripping device is located at the base of the creel.

1.2g Unrolling creels

Some special types of yarns (such as polyolefine tape yarns) are wound up to 4-5 kgs capacity, as large cylindrical cross-wound packages. The high width to thickness ratio of the tape creates problems in case of over end unwinding. Also such packages have trapped twist and therefore require the package to unroll. The packages have some inertia owing to their large size and weight. Hence some means will have to be provided to control the rotation of the supply package as the warper beam speed reduces. This is achieved by means of a rim brake operated through thread tension. As tension is reduced when the warping machine slows down, a wire tensioner applies a rim brake at the back of the package. When the warper accelerates the reverse action takes place. A pneumatic braking system would be suitable for even larger packages.

1.3 Brake and Stop motion

In order to stop the heavy warping beam rotating at high speed a very efficient brake is used on the machine. The brake may be operated by mechanical, hydraulic or electrical devices and it is fitted at the head stock or at the creel of the machine. The thread stop motion may either be of the mechanical or electrical types. The former is used on conventional machines and the latter on modern machines.

The mechanical type of thread stop motion is shown in fig. 1.4. The working of this device is based on the falling of a bent wire between the nip of pair of revolving rollers and there by effecting a forward movement of one of these rollers.

The winding drum is rotated by the motor through the operation of clutch in one end. On the other end of the drum shaft a brake drum is provided with a brake shoe This brake shoe is in connection with the brake lever, and

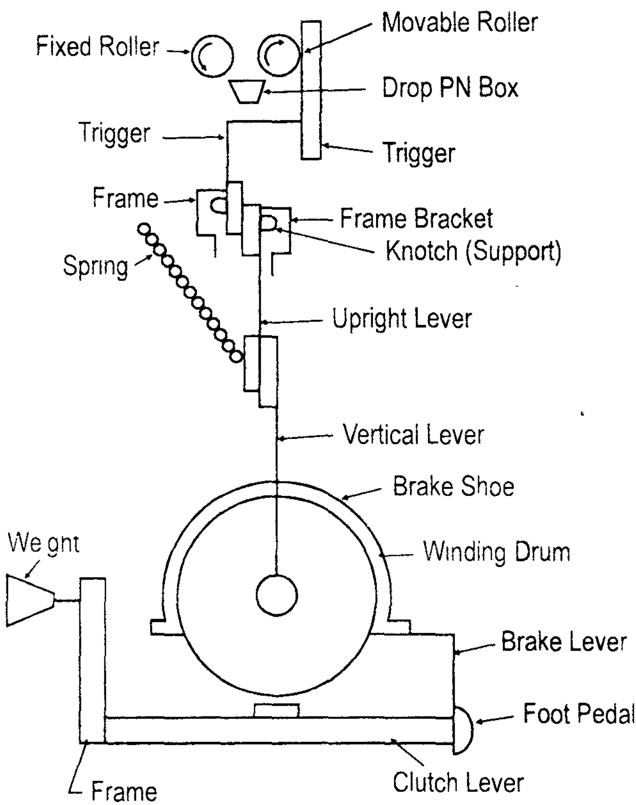


Figure 1.4.

is attached to the foot pedal. When the foot pedal is pressed, then the brake is operated on the wooden warping drum. In the foot pedal, a clutch lever is connected in order to make simultaneously the brake operation by the frictional clutch also to disengage the drive of the warping drum. On the clutch lever, there is an upright or vertical lever with a notch at its one end. During the working condition, the notch supports on a bracket so that the brake drum and brake frictional clutch will not act. When an end breaks, then the drop pins finding no support and falls in between the two rollers (fixed and movable drop pin rollers) rotating in the opposite direction. This causes the movable roller to be moved sideways. During this time, the trigger, which is in contact with the movable roller is put into action to push the upright lever, from the notch of the bracket. This causes the friction clutch on the driving shaft to be thrown out of gear, simultaneously putting the drum-brake into action so that the machine attached to the lower part or the trigger will assist in the performance of the above operation. The machine is also capable of being stopped at any time manually by the operative. On top of the lever there is rod, which extends the entire width of the frame when the machine is required to be stopped manually, the operative moves the rod back ward by a slight push. This results in the machine being immediately stopped by the lever, knocking off the trigger from its support.

Chapter 2

SECTIONAL WARPING MACHINE

2.1 Introduction

The sectional warping machine is used for preparation of multicoloured warps to be woven as striped of checked design fabrics. It is also used for doubled grey or monocoloured warps that do not require sizing. Unlike the beam or direct warping where a warper's beam is produced that is sent to the subsequent sizing process, in the case of sectional warping, the weaver's beam is produced and hence does not require sizing. In the case of single yarns that are multicoloured, the yarns are sized and then wound on the sectional warp beam. The yarn is wound in sections, each section having a particular width. Thus the total number of warp ends for the weaver's beam is divided into suitable number of sections on a warping drum. The sections are then combined to form the weaver's beam. Therefore, there are two distinct operations involved, namely, warping and beaming.

2.2 Passage of yarn through the machine

The passage of material through the sectional warping machine is shown in figure 2.1. The supply packages are in the form of cones or cheeses. They are placed on a V shaped creel or a semi circular creel depending upon whether stop motion is used or not.

The yarn from the creel passes through the back reed. The reed maintains uniform spacing of the yarn throughout the width of the warp.

Then the yarn passes over and under guide and drop rollers. The drop rollers impart tension to the yarn passing

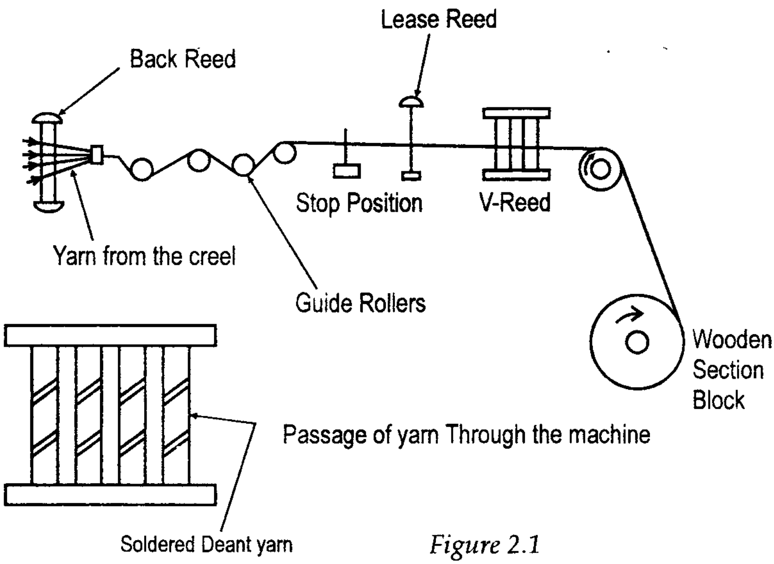


Figure 2.1

under them and holds the yarn tight when the machine is stopped.

From there the yarn goes through a stop motion device which stops the machine in the event of an end breakage in supply package, getting exhausted.

From the stop motion device the yarn passes through a leasing reed. The use of the reed is to form an end and end lease at the start and completion of each section. The reed depth of the reed is comparatively much more than that of the ordinary reed. Each end of the wap passes separately inserted in the warp at the completion of one section of warp and the reed is lowered.

This will bring all the alternate ends passing through the soldered dents down, i.e., alternate ends passing through the doldered dents down, i.e., alternate ends will form the bottom line and another set will form a top line. This division of warp threads is called shed. Now a lease band is inserted. As soon as it is done, the reed is lifted.

This will cause alternate set of warps, which were down in the previous operation to be lifted up an those which were on the top to be lowered. Now another lease band is inserted and the reed is brought back to its normal position, i.e., middle position.

The purpose of this leasing is to wind as well as to unwind the warp without any entanglement between threads to distribute evenly. Also it helps the yarn to maintain in position and helps to detect the broken end and mend it properly.

The yarn next passes through a V-reed which enables the width of the warp through it to be adjusted according to the width of the sections to be made.

Then the yarn passes over a measuring roller and is wound on a wooden block called swift. After winding the predetermined length of warp, leasing is carried out. The sections of threads are continued to the swift in a bunch form. Next, section is wound in the side of the previous one. The same process is continued until required number of sections are made on the wooden swift. Then all the sections are taken and transferred to a beam by means of running-off machine. The beam is driven by a motor or manually. The section width may vary from 10cms to 20 cms.

2.3 Merits and demerits

The sectional warping machine has the following advantages :

a) It is suitable for striped warp .
b) The labour charges are also less.
c) Power requirement to drive the machine is low
d) Sizing process is eliminated

The demerits are :

a) There are two stages, namely, warping and beaming.

b) Warp will have to be dyed, sized and dried separately by slow and expensive processes before warping.
c) Some amount of size will be removed from the warp during the process of sectional warping.

Chapter 3

MODERN DEVELOPMENTS IN WARPING

3.1 Introduction

The conventional concept that warping is merely an assembly of yarns on a beam is no longer valid today. This can be justified in a number of ways considering the role of the warping in relation to modern sizing and unconventional weaving machines. The recent developments have been concerned with the improvement of the headstock, which is considered to be crucial for achieving the stringent quality requirements of the subsequent process in order to weave quality fabric.

3.2 Head stock

It is customary in the case of all warping processes to present a continuous length of yarn in sheet form to the successive process of sizing. Moreover, the integrity and elasticity of the warped yarn is fully preserved.

Recent developments have been concerned with improvements in the headstock design with the basic objective of increasing the warping speed and using larger warper beams to get more yarn content. In this context, attention has been focussed on aspects of warping such passage of warp, beam drive, brake motion, etc. A number of developments have taken place in the introduction of exact yarn guidance to prevent cross ends and for preparing cylindrically wound beams of uniform length from a clean warp sheet.

The new generation warping machines are either computer or microprocessor controlled and display various process factors such as

- Warp length/beam
- Drum prsessure as per the count and no.
- No. of stops/beam/set
- No. of thread breaks/beam/set
- Thread tension to be set as per the count working (cN = Dtex x 0.08)
- It is very easy to change process parameters in running machine if required.
- Display of fault messages.

3.3 Passage of warp

The construction of headstock of modern high speed and super high speed warpers are simplified to a great extent. It eliminates the passage of yarn through the conventional measuring roller, the brake roller, the falling roller, etc. The yarn from the creel passes through the rear guide rod, the expanding comb, over the front guide roller and finally onto the warping beam. The present arrangement has helped to reduce the tension and the friction of the yarn, thus leading to increase in the warping speed.

3.4 End guidance and prevention of cross ends

It is achieved by means of the following:

a) Zig-zag comb with segments only 50 mm long.

b) Short free yarn length between reed-deflecting roll beam

c) Using an automatic end uncrossing device between comb and deflecting roll, which operates the ends by applying tension

3.5 Effective comb blow off

The comb is always kept free from fluff by blowing air through jets. It prevents fluff from becoming trapped in the warp windings and thus improves the warp quality.

3.6 Warping beams

The latest trend is towards using warper beams having large diameter flanges. Flange diameter of beams used on modern super high speed warping machine is as high as 1250 mm (Benninger, Amritlakshmi Super speed warper - 1000 mm) as against the flange diameter of 50 cm used on slow speed warping machines. The yarn content on the beam has, therefore, increased considerably and this gives longer runs on the sizing machine. The width of the beam varies from 1400-2200 mm.

The surface of barrels are duly coated with felt (flannel) cloth to give unobjectionable smooth and optimal beam rotation. Surface treatments of warp beam barrels have considerable influence on long term and warping quality. Barrels are provided with additional welded steel inner plates to increase stability.

The density of the beam is primarily controlled by the amount of tension that is applied to each active yarn at the creel. The press roll is used to prevent the build up of ridges and to keep the warp smooth. Pressure is applied to the roll hydraulically and is adjustable. Agauge mounted at the control panel shows the amount of pressure being applied. This pressure should remain constant from start to finish of the beam. (Pressure force 1000-5000N; Benninger).

The press roll is dynamically balanced and made of a synthetic material with metal edges to prevent chipping of the material should it accidentally contact the flanges of the beam.

It is important that the press roll be centred accurately between the flanges of the beam.

3.7 Yarn length measurement

The warp length is determined precisely by measuring the revolution of the beam and the press roller. The pulse measuring system takes into consideration the starting and braking phases and by using fuzzy logic estimates the current diameter of the warp to an accuracy of 1/10 mm and calculates the precise warp length on the basis of the warp beam speed.

Another feature available to ensure increased quality on warper is a press roll kick back device, which prevents the yarn from being scuffed should the brakes not be synchronized during deceleration of the warper.

3.8 Beam drive

There is an increasing trend towards use of spindle driven machines having some mechanical, hydraulic or electrical means to reduce the speed of the warping beam as the diameter increases. The wooden or metallic drum is discarded in order to totally eliminate the rubbing action of the winding drum on the warp which increases the hairiness of the yarn and it was a barrier in the way of achieving higher warping speeds. To change the speed of the beam, as its diameter increases the DC motor with speed-control either by varying the field-strength or the voltage input of the motor used.

West Point Solid-state DC drive designed to provide constant yarn speed from empty to full beam. The speed is adjustable on the operator's control panel upto maximum speed. The maximum speed (Warping Speed: 1500 mt/ min - sucker Muller) is dependent upon the number of yarns to be run and the desired tension value in the yarn. The total web tension may e computed by the equation

$$\text{Web tension (kg)} = \frac{\text{Number of ends} \times \text{tension per end (gm)}}{1000}$$

3.9 Brake

As modern high speed and super high speed warpers operate at very high speed and the weight of the beam is also increased considerably, an efficient and powerful brake is essential to stop the beam instantaneously. The ability to stop the beamer before ends are buried on the beam is paramount, but ends will occasionally break so near to the beam that the end is buried. Either the beam must be inched forward to locate the buried end, with the possibility of locating it on the wrong side of an adjacent end resulting in crossed ends and slasher stoppages, or a yarn storage device must be used between headstock and creel which permits the beamer to be reserved until the end is uncovered; this is most important feature of a beam warping machine if high quality weaver's beam capable of supporting large weaver assignments at high loom efficiency are to be produced. Usually the brake is operated by an automatic thread stop motion located at the creel and from the full beam stop motion.

The brake is either applied on the winding drum or the warping beam itself, depending on the type of drive used. The brake may be applied by means of levers and weights, friction discs, or by pneumatic and hydraulic devices or electromagnetic devices.

3.10 Beam lowering and lifting motion

As the weight of ful beam can range from 272 kg to even 1 tonne or more, according to its size, some power lifting and lowering devices are provided on modern warping machines. Doffing button is provided on the control panel, when pushed, and the beam is removed from the machine by the semi-automatic hydraulic doffing mechanism. This system supports the full beam, lowers it to the floor, and reloads the empty beam.

3.11 Accumulators

A yarn accumulator with a storage capacity of atleast 40 feet can be installed behind the warper head to draw the entire yarn sheet from the beam should an end break at the comb and get lost in the beam. The method of operation is to clamp first the entire yarn sheet at the creel side of the accumulator, then the moveable rolls of the accumulator start down, and the entire yarn sheet is unrolled from the beam until the broken end is uncovered.

After the broken end is repaired, the warper rewinds yarn stored in the accumulator. When the accumulator is emptied, the clamp automatically releases and normal operation is resumed. Tension of the yarn sheet during accumulation and rewinding is controlled either pneumatically or hydraulically. Installation of a photoelectric stop motion, between warper carrier roll and beam, reduces length of yarn sheet that must be accumulated to repair the broken end.

3.12 Static eliminator

High-speed machines, which run faster than 500 m/min are normally equipped with double the number of bars in combination with a biophase power unit. In order to obtain a proper and neutral warp beam. A great advantage of neutralization is the fact, that the yarns can be warped at equal distances, without repelling each other.

Chapter 4

END BREAKS AND WASTE IN WARPING

4.1 Introduction

The end breaks in warping are an important in aspect to be considered since this influences the productivity and efficiency of the warping machine. In this chapter the major causes for the end breaks in warping are discussed. Also The various factors affecting the end breaks are discussed.

4.2 Basic causes of end breaks

The following causes are known to affect the end breaks in warping:

a) Faults present in the spun yarn

b) Faults present in the winding package

Studies have revealed that the contribution of the spinning and winding faults ranges between 40 - 50%. Besides the above two factors other factors in warping such as wrong machinery settings and process parameters also contribute to the end breakage rate in warping. Formerly the end breakage rate in warping was expressed in terms of end breaks per 4 lakh meters of yarn, i.e., 400 ends per 1000 meters. Presently it is expressed in terms of one million meters of warp. Thus the end breaks per one million meters of the warp yarn provides the basis for assessing the warping performance.

4.3 End breaks due to faults in the spun yarn

A number of faults in the spun yarn contribute to the end breakages in warping. The important contributing faults are foreign fibres, poor piecings, slubs, thin places etc. However, considerable amount of the faults are removed by the clearing devices in winding. With the advent of the electronic clearers, the clearing limits are increased and thus the electronically cleared yarn contributes to lesser breaks in the warping.

4.3a *Influence of package density of ring spun yarn*

Spinning packages with lower package density (soft) tend to slough off during winding. Some of the loose unwound coils from ring cop manage to go through the clearers and pass onto the wound packages. Subsequently, these lead to bunch formation at the reed of the warping machine and often result in end breaks. Studies have revealed that ring cops with lower package density formed more bunches and thus contributed to higher end breaks in warping as compared to spinning cops with higher package densities.

4.3b *Influence of inproper belt drive to ringframe spindles*

This was another important contributing factor to the end breaks in warping. A number of factors such as defective belt tensioning, slack or loose belt or tape, damage of the inner surface of the spindle wharve, poor maintenance, etc, result in improper drive to the ring spindles. This results in lower spindle speeds than normal, ultimately leading to a high incidence of soft ends.

4.4 End breaks due to faults in winding package

A number of winding package faults contribute to the end breakage in warping. Some of the important faults are uneven/loose knots, fluff, slough off, wild yarn etc. The winding package faults such as ribbon formation, entanglements, cuts etc., obstruct the yarn during unwinding from the wound package and mostly lead to end breaks.

It has been observed that the type of winding machine also influences the end breakage rate in warping. The packages produced on modern high speed automatic winding machines give considerably lower end breaks in warping as compared to those produced on the conventional winding machines. Electronically cleared yarns give the best results in warping.

The warping performance is also affected by the winding speed in the following ways:

i) The winding speed influences the sloughing off of the supply package and this becomes more significant at higher winding speeds.
ii) The winding speed influences the end breakage rate in winding and thus the total number of knots in the yarns.
iii) The winding speed also affects the tensile properties of the yarn. There is deterioration in the tensile properties at higher winding speeds.

Hence it can be seen that yarn wound at higher speed (other parameters remaining constant) usually gives a higher end breakage rate in warping.

Another important contributing factor to the end breakage rate in warping is the presence of wild yarn. This is, however, not valid for all wild yarns.

4.5 Influence of warping conditions

4.5a Warping speed

The end breakage rate in warping is found to increase with the increase in warping speed, though not proportionately. Hence based on the quality considerations and optimal working conditions, it is more practical to run the machines at the maximum possible speeds.

4.5b Yarn tension

A number of factors are found to influence the warp tension. Some of these are the warping speed, yarn count, type of tension devices, yarn friction at guide points.

Problems such as snarl formation and entanglement can be avoided by maintaining proper level of tension. Since the tension in warping extends over a longer length of yarn and greater duration of time, weak places that have withstood the winding , yield to the warping tension, thus causing end breaks.

The variation in yarn tension is another important aspect that needs attention. Greater variation in tension leads to end breaks. It is more practically difficult to set tolerance limits for the tension variations. In the case of modern warping machines tension compensators have been provided to ensure minimum tension variation.

4.6 Machinery conditions and settings

Improper machinery conditions such as worn out machine parts, eccentric guide rollers, etc., lead to more end breaks. Worn out parts create more abrasion on the yarn moving on their surface, and eccentric guide rollers cause tension variation. Both these result in more number of end breaks. Besides these, the alignment of the warping creel is also critical in influencing the end breakage rate. Improper alignment causes yarn abrasion with the nose of the supply package during unwinding, thus resulting in more end breaks.

4.7 End breaks at supply package changes in creel

This occurs mainly in the case of magazine creel. In the case of a magazine creel the tail end of the running cone is knotted with the leading end of the reserve cone. Despite the advantages this system offers with respect to reduced down time in creeling and improvement in production and efficiency, there exist a number of possibilities for causing end breakages. Some of the important causes are improper alignment of the creel, slough off of the last few layers of yarn from the running cone, cuts at the nose points of cones, and improper knotting of ends by the operators during creeling.

4.8 Implication caused by end breakages

The major factor influencing the efficiency of the warping machine is the end breakage rate. The time consumed in mending a broken warp end is generally thirty to sixty seconds. Even under normal circumstances, where the warp breakage rate is considered to be normal, the mending time of the breaks is nearly equal to the running time of the warping machine per beam. Hence the running efficiency of the warping machine is generally low (50-60%). Thus any further increase in the end breakage rate, even by a small amount, will further affect the warping efficiency. Moreover, stoppages resulting from end breaks are more expensive as compared to that in the winding process, since it involves several warp ends. Besides the machine productivity, the end breaks also influence the labour productivity, as it increases the workload of the operative per unit of production.

The end breakage rate also affects the quality of the warper's beam in the following ways:

i) The number of knots put in the warper's beam increase proportionately with the end breakage rate, which ultimately affects the weaving performance.

ii) Whenever an end breaks, a brake has to be applied in order to stop the warping machine. This creates a lot of risk of the warper's beam surface getting damaged due to friction between the drum and beam surface, in case of drum driven machines.

iii) Higher levels of end breakage rates increase the workload of the operator per unit of production.

iv) When the broken ends are wrongly tied, it leads to lappers and migration in sizing process. The frequency of migration and lappers in sizing increase with the end breakage rate in warping. This consequently leads to crossed and missing ends in the weaver's beam and thus affects the weaving performance.

Thus in order to control the end breakage rate in warping, the important warping parameters such as machine speed, tension and machinery maintenance need to be properly selected. Periodical end breakage studies, causewise, should be conducted regularly to keep a check on the causewise distribution of the total end breaks.

4.9 Waste in warping

The level of waste is warping is an important consideration and measures are to be ensured that the waste is kept at a minimum. Important sources of waste are damaged cone/cheeses, package changes at creel and entanglements. The level of waste at warping is further increased by other factors such as inadequate supply packages, poor training of operatives, poor working conditions, bad house keeping, etc. Thus control of waste at warping becomes crucial.

4.9 Measures to reduce level of waste

i) Cones with very rough surface at their nose create more breaks during the final stages of unwinding. Hence such cones may be removed by the operative before they are completely unwound.

ii) In earlier machines (Barber colman type) each creel change resulted in considerable amount of waste. The operatives should therefore not wind long lengths on the beam while denting the ends.

iii) After warping the last beam from the set, the starters should have little yarn remaining on them, otherwise, the yarn layers get swollen and they come out at the sides and result in waste.

iv) The yarn tension between warper's beams should be maintained uniform during warping so that the grey waste at the next process is reduced.

Thus following the above mentioned steps could considerably reduce the hard waste at the warping process and could thus result in savings for mills. Additionally, maintenance of a waste record would be a step forward in the waste control activities. This would be necessary as it would not only reveal details of the causes daily, but also pin point the areas responsible undue waste.

Chapter 5

PRODUCTIVITY AT WARPING

5.1 Introduction

The productivity of any machine is a measure of the efficiency of the production of the machine. A number of factors are known to affect the productivity of the warping machine. These are the machine speed, end breakage rate, yarn content of warper's beam, number of beam doffs per creel set, type and size of creel, etc.

5.2 Factors influencing productivity

5.2a Speed of warping machine

Theoratically, the productivity of a warping machine increases with its running speed. Hence the trend is to go towards the maximum possible speeds. On the contrary, in practical conditions, running the warping machine at higher speeds increases the end breakage rate, which in turn results in more machine stoppages. Thus in order to maintain optimum working of the warping machine and get the best quality of warper's beams, it is recommended to run the machine at 70 - 80% of the maximum attainable speeds.

5.2b End breakage rate

The mending of an end break takes considerable time (30 to 60 seconds). Also, some amount of time is lost due to the interval between the starting of the warping machine and its picking up full speed. Thus the mending time of a warp breakage includes the time for mending and starting time of machine till it picks up full speed. This considerably affects the warping machine productivity.

5.2c *Amount of yarn present in the warper's beam*

The yarn content in the warper's beam affects the running time of the warping machine and the end breakage rate per creel set, considering that the number of doffs remain the same. Thus the efficiency of the warping machine is improved with more yarn content in the warper beam. However, it is to be noted that small increases in yarn content is not practically significant. An increase in yarn content of the beam by 5000 meters improves the machine efficiency by only about 1%.

5.2d *Doffs of warper beams per creel set*

The time to doff or remove full warper beams is insignificant in relation to the total time during which the machine was run. Thus change in the number of doffs per creel set does not significantly affect the efficiency of the warping machine.

5.2e *Creel type and capacity*

The various creels used on warping machines are the single cone and magazine creel. The single cone type of creel is generally used on high speed warping machines. The total service time with this type of creel includes creeling time, mending time of breaks, doffing time and time for different types of stoppages.

The advantage of the magazine creel is that the creeling time is reduced since the tail end of every package is attached to the leading end of the reserve package. Hence the machine does not have to stop for creeling operation. However, considerable time is lost in cleaning the when changing to another count. This time is estimated to be 40 minutes.

The creel capacity normally range between 400 - 500 ends per warper beam. In modern machines it is around 700. In the case of single cone creel, the increase in the creel size causes more creeling time and thus lowers the efficiency of the warping machine. Moreover, the number of breaks per creel set and thus the number of stoppages per creel set increase with the creel size. In other words, increase in the creel capacity or size reduces the efficiency of the warping machine.

5.3 Productivity calculations

5.3a Direct beam warping

Efficiency %

$$= \frac{\text{Machine running time per creel set in minutes}}{\text{Total time in minutes per creel set}} \times \text{utilisation}^{*}\ \%$$

* Generally utilisation is considered to be 95%

The calculation of the total time differs for various types of warping machines.

In the case of high-speed and slow speed single cone creel machines,

The total time in minutes = running time + mending time + doffing time + creeling time per creel set + miscellaneous time per creel set.

Running time per creel set

$$= \frac{\text{Length/warper's beam in m} \times \text{number of doffs/creel set}}{\text{Warping speed in mpm}}$$

Mending time per creel set = number of breaks/creel set x (piece-up time+time for Acceleration per break in min.

Doffing time per creel set = number of doffs/creel set x doffing time in min. per warper's beam

Creeling time per creel set = creeling time in minutes per cheese x number of ends/warper's beam

Miscellaneous time per creel set = Length/warper's beam in m x number of doffs/creel set x miscellaneous stop time in minutes per 1000 m

5.3b Warping machines equipped with magazine creel

Efficiency %

$$= \frac{\text{running time/creel set in minutes} \times \text{Total time in min/shift of 8 hrs-40}'}{\text{Total time in minutes per creel set}}$$

* Total time in min/shift of 8 hrs

* Total time in min/creel set = running time + mending time + doffing time + miscellaneous time

\# 40 = time in minutes provided for cleaning, count changes, etc./machine shift

The production/ shift of 8 hrs

$$= \text{Warping speed in meters/min} \times 60 \times 8 \times \frac{\text{Efficiency}}{100}$$

5.3c Sectional warping

There are two sequences of operations involved in sectional warping, namely, warping and beaming. Since a sizeable amount of time is consumed in beaming or running off operation in addition to other servicing times, the efficiencies attained on these machines is normally very low.

Efficiency %

$$= \frac{\text{running time in min. per creel set}}{\text{Total min. per creel set*}} \times \text{utilisation}^{\#}$$

* Total min. per creel set = running time + running-off time + piecing up time + leasing time + creeling time per set

\# Normally utilisation of 90% is considered

Production in meters/machine shift of 8 hrs

= Warping speed in mpm x 60 x 8 x efficiency

5.4 Labour complement

This is another important aspect to be considered in relation to productivity of the warping machine. It consists of warper, creel boys and auxiliaries, if any. It is preferable that fewer creel boys should be employed to get better labour productivity.

Chapter 6

DEFECTS IN WARPER'S BEAMS

6.1 Introduction

The quality of the warper's beams is an important aspect to be considered for it reflects on the performance in the subsequent process. Also it determines the success or failure of the warping process. The quality of the sized beams is also considerably influenced by the quality of the warper's beams. This will have a bearing on the weaving performance. A number of defects are commonly encountered in the preparation of the warper's beams. This chapter therefore investigates into the causes of defects found in warper's beams and the necessary remedial measures to be taken in order to ensure good quality warper's beams.

6.2 Types of defects

6.2a Sunken ends

In this type of defect, some of the warp ends of a layer can get submerged in the next inner layers.

Causes : The flanges get damaged due to improper handling of the beam and unsatisfactory storage condition. Due to this, unwinding of the yarn near the flanges will not be satisfactory if the front comb width is less than the width of the beam between its flanges.

Remedies : Care should be taken for the beam and it should be stored in beam racks. It would be preferable to put cushioning seats in between beams.

6.2b Cross ends

In this type of defect some of the warp ends are not in their place and get crossed over one another. Such defects create problems in the weaving.

Causes : The main cause is the improper functioning of stop motion and brake mechanism. The worker lays across the end during mending the broken end.

Remedies : The warp stop motion and the efficiency of the brake should be checked once in every shift of eight hours.

6.2c Ridgy beam

In this type of defect the surface of the wound beam is not uniform, and has ridges or projected portions across its width.

Causes: This is due to the uneven spacing of the ends caused by incorrect drawing of ends through the dents. If the comb wires are bent or if, their spacing is irregular, ridgy beams will be produced.

Remedies : Drawing of ends must be done carefully for even spacing. Proper maintenance has to be done on the comb unit.

6.2d Soft beam

In this type of defect the beam does not have the usual or normal package density. The package is density is lesser than usual.

Causes : Low tension of warper's beam

Insufficient pressure between beam and drum

Tension drop wires not held properly by warp ends

Remedies: The yarn tension is to be properly maintained. Also the pressure between the warper's beam and drum is to be properly maintained.

6.2e Damaged yarn surface in the warping beams

In many warping machines the beams are driven by the frictional contact with the driving drum. The driving drum should be highly and uniform pressure must be maintained in between beam and driving drum through the process.

In the event of a warp break, the warper's beam has to be stopped in a very short time, during which the drum rubs on the outside layers of yarn on the beam. If the drum surface is not smooth, the damage to the yarn is severe.

Preventive maintenance and routine maintenance must be carried out regularly to avoid the above said defects.

Chapter 7

PROCESS CONTROL IN WARPING

7.1 Introduction

The importance of the quality control measures has already been highlighted in the preceding chapter (winding). In this chapter the various quality control measures in warping department are discussed and will provide as a general guideline in the control of the quality of the warper beams. The various studies related to the quality are discussed herein. Two types of studies are done namely, routine and special studies.

7.2 Routine studies

The following are the routine studies done at the warping department:

7.2a Winding package defects

Rounds are to be made in the department in order to observe the wound packages that are stacked. This will help to identify important types of package defects such as cob web, entanglement in packages, stitches etc.

7.2b End breakage study

End breakage study is to be conducted a number of times in a month, say about 10 times, so that about one lakh meters can be covered countwise. The data collected from the study is to be entered in the appropriate format which is shown below. The data has to analyzed cause wise so as to pin point the causes of the excessive breaks.

Format for analysing causes of end breakages

Breaks at warping			
Investigation	Date ________	Count ________	
	Machine _____	Sheet No. _____	
Mills	Speed ________	Observer _____	
No. of observations	Dry	Time	
	Wet	Start	Finish
		RH%	
Actual time			
Dial	Start		
	Finish		
Meters observed			
No. of ends			
Cause (Frequency of breakages)			
1. Soft end			
2. Thin end			
3. Slub			
4. Snarl			
5. Slough off			
6. Bad piecing			
7. Foreign fibre			
8. Others			
SUB TOTAL (A)			
9. Improper knot			
10. Entanglement			
11. Package cuts			
12. Wild yarn			
13. Fluff			
14. Wrong count			
15. Cone change			
16. Others			
SUB TOTAL (B)			
TOTAL BREAKS (A+B)			
Breaks/1000 ends/ 1000 meters			

7.2c Stop motion study

The effective working of the stop motions should be studied once in a month

7.2d Mechanical condition of machine parts

Important parts of the warping machine are to be observed for their proper functioning and condition once in 15 days. The machine parts that need to be looked into are the creel fan, thread guides, tensioning devices, stop motion pins, reed and comb dents and warping drum. The creel fan, in particular, should be checked for its functioning, and the other parts should be checked for grooves, cuts or burrs on their surfaces. Other parts to be checked include thread guides, tensioning devices, stop motion pins, reed and comb dents and warping drum. If any of these parts are found to be defective, they are to be noted and necessary action has to be taken to replace the same at the earliest.

7.2e Brake and clutch

The brake and clutch mechanisms should be checked for their proper functioning at least once in a month. The important points to be checked are the clutch vibrations, excessive heat generation, smoothness of the starting and stopping operations and the time interval taken by the machine to stop after applying the brakes.

7.2f Beam gross weight

The warper beams have to be checked for their tare/ gross weight. This is necessary for assessing the yarn count. Generally there will not be variations in the tare weight of the beams unless otherwise worn out parts have been replaced by new ones. Even a variation in the beam tare weight by 1% or 500 grams alters the beam count significantly. It is suggested that about 25 - 30 beams have to be checked at random on a monthly basis. In case of variations in weight of the beam beyond the tolerance limit, mark will have to be made on the flanges of such beams and also necessary correction are to be applied for calculation of beam count.

7.2g Measuring motion

It is necessary to regularly check the mechanical condition and settings of the measuring motion. This enables to pin point faulty setting or wear out of measuring motion. In such cases the yarn content on the warper beams exceed 0.2%.

7.2h Machine speed

The speed of the warping machines will have to be checked once in a month by using a tachometer. In case of variation of speed, steps are to be taken to restore the proper machine speeds.

7.2i Standardization of extra length on warper's beam

As some yarn will go as waste in the sizing process, it is necessary to provide some additional length of warp either at the start or the end of the warper's beam. However, mills need to develop appropriate standards for the additional length so as to prevent undue waste of unsized yarn due to leftovers on beams during sizing.

7.3 Quality of warper's beam

Beams are to be studied at random for frequently occurring faults and this will enable to give an idea about the quality of the warper's beam. Beams that are in the warping machines and those that are stored nearby are to be selected for the studies.

7.4 Hard waste

The level of hard waste should be assessed on a monthly basis from the waste records.

7.5 Machine efficiency and production

These too are to be calculated on a monthly basis from the concerned records.

7.6 Maintenance

In carrying out machinery maintenance audit work, the frequency of checking should be planned as per the maintenance schedules.

7.7 Humidity

The humidity level of the warping department should be checked on a weekly basis by using a whirling hygrometer. A thermograph could also be installed in the department.

7.8 *Special studies*

7.8a Hard waste studies

Studies on hard waste are to be conducted causewise, whenever there is a deviation in the level of hard waste from the normal trend, as assessed by calculations done on a monthly basis.

7.8b Yarn tension and tension variations

The tension of the warp yarn and its distribution across the width of the warp sheet should be checked using a tension meter, as and when required. The short term tension variations arising due to uneven build of package or improper alignment at the creel can be detected by observing the creel while it is working. In such cases, the stop motion pins of the defective creel positions exhibit jumping tendency.

PART III
SIZING

Chapter 1

SIZING AND ITS IMPORTANCE

1.1 Introduction

Sizing is the intermediate process of weaving preparation. The yarn after being warped is sized or coated with a thin film of adhesive. The purpose of sizing the yarn is to improve its weavability. A single unsized yarn is incapable of withstanding the strains of weaving and also affects the loom production and efficiency. Hence it becomes crucial to size the yarn, particularly single yarn. In fact, sizing is the most important in the weaving preparatory process. It would not be an exaggeration to say that to size well is to weave well, just as the saying goes that to card well is to spin well. The size material used in sizing consists of a number of ingredients mixed together in suitable proportions to form a viscous paste. The type of sizing material differs for different types of textile materials.

1.2 Objectives of the process

The objects of sizing are manifold and are as follows:

a) Add strength to the yarn so as to withstand the stresses and strains of the weaving process.
b) Improve the abrasion resistance of the yarn
c) Make the yarn smoother
d) Add more weight
e) Cover the protruding fibres on the yarn surface

1.3 Important technical considerations

The following are the basic considerations to be made in sizing of warp yarns:

a) Type of weaving machinery on which the sized yarn is to be used. The extent of tension that the yarn is subjected to depends on the loom type.
b) The type of textile material being sized. Different materials (cotton, polyester etc.) respond differently to the strains encountered in weaving. The sizing material used depends on the type of textile material being used.
c) The stresses and strains that the yarn is subjected to during the sizing process.
d) Energy consumption and cost in sizing.
e) Characteristic of the ingredients used, methods of size paste preparation and their, concentration of the ingredients, viscosity of the size paste etc.
f) Desizability of the sized material after weaving and the cost involved.
g) The sophistication of the sizing machine.
h) Economy of the process to get the best quality of warp at the lowest cost.

1.4 Suitability of size for different textile materials

Each type of textile material responds differently to the stresses and strains to which it is subjected in the weaving process. For example cotton material responds differently as compared to polyester material. Continuous filament yarns have good resistance to the weaving tensions due to their better cohesion and continuity of filament length. The purpose of sizing in such cases is only to improve the abrasion resistance rather than strength. The toughness of the textile material is even more important than its strength. Synthetic fibers are advantageous in this aspect. Each type of textile material has its own merits and demerits and the type of size ingredients have to be used accordingly to compensate for their demerits.

Chapter 2

SIZING INGREDIENTS

2.1 Introduction

The fundamental objectives of the sizing can be achieved only by impregnating the yarn with the appropriate size mixture consisting of various ingredients in suitable proportions. Each ingredient should impart a particular property to the yarn. Accordingly there are two types of ingredients, namely the primary and secondary ingredients. The primary ingredients are those that are essentially required in the size paste whereas the secondary ingredients are those that may or may not be added to the size mixture according to the requirements. The primary ingredient is the main ingredient and it helps to give additional strength to the yarn and also improves its abrasion resistance. The other ingredients known as the secondary ingredients give additional properties to the yarn such as feel, weight, appearance etc.

2.2 Types of ingredients

The following are the types of ingredients used in sizing

Primary
Adhesives
Softeners/lubricants
Antiseptics

Secondary
Humectants
Antistatics
Weighting agents
Brightening/bluing agents
Wetting agents
Antifoaming agents

2.3 Primary ingredients

2.3a Adhesives

Adhesives are those materials that can adhere to the warp yarns through out the weaving process by increasing the yarn strength and also making its surface smooth so as to withstand abrasion between neighbouring warp threads. The adhesive improves the yarn strength by binding the fibres in the yarn together thus making the yarn strong enough to withstand the weaving stresses and strains. In other words the adhesive is that which binds the fibres together and brings about better cohesion between them. Additionally the adhesive should have a certain level of viscosity so that it can form a coating or thin uniform film around the surface of the yarn thereby reducing its frictional resistance and thus reduce abrasion between neighbouring warp threads. Also the adhesive should bind the protruding fibres to the surface of the yarn.

A number of adhesives are available and these are listed below:

a) Starch and starch products
Ex: Maize starch, Tapioca starch, Potato starch , Sago starch, Wheat starch etc.

b) Thin boiling starch/ soluble starch
Ex: British gum, Dextrin

c) Natural adhesives other than starch
Ex: Tamarind kernel powder , gum Arabic, gum tragacanth, gum karaya, bean gums

d) Protein substances
Ex: Glue and gelatine, Casein, Soya bean protein

e) Pectin materials
Ex: Alginic acid

f) Starch, gum and cellulose derivatives
Ex: Starch ethers and esters, gum guar, Carboxymethyl cellulose

g) Synthetic adhesives
Ex: Polyvinyl alcohol, Acrylic polymers, Vinyl polymers, Polyethylene glycol, Polystyrene etc.

2.3b *Softeners/lubricants*

These are next in importance to the adhesives. The adhesives produce a film on the yarn which is rather stiff and thus renders the yarn inflexible. Hence in order to make the adhesive film flexible or pliable, the softener is added. Another problem is that the adhesive film on the yarn is not smooth, i.e., has rough or uneven surface. This tends to generate frictional forces between neighbouring warp threads in the loom during shed formation and also between yarn and certain loom parts such as reed, heald eyes etc. The effect would be that the rough coating of size would come off the yarn and subsequently lead to yarn breakage in the loom. Therefore it is necessary to make the yarn surface smooth. The softener thus performs the dual function making the yarn flexible and smooth. In other words it also acts as a lubricant. Softeners/lubricants used are the following

Example : Oils and fats, waxes, mutton tallow, oils and emulsions, stearic acid emulsions, vegetable tallow, soaps, sulphated oils and fats, mineral oils, paraffin wax, plasticizers, etc.

Of the many softeners available, mutton tallow is considered to be the best since it acts well as a softener and lubricant.

2.3c *Antiseptics*

These are also known as preservatives. Cellulosic or protein materials which are sized, are particularly susceptible to attack by microbiological organisms, moth and insects and mildew. This is due to the hygroscopicity of the textile material & the adhesive with which they are coated. The following antiseptic agents are used in sizing

a) Metallic salts
Ex: Zinc chloride, copper sulphate, zinc sulphate, sodium silicofluoride

b) Organic compounds
Ex: Sailcyclic acid, Phenol, Cresol, Benzoic acid etc.

Among the various antiseptics used, zinc chloride is the best since it acts both as an antiseptic as well as humectant.

2.4 Secondary ingredients

2.4a Deliquescents

These are basically hygroscopic agents and therefore are also called humectants. They help the sized yarn to regain its moisture and flexibility. In other words the deliquescents prevent the yarn from overdrying and becoming brittle, by retaining the moisture in the cotton yarn in the required level of 8-10% and thereby maintain the flexibility of the yarn. These are, however, not required in modern sizing machines that are equipped with moisture controllers. The various types of deliquescents that have been used in sizing are Zinc chloride, magnesium chloride, Glycerine etc.

2.4b Antistatics

Though the antistatic agents are considered to be under the category of secondary ingredients, they are of importance in the sizing of synthetic hydrophobic that are prone static electricity. Fibres such as polyester, nylon, cellulose acetate are highly prone to static electricity. The static charges generated create problems in the subsequent processes, difficulty in unwinding of the weaver's beams, cloth rolls, and in extreme cases can even cause fire hazards. Hence it becomes necessary to control the static charge generation. The antistatic agents used are glycerol, polyethylene glycol, lissapol NX. Out of these lissapol NX is the best. Besides there are also several types of antistatic agents that may be of anionic, cationic, non ionic or amphoteric in nature.

2.4c Weighting agents

These are also variously known as weightening agents, filling agents, fillers etc. They help to add weight to the yarn so as to make the fabric get a feel of fullness. This is of importance when the cloth is to be sold in the grey state on a weight basis. Some of the well known weighting agents are China clay, Gypsum, Talc or French chalk or soapstone, Barium sulphate, Epsom salt etc.

2.4d Brightening/bluing agents

These are colouring/whitening agents. Here too, just as in the case of the weighting agents, these agents are required when the cloth is sold in a grey state. Cotton materials have natural colouring matter which makes them dull or creamish in appearance. Hence in order to improve the aesthetic look of the material, they are generally made whiter or given a bluish tinge. Some of the well known brightening /bluing agents used are Ultramarine blue, acid dyes, fluorescent brightening agents etc.

2.4e Wetting agents

In the case of synthetic textile materials such as polyester, nylon etc., the natural adhesives such as starch cannot wet the fibres, since they are hydrophobic in nature. Therefore synthetic adhesives will have to be applied with some suitable wetting medium. The wetting medium which is ideally suited for the purpose is turkey red oil. Other oils such as P4 oil can also be used.

2.4f Antifoaming agents

During the sizing there is always the possibility of foam generation in the size or sow box. The foam is generated by surface active agents such present in the size paste such as soaps, turkey red oil etc. Alkali foam is formed due to the churning action of the squeezing rollers. The foam that is formed is carried by the warp sheet and causes smudging of the drying cylinders. Hence in order to reduce the foaming tendency of the size paste, anti-foaming agents are to be added. Some of the well known anti-foaming agents used are amyl alcohol, turpentine, pine oil, etc.

Chapter 3

SIZE PASTE PREPARATION

3.1 Introduction

The preparation of size paste is a crucial aspect in sizing, since it has a direct bearing on the quality of the sized warp sheet. Proper care and caution is therefore needed to be exercised during the size paste preparation, particularly when starch is used in the size paste. Once the type of ingredients for the size paste is selected, the size paste or mixture has to be prepared in a proper way. Factors such as sequence of adding the size ingredients, temperature and duration of sizing are to be properly controlled, as otherwise the very purpose of the sizing is lost.

3.2 Preparation of the size paste

The preparation of the size paste involves the following aspects:

a) Size formulation
b) Cooking equipment
c) Storing

3.2a Size formulation

The important aspects to be considered here are the gelatinisation, concentration of size paste, and sequence of addition of ingredients in the size paste.

In the preparation of the size paste, the main aspect to be considered is the uniform distribution of the adhesive such as starch, in the size paste. This requires a process known as gelatinisation, which involves a high temperature. Even equally important is to maintain the viscosity of the size paste at the required level. During gelatinisation, the starch granules get burst during further heating and stirring, and thus reduce the viscosity of the paste. Hence it becomes necessary to continue the heating and stirring long enough such that a kind of equilibrium stage is reached, whereby the viscosity of the size paste becomes more or less stable. The concentration of the size paste is another important aspect to be considered, since this is necessary to get an uniform size film on the warp. Therefore the concentration, or the weights of the various ingredients used per unit volume of the size paste, must remain constant.

During the initial stages of size preparation, cold water is taken in a vessel, and this is lesser than the final required volume. This is necessary so as to avoid the increase in volume of the size paste due to condensation of the steam, which causes decrease in concentration of the size paste. The ingredients are mixed in the cold water and then stirred for about 15-60 minutes, depending on the ingredients added and the their quantities. Steam is then introduced and this initially condenses and increases the volume, until the boiling temperature is reached. The condensation of the steam stops, as soon as the boiling of the size paste starts. The steam is therefore reduced and maintained just to keep the mixture simmering. The duration of boiling depends on the types of ingredients and their quantities. It may be noted that during the time of gelatinisation, the starch granules are swollen to their maximum extent and the viscosity of the paste is maximum. Further boiling breaks the granules and the viscosity decreases to some extent. During boiling the volume and therefore the concentration of the paste will remain constant.

It is usual to mix as many ingredients as possible in the cold water while stirring. Adhesives that are either partially or fully soluble in cold water and also those that are likely to form lumps in water are preferably sifted into the cold water, so that they come in contact with cold water in their finely divided condition. In the case of starch and china clay, it would be preferable to mix them with cold water in a separate mixing vessel and the slurry then added to the mixing vessel containing the other ingredients added in the cold condition. Those ingredients such as CMC, thin boiling starches, PVA etc., that partially or fully dissolve in cold water and form thick pastes, and which do not require long steeping are added in the dry condition only through a sieve to cold water in the cooking vessel, while stirring. Mutton tallow is preferably added when the temperature of the mixture is above the melting point of the tallow, but below the gelatinising point of the starch (50-60°C). This enables to keep the other ingredients in a stable suspension, preventing them from separating out during boiling or sizing. The stirring in the cold condition is carried out for 15-45 minutes, and then heating started and when the paste is hot enough, ingredients such as tallow, gum paste, etc. are added and heating continued till boiling point. The boiling is continued for 45 - 120 minutes, depending on the amount of starch and other ingredients present. In case all the ingredients are soluble in cold water, the duration of boiling is shortened.

The number of ingredients to be added in making the size paste should be as minimum as possible. It is recommended that the number should generally range between 3-6.

As regards the quality of water to be used in the preparation of the size paste, it should be clear, colourless, odourless, neutral, reasonably soft, free from excessive proportions of inorganic salts and free from micro-organisms. If the water is acidic, it will tend to affect the viscosity of the size paste. On the other hand, if the water is alkaline, it can generate foaming tendency of the size paste.

3.2b Cooking equipment

Various cooking equipments have been developed over the years. The following are the types of size cooking equipment

i) Size cooking kettles

ii) Homogenisers

iii) Pressure cookers

iv) Injection cookers

v) High shear size mixing equipment

3.2b(i) Size cooking kettles

These are also known as the becks. They are the simplest and most conventional types of cooking vessels. A beck is a vessel made of wood and shaped cubically with each side measuring 1.25 meters. Additional beck is provided for the purpose of storage. The cooking beck is provided at its centre with a stirrer that is driven by bevel wheels on a shaft, which in turn is driven by a line shaft or by an individual motor through reduction gearing. Subsequently, cylindrical becks had been developed, which are made of cast iron and lined inside with copper in order to prevent corrosion of the cast iron. Sometimes becks were also made of pure copper. However, these were more expensive. The cylindrical becks are advantageous compared to the cubically shaped ones in that the stirrers can reach all parts of the beck, whereas in the cylindrical becks, the four corners of the beck will be out of reach of the stirrers. The becks are provided with steam pipes besides the stirrers, for heating purposes. The capacity of the size mixing becks ranges between 675-1800 litres.

3.2b(ii) Homogenisers

During continued boiling and stirring of the cold size paste (slurry), the swollen starch granules burst out to uneven sizes and hence the viscosity of the size paste is unstable. Such a size paste is easily affected by changes in temperature and also by storage. The size film that is formed is also not uniform. The homogeniser is an equipment, where the swollen starch granules are broken up into smaller particles of more or less uniform size. Thus the viscosity of the size paste becomes more stable and also the size film that is formed is also more uniform. During the process of homogenising the cold starch slurry is heated to a temperature just above the gelatinising temperature of the particular starch. The starch paste containing the swollen but unbroken granules is then passed through a small hole of microscopic dimensions, with such as great force and speed that the swollen granules rub with one another and against the wall of the hole and thereby get broken up into more or less uniform small size. The paste thus obtained has more viscosity and the film that it forms on the yarn is also more uniform. The homogenisers were popular till the recent years.

3.2b(iii) *Pressure cookers*

Pressure cookers have the advantages of less cooking time and steam consumption. They are cylindrical in shape and the general dimensions are 1.25 m dia x 1.5 m length. A stirrer is placed at the centre of the cooker and rotates at a speed of 40-60 rpm. As shown in the fig. 3.1, the cooker is provided with a safety valve and inlet and outlet pipes for steam and water.

There is provision for temperature control. The volume of water (containing adhesive) taken is somewhat lesser than the final volume. The stirrer is started and steam is let into the steam jacket. The lid of the cooker is closed as soon as the boiling commences, the supply of steam into the cooker is stopped and the steam pressure is raised upto 1.5 bar. The cooking is done for half an hour at the optimum temperature. After the cooking is completed, the pressure is allowed to drop and the size mixture is transferred to the storage tank. At this point, ingredients such as

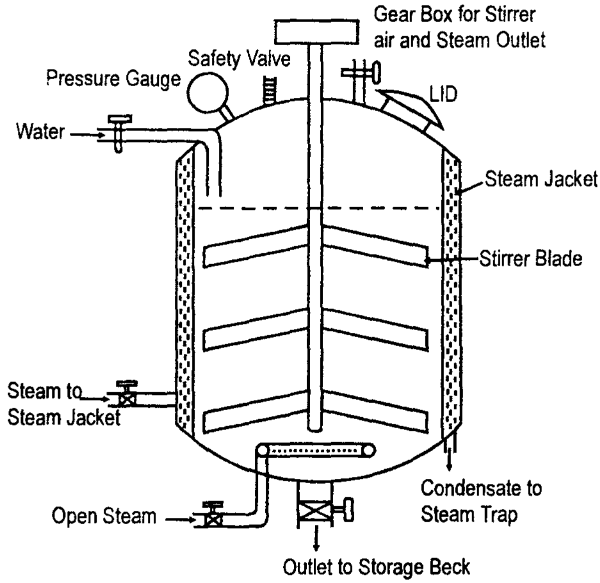


Figure 3.1

antiseptic, softener etc are added to the size mixture and the mixture boiled and then made up to the desired volume.

3.2b(iv) Injection cookers

The injection cooker is a modified version of the pressure cooker and is intermediate between the pressure cooker and homogeniser. This is due to the fact that during the cooking, pressure and mechanical agitation are involved. A centrifugal pump fitted below the cooker, and it pushes the size mixture upwards and forces it from the top into a pipe mixer inside the cooking vessel. The size mixer pipe has slots near its bottom, through which the size mixture is forced out into the cooking vessel. The size mixture emerging from the mixer pipe is also pushed down by pressurised steam, which is injected at the top of the pipe mixer. The injected steam creates a small pressure in the size mixture due to the pressure of the centrifugal pump. Mechanical agitation takes place due to the high rate of flow of the size mixture and the injected steam, accompanied by high temperature. This condition causes the starch granules to swell quickly and then burst out. The cooking time thus gets reduced to one third of the usual time, thereby reducing steam consumption considerably. The cooking vessel has device to measure the viscosity of the size mixture. When the viscosity level has reached optimum value, the steam supply is shut and the third opening of the valve in the size circulation passage is opened so that the centrifugal pump forces the ready size paste to the storage vessel.

3.2b(v) High shear size mixing equipment

The homogeniser has proved to be effective for producing a good quality of size paste with uniform size film. However, the circulating pump in this case has to be a very powerful one. Hence subsequent attempts have resulted in high shear size cooking equipments of various types.

A number of advantages have been claimed by the use of these equipments. These are as follows:

a) A somewhat considerable reduction in steam consumption
b) Time to prepare size paste is lesser
c) As viscosity of size paste is lower, size penetration into the warp is better
d) Since size film is more uniform, the weaving efficiency is improved
e) Results in saving in size ingredients

A number of high performance size cooking equipments are based on this principle. Some of the well known ones are the zell-o-mat cooker, platt high shear mixer, sucker turbo mixer and hibbert's rapisonic homogeniser.

TECHNIQUES OF SIZING

4.1 Introduction

The basic object of sizing is to coat the warp yarn with adhesive so as to increase its strength and abrasion resistance and also to make it smooth and uniform. This is achieved by various techniques, depending upon the capacity of the weaving. In the case of cottage industries operating on a small scale, the hank sizing is the most suitable. Hence the method is suitable for handloom sectors or small scale powerloom sectors. It is known to be simplest method of sizing. When operating on a slightly larger scale, the ball warp sizing is adopted. It is a more advanced method compared to the former one. The method has become obsolete nowadays. The third method, namely, tape or slasher sizing is the most commonly adopted method today.

4.2 Hank sizing

This method is suitable in remote rural areas where the warp is available in hank form. This method has become obsolete due to the difficulties encountered in the processing of the hanks in the viscous adhesive size pastes. Hank sizing was adopted by using minimum number of size ingredients. The sizing of the hanks was followed by shaking, stretching and brushing in order to achieve a more thorough and uniform distribution of the size paste along the threads to make it smoother and to prevent the tendency of the yarn to stick together in a group. Since this technique is not continuous, and is slow, it resulted in a very low rate of production. It is prevalent only in the handloom sectors in India.

4.3 Ball warp sizing

This method is also called chain warp sizing. The warp yarn in the form of a loose rope is made to go through a vessel in which is kept the size paste. The vessel also contains a number of guide rollers over and under which the warp yarn passes. The yarn is sent out of the vessel after getting thoroughly soaked with size. It is then dried. The main advantage with this system of sizing is that since the sizing, drying and winding of the warp are done separately, there is more scope for penetration of size in the yarn, and also dried yarn gets sufficient time to absorb moisture from the atmosphere. Another advantage is that the extensibility of the yarn is preserved owing to little tension during sizing or drying. Though the seperateness of the operations in this method is an advantage, it also becomes a disadvantage, as it is a slow process and therefore cannot satisfy modern requirements of high productivity and hence has become obsolete. It is, however, suitable for sizing of short lengths.

4.4 Tape or slasher sizing

This method is universally adopted and is suitable for large scale operations. In this method a number of warp yarns as per requirement, is assembled in the form of a continuous sheet, sized and then wound onto a weaver's beam. These operations are supported by auxiliary operations such as separation of ends, measuring warp length, marking into cut lengths and winding the warp of equal length to form the warp of a fabric. All these operations are performed by the slasher or tape sizing machine.

The slasher sizing machines are classified according to the method of drying. Accordingly there are three types, namely,

a) Cylinder drying - Twin and multi cylinder types

i) Hot air drying
ii) Electrical drying

The first method is based on the principle of conduction and is widely used in industry. Twin cylinders were used for drying of sized warp in the conventional machines. Later multi cylinders have been used and are commonly prevalent nowadays. The second method is based on the principle of convection, and the third is based on the principle of radiation.

4.5 Passage of material through a slasher machine

The general passage of warp through a two cylinder slasher sizing machine is shown in figure 4.1.

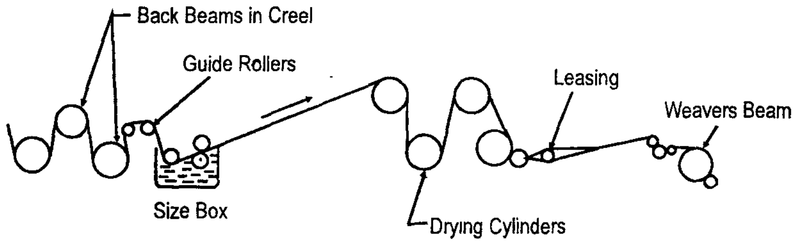


Fig. 4.1 Passage of material through a slasher sizing machine

The yarn from the warper's beams usually containing about 500 - 800 warp ends, are made to pass into a size box through a guide roller. The warper's beams also known as the back beams are placed in a stand called creel. The number of warper beams depend upon the total number of ends required in the cloth or weaver's beam. The warp from rearer beams pass over and under the successive back beams. The warp sheet emerging from the back beams enters a size box that is kept heated by constant supply of steam through pipes. The warp sheet is made to go under a partially immersed immersion roller, and then passes between the nip of the size and squeeze roller. The squeeze roller impregnates the size into the yarn structure and also removes external excess size and at the same time drags the warp sheet through the paste.

The wet size yarn then enters the drying zone comprising of either two or multi cylinders or hot air chamber. The sized yarn is dried here. The residence time of the sized warp in the drying zone is regulated in such a way so as to avoid over drying. All the cylinders are steam heated except the last one, which is kept cool by supply of cold water. This is done so as to cool the warp sheet when it leaves the drying zone.

The sheet of warp yarns after leaving the drying zone, is then split into as many sections or layers as there are beams in the creel. This is done by means of lease rods or split rods. The purpose is to eliminate stickiness of neighbouring warp threads. The split warp threads are then recombined and then made to pass through an 'expanding or zig zag' reed or comb. This comb regulates the width of the warp sheet to the required dimensions. The warp is then made to pass between the nip of a 'drag roller' and a 'nip roller', and is finally wound on a beam called 'weaver or sizer's' beam. In short, the entire slasher machine can be divided into three important zones, namely,

a) Creel and size box forming the rear or back side of the machine
b) Drying arrangement forming the middle zone of the machine, and
c) Front zone or head stock consisting of weaver's beam, and various controls.

TYPES OF DRYING

5.1 Introduction

The warp sheet after leaving the size box gets impregnated with wet size paste to the extent of about 90% - 140% of its own weight. The process of drying involves complete removal of the moisture from the size paste and at the same time retaining the moisture in the yarn. This is particularly so in the case of cellulosic or any other natural fibre yarns. It is to be noted here that the degree of drying largely influences the yarn properties such as strength, flexibility, brittleness, plasticity and so on. Also the rate of drying determines the speed and production of the sizing machine. Hence the drying is to be effected in such a way so as to retain the desirable properties of the yarn and economy maintained with respect to production and energy consumption. The time and temperature of drying play an important role, and proper care and caution is to be exercised in this aspect as otherwise it would result in over or under drying of yarns that could create problems in subsequent process. There are different methods of drying sized yarns, the merits and demerits of each of which are discussed in the foregoing sections.

5.2 Methods of drying

There are three important methods of drying in sizing. These are :

a) Conduction method
b) Convection method, and
c) Radiation method

5.2 a Conduction method

In this method the drying of the warp sheet is effected by conducting or transmitting heat from metallic surface of drying cylinder which are steam heated. This is also known as contact type of drying, and is most popularly used in most of the slasher sizing machines nowadays. It is also very economical with respect to energy consumption. The only draw back with this method is the at a certain degree of flattening takes place due to contact of yarn with drying cylinders.

5.2 b Convection method

In this method the drying of the warp sheet is effected circulation of hot air around in the drying zone. The air may be heated either electrically or by steam. The hot air is circulated by fans and ducts. The main advantage with this method is that the yarn is not flattened as in the previous case.

5.2 c Radiation method

In this method the drying of warp sheet is effected by heat transferred to it by direct radiation. Electrical heaters are used for the purpose. Energy is transmitted to the yarn in the form of heat waves, by means of electromagnetic radiations, and this removes the water present in the yarn. In this method, also, as in the previous one, no flattening of yarn takes place , since the yarn has no contact surface. It is considered very poor with respect to economy in energy consumption and hence is seldom used. It is however suitable for laboratory trials as well as large scale operations that need quick drying.

5.3 Multi cylinder drying

As already pointed out, this method of drying is most commonly adopted in the industry. In this case, the number of drying cylinders used ranges between 5-13. The size of the cylinders is much smaller compared to those used in the conventional twin-cylinder machine. In some special cases, where dyeing and sizing are done simultaneously, such as in the dye-sizing operation for denim, the number of drying cylinders are much more, and may go up to 32. The cylinder diameter is about 762 mm. Steam pressure are normally higher and vary with different places. In some places, the steam pressures range between 2 - 2.5 kgs/cm^2, where as in other places it can range as high as 5 - 7 kg/cm^2. Higher steam pressures permit greater running speeds. The cylinders of a multi cylinder slasher machine are arranged in two rows (figure 5.1).

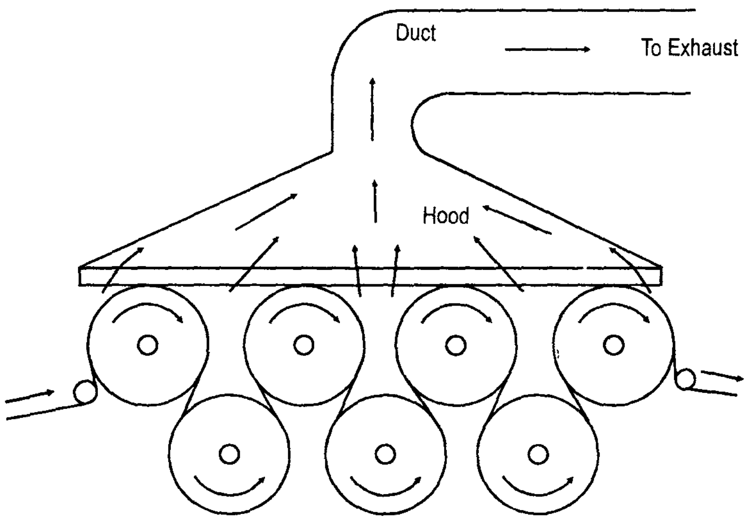


Figure 5.1 Cylinder Dryer with Hood

One of the advantages of the multi cylinder drying is that the cylinders are positively driven, and this prevents any undue tension on the yarn. The cylinders rotate smoothly since they are mounted on ball bearings. Each cylinder is provided with independent steam supply valve, so that the temperature of each drying cylinder can be individually controlled to suit the type of yarn and the machine. A number of parameters, such as type of yarn, speed of machine, number of cylinders, etc., govern the temperature of each drying cylinder. The first cylinder is at higher temperature, and the temperature falls at successive cylinders. The last cylinder is kept cool so that the dried yarn leaves the drying zone in a cool condition. The first one or two cylinders are coated with Teflon so as to prevent the problem of 'smudging' (size stain). The cylinder temperatures vary with the type of yarn sized. It ranges from a maximum of about 150° C for cotton yarns and minimum of 80°C for acetate rayon filament. Polyester and polyamide yarns are dried at 85 - 90°C.

The table 5.1 compares the two and multi cylinder sizing machines

Table 5.1 - Comparison between twin cylinder and multi cylinder drying

S.N.	Two cylinder machine	Multi cylinder machine
1	Rarely used	Commonly used
2	Larger cylinder diameters	Smaller cylinder diameters
3	2 drying cylinders used	5-13 cylinders used
4	Causes differential drying of size film	No such problem
5	Cylinders driven by negative frictional contact	Cylinders driven positively
6	Slower speed and production	Higher speed and production
7	More possibility of size sticking on cylinder surface.	Less possibility of size sticking on cylinder surface

5.4 Mechanism of cylinder drying

The mechanism of drying of yarn on the cylinders is schematically shown in figure 5.2. The sized yarn enters the drying zone in a cool and wet state. It then contacts the cylinder which is steam heated. At this point, the saturated steam just inside the cylinder surface cools and condenses and thus delays further heating of the cylinder surface. Presence of air in steam greatly reduces transmission of heat. The outer surface of cylinder heats the lower contacting face of the yarn, resulting in evaporation of water and thereby creating a thin layer of water vapour between the surface of the cylinder and the yarn. So too, when the water content on the upper face of yarn (not in contact with cylinder surface) evaporates, a thin layer of water vapour is formed is formed above it. Thus both the layers of water vapour (below lower face and above upper face of yarn) prevent further evaporation of the moisture in the yarn. Hence it becomes to remove the condensed water and air by means of steam trap and air vent respectively. This is accomplished in a simple way in modern machines, while the machine is running. The thickness of the layer of water vapour between surface of cylinder and yarn can be minimised by increasing the yarn tension, and this facilitates better heat transfer.

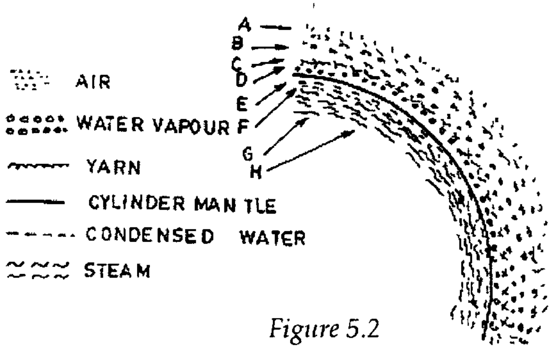


Figure 5.2

5.5 Hot air drying

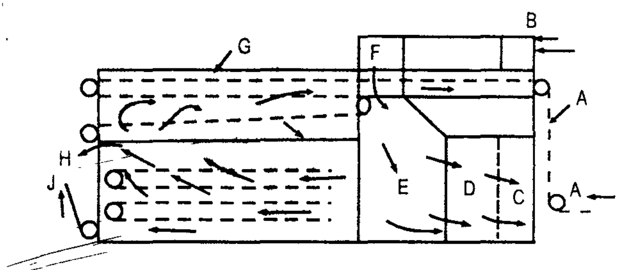
The hot air drying method was introduced so as to overcome the draw backs of the two cylinder drying system. It was prevalent before the use of the multi cylinder drying system. In this method, the warp sheet enters a chamber where hot air is circulated over it. The moisture in the warp sheet is thereby evaporated. The hot air not only removes the moisture from the yarn, but also carries away the water vapours that are formed.

One of the obvious advantages of this system over the cylinder drying system is that the hot air circulates all around the yarn surface and thus ensures uniform drying of the yarn. Another advantage is that the temperature and moisture content of the air can be adjusted to suit the properties of the yarn. This is accomplished by adjusting the degree of heating of the air and also mixing the fresh air with the moisture bearing exhausted air. This prevents the risk of over drying of the yarn. The major differences between hot air and cylinder drying are highlighted in the preceding section. Due to its disadvantages the hot air drying method is rarely used.

There are different systems of hot air drying and two important types are discussed herein.

5.6 Ruti hot air dryer

In this type of drying system the warp sheet enters the hot air chamber and moves around guide rollers. The hot air comes from both sides at the lower part of the chamber, and is properly distributed by baffles. The filtered air is sent to the upper part of the air chamber by means of suction fans and then made to go out . Additionally, cool air is also admitted into the chamber from outside, so as to prevent over drying of yarn at crawl speed. A sectional view of the dryer is shown in figure 5.3.



A Warp from size box
B Exhaust Fan
C Baffles
D Filter
E. Air Heaters
F Air intake Fan
G. Drying Chamfer
H. Suctions Fan
J. Warp Exist

Figure 5.3

5.7 Hibbert hot air dryer

The warp yarns from the size box enter the back portion of the drying chamber and then the front portion. It follows an almost horizontal path in the drying chamber. Hot and humid air from below enters the front portion of the dryer. It then enters the back portion of the compartment from where yarn enters. This enables better heat utilisation. The warp sheet after leaving the front portion of the drying chamber passes cold moist air that enters from outside. The warp sheet going out of the drying chamber therefore contains the required amount of moisture and is thus cooled. The schematic sketch of the dryer is shown in figure 5.4.

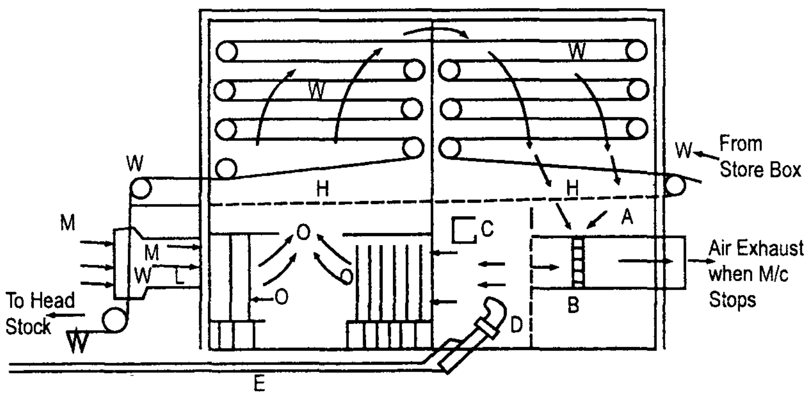


Figure 5.4

Chapter 6

SPECIAL DEVICES IN SIZING

6.1 Introduction

It would appear that once the sheet of warp is dried the next operation is to simply wind in on to the weaver's beam. This apparently looks to be very simple. However, it would be intriguing to note that a number of operations are to be performed after drying of the sized warp just before winding on to weaver's beams. These are necessary so as to ensure a beam of good quality suitable for the subsequent process of weaving. Some of the important devices are discussed in the foregoing sections.

6.2 Measuring and marking motion

When a textile mill sells its fabrics to the marke. t or its customers, it would be preferred to be sold in specific lengths. For example, a customer places an order for 10000 meters of a particular sort or quality of fabric. He would further specify that it be supplied in piece lengths of 200 meters and thus 50 pieces. Now considering that a weaver's beam can accommodate, say, 2500 meters of warp. Once this length is woven the entire fabric can be cut to pieces of 250 meters length. This is however, a tedious process for the required piece length has to be measured and cut. Hence it would be preferable that the required length be measured at sizing and marked, so that the mark can be identified in the fabric and easily cut. A measuring and marking motion therefore becomes necessary in the sizing machine. Different types of measuring motions are available. These are

a) Mechanical type

b) Electrical type

6.3 Mechanical marking and measuring device

The commonly used device is shown schematically in figure 6.1.

B. Color Wheel C. Nip Roller
E. Stepped CAM F & G Bevel Wheel
I. Measuring Roller Wheel
J. Carrier Wheel K. Worm Wheel
L. Worm S Stud Wheel
W. Weight H. Shaft
R. Dial

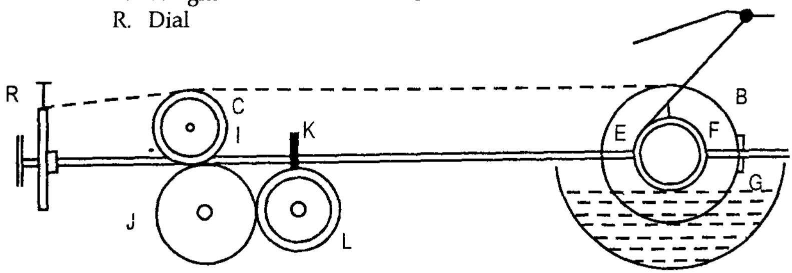


Fig. 6.1 Mechanical marking and measuring System

The warp sheet is made to pass over a colour roller, which is covered with felt and made to partly be immersed in ink. The warp then is made to pass over a nip roller that serves as measuring roller. In certain machines, the guide roller a guide roller that is situated just before dry splitting acts as a measuring device. The measuring roller has a fixed circumference and hence for one rotation, the length of the yarn passed will be equal to the circumference. This actuates a set of wheels, namely, measuring roller wheel, carrier wheel, stud wheel, worm, worm wheel and bevel wheels. A stepped cam is mounted on the same shaft as that of the bevel wheel. An impression or mark is made for every rotation of the stepped cam. This is facilitated by a marking hammer. A suitable weight is fixed at the end of the hammer so as to bring it to its original position after striking. By adjusting the speed of the cam relative to that of the speed of movement of the warp sheet, the length to be marked can be set. Thus by varying the ratio of the speed of cam to that of the speed of warp sheet, it is possible to adjust the length of warp sheet to be marked, over a wide range. This is practically done by changing the size of measuring roller wheel and stud wheel.

In the type of the system shown in fig. above, a shaft also acts as an indicator by means of a worm fitted to it. The number of piece lengths that have been wound on the weaver's beam is indicated on the dial through the shaft.

6.4 Electrical type of marking and measuring device

This type of device is nowadays used in modern sizing machines. It is comparatively more accurate than the mechanical type. It also eliminates several devices that have been used in the mechanical type of marking and measuring device, such as lever, hammer, double stepped cam and the colour wheel. The main element of the device is a solenoid switch that is actuated by means of a cam. The cam touches a lever which engages the solenoid switch and thus makes a mark on the yarn. The solenoid releases a clutch and thus enables marking on the warp sheet after the preset length of the warp has been wound.

6.5 Beam pressing devices

The beam pressing device has a direct bearing on the density or compactness of the warp sheet. This is particularly the case in the case of cotton and blended warps. However, when filament or texturised warp is used in sizing, the compactness of the beam is dependent mainly on the warp tension. Ideally a more compact sized beam is desirable since it increases the yarn content and thereby reduces the loom stoppages and also reduces the cost of drawing in and gaiting of the sized beam. However, it is to be borne in mind that the compactness of the beam in the case of staple yarns cannot be increased by increase in warp tension alone, as with filament or textured yarns. The warp tension in this case has to be adjusted in such a way so as to maintain the flexibility of the yarn. Beam pressing becomes necessary to get the desired compactness of the sized/weaver's beam. Care is to be taken to ensure that the beam is not unduly compact, as this would not enable the warp to withstand the beat up force of the reed in weaving. Pressure is applied to the warp beam by means of a single or a double hollow rollers that press against the beam.

The following types of beam pressing devices are commonly used:

a) Mechanical
b) Electrical
c) Pneumatic

The first type has been used in conventional sizing machines and the other two are being used on modern sizing machines. These devices enable a constant pressure to be applied on the beam and thus help to get more length of warp.

6.6 Mechanical type of beam pressing device

The principle of this type of device is best explained based on the fig. 6.2.

Two rollers 1 and 2 are made to press against the weaver's beam as shown. These are carried on a carriage such that both the rollers are made to contact the warp on the weaver's beam. The back roller 2 is lesser than the width of the weaver's beam. It rests on a pair of antifriction bowls that are mounted on a carriage. The carriage is supported by two brackets. The antifriction bowls are maintained in the same position and the rollers 1 and two move laterally across the width of the beam. The front roller 1 consists of two sleeves (fig (ii)) that fit upon a central shaft which carries a collar that fits between two lugs on the carriage and keeps the shaft at the centre. The two sleeves can move inwards or outwards. The ends of the roller 1 rest on two inclined bowls, fitted on swivel brackets at the front of the carriage. The inclination of the bowls towards the front

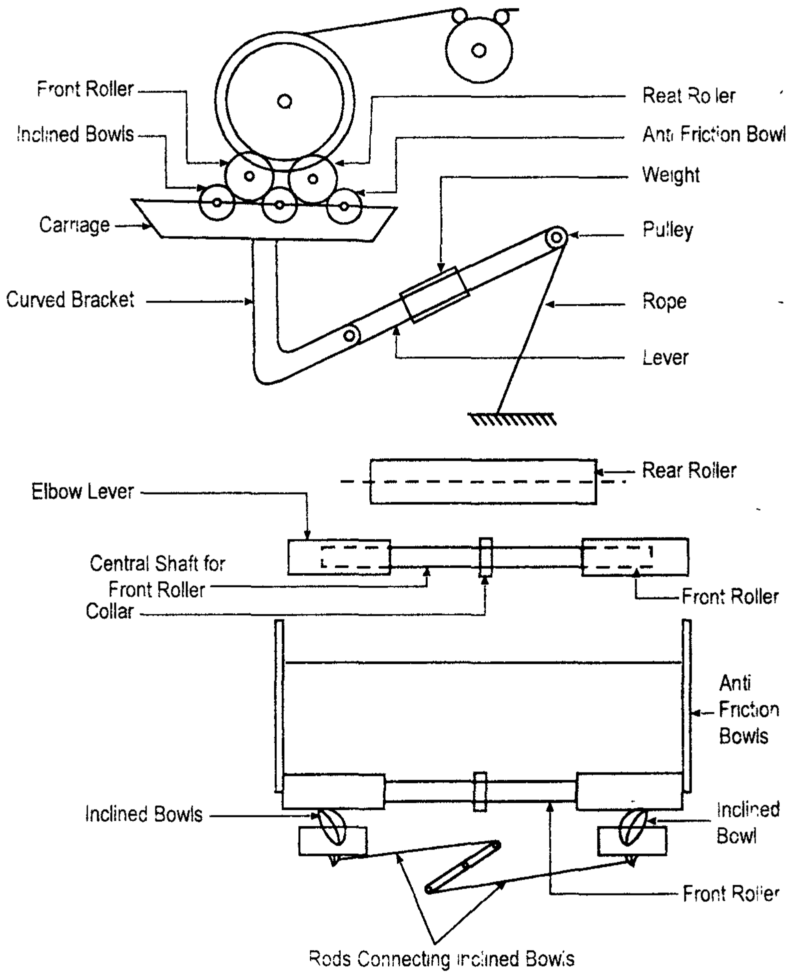


Figure 6.2 Mechanical Beam Processing Device

cause the roller 1 to recede. This is done when a new beam is commenced. The two bowls are connected to one another by means of rods through an elbow lever, that is fixed to the centre on the shaft (fig.(iii)). When the weaver's beam attains the preset diameter, the roller 1 moves inwards, so as to prevent the yarn spreading along the beam flanges.

One end of the curved lever rests against the carriage, while the other end fits on to a square shaft. Another lever is connected to the curved lever and carries a suitable weight. When the straight lever raises to turn the shaft, the curved lever also turns, thereby lowering the carriage by gravity. The carriage is made to move up or down in a controlled manner. At the commencement of a fresh beam, the weight is at its lowest position and the carriage is at its top most position. Uniform pressure is maintained by shifting the weight on the lever by means of a chain or rope, which passes over a pulley and is hinged to the floor.

6.7 Hydraulic beam pressing device

This type of pressing device is used on modern sizing machines and is shown in figure 6.3 below

The pressure on the beam is regulated by means of a piston the other end of which dips in an oil bath. The pressure is applied vertically by the piston through the pressure rollers. The pressure rollers are supported by means of suitable bowls just as in the previous type of device. The rollers are covered with plastic at their outer ends so as to prevent damage to the flanges. The piston is driven by means of oil pressure which is supplied by means of a hydraulic pump that is motor driven. It stops automatically as soon as the machine stops. There is provision to adjust the pressure over a wide range. The mechanism also permits lifting of the full beam, by raising the pressure.

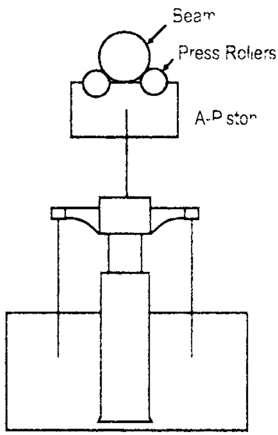


Fig. 6.3
Hydraulic beam pressing device

Chapter 7

CONTROL SYSTEMS IN SIZING MACHINES

7.1 Introduction

The control system in a sizing machine plays a crucial role. It has a great bearing of the quality of the sized beam. Modern sizing machines are equipped with various controls. These are discussed in detail in this chapter. The various controls used in modern sizing machines are

a) Temperature control
b) Size level control
c) Moisture control
d) Stretch control
e) Tension control

7.2 Temperature control

In the case of conventional sizing machines the temperature of the size in the size box has to be periodically noted manually. In modern sizing machines the same is done with the effective devices. These devices not only sense the temperature but also adjust the steam inlet automatically. If the temperature is a little too high, the steam supply can be reduced and if too low the steam supply can be increased until the desired temperature is reached. Temperature control is necessary at the size box and the drying cylinders

7.3 Control of temperature at the size box

The figure 7.1 shows such a type of device as used in the size box.

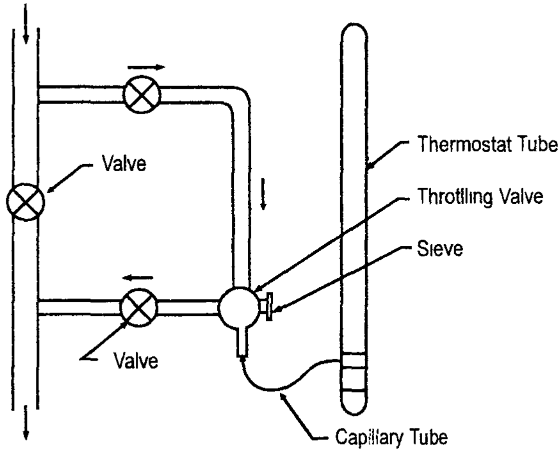


Fig. 7.1 Thermostat Tube Automatic Temperature Control

In the above device, a thermostat tube is inserted into size paste through a hole at the side of the size box. It is connected to the throttling valve by means of a capillary tube. The thermostat tube is equipped with a temperature setting unit which can be adjusted by means of a key inserted at the end of the thermostat tube. The throttling valve is situated in steam supply line. A by pass arrangement is also provided to supply the steam directly to the size box. In such cases the valves 'X' and 'Y' remain closed and the valve 'Z' should be opened when the temperature of the size mixture in the box has reached the pre-determined degree. When this happens, the fluid in the thermostat tube expands along the capillary tube and closes the throttling valve which has a double set ring, thus cutting off the steam supply.

When the temperature falls below the pre-determined degree due to the cutting of the steam supply, the fluid in the capillary tube contracts and the spring at the top of the set ring causes the valve to open and to allow the steam to pass from the supply line to the size box.

7.4 Control of temperature at the drying cylinder

In the multi cylinder range the temperature of the different cylinders may be different. So, devices have been introduced to indicate or record and also to control the temperature of the cylinder. Temperature controls of group of cylinders can be kept at the desired temperature by means of these devices. The sensors of the devices are located either just outside the cylinders or in the steam trap. In the steam trap they come in contact with the condensate and the steam whose temperature is proportionate to the temperature of the surface of the cylinder. The figure 7.2 shows such a device as used at steam inlet side and the condensate side of the drying cylinders.

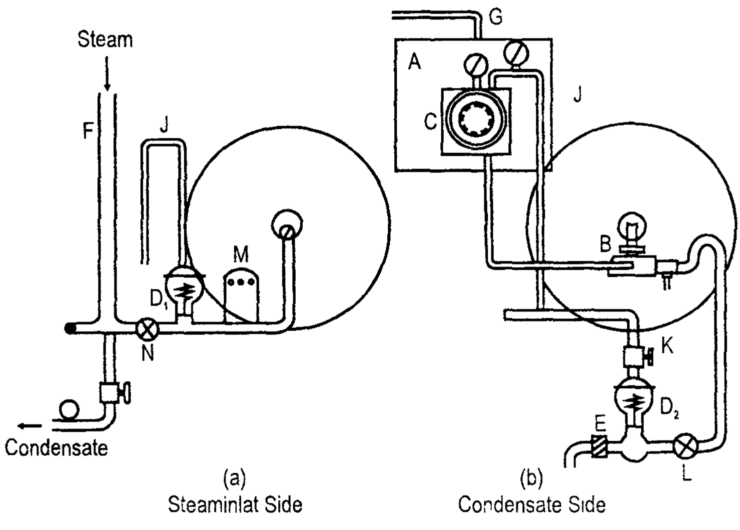


Figure 7.2

The measuring scale is calibrated to indicate the corresponding cylinder surface temperature. The sensors are connected with pneumatically operated steam valves to open or close them to get the predetermined temperature. The sensor shown in the figure is placed in the condensate line and controls the sensitive and powerful pneumatic valve. This valve regulates the air flow to the diaphragm valves 1 and 2 to stop the steam. When the temperature cools down the sensor will close the air valve and the steam flow will start again. There is a hand operated valve which is to be closed when the steam supply is stopped for an indefinite period to retain condensate water in the line.

7.5 Size level control

There are two systems of size level control in a sizing machine. These are

a) Float system : This is a mechanical type of size level control system. It is of the conventional type and is not used nowadays in the modern sizing machines. In this system, a metal roller floats at the surface of the size paste in the size box. It controls the supply of size paste into the box by means of a feed valve that is made to open and close as required by a lever arrangement. The main draw back with this system is its slow response to changes in the level of size. However, in some types of modern sizing machines, the float roller is made to actuate a transmitter, which would in turn operate a pneumatic control valve in the size pipe line by closing or opening according to the level of the size in the box, thereby allowing of shutting off the supply of size paste into the size box.

b) Electrical control system : This system utilizes two electrodes that are dipped in the size paste in the box.

The size paste itself acts as electrical conducting medium. The electrodes are placed at different levels in the size paste. The upper electrode is just touching the size paste and the lower electrode is dipped at a little depth. When the size paste is just touching the upper electrode the electric circuit is closed and this actuates the pneumatic control feed valve causing it to close, thereby cutting off supply of size into the box. On the other hand when the level of size paste falls below the lower electrode, the electrical circuit is broken and this actuates the pneumatically operated feed valve causing it to open. This allows size paste to flow into the size box. This system maintains the level of size in the box at ±5mm of the standard level. Though the system is advantageous as compared with the previous system in its quicker action, it still suffers a draw back in that electrodes can have deposition of size paste over a period of time. This problem can easily be remedied by coating the electrodes with Teflon. The feed valve can be operated by a solenoid in place of pneumatic control.

Besides the electrode system, other systems of controls are also used. One of the well known is the bubbler type of device, which works on the principle of differential pressure. The difference in pressure between the surface of the size and the base of the bubbler tube in the size is recorded.

7.6 Moisture control

The control of moisture in sizing plays a crucial role in determining the quality of the sized warp. If the moisture level is not properly controlled, it could lead to problems of over and under drying. Over dried yarns tend to be more rigid, less strong and brittle, and also take a long time to absorb moisture from the atmosphere. On the other hand, under dried yarns which contain more moisture than is required in the yarn could pose problems in weaving. Such yarns could be more susceptible to biological attack (in absence/inadequacy of antiseptics) and also could cause stickiness of yarns with one another. Such sticking of neighbouring yarns in weaving, can deter shed formation, shedding of the size film and also some fibres can come off with the size. This would result in more end breaks in the loom.

Instruments used for measurement of moisture content in yarn, can not only indicate the moisture content of moving yarn but also record it. In later machines, the moisture instruments can even control the speed of the size of the machine so as to get the desired moisture content in the yarn. The conventional instruments had some problems which have been overcome in the modern instruments.

Modern moisture control devices are located either immediately after the drying system or near the weaver's beam. Also, a portable instrument is available that can be taken near the sized beam so that the moisture content of the upper layer of the warp can be measured, as it is wound on to the beam.

The modern instruments used for measurement of moisture operate on three principles, namely,

a) measurement of electrical resistance of warp,
b) measurement of capacitance of warp, and
c) measurement of propensity of warp to become electrostatically charged.

7.6 a Measurement of electrical resistance of warp

It is a well known fact that the electrical conductivity of cotton yarn is directly related to its moisture content. The electrical resistivity of a material is the resistance measured on a sample of unit mass uniformly distributed across the space between two parallel electrodes, a unit distance apart. The instrument for measuring electrical resistance of warp consists of a pair of rollers that are coated with chromium. The warp sheet is made to pass between these rollers and its electrical resistance is continuously measured and the same is indicated as reading of the moisture content present in the warp. The rollers are 25 mm in diameter and one of them is connected to earth and the other to the output of an electronic unit of the indicator instrument.

Generally the instrument utilises a vacuum tube bridge or a vacuum tube voltameter that is connected to a resistance bridge and allow measurements upto about one lakh mega ohms. This range is considered to be suitable for all types of textile fibres. The moisture content of the sized cotton warp is related to its electrical resistance mathematically as follows:

$$\text{Log } R = 8.1 - \log\frac{N}{N_1 L} - 0.0715\ H$$

Where R = Resistance in mega- ohms
L = length of warp in inches
N = number of ends in the warp sheet
N_1 = Cotton count
H = relative humidity of the atmosphere

The ratio of N/N_1 is called warp factor and can be adjusted by making suitable corrections for different fibres.

7.6 b Measurement of capacitance of warp

This method is based on the principle of the capacitance of a suitable material tested in relation to the capacitance of air. The textile material, namely, the warp, which is partially conducting, is made to pass between a pair of condenser plates. It has been found that the capacity of the condenser when any material is passing, increases as compared to that when air is passing. The ratio of these two is considered, i.e., the ratio of the capacitance of air and dielectric such as textile material is considered here. Such a ratio is called the relative permittivity or di-electric constant of the material. The capacitance of a textile material that is passing between a pair of condensers is measured continuously using an alternating current.

This method has certain limitations. These are as follows

a) The dielectric constant is greatly affected by the AC frequency and hence the frequency has to be properly adjusted and maintained constant.

b) A number of factors such as temperature, vibrations, etc., cause variations in distance between capacitor plates and thereby affect the capacitance values.

c) Even small variations in the mass of warp between the capacitor plates can seriously affect the readings.

The advantage of this method, however, is that it is less affected by the type of fibre as compared to the resistance method. Also influence of temperature variations is only about one fourth as compared to that with resistance method.

7.6 c Electrostatic charge method

This method is based on the observation of static charge build up in the yarn when it retains its natural moisture content during the process of drying. The static charge build up in yarn can be continuously monitored to indicate the moisture content. The instrument for measurement of static charge has to be calibrated for different fibres independently. The method is very suitable for warps made of polyester, nylon, acetate rayon etc., that have high resistivity.

7.7 Stretch control

During the process of sizing, the yarns are pulled from the back beams as there is no positive drive to these. This creates a certain amount of tension which is responsible for the stretch in the warp sheet. This stretch causes loss of elongation in the yarn.

The tension which is imposed on the warp sheet during the sizing process results in permanent elongation of the yarn. This increase in length is known as the stretch. Greater the stretch on the yarn, higher is the loss in elongation at break.

The various zones of stretch control on modern cylinder sizing machines are

a) Creel zone
b) Wet zone
c) Drying zone
d) Splitting zone, and
e) Winding zone

7.8 Control of stretch at the creel zone

As the sizing progresses, the yarn tension in the creel zone increases. To compensate this, the tightening of the beam is adjusted suitably. The brakes should not be overtightened to avoid over running of the beam when the machine is stopped. All the beams in the creel should be provided with ball or roller bearings to reduce the creel stretch. If guide rollers are used, they should run on ball bearings. Beam with large barrel diameter (30 - 35 cms) will produce low creel stretch.

7.9 Control of stretch at wet zone

The control of stretch in this zone is of much greater importance than in any other zone. Use of positive dry nip arrangement just before the size box and after the creel will avoid pulling of the yarn from the wet nip and feed yarn into the size box in a relaxed state.

On machines which have two pairs of squeezing rollers and sizing rollers, both the positively driven bottom rollers should be of the same diameter or preferably the finishing sizing roller can be slightly smaller in diameter by about 0.3 mm. This will ensure that there is no stretching of yarn between these pairs of squeezing rollers.

Use of positive infinite variable (PIV) gears to synchronize the speed of the dry nip and the finishing sizing roller will help to maintain constantly stretch at a low level.

7.10 Control of stretch in drying, splitting and winding zones

On modern multi cylinder sizing machines equipped with positive dry nip, control of stretch in the drying pad splitting zone is a simple matter of synchronizing the PIV gear driving the cylinders with that driving the finishing squeeze roller in the wet zone. The total stretch can be maintained at a low level of about 1.2% on such machines.

The circumference of the drag roller, which governs the delivery rate should be adjusted suitably by changing the cloth layers.

The length of split of the yarn sheet behind the first lease rod in the splitting zone is indicative of the tension and stretch of the yarn. A long split indicates high tension and vice-versa. The split generally should be 1.5 - 2 times the diameter of the lease rod.

Winding tension and stretch can be easily controlled by controlling the winding zone tension.

7.11 Stretch control device

Modern sizing ranges are generally equipped with either mechanical or electronic stretch indicators.

In electronic stretch controller, it monitors the yarn stretch on a sizing machine continuously. Whenever the stretch exceeds or goes below pre-set values, a servomotor suitably operates an appropriate PIV drive to increase or decrease the pull of yarn through first pulling nip.

SINGLE END SIZING

8.1 Introduction

One of the inherent problems in sizing is the sticking of neighbouring warp threads. This is due to the wet condition of the applied size paste. When such a warp sheet is dried, the neighbouring threads stick more rigidly. This would create problems at splitting, such as some of the size shedding or coming off and may also involve loss of some fibres in yarn, which is undesirable. The problem is even more acute in the case of closely set warp sheet, where density of threads per cm is more. Dry splitting cannot avoid this problem, particularly so in the case of denser warp sheets. Wet splitting offers solves the problem only partially even though it is coupled with dry splitting. The concept of single end sizing, however, appears to be promising in this regard.

8.2 The concept

The very objective of the single end sizing is to reduce the damage to yarns during dry splitting. The single end sizing is a process that involves sizing and drying of yarns by maintaining the yarns without touching each other till a stage is reached when the sticking of yarns is not possible and is achieved by maintaining the ends well separated from one another. This process avoids size film splitting.

8.3 Different systems of single end sizing

A number of methods are followed, of which a few important ones are described herein.

System 1:

In this system the warp sheet after passing through the size paste and squeeze rolls, is split into two sets and made to pass over suitable guide rollers. Each set of the divided warp sheet is passed over a hot cylinder separately, constituting the pre-drying zone. It is then combined into a single sheet so as to complete the actual drying process. Such a system is shown in figure 8.1.

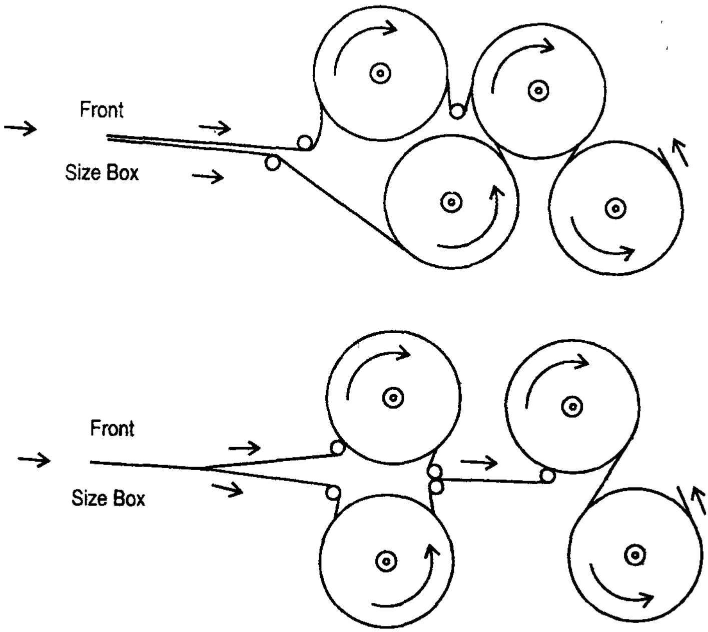


Fig. 8.1 Two Simple Arrangements for Pre-Drying Sokit Ware Sheets Separately

Fig. (i) shows one method of the system and can be adopted with existing equipment only. Care is to be taken to ensure that the two divided sheets are under equal tension during their separated passages. In yet another method shown in fig (ii), there are two additional cylinders at the beginning. The advantage with this method is that the length of passage for the two parts is the same.

System II:

In this system the warp sheet is divided into two sets after passing through the squeeze rolls. Each set is then made to pass over its corresponding pair of drying cylinders (pre-drying) and are combined as one sheet for actual drying. This is shown in figure 8.2.

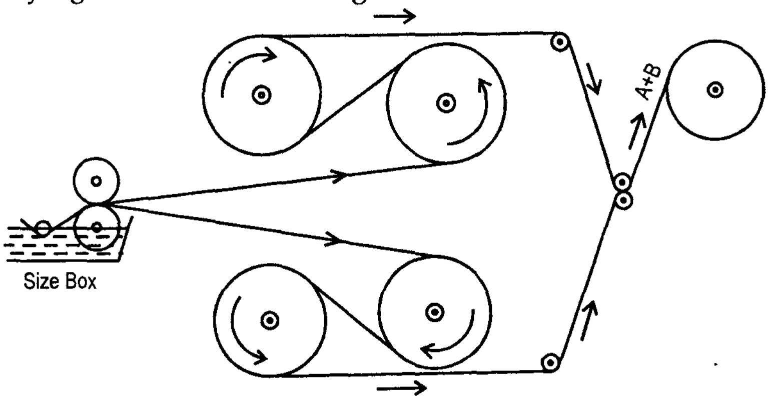


Fig. 8.2 Pre Drawing on Synntetrical Pairs of Cylinders

In this system the pre-drying is a little more complete as compared with the previous one.

System III:

This system is particularly suited to twistless filament yarns. The warp yarns emerging from the squeezing rollers are divided into a number of layers corresponding to the number of warpers beams in the creel (see figure 8.3). The pre-drying of the split sheet of warp is done in a chamber by means of hot air or infra-red radiations. The split layers of warp are combined together after leaving the pre-drying chamber. They are then passed over a series of cylinders to complete the drying process. The disadvantage with this system is the expensiveness in use of infra-red radiation, and even if hot air is used, very high temperature is required to get adequate pre-drying.

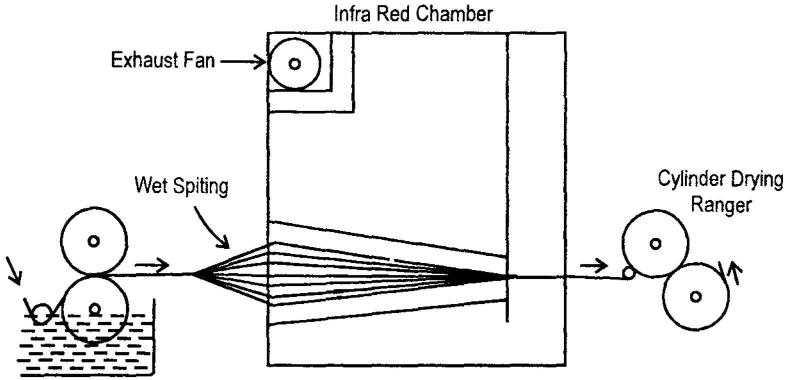


Fig. 8.3 Infra Red Predrying

System IV:

This system is suitable for sizing of very heavy density warp sheets (more number of warp threads/cm). It requires two size boxes as shown in figure 8.4. The warp from the creel is split into two sheets. One set of the warp sheet passes through the first size box and drying cylinders. The other set passes under the first size box and drying cylinders and enters the second size box and drying cylinder range. The first set of warp sheet emerging from its drying cylinders passes above the second size box and its respective drying cylinders. The two sets of warp sheets then combine together to pass over a series of drying cylinders arranged vertically. The advantage with this system is that the split warp sheets that pass over respective size boxes get a greater impregnation of size. The disadvantage with this system is the large floor space it occupies. It can, however, be used for other techniques of sizing also.

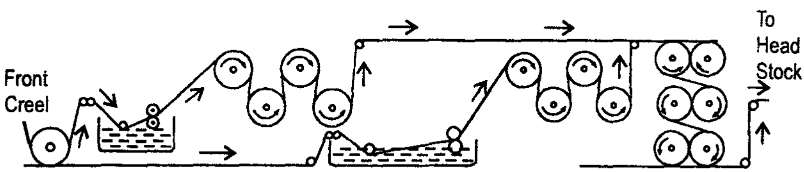


Fig. 8.4 Double Size Box for Sectional Sizing and Drying

Chapter 9

SIZING OF SYNTHETIC AND BLENDED YARNS

9.1 Introduction

Nowadays synthetic are gaining more commercial importance on account of their desirable properties. But still they do have draw backs such as poor moisture retention. Hence wherever comfort property is desired such as dress materials, it is necessary to blend the synthetic fibres with natural fibres so as to combine the advantages of both these fibres. The important considerations in sizing these yarns, namely, synthetic and blended yarns are discussed in this chapter. Synthetic yarns are made in two forms, i.e., continuous filament yarns and staple fibre or spun yarns.

9.2 Sizing of continuous filament synthetic yarns

It is well known fact that synthetic fibres are hydrophobic in nature, as they have very little or no affinity for water. Hence natural adhesives such as starches are not effective in sizing of these yarns. Adhesives which are basically synthetic polymers are found to be suitable in this case. One of the intriguing aspects to be noted here is that the viscosity of the size paste is not of importance as it was the case with cotton yarns. The reason for this is that there is no need for laying the protruding fibres on surface of filament yarns, as was the case with cotton yarns. The main objective of sizing filament yarns is to hold the filaments together in the yarn structure so as to make the yarn to withstand the abrasion and strain of weaving process and also avoid static charge generation. It is to be noted that synthetic continuous filament yarns are generally very strong and resistant to abrasion and mostly do not require sizing. Monofilament yarns do not require sizing at all, since there is no question of binding filaments together as in the case of multifilament yarns. Also, the spin finish oil applied to monofilament yarns acts as antistatic agent and reduces abrasion. Certain types of multi filament yarn also do not require sizing. The factors that decide the sizing are the fineness/denier of the filaments and the twist on the yarn. Coarse denier filaments of , say, 10 denier, with little twist do not require sizing. Finer filaments of, say, 4 denier can be given a reasonable amount of twist in the range of 100 to 150 tpm and oiled and used without sizing. Another important consideration is the speed of looms and number of looms per weaver. In the case of high speed looms and more number of looms per operative, sizing is a must even for yarns that would not ordinarily require sizing. Ordinary zero twist synthetic filament yarns do require sizing. Also highly twisted yarns that are unset or partially set, require sizing so as to control the torque and enable easy handling during weaving.

The selection of appropriate size ingredient is based on a number of considerations. In one instance, where the yarns are to be used in water jet weaving machines, water insoluble sizes are required. Ammonium salts of vinyl copolymers or acrylic copolymers would aptly suit the purpose. The basic requirement of the size is that the paste should be thin (less viscosity) and at the same time have good adhesive, lubricant, and antistatic properties. Polyvinyl alcohol (PVA) is the best available size meeting these requirements. It is suitable for synthetic filament yarns such as nylon, polyester, etc. PVA normally has good adhesivity for synthetic fibres and requires a lesser proportion of softener- lubricant, which reduces the frictional effect and also acts as antistatic agent. Also it can serve as a wetting agent. Sometimes wetting agent will have to be used since the hydrophobic nature of the synthetic fibres will not permit easy penetration of size into the yarns.

Wax emulsion is also recommended, since it combines softener-lubricant properties. The draw back with wax emulsion is that it cannot act as wetting or antistatic agent. Hence a non ionic type of wetting agent that also acts as antistatic agent, should be added. Sorbitol is found to be suitable in this case, as it possesses the hygroscopic properties and is also found to have antistatic properties.

Besides PVA, other adhesives such as polyacrylic acid, polymethyacrylic acid, their partial esters, copolymers, neutral vinyls and unsaturated acids, either in the form of poly acids or their salts or partial esters, are used. Acidic type of adhesives are more suitable for nylon warps while alkaline type of adhesives are suitable for polyester warps.

9.3 Sizing of staple fibre synthetic yarns

The major problem with synthetic staple fibre/spun yarns is their hairiness. The hairiness is visualised by protrusion of fibres on the surface of the yarn. This is more prominent in case of synthetic spun yarns as compared to spun yarns made from natural fibres such as cotton. The reason for this lies in the hydrophobicity and higher elasticity of synthetic fibres. It is therefore difficult to lay the protruding fibres on the surface of the yarn. It is to be noted that coarser fibres tend to give more hairiness to yarn. Hairy yarns are one of the major causes for end breakages in weaving due to their higher friction and entanglement with neighbouring threads. Hence the main role of sizing is to lay the protruding fibres on to the yarn surface and thus make the yarn surface smoother.

The viscosity and concentration of the size paste is of importance in this case. Hence higher viscosity and concentration of the size paste than that used for filament yarns needs to be used. This will enable to form a better film and also lay the protruding fibres on to yarn surface. It is interesting to note that for a given size recipe, with identical count, fibre length, and cloth construction, the abrasion resistance of the yarn and also end breakages in weaving will be influenced by the denier/fineness of fibres. Finer denier fibres give better abrasion resistance and lesser breakages in weaving, as compared with coarser denier fibres. Hence yarns made from coarser denier fibres require higher size add on than that required for finer denier yarns.

Polyacrylic acid size is recommended for nylon spun yarns as it has good adhesive properties. The draw back with this size is its expensiveness and tendency to corrode the size box. A cheaper alternative would be combination of sago starch and PVA in the ratio of 4:1. The problem in this case is that a higher concentration will have to be taken due to poor adhesivity. Also larger quantity of lubricant such as mutton tallow will have to be added to increase abrasion resistance. Other option would be combination of thin boiling starch and PVA, with or without CMC (carboxy methyl cellulose).

In case of polyester spun yarns, polyacrylic acids would be unsuitable since these do not have affinity for the polyester fibres. Neutral acrylates would be the better choice as adhesives. Higher concentrations of the adhesives will have to be used due to the greater hydrophobicity of the polyester fibres. The temperature of sizing will be same as that required for filament yarns.

The typical size recipes for nylon and polyester spun yarn is given in tables 9.1 and 9.2 below

Table 9.1 : Size recipe for nylon spun yarns

S.No	Type of ingredient	Quantity required (kgs/1000 litres)
1	Thin boiling starch	100
2	PVA	30
3	Mutton tallow	6
4	Antistatic	1-2
5	Add-on	14

Other combinations are also possible though they are not mentioned herein.

Table 9.2 : Size recipe for polyester spun yarns

S.No	Type of ingredient	Quantity required (kgs/1000 litres)
1	Thin boiling starch	160
2	CMC	30
3	PVA	30
4	Mutton tallow	8
5	Antistatic	2
6	Add on %	18

9.4 Sizing of blended yarns

The sizing of blended yarns has been receiving more attention nowadays. This is because of the fact that most of the synthetic fibres produced today are blended with other fibres. Various types of blends are used. The important ones are polyester-cotton, polyester-viscose, and polyester-wool. Besides other blends such as polyester-silk, acrylic-wool, nylon-viscose etc. are used, but to a lesser extent. Polyester continues to be the important component in most blends used today.

In a blend consisting of synthetic and natural fibres, the synthetic component contributes more towards the strength, and elongation at break. However, the drawbacks with synthetic fibres are their hydrophobicity, static formation, and elasticity. Due to their hydrophobic nature and tendency to static formation, special synthetic adhesives are required. Static tendency and and elasticity of synthetic component of blend contributes more to hairiness of yarn made out of them.

9.5 Sizing of polyester-cotton blends

The sizing consideration of these blends is basically same as those of spun polyester yarns. The only difference is that the cellulosic component has to be specially taken care of. Blend yarns consisting of higher proportion (>50%) are very strong and normally need not be sized, but for their hairiness. Hence the purpose of sizing is to lay the protruding fibres on the surface of the yarn. The viscosity of the size paste is of importance in this case. Normally a combination of PVA and maize starch or thin boiling starch is used. CMC can also be used additionally. The starch component sticks to the cellulosic component of blend preferentially and the other two components, namely, PVA and CMC go to polyester. As these components have some affinity for cellulose, the adhesion of starch is improved. Acrylic ester copolymers are considered to be even better than PVA, but are costlier.

The other important ingredients required besides adhesives are lubricants and antistatic agents. Mutton tallow would serve as ideal lubricant. Besides PVA, the other adhesive to be used is thin boiling starch, as this is required for the cotton component of the blend. The main advantage of using thin boiling starch in preference to other adhesives is that it can be very easily gelatinised and give a smoother paste and more uniform film. CMC has adhesion for both polyester and cotton, and can be used partially with PVA, with the advantage of economy in the process.

The amount of size add on depends on the proportion of the component fibres in the blend. More add on would be required with greater percentage of polyester fibres in the blend. Some typical examples are given below:

a) 80:20 polyester-cotton blend require add on of 18 - 20%

b) 67:33 polyester-cotton blend require add on of 16 - 18%

c) 50:50 polyester-cotton blend require add on of 14 - 16%

Mutton tallow is used as softener-lubricant due to presence of starch or thin boiling starch. It should be used in minimum quantity as other wise it would reduce the strength of the size film and increase the warp breakage rate. A typical recipe for polyester cotton blend is given in table 9.3 below

Table 9.3 - Size recipe for polyester-cotton blends

Type of ingredient	Blend proportion			
	80:20	67:33	50:50	25:75
Thin boiling starch	120	110	110	100
CMC	20	20	15	10
PVA	30	25	15	-
Gum Arabic	-	-	2	5
Mutton tallow	10	8	8	8
Antistatic	1	1	1	-
Antiseptic	1-2	1-2	1-2	1-2
Add on %	18-20	16-18	14-16	12-14

Chapter 10

PROCESS CONTROL IN SIZING AND SIZING FAULTS

10.1 Introduction

The sizing constitutes an important part of the weaving preparatory process and has considerable influence on the weaving performance. Successful sizing is determined by the effective control of various parameters. This could be possible only if proper quality control activities are undertaken, as otherwise sizing faults would occur that could prove to be detrimental in the weaving process. The various process control measures and the commonly occurring sizing faults are discussed in this chapter.

10.2 Process control measures

The process control measures in sizing fall under the following heads:

a) Routine studies
b) Special studies
c) Sized beam quality studies

10.3 Routine studies

10.3 a Frequency of lappers

The warp sheet has to be observed during running on the sizing machine. This has to be done about ten times in a month. Each study should cover a length of 2500 meters. The frequency of occurance of lappers has to be observed at different places of the machine, such as back beams, guide roller, immersion roller, sizing roller and squeezing roller. This should be expressed in terms of lappers per one million meters.

10.3 b Size pick up variation

This is to be calculated from records for different sets, on a weekly basis. It will enable to identify variations in size pick up and could possibly indicate the contributing factors to the variation such as concentration of size paste in sow-box, size level in sow box, depth of immersion roller in the size, temperature of size paste in sow-box, speed, stretch, moisture content in weaver's beams and actual vs recorded tare weights of sized beams.

10.3 c Dead loss (%)

This is to be calculated from available records on a monthly basis. The factors seriously affecting the dead loss are wastage of size paste and materials, weighing errors, low moisture in sized yarn, and high moisture in grey yarn and size materials.

10.3 d Frequency of migration

This is to be done once in a month for two sets of a count or 10,000 meters of warp for a count of yarn. It is to be expressed in terms of migration per one million meters of yarn.

10.3 e Mechanical stretch

The stretch of warp in the sizing machine should be studied for 1000 meters once in a week. The average stretch % should be calculated once in a month based on 4 weekly studies.

10.3 f Sow box temperature

This has to be checked daily with a thermometer. The temperature has to be cautiously checked at both the sides of the sow box in order to find if there is any variation.

10.3 g Viscosity of size paste

This is to be checked daily for different size mixes. Viscometers such as Ostwalds or Redwood type can be used for the purpose. It would, however, be preferable to use a viscosity cup made of brass with a hole at bottom, ranging from 3-6 mm dia, depending on whether the concentration of size is up to 10% or more.

10.3 h Beam tare weight

A minimum of 50 sized beams selected randomly, will have to be checked for tare weight. Beams that vary by 0.5 kgs or 1% (whichever is less) should be marked.

10.3 i Functioning of control instruments

The measuring devices on the sizing machines such as those for stretch, moisture control, sow box temperature, cylinder temperature, beam pressure, squeeze roller pressure, etc. should be checked every week. Any malfunctioning of the devices mentioned should be duly reported.

10.3 j Hard waste level

This should be calculated every month from the records.

10.3 k Production and efficiency

These should also be calculated every month from the records.

10.3 l Material analysis

Prior to accepting any consignment of size ingredients, it is recommended to carry out analysis of these ingredients and take the decision accordingly. All lots should be analysed.

10.3 m Maintenance

All machinery maintenance audit work should be planned as per the preventive maintenance schedule.

10.3 n Strength and elongation checking

All the counts of yarns that are sized should be checked for gain in strength and loss in elongation, once in a month. About 200 tests will have to be conducted for sized as well as unsized yarns. Increase in strength of 10% for blend yarns and 25% for cotton yarns reflect on good sizing. It is important to note that very high strength coupled with low elasticity and very low strength coupled with high elasticity are undesirable for weaving. Hence the gain in strength has to be balanced by loss in elongation for good weavability.

The loss in elongation of the warp in sizing should be maintained below 25% by controlling the stretch. In order to assess the sizing performance, regular studies should be carried out to investigate the loss in elongation and gain in strength of sized yarns.

10.4 Special studies

10.4 a Tension measurement

The tension of the sized yarn has to be measured at the creel zone and head stock of sizing machine, when necessary. This may be done with the help of a tension meter.

10.4 b Percentage of solids

This is to be checked only if necessary, as otherwise it would be sufficient to check the viscosity of the size paste daily. The percentage solids of the size paste can be found with the help of a refractometer. This gives an idea of the concentration of the solids in the size paste at the time of size application.

10.4 c Moisture content of sized yarn

On modern machines the moisture content of the sized yarn is measured by electrically controlled moisture meters. If necessary , lab tests of moisture content in sized yarn should be conducted.

10.4 d Hard waste studies

When the hard waste level deviates too much from the standards one should conduct causewise hard waste studies to find out the causes of excessive hard waste.

10.5 Sized beam quality studies

The performance in sizing influences the weaver's beam quality which in turn influences the weaving performance. Some of the important aspects of the weaver's beam quality are highlighted below

10.5 a Incidence of soft beams

Soft beams are those that have low size pick up and may result from inadequate adhesive content of size mix, variations in moisture content of size ingredients, excessive amount of softener and deliquescent material in size mix, prolonged boiling and agitation during storage, too much condensation of steam in sow box, excessive foaming of size paste or use of wet dye beams at the creel. Soft beams pose problems in weaving by causing ball/bead formation between healds and reed, and sometimes between healds and lease rods, fraying and falling of fibres, entanglements of warp ends etc. All these obstruct the shed formation on the loom, resulting in more warp breakages. It is therefore necessary to ensure that there is proper size pick up by the warp.

10.5 b Uniformity of size pick up

A number of factors affect the pick up of size by the warp. These are the fibre and yarn characteristics, characteristics of immersion bath such as concentration, viscosity, level and temperature of size, and other factors such as machine speed, depth of immersion, squeeze roller hardness, squeezing pressure, density of ends etc. Overall it can be said that a good sized beam should have uniform pick up of size both along and across the warp sheet.

10.5 c Moisture content of sized yarn

The factors that affect the moisture content of the sized yarn are the type of yarn, level of size pick up, machine speed and efficiency of the drying unit. The amount of moisture to be controlled depends upon the type of yarn, such as 7-8% for cotton yarns, and 3-4% for polyester blends. Lower moisture content than necessary is due to over drying and higher moisture content is due to under drying. Both of these are to be avoided since over drying results in excessive shedding of size and also reduces yarn elasticity. On the other hand under dried warps being wet are prone to microbiological and mildew attack and also cause warp stickiness.

105 d Frequency of missing and crossed ends

Missing ends are caused by lappers, which may be influenced by yarn quality, end breaks in warping, operator practices in warping, excessive stretch at sizing, frequent interruptions of sizing machines, condition of various machine parts like beam bearings, guide roller, immersion rollers, sizing and squeezing rollers, drying cylinders, etc. On the other hand crossed ends are caused by migration of neighbouring ends (termed as invisible break). Both of these can result in stoppages of loom and also cause cracks along warp direction of fabric during weaving. The frequency of missing and crossed ends should thus be minimised. Proper leasing frequency should be followed. Extra warp ends of about 0.15% of the total warp ends in beam are sufficient to take care of the incidence of missing and crossed warp ends.

10.5 e Incidence of lumps & streaks of size on warp sheet

Lumps and streaks of size on the warp sheet are due to imperfect sizing. Streak across the warp sheet may also be caused by change of a new blanket/cover on the squeeze roller. Improper agitation in the size box/and in the storage vessel leads to the formation of scum which does not mix with the paste despite severe stirring. The lumps formed cause trouble during the splitting of the warp sheet at the leasing zone. Proper agitation in the storage vessel, and periodic cleaning of the kettle and sow box with steam are beneficial.

10.5 f Build of weaver's beam

The build of a weaver's beam is determined by its compactness, uniformity of its surface and correctness or otherwise of its selvedges. The compactness of the beam should be such that it should enable easier unwinding during weaving. Uneven surface of beam results from uneven movement of a beam presser roller and uneven spacing of the dents of the reed. Beams with defective selvedges, such as, sunken and bulged selvedges result from improper setting of the comb width with respect to that of the beam. The defective selvedge and the ridgy surface of a beam may, then, affect the unwinding performance of the beam during weaving.

10.5 g Fibre lay

The sizing helps to lay the protruding fibres on surface of yarn and thereby minimise the yarn entanglements during weaving. The fibre lay can be further improved by after waxing treatments, brushing etc.

10.6 Sizing faults

The quality of sized beams is important for good performance in weaving. A number of faults occur that need to be properly rectified so as to ensure good quality weaver's beams. The commonly occurring faults and their causes and remedies are discussed in this chapter.

10.6 a Broken, missing, crossed and sticky ends

The major sources of all these faults are breaks during sizing, accumulation of layers of yarn on the warper's beams. Missing ends, i.e., total number of ends in the back beams, some of the ends which are missed in the warping itself. The remedy is that the ends are to be joined afresh into the back beams.

Crossed ends are formed during sizing and therefore the warp ends are not present in their proper place on the beam. Hence there is chance to knot the missing end to the other end in the sized beam. The size beam flanges have to be kept in good condition and care should be taken in mending the broken ends. Sticky ends are formed due to the improper cooking of the size ingredients. The stickiness has to be reduced after the drying process by using revolving lease rods.

10.6 b Defective selvedge

The selvedge ends in a weaver's beam cause more difficulty in unwinding the ends during weaving. Sunken and bulged selvedges are defective selvedges of the sized beams. Sunken selvedges can be controlled by correctly setting the expandable comb at the head stock. For the bulged beams the beam pressing roller is set in correct manner so that it reaches to both flanges.

10.6 c Ridges on the beam

Ridges on the beam are formed when the ends that are taken in one dent of the comb do not spread out. To minimise this defect, the dancing roller at the head stock should be adjusted properly.

Chapter 11

MODERN DEVELOPMENTS IN SIZING

11.1 Introduction

The recent researches in sizing have been prompted by modern day demands. The present day requirements in sizing are two fold, namely, conservation of energy and conservation of environment. Energy conservation has become very crucial because of the steadily increasing cost of fuels that are being used. This has paved the way to development of sizing methods that minimise the energy consumption to the barest minimum. The second need, i.e., conservation of environment, has led to research into the possibilities of reclaiming water and the sizing materials from the desizing wash waters and also sizing in a medium other than water or no medium at all. This chapter deals with some of the approaches made in this regard.

11.2 Approaches to energy conservation

Estimates show that one kg of warp yarn that is sized will consume about 1500 kilo calories of energy. This energy is necessary for size preparation, storage, heating size box, drying sized yarn and replacing heat losses. The heat losses per kg of sized yarn is estimated to be about 110 kilo calories. The energy can be considerably conserved if proper care is exercised on various aspects in sizing. The following are the various steps suggested to reduce the energy consumption:

a) Lower temperature of size cooking
b) Lower duration of size storage
c) Use of single squeeze roll instead of a pair
d) Use of harder squeeze roll
e) High pressure squeeze system

f) Use of lesser volume of size
g) Lower viscosity of size

11.3 Emulsion sizing

The main advantage of using liquid emulsions of ready made sizes is that cooking can be avoided, and therefore heating and drying are eliminated. Emulsions can be prepared with high concentrations of up to 60%. When high squeeze pressure is used, the pick up of the size paste is reduced. In such cases high concentrations of emulsions (with higher solid content) can be used without any dilution or with only a small dilution to give the required solid add on, thereby saving energy required for drying.

11.4 Hot melt sizing

This is yet another approach to energy saving. Certain polymers have a low melting and quick setting properties. The equipment used has a grooved metal roller that is heated to a temperature of about 200°C. Each warp end passes through individual groove of the roller. The size material in the form of a solid block presses against the roll. The melting point of the size block ranges between 125 to 155°C. The size block on coming in contact with the hot grooved roller melts and gets coated over the warp ends. As the size impregnating the yarn is in a molten state and has lower viscosity, some of this penetrates into the yarn. The size sets immediately after the warp leaves the roller. It can be easily be washed away with water. Three grooved rollers are used for sizing warps of different counts, ranging between 12 - 120 tex. This method proves to be very economical from +the energy saving point of view as approximately about 80% lesser energy is required as compared with the conventional wet system. It is also simpler compared with the conventional system. The size also does not pose much problems in waste disposal as it has a reasonable level of biological oxygen demand (BOD). Though the system has advantages of energy saving of upto 80% and requires low investment cost, it has the disadvantages of slow speed of application (@12% less than conventional system), and high water contamination after desizing.

11.5 High pressure squeeze system

This system has proved to reduce the energy requirement for drying. A higher concentration and squeezing pressure than normally adopted is used. Higher squeeze pressures do not significantly alter the quality of the sized warp. Experimental studies have revealed the following findings:

a) When the squeeze pressure is increased to 25 times, the energy consumption per kg of yarn is only 1.5 to 1.8 times the original, depending on the speed of the yarn.
b) Energy consumption per kg of yarn decreases drastically with increase in yarn speed.
c) The difference between low size pick up between low and high squeeze pressures has been found to be marked at low yarn speeds.
d) Heat energy required for drying of the yarn is much more than mechanical energy required by squeeze rolls for pressing.
e) In case of cotton yarns, the best squeezing effect is obtained at slow speeds coupled with high squeeze pressure, thus giving best energy saving.
f) High speed with low squeeze pressure consumes most heat energy eventhough requiring least mechanical energy for squeezing.

High squeeze pressures enables more use of concentrated size paste than the one used for the conventional system, in order to get the same add on % and same quality of sized warp. Less energy is required in this case since less water needs to be evapourated. High pressure squeezing enables saving in size consumption because of better add on regularity. The comparison between conventional and high pressure squeezing is given in table 11.1.

Table 11.1 - Comparison of normal and high pressure squeezing

	Normal squeezing	High pressure squeezing
Size concentration	8%	14%
Wet size pick-up	120%	68.5%
Dry size add-on	9.6%	9.6%
Moisture in wet sized yarn	110.4%	58.9%
Moisture in dried sized yarn	4.5%	4.5%
Water evaporated in drying	105.9%	54.4%

In the case of high pressure squeezing system the quantity of water evaporated by the drying system is about half of that in the normal system. However, a proper balance between factors such as concentration of size paste, squeezing pressure and machine speed will have to be arrived at for which a number of considerations have to be made. Also squeeze rollers specially designed for the purpose will have to be used.

11.6 Foam sizing

This is another interesting approach to energy saving. Certain types of synthetic sizes have the capability to generate foam or lather. The advantage of generating foam is that it can be produced with a large bulk and a very light density. Also by using high concentration size paste prior to foaming, size add-ons almost equivalent to conventional sizing can be obtained with very small size pick up. The warp sheet can be made to pass through the foam and then squeezed. Though polyester types of sizes have good foam generating capacity, they are too expensive.

Hence these sizes will have to be used in combination with other conventional sizes and a foam stabilizer such as sodium lauryl sulphate. The important considerations in foam sizing are the viscosity of the foam, its density and stability. A draw back of the method is that the viscosity of the foam reduces with time. It can be effective only if high concentration size pastes are used for foaming.

Another problem is that the bulkiness of the foam reduces with higher concentration of size. The foam technique has been successfully implemented in the textile printing, and it also holds good promise in sizing.

11.7 Energy saving in drying

A great deal of effort has been taken in reducing the steam consumption in drying. In case of hot air method of drying the sized warp yarns, energy saving is possible by replacing fresh air with hot moist exhaust air to the extent of about 20%. This is again heated and recirculated in the hot air chamber. A newer method has been developed for recirculation of exhaust steam in cylinder drying method and has proved advantageous by reducing the steam consumption to almost 1.3 kg per kg of water evaporated.

A typical energy saving system in drying is shown in figure 11.1

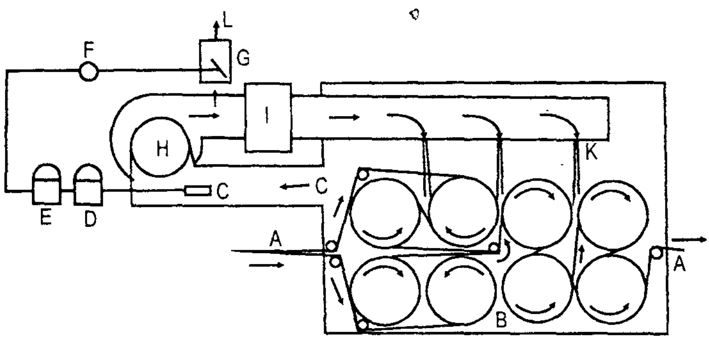


Figure 11.1

The range of drying cylinders is enclosed in a chamber that is insulated. The hot moist air escapes through the back side wall of the chamber. An exhaust fan forces the moist air through a heat exchanger. The R.H of the air is controlled to the desired level. Provision is made for partially by-passing the exhaust air. This air is then made to go through the heat exchanger, and heated to a temperature of 80 - 90°C. It then passes into the chamber through a duct and then passes on to the warp sheet at different points between the cylinders. The air is replaced by drawing it though the entry and exit points of the warp sheet. Also outside air can be brought in from the top of the chamber if required. The advantage with this system is that the drying of the warp sheet by the cylinders is assisted by the air circulating around them. The humidity and temperature of the circulating air can be adjusted and controlled and can also be replaced by fresh air.

11.8 Approaches towards conservation of environment

One of the major problems posed by the sizing process is its contribution to pollution of the environment by the discharge of effluent. The effluents can be both from sizing as well as desizing sections. The effluents can be tested for their toxicity/polluting capacity by means of BOD and COD (biological oxygen demand and chemical oxygen demand). The COD method has preference over the BOD method. It represents the oxygen required to chemically decompose completely the pollutant, and therefore is the total reducing power of the polluted water acquired by it due to the presence of impurities.

In the industrially advanced countries, the governments have become more aware of the pollution problem and have compelled industries to treat their waste waters to reduce COD. Industries are levied charges on the basis of the volume of the waste water and the impurities in it. Although the sizing process contributes very less to the total volume of the effluent, its solid content is mostly comprised of organic matter and is very high. Hence sizing process contributes to COD and suspended solids significantly.

In order to reduce the contribution of the sizing-desizing effluents to pollution, the following measures have been suggested

a) Conventional adhesives have to be replaced with high efficiency synthetic adhesives so as to reduce the effluent concentration.
b) Adhesives that could be recovered from the desizing effluent are to be used.
c) Special desizing methods are to be used so as to destroy the adhesive without affecting the fabric.
d) Suitable solvents will have to be used for sizing or desizing or both, in place of water.

11.9 New adhesives

Researches have indicated that partial substitution of starch or CMC by PVA or a highly soluble polyacrylate adhesive has resulted in considerable savings. PVA has a COD of 170% as compared with starch or CMC having a COD of 110%. Polyacrylate adhesive has a COD of 135%. The advantages of these sizes is that the total concentration of the size can be greatly reduced by their partial substitution with starch. This proves economical in cost of raw materials and effluent charge. The savings in size materials far outweigh the effluent charge.

11.10 Recovery from desizing effluent

This aspect tends to be very prospective, provided that the desizing method is not detrimental to the size material. This can be easily taken care of, but, however, it is necessary to ensure that other ingredients of the size mixture should not pose problems in the recovery of the size. This seems to be an uphill task. Researches relating to this point of view seem tc be based on the presence of only the adhesive in the mixture. This poses a serious limitation. However, the following attempts seem to be encouraging in this regard.

Size that is highly soluble and non-degradable can be a very efficient washing system so as to obtain the size in adequately high concentration and use it as such or with a small addition of fresh sizing material. Using a special washing system with special type of size with repeated treatment is said to give 50-70% recovery of size. The advantage accruing out of this is that the COD of the effluent is reduced to the same extent and also sizing cost is reduced. Also, the volume of the size effluent is reduced due to absence of desizing effluent. The system has simple arrangement.

Another effective system known as the duplosolve system is similar to the previous mentioned one. The difference in this system is that perchloroethylene is used to assist removal of water from the cloth. The sized fabric is passed through water and strongrful jets of the solvent. The size in the cloth is dissolved by water and the mixture of perchloroethylene and the aqueous solution comes out. The heavy solvent is reused again. The aqueous solution is heated to remove traces of solvent from it and used again for sizing. The use of solvent also helps to remove oil and wax present in the fabric.

The most effective method of size recovery is the ultrafiltration method. The wash water containing desizing material is made to pass through semi-permeable membrane. The super fine holes of the membrane permit only smaller molecules of water and other soluble substances to pass through, and prevent the larger molecules such as PVA or CMC from passing through. Also, the recycling process can be repeated 4-5 times or even more.

11.1 Special desizing methods - Plasma treatment

Efforts have been directed to destroy the adhesive material, particularly PVA, by the use of high energy ions and electrons so as to decompose it. In this method the adhesive is not recovered and there is also no problem of pollution since it is destroyed. Plasma is considered to be very reactive since it contains ions, electrons and gas molecules of high energy. It is produced by subjecting oxygen to a high potential difference between two electrodes. The oxygen plasma which is a high energy gas that contains electrons, positive ions, negative ions and molecules of oxygen is made to impinge on the cloth to be desized for a certain duration. This is then followed by cold and hot washes with water. The advantage with this treatment is that the removal of PVA is almost 100%. The removal has been to the extent of 60-70% before the water wash. The problem with the method is that there is some fibre loss and also loss of strength of treated material. Attempts are on to overcome this problem.

11.2 Sizing without size box

In yet another interesting development, the size box has been dispensed with. The warp yarns have been sized by an electrostatic method of spraying without the use of a size box. Most of the adhesive has been recovered by efficient washing and this has resulted in economy in many ways. The method is also applicable to hot melt sizing discussed previously, provided the melting adhesive is made highly soluble in water. In such cases, the adhesive can be washed out completely with the minimum quantity of water and then reclaimed for reuse.

11.3 Use of solvents

The major focus has been on the use of organic solvents in sizing and desizing. This may have probably been prompted by the use of solvents in other processes such as scouring, bleaching, dyeing, etc. Organic solvents are used in place of water, to dissolve the adhesive. The solvent and the adhesive are recovered by distilling off the former and collecting the residue of the adhesive and the condensate of the solvent. A number of alternatives are alternatives can be adopted in this method. The solvent sizing method has the following merits:

a) Total elimination of pollution problem
b) Savings in energy
c) Lesser sizing cost per unit weight of the yarn as compared with aqueous sizing
d) Improved sizing efficiency

One of the primary considerations in the solvent sizing is the choice of the solvent. This depends on factors such as availability, cost and safety. Generally organic solvents are inflammable.

11.4 Other approaches

The sizing process though beneficial for weaving , poses a problem in so far as its removal from the textile material is concerned. Recent approaches have aimed at combining sizing with other wet processes such as bleaching, dyeing or finishing. The advantage of such a combination would result in economy with respect to energy, labour and time. It also reduces the number of processes that the textile material has to pass through. This method has its own limitation since it is unsuitable for fabrics where warp and weft threads need to be alike. It is however suitable for fabrics such as denim where the warp threads are to be dyed and the weft undyed.

11.5 Combining sizing with dyeing

In this method the sizing and dyeing are either done in a single operation or successively. Dyes such as vat, azoics, reactives, pigments, reactives, pigments, disperse etc. are used for dyeing. A number of systems exist, of which the open-width indigo dyeing and sizing is popular in our country. The indigo system of dyeing is suitable for denims and chambrays. The system permits for the requirement of indigo dyeing of alternate dipping and alternate oxidation in order to build up the shade. It includes scouring, rinsing, padding through the indigo solution, squeezing, oxidation by airing, then repeated padding and airing a number of times, followed by repeated washing with water, drying, passing through the size paste, drying, passing through a compensator unit to allow non-stop operation during doffing of the loom beams and winding on the loom beams.

11.6 Combining sizing, dyeing and finishing

This method integrates the three processes into one. The sizing materials, pigment colours and thermosetting precondensate along with catalyst are kept in the size box. A softener and wetting agent are also present. The sheet of warp yarns is made to go through the size box and then dried. It is then sent to the weaving shed where the weft (untreated) is inserted. After weaving the fabric, it is passed through a heat setting chamber, where the thermosetting gets cured. The thermoset resin fixes the pigment colours and also the sizing ingredients, and if the warp is synthetic material, it gets heat set and stabilized. The fabric is then soaped and washed. A permanent or durable press can be given with the synthetic resin. The system is claimed to have several advantages.

11.7 Sizing with silica dispersion

In this system a new additive is included in the size mixture so as to enhance the performance of the existing conventional sizing additives. It is basically silica in colloidal dispersion form in an emulsion of rubber latex. This helps to improve the abrasion resistance of the size film and also imparts softness and pliability to the size film. The rubber latex film has good adhesive strength and helps to lay the protruding fibres on the yarn surface, and also improves hydrophilicity and prevents slippage of fibres. On addition of the colloidal silica to the latex the microfine particles of silica get embedded in the film and enhance the performance further. The advantage with this method is that even with addition of a small quantity of say about 5% of the silica additive, the warp strength is considerably improved, hairiness is reduced, and lubricity is improved. This reduces the warp breakages by about 20 - 30% on looms weaving cotton.

11.8 Heat shock treatment

In this method the warp sheet is made to go around a heated roller before entering the size box. The method is found to further improve the sizing performance, by reducing the warp breakages on loom by about 30% and increasing the loom productivity by about 5%. This is due to improved strength of the yarn by the prior heat treatment given. The draw back is that the elongation is slightly reduced.

11.9 Fusion of yarn surface fibres

This method is particularly suitable for pure synthetic yarns and their blends. The yarn is subjected to a very brief heat treatment. The temperature of the heat treatment is slightly above the melting point of the fibre, so that the fibres at the surface of the yarn melt and fuse together resulting in a compact, resistant surface layer. It has been found that the abrasion resistance of the heat treated yarn improves without affecting their strength and dyeability.

PART IV
DRAWING IN

Chapter 1

PRINCIPLES OF VARIOUS MACHINES

Introduction

The process of drawing in is also known as entering and knotting or looming. It is the process that connects the sizing and weaving. The important operations of this process are leasing, drawing, tying and dropper-pinning, which in turn depend on different types of yarn, colour-planting, weaving machine type, and character of production, i.e., degree of diversity. The drawing in operation required skilled operatives in the earlier days. Subsequent developments led to considerable mechanisation in the operations. One of the noteworthy example of this aspect is the Barber colman machines, that have been designed to perform different operations automatically. Machines have been developed to increase the productivity of hand processes without complete mechanisation.

Types of drawing/tying

According to our industrial practices, three modes of tying are practised, namely,

a) Hand drawing
b) Auto-reacher or semi-automatic drawing-in
c) Automatic warp tying

Hand drawing-in is the oldest method and our industry still continues with it in view of the requirements of fancy sorts. Therefore, generally speaking, grey beams other than fancy varieties are worked with auto-reaching arrangement or with auto tying machines while all coloured and fancy sorts are hand drawn.

Hand drawing

This is also known as manual drawing in, since the warp ends are drawn in manually. The only equipment needed is an upright frame for mounting heald frames and the reed. It requires two persons to carry out this operation, where one finds the subsequent ends from the weaver's beam and gives it to the other person, who in turn draws the same though the appropriate heald eye and dent spacing.

This method is more labour- oriented and less capital oriented. It is the most versatile method for drawing in any count of warp or any pattern. However, a separate drawing in section is necessary to carry out this operation, therebyincreasing the cost of drawing in is more than any other type of process.

Mechanical drawing-in

This can be further sub-divided into two processes:
Semi-automatic reaching-in and
Fully automatic warp reaching in

Semi-automatic reaching in machines

Here, the reaching-in machine is employed for the purpose of end-finding from the weaver's beam, thereby reducing the labour requirements from two workers per set to one worker per set. The worker has only to draw the ends as given by the reaching-in machine through appropriate heald eyes and dents in the reed.

It is quicker than the manual drawing-in, the quality of work is better, the cost of drawing-in is less, and the floor space requirement for a given size of loom shed is less as compared to manual drawing-in process. However, since the capital investment is more, it is economical only where the volume of work is sufficient to keep the machine fully engaged.

Automatic reaching-in machine

As its name implies, the machine automatically carries all warp ends to the reed hook in proper sequence. The beam is fitted on the stands of the machine provided for that purpose.

The warps are fixed between a pair of clamps without disturbing their relative positions. The first warp end is connected with the automatic reaching-in motion and the current switched on. The automatic device will now present to the reed hook all the warp ends one by one on correct rotation.

As soon as any warp end is taken off by the drawer, the next end is ready for him. In order to minimise eye strain of the drawer, the drawing-in threads is electrically illuminated. Further, the machine is provided with a mechanism for separating the warp ends that might be sticking together. This will ensure only one end being conveyed to the reed hook at each operation.

The operation of the machine is very simple, and requires an adjustment when changing over from one count to other. It can be used for all types of textile warps.

Although the machine presents the warp threads to the drawer at a rate which is higher than what can be done manually, the actual time saved by the use of an automatic reaching-in machine, of course, is not significant. This is due to the fact that the machine required adjustment every time a new warp is started and therefore some time is lost in performing that operation.

Denting

The drawer takes a bunch of ends which have already been drawn in through the heald eyes, straightens them up, selects them in pair or in any other orders as the case may be, by his left hand, and finally draws them through the dents of the reed in the proper order by means of the hook with his right hand. The operation is repeated until all the ends of the bunch have been drawn in. These free ends of the bunch will then be loosely knotted together. The drawing-in of the ends of the remaining bunches will be carried out exactly in the above manner. Sometimes the denting is performed mechanically.

An efficient drawer can draw from 1500 to 2000 warp ends in plain order per hour. One frame can supply 60 to 100 looms depending on the total number of ends per beam. The average number of picks per inch in the cloth woven, the average loom speed etc.

Denting apparatus

Only one operative is required to perform the operation of denting. No power is required to drive the apparatus, except a downward pull of a cord by the thumb of the operative. It can be used in the drawing in frame as well as on the loom.

To start with, the operative holds a bunch of ends by one hand, selects the ends in pair or any other order as required by the pattern and inserts these ends in the slot of the drawing in hook. As soon as this is done, the cord, which is held by the thumb of hand holding the bunch of ends is pulled downwards. This will result in the drawing in hook along with the ends hooked in it, being inserted into the dent of the reed, which has been already kept open by the drawing in blade for that purpose.

The operative now selects the next pair of ends for insertion in the hook, when the later returns to its receding position. The drawing-in blade mechanically selects and opens the dents of the reed in succession for the denting hook to pass through them. The whole cycle is repeated until all the ends from one selvedge to the other have been dented through the reed. The denting blade can be adjusted to suit reeds of different counts without changing any part of the apparatus.

The main work of the operative is to select the ends and put them in the slot of the hook. The selection of dents and insertion of the ends through them involve no eye strain. The apparatus is simple in construction and contains only a few parts. Consequently, however, limited cases where the operation of drawing-in is semi-automatic, i.e. drawing-in of the ends through the healds is carried out alone or where there is scarcity of 'reachers'. The production of the apparatus depends on the speed of the operative.

Automatic knotting or tying- in

The process is widely used now a days in mills where the quality of the warp is not often changed and the volume of work is sufficient to keep the tying machine fully engaged.

The process can be used onlhy where the new warp is identical to the old warp in respect of total number of ends, counts of healds and reed and the order in which the ends are to be drawn through the healds and reed.

In the case of striped warps, the warp patterns should be identical as well. Both stationary and portable machines are available for carrying out the process. The sequence of operations carried out on these machines is similar to that followed in the case of manual twisting in.

The operations of selection and knotting of the ends, cutting the tail ends of the knotted thread and stopping the machine in the event of a thread found missing or broken are performed mechanically and automatically.

Automatic tying machine

An automatic tying apparatus is usually provided with the following important parts of mechanism

a) A carriage on which the tying apparatus is fitted.
b) Selector needles for picking up threads from the old and new warps one by one in the proper order.

c) Thread carrier for carrying the threads picked up by the selector needles for the next operation of knotting.

d) A knotting unit for knotting the threads picked up by the thread carrier.

e) A shearing mechanism for cutting the tail ends of the knotted threads.

f) A traverse motion for effecting advance movement of the carriage carrying the tying apparatus.

g) An electric lamp for providing additional light for watching the performance of the important parts of the apparatus and also the parts of warp situated immediately near the apparatus.

h) A hand wheel for operating the apparatus manually at the start or for inspection purpose.

i) A driving unit consisting of a small electric motor with necessary arrangement for adjusting the speed.

Stationary tying-in machine

The stationary machine works in the preparation room. The old warp with its healds and reed is carried to the preparation room where the new warp would already be position on the stationary adjustments of the machine, the actual tying-in is started.

On completion of knotting of all the ends, the knotted ends of the new warp are pulled through the healds of reed. The ends of the old warp threads are then cut off. Thereafter, the new warp with its healds and reed is brought to the room and gaiting up is carried out in the usual manner.

To prevent the stationary tying machine from lying out of production for the preparation of warps before actual tying-on operation is started, usually two trucks are used nowadays, so that while the automatic knotting is progressing on one of the trucks, the other truck is loaded with the harness and the warp for the next tying on operation.

Precautions to be taken by the looming department

Unlike in other processes such as winding, warping, sizing, etc, in drawing-in processing or converting machines are not involved. Therefore, the scope and approach of process control in this section is somewhat different from that of other sections.

The main requirements of carrying out this process properly and efficiently are:

a) the operators should be aware of the principles of drawing-in and be trained to do the job speedily because any mistakes are delays in carrying out of the process would prove to be costly.
b) the healds and reeds should be in good condition and of suitable specifications for ensuring that these are not the cause of warp breaks on the loom and of defects in the fabric.
c) the dressing of the beam should be done properly to avoid cross ends on the beam and
d) suitable precautions should be taken to reduce the incidence of extra ends and to compensate for the missing ends during weaving of the beam.

The first aspect is operative training and other aspects are care of healds, cleaning of healds and heald frames and care in use and selection of reeds.

The healds from the exhausted beam of the loom must be cleaned thoroughly and checked for damage being reused for a new beam. The reeds taken off from the loom should be cleaned by a hand brush or preferably on a reed cleaning machine. Non-uniform spacing of dents in a reed affects the weaving performance and fabric quality.

These above precautions should be taken while looming process of drawing-in, and denting operation.

PART V
MICRO DENIER YARNS

PREPARATION OF MICRO DENIER YARNS

1. Introduction

Microdenier yarns differ considerably from normal synthetic yarns. A thorough knowledge of the differences in terms of the physics, properties and manufacturing technology of these yarns enables to tune any post-spinning process. The development of microfibres has provided oppórtunities to produce a new generation of fibres and fabrics of totally novel characteristics, which have not previously been possible from either natural or synthetic fibre sources. The yarns produced may be of many types such as conventional, fine and/or superfine filaments, filaments of widely differing shrinkage characteristics, very high and low twist yarns, textured, air textured and flat filament yarns, and variations in cross-sectional shapes. These can produce a very wide range of materials and effects such as imitation silks, peach skin, light to heavy suedes, and air and water permeable water proof fabrics. The areas of applications of such yarns include apparel, sports wear, leisure wears, furnishings, upholstery, and lenswipes.

2. Definition and fundamental concepts

Micro fibre yarns are those that contain filaments of less than one deci tex per filament. It would be more pertinent to compare them with natural fibres. The following comparison is given:

Human hair	30 - 50 dpf
Wool	4 - 6 dpf
Cotton	1.4 - 1.6 dpf

Micro fiber	less than 1 dpf
Super-micro fiber	less than 0.3 dpf

3. Methods of producing micro fibres

Micro fibre filament yarns are produced by three methods, namely:

Conjugate technology

Sea/island technology

Direct melt spinning

In India only direct melt spinning technology is being used to produce microfilament yarns.

4. Warping and draw warping

Micro denier continuous filament yarns are different from standard higher dpf (denier per filament) yarns with regard to the physical aspects. Firstly they need a smaller amount of force to stretch and/or break them as compared with normal dpf yarn. Secondly micro denier filament yarns have higher surface to volume ratio of filaments. Hence greater amount of finish is required to get the same degree of protection and lubricity. Also they are more prone to static charge generation.

Generally micro denier filament yarns are subjected to draw warping process instead of the standard warping that is done for normal dpf yarns. The creel structure, however, remains the same in both cases. The tension device is considered to be most vital element in the warping. It is necessary to note that the tension device does not remove the yarn tension but only adds to it. Also, it cannot compensate for tension variations during warping at high speeds. Hence a simple device that provides minimum tension is suitable. Also, a S-type wrap sheet tensioner should be used down stream of creel to lower tension that is added by air friction on moving yarn sheet. Light weight tension disc which add tension independent of speed of wrap angle are used to give just enough tension (3 - 5 gm) to hold the thread sheet stable during a stop.

All eyelets in tension device, eye board, eye bars in creels must be of low friction ceramic material with matt surface (surface must be maintained free of any cuts and snags). Stop motion device should be motion sensor type that does not touch the yarn or add tension.

Static bars are a necessity at the end of the creel and should be located after every reed and every 5 - 10 feet of free yarn traverl. The number of eliminators depends on humidity in the warping area. In general, an increase of 5% in humidity is recommended for low dpf and micro yarns.

The second most important element is reed. The reed blades must be free of burrs and snags. Yet another interesting aspect to be noted is that the traverse should be extremely small.

The requirements for draw warping microdenier yarns are similar to those for warping. The equipment from creel to collecting eye board is same. Draw unit and interlace unit is added. Additional reeds and static bars may be necessary for microdenier yarns. This makes quality of reeds even more important.

From operational point of view, draw warping of micro denier yarn is same as standard filament yarn. However, more attention to detail must be used in handling the yarn. POY is loaded on push off trucks preferably with minimum handling. These push off trucks are then put inside the creel. Any slippage between rolls and yarn during a stop must be avoided. Relaxation after drawing should be carefully controlled by adjusting parameters of drawing and setting. Higher residual shrinkage may create problems of hard beams and streaks in fabrics, if downstream process control is poor.

5. Sizing

The principle applied in sizing will almost be the same as in warping discussed in the previous section. In the sizing of micro denier yarns, the size box needs special consideration. The size box configuration for micro denier yarn will not vary from conventional filament size box, but the things done for normal yarns will be critical here. It is preferable to have spray bar in size box. During stop, creep or slow speed, a spray bar keeps the sized yarn located between the immersion roll and the squeeze roll from drying out. This prevents hard size marks as well as the broken filaments, as the yarn exits the squuze roll and passes into the wet split section. In case of micro denier yarn, the tiny filaments are vulnerable at exit especially if slasher has been in a creep speed or stopped for any length of time and the rolls are tacky. The filaments can stick to rolls and break.

Micro denier yarns will probably have more finish than normal yarns. Depending upon size comparibility, this can lead to, yarn finish forming a thin layer of skim in the box. So, overflow weirs, in size box, is recommended to get rid of, finish. Another important variable in the size box that needs to be monitored carefully is pick-up. Micro denier yarn tends to pick up more size. Squeeze roll pressure and size formula will have to be adjusted to find right balance for weaving. The important thing to remember is, too much size will cause a hard break at the front of the slasher and possible broken filaments. Generally 1 -1.5% higher pick up is necessary for micro yarns.

Leaving the size box, the yarn passes on to the wet-split, and hot air pre dry oven. This is a must and is critical for zero-twist micro denier yarns. If the yarn is 75% to 85% dry when it reaches the first drum, the yarn ends do not stick to each other and break filaments when this reach leasing section. The speed of the machine should be adjusted to obtain proper moisture level at the exit of the oven. Individual temperature control and good Teflon covering is more desirable for micro denier yarns.

Most of the things done for conventional filament yarn should be practised in head stock section keeping in view low breaking load of micro denier. While sizing micro denier yarn is to be specially noted that de-sizing of micro denier filament fabric is difficult as compared to normal fabric.

5. Twisting

One for one twister with flyer is not recommended, as it creates lot of broken filaments. Two for one twister are best suited. Reduced spindle speed and tensions is useful in controlling broken filaments. All the guides should be maintained in good condition, without ridges or cuts. Twisting enhances shrinkage differences in base yarn which creates problems in processing of fabrics and hence it is essential to have high quality feed yarn with low and more uniform shrinkage.

PART VI

BTRA NORMS IN WINDING, WARPING, SIZING AND DRAWING IN

APPENDIX IA

BTRA norms of Classimate faults for wound yarn

Type of yarn	Count	Type of fault	No. of faults/km
Carded (100% Cotton)	10s	$A_1B_1C_1D_1$	<45
		$A_3B_3C_2D_2$	<1
		H_1	<6
	16s	$A_1B_1C_1D_1$	<65
		$A_3B_3C_2D_2$	<2
		H_1	<6
	20s	$A_1B_1C_1D_1$	<75
		$A_3B_3C_2D_2$	<2
		H_1	<6
	30s	$A_1B_1C_1D_1$	<175
		$A_3B_3C_2D_2$	<2
		H_1	<12
	40s	$A_1B_1C_1D_1$	<325
		$A_3B_3C_2D_2$	<2
		H_1	<35
Combed (100% Cotton)	40s	$A_1B_1C_1D_1$	<70
		$A_3B_3C_2D_2$	<1
		H_1	<2
		$I_1H_2I_2$	<1
	50s	$A_1B_1C_1D_1$	<125
		$A_3B_3C_2D_2$	<1
		H_1	<5
		$I_1H_2I_2$	<2
	60s	$A_1B_1C_1D_1$	<150
		$A_3B_3C_2D_2$	<1
		H_1	<5
		$I_1H_2I_2$	<5
	80s	$A_1B_1C_1D_1$	<225
		$A_3B_3C_2D_2$	<1
		H_1	<45
		$I_1H_2I_2$	<5

APPENDIX IB

BTRA norms for yarn breakage rate in winding

Type of machine	Type of material	Yarn breaks per lakh meters		
		Good	Average	Poor
Autoconer	Cotton	20	30	45
Murata & Savio	Blended	25	35	45

APPENDIX IC

BTRA norms for clearing efficiency (%) on winding machine

Type of machine	Clearing efficiency(%)		
	Good	Average	Poor
Autoconer, Murata, Savio	95	90	85

APPENDIX ID

BTRA norms for winding machine speed and efficiency

Type of machine	Winding speed (m/min)		
	Cotton		Blends
	< 40s	>40s	
Autoconer, Murata, Savio	1400-1500	1000-1400	1350-1500

Type of machine	Machine efficiency (%)		
	Good	Average	Poor
Autoconer, Murata, Savio	90	85	80

APPENDIX IE

BTRA Norms for splice quality

Splice dimension	:	1.2 to 1.4 times the parent yarn diameter
SAG-Splice appearance grade (ATIRA)	:	3
Length of splice	:	3 - 3.5 cms
Retained splice strength	:	> 85%
Splice breaking ratio	:	Maximum 20%

Yarn tension in winding

The yarn tension during winding should be about 10% of the single yarn strength.

Atmospheric conditions

The relative humidity in the winding department should be between 68 - 72%.

APPENDIX I F

Norms for man power requirement in winding

Magazine feed

Count	20s	30s	40s	60s	80s	100s
Drums/winder	30	30	60	60	90	90

Bobbin feed

Count	20s - 40s	41s - 60s	Above 60s
Drums/winder	90	120	150

Norms for hard waste in winding

The hard waste in winding should not exceed 0.7%

APPENDIX I G

Recommended clearer settings

Type of machine	Type of yarn	Settings
Ordinary cone and Cheese winders	Carded	2.0 x D*
	Combed	1.5 x D
Autoconer	Carded	3.5 x D
	Combed	3.0 x D

D* - yarn diameter

APPENDIX II A

BTRA Norms in Warping
Norms for warping machine speed

Direct warping

In the case of super high speed warping machine such as Benninger the speed should be between 800 - 1000 mpm for cotton yarns and for coloured yarns the speed should be reduced by about 5%.

Sectional warping

In the case of super high speed sectional warping machine the speed should be between 400 - 500 mpm.

APPENDIX II B

Norms for warping breakage

Type of machine	Warping stops/400 ends/1000m		
	Good	Average	Poor
Super high speed warping machine	0.2	0.5	0.7
Super high speed Sectional warping machine	0.4	0.8	1.0

APPENDIX II C

Norms for contribution of spinning and winding faults

In the case of super high speed warping machine the spinning faults should not exceed 65% and winding faults should be 35%.

APPENDIX II D

Norms for efficiency of warping machine

Type of machine	Efficiency
Super high speed warping machine	60 -65
Super high speed sectional warping machine	45 - 50
For coloured pattern set	30 -35

Norms for warping knot

The warping knot tail should have length of 5-6 mm

APPENDIX III

BTRA Norms in Sizing

Norms for mechanical stretch - 1%

Norms for optimum yarn tension during sizing

	% of single thread breaking strength of ring yarn	
At creel	Between finishing squeeze roll to first drying cylinder	At head stock
2 - 3	4 - 5	10 - 15

Norms for sized yarn residual elongation - 4.5%

Norms for gain in strength and loss in elongation at break of sized yarn

Type of yarn	Gain in strength (%)*	Loss in elongation (%)
Upto 40s	>25	<10
Above 40s	15 - 25	< 10
Polyester blended Yarn	5 - 15	< 10

* Based on the single thread breaking strength and elongation at break of ring yarn.

Norms for dead loss %

- Good - 15
- Average - 20
- Poor - 25

Norms for variation in size pick up

- Good - ± 1
- Average - ± 2
- Poor - ± 3

Norms for migration of ends

Count of yarn	No. of ends/1000 ends/1000m Good	Average	Poor
Upto 40s	1	3	5
Above 40s	3	7	10

In the case of coloured yarns, these values will have to be increased by 15%

Norms for lappers (lappers/1000 ends/1000m)

Good - 0.2
Average - 0.4
Poor - 0.8

APPENDIX IV

BTRA Norms for drawing in production

Manual drawing in - 5500 ends/2 persons/shift of 8 hrs

Fully automatic drawing in machine - 65000 ends/day

Knótter productivity - 13000 ends/operative

REFERENCES

1. Weaving conversion of yarn to fabric, Lord and Mohammed, Merrow publications.
2. Modern preparation and weaving machinery, Ormerod. A, Butterworth and Co., 1983.
3. BTRA monograph series - Winding
4. BTRA monograph series - Warping and Sizing
5. Yarn faults and package defects - Effect, causes and rectification, Indra Doraisamy, Chellamani .K.P, and Kanthimathinathan.A, South India Textile Research Association, 1995.
6. Yarn winding, Edtd. Banerjee P.K, and Alagirusamy. R, Nodal Centre for upgradation of textile education, IIT, Delhi, 1999.
7. Sharma IC, Some studies on spliced yarn, PhD Thesis, MD University, Rohtak, 1998.
8. Bissman O., Knotfree yarn joins by splicing, Int. Text. Bull. Weaving 3 1981.
9. Lunenschloss J & Theirhoff J, Knotless yarn joining, Int. Text. Bull, Yarn forming 4 ,1984.
10. Kaushik RCD, Sharma IC and Hari PK, Mechanism of splice, Text Res. J, 58, 5, 1988.
11. Garde .A.R, and Subramaniam T.A, Process control in spinning, ATIRA, 3rd edition, 1987.
12. Sewing threads, Man made textile encyclopedia, 1959.
13. Cotton and synthetic sewing thread - I, The Indian textile journal, 63 - 64, Aug., 1984.
14. Two for one technology and technique for spun yarn, Kulkarni HS and Murthy HVS, Tecoya publications, November 1992.

15. Saurer twisting systems generation-6 by Volkmann, Germany.
16. Sizing materials, methods, machines, Ajgaonkar DB, Talukdar MK, and Wadekar VR, Textile trade press, Ahmedabad, 1982.
17. The drying of sized warp, Technology of warp sizing, Ed. Smith JB, Columbine press, Manch & London.
18. Von Kannen A, Unwinding tension and its control on the sizing machine, Intern. Text. Bull. 1973.
19. Trauter J., & Rues B, Third annual symposium-sizing, IIT ,Delhi, September 1980.
20. Neale SM, J. Text. Inst., 15 (1924), T443.
21. Seydel Paul V, Warp sizing, Smith publishing Co, 1958.
22. Paul GT, Wilhelm RH, Radiation drying of textiles, Text Res. J., 1948.
23. Gill Bob. L, Instrumentation for slashers, Intern. Text. Bull., 1/1973.
24. Chowdhary PA, Continuous filament yarn sizing of nylon and polyester, Seminar on sizing of man made fibre yarns today and tomorrow, Textile association (India), Bombay branch 1978.
25. Karani TC, Problems associated with sizing of man made fibre yarns, ibid.
26. Blumenstein CR, Sizing synthetics and blends, Text Indust. 1963, 127, No.8, 58.
27. Dattagupta NC, Sizing of man made fibre blended yarns, Seminar on sizing of man made fibre yarns, today and tomorrow, Text. Assn. (I), Bombay 1978.
28. Seydel SO, Recent sizing developments in the united states, Third Intern. Symp on sizing , Manchester, 1977.

29. Seydel SO, Fourth International sizing symposium in Mulhouse, France, June 1980, Text Asa, 1980 (Sept.).
30. BTRA norms in weaving, 2007.
31. NCUTE HRD programme on "Filament weaving", Ed. Khatwani PA and Yardi SS, 2000.
32. Kothari VK and Reeti Pal Singh, Modern developments in cone winding : A Review, Indian Textile Journal, December 2006.
33. Autoconer 338 RM/K/E Sensor-controlled package winding, Schlafhorst Saurer Group information Brochure.
34. Textile Technology, Edition 1, Number 1, Sept 2001, Saurer Group Information Brochure.
35. No:21C Process Coner Automatic Winder, Murata Machinery Information Brochure.
36. Orion, Savio Macchine Tessili, Information Brochure.
37. Perla-A/Perla-D Hairiness Reducing System, Murata Machinery Information Brochure.
38. NCUTE programme on latest textile machinery used globally.
39. Autoconer 338 D/V, The Caddy-System - Innovatin, Efficient, Fleixible, Schlafhorst Saurer Group Information Brochure.
40. Carl A Lawrence:Fundamentals of Spun Yarn Technology, CRC Press Publication, 2002.
41. Manufal of Savio - ESPERO.
42. Peter.R.Lord: Handbook of Yarn Production: Technology, Science and Economics, CRC Press Publication, 2003.
43. Mesdan System for Knotfree Yarns, Information Brochure of MESDAN SpA.

44. Smith JB, 'Influence of technology of warp sizing'. The technology of warp sizing, Publ. Columbine Press, Manchester and London.
45. Khatwani PA, Ajmeri JR and AJmeri CJ, Development in warping, Journal of the Textile Association, Jan - Feb 2003.
46. Hari PK, and Behera BK, Indian Textile Journal, (12), 22 (1996).
47. Nilesh M, NCUTE-Pilot programme, Weaving - I Shuttle loom, (9), 33 (1999).
48. Bhattacharya PK, Indian Textile Journal (4), 35 (1996).
49. Technical specifications : Amritlakshmi Super Speed Wawrper.
50. Technical specifications : G-H warp beams.
51. Modern Warping, ATA Journal, (12) 47, (1994).
52. www.Tontu.com.tw.
53. Vernekar ST, ISTE sponsored STTP on "Modern developments in weaving and processing techniques of cotton, blends and manmades", (7), 32 (2001).
54. Ormerod A and Sondhelm WS, Weaving : Technology and Operations, The Textile Institute, (1998).
55. Kapadia VH, ISTE sponsored STTP on "Modern developments in weaving and processing techniques of cotton, blends and man mades", (7), 32 (2001).
56. Kapadia VH, NCUTE-HRD programme on "Filament Weaving", (2), 7 (2000).
57. NCM - (10), 51 (1997).
58. Paliwal MC, Naik,Sehgal, Patel, Shah, Ramalingiah and Bhatt, Proceedings of 38th All India Textile Conference, on "Blended Textiles", 167 (1981).