CHAPTER - II

WORKING OF SPINNING MILL

2.1 Introduction

As observed in the introduction chapter spinning technology has undergone vast changes over the years since the beginning of mule spinning in England in 1800’s to Open-end and Ring spinning of today. Cotton spinning over the years has adopted modernization to save the wastes and also to control the emission of ‘fiber flies’ in the department. In the early days spinning mill was based on man power and more mechanical systems drawn by the electric motors and large machines with heavy metallic spikes, canvas lattices, with spikes rotating over rollers in blow-room. The carding machines with licker-in, cylinder, flats and doffer rollers with small and pointed needles for combing purposes created more dangerous situation for the operators to handle.

In the conventional spinning mill set up housekeeping and controlling sweeping waste was a big challenge. Another big problem with old spinning technology was controlling the fire accidents especially in blow-room and carding departments. The fire accidents usually take place when metal pieces are carried from machine to machine through the pipe lines along with the processed cotton tuffs come across open metallic wires mounted on high rotating rollers like cylinder, licker-in and doffer in carding department.

Even though in conventional mill the speeds of rollers, spindles and drums were low, the accidents could not be controlled due to in secure measures of the machine makers. Secondly, cotton micro dust pollution in the departments namely blow-room, carding, speed-frame ring-frame and cone winding departments was very high which not only affected the health of the workers but also the quality of yarn. Due to these reasons new technologies in machinery was introduced and today most of the spinning mills have modernized their units with modern machines.
The modern spinning mill is a perfect structure of right working of spinning mill with all precautionaries, quality measures, waste controls and need for quality raw material. One important observation of modern spinning mill is that there is considerable reduction in departmental pollution and sweeping wastes in departments. The humidification factor has also played vital role in maintaining quality of yarn as well as health of the workers. The computerized operations of machines in maximum departments of spinning mill have also contributed to the productivity by reducing detention time of machines and maintenance works.

The process flow in a spinning mill is as follows;

**Chart no. – 2.1**

```
        | Blow room       | Carding |
        |                 | Carded yarn |
        |                 | Combed yarn |
        |                 | Sliver lap machine |
        |                 | Ribbon lap machine |
        |                 | Super lap machine |
        |                 | Comber machine |
        |                 | Draw frame |
        |                 | Speed frame |
        |                 | Ring frame |
        |                 | Cone winding |
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The above flow chart gives most commonly practiced process in cotton Spinning mill.

The above process is for carded yarns while for combed yarns the process is as follows.

Blow –room – Carding – Draw – frame – Sliver lap – Ribbon lap – Comber – Speed – frame - Ring – frame – Cone – winding. This process channel does not include mixing process which is done manually and the packing of cones of readymade yarn.

2.2 Process activity of a spinning mill;

The ginned cotton purchased from the traders is brought in the form of bales of 165 kgs to 175 kgs and stored in godowns. The variety of cotton is selected on the number of count of yarn that is to be spun in the mill. The following table shows the various counts of yarn that is spun in co-operative spinning mills in Northern Maharashtra, and the variety of cotton that is used for those counts;

Table – 2.1 Shows variety of cotton used to obtain different counts

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Count</th>
<th>Variety of cotton</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20&lt;sup&gt;3&lt;/sup&gt;</td>
<td>LRA, Lakshmi, NH4</td>
</tr>
<tr>
<td>2</td>
<td>34&lt;sup&gt;3&lt;/sup&gt;, 35&lt;sup&gt;3&lt;/sup&gt;, 36&lt;sup&gt;3&lt;/sup&gt;</td>
<td>NH4, Y1, H4, LRA, MCU5</td>
</tr>
<tr>
<td>3</td>
<td>38&lt;sup&gt;3&lt;/sup&gt;, 40&lt;sup&gt;3&lt;/sup&gt;, 42&lt;sup&gt;3&lt;/sup&gt;</td>
<td>H4, MCU5, NH44</td>
</tr>
</tbody>
</table>

(Source: SITRA Coimbatore)

Basically the selection of cotton for any count of yarn depends on various characteristics of cotton for different counts such as staple length, fiber strength, evenness, uniformity, luster, moisture content micronaire (fineness) and maturity ratio. For various different counts ranging from 4<sup>8</sup> to 100<sup>8</sup> the above said parameters change as the count number increases from 4<sup>8</sup> to 100<sup>8</sup>.
The following table shows the various parameters such as yarn U%, Span length, Maturity Ratio and Micronaire value standards that are required for some select counts.

Selecting right quality of cotton is very essential to produce quality yarn. Cotton being a natural fiber, that under goes mechanization such as drafting, twisting and tensile strength when processed through various machines. In a ring-frame system which is existing in Khandesh spinning mills, the ginned cotton of various types are first mixed and then processed in blow-room. From blow –room it is carried on to carding then to drawing, from there speed frame and ring-frame machines and then to cone winding.

Table – 2.2 shows the cotton quality norms for various counts

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Count (Ne)</th>
<th>Yarn (U%)</th>
<th>50% Span length (mm) (L)</th>
<th>Maturity Ratio</th>
<th>Micronaire value (µg/inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20S</td>
<td>12</td>
<td>12.8</td>
<td>0.80</td>
<td>3.9</td>
</tr>
<tr>
<td>2</td>
<td>24S</td>
<td>12</td>
<td>13.7</td>
<td>0.80</td>
<td>3.8</td>
</tr>
<tr>
<td>3</td>
<td>26S</td>
<td>12</td>
<td>13.8</td>
<td>0.80</td>
<td>3.7</td>
</tr>
<tr>
<td>4</td>
<td>30S</td>
<td>13</td>
<td>13.3</td>
<td>0.80</td>
<td>3.5</td>
</tr>
<tr>
<td>5</td>
<td>36S</td>
<td>13</td>
<td>14</td>
<td>0.80</td>
<td>3.4</td>
</tr>
<tr>
<td>6</td>
<td>40S</td>
<td>14</td>
<td>12.5</td>
<td>0.80</td>
<td>3.3</td>
</tr>
<tr>
<td>7</td>
<td>44S</td>
<td>13</td>
<td>11.6</td>
<td>0.85</td>
<td>3.3</td>
</tr>
<tr>
<td>8</td>
<td>50S</td>
<td>12</td>
<td>19.5</td>
<td>0.85</td>
<td>3.3</td>
</tr>
<tr>
<td>9</td>
<td>55S</td>
<td>12</td>
<td>20.5</td>
<td>0.85</td>
<td>3.2</td>
</tr>
<tr>
<td>10</td>
<td>60S</td>
<td>12.5</td>
<td>22.0</td>
<td>0.90</td>
<td>3.2</td>
</tr>
<tr>
<td>11</td>
<td>70S</td>
<td>13</td>
<td>20.0</td>
<td>0.85</td>
<td>3.2</td>
</tr>
<tr>
<td>12</td>
<td>80S</td>
<td>13.0</td>
<td>20.5</td>
<td>0.85</td>
<td>3.0</td>
</tr>
<tr>
<td>13</td>
<td>90S</td>
<td>14</td>
<td>19</td>
<td>0.85</td>
<td>3.0</td>
</tr>
<tr>
<td>14</td>
<td>100S</td>
<td>14</td>
<td>20.6</td>
<td>0.85</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Source: Norms For Cotton Spinning 2004, SITRA
Now discussing the various process in detail

2.3 MIXING –

This is the first process which is carried out manually by labours. Various types of cotton which have staple length of required standard suitable for the count of yarn to be spun are mixed on a floor depending on the capacity and requirement of the plant and the production for the day. In mixing 1% to 2% soft waste is added to the virgin cotton. Mixing enables the technicians to reduce the raw material cost for particular yarn. Mixing enables technicians to mix superior and inferior cotton in a certain proportion as required in the market of the yarn. Therefore in a spinning mill mixing is a vital process which enables raw material cost reduction as well as to keep cotton lint with same moisture content. Mixing also enables the cotton lint to open up easily in the blow-room and carding process. In general practice, a mixing oil is mixed in water and at every layer of mixing this solution is sprayed over the layer. This is done to reduce the micro dust pollution in the departments. Micro dust and small fibers are the main components which cause thick and thin places in yarn. To achieve better evenness in yarn the departmental pollution of short fibers should be reduced to minimum. After mixing the mixed cotton is carried to blow – room.

2.4 BLOW – ROOM

It is the first department where the cotton is subjected to machines. It is called ‘Blow – room’ because the process of material takes place with the help of air currents. The material is blown from machine to machine through the pipe lines. The blow - room process has the following sequence of machines.

Bale - breaker → Hopper feeder → Axi-flow → Condenser →
Multi – mixer → Scutcher
A bale – breaker consists of long horizontal conveyer which carries the cotton into the machine. Inside the machine there is a wooden lattices joined by canvas cloth with small metallic spikes rotating vertically inclined to certain extent in a chamber. In this chamber the cotton that comes from the conveyer is subjected to lift and fall and opening of lints to certain extent by the spikes and cotton lints which gets opened up is carried by the spikes to the spiked rollers at the top of the chamber and released to the pipe line.

2.2 shows Flow diagram of Blow – room

![Flow diagram of Blow – room](source: LMW Machinery layout diagram)

From the above flow diagram we see that the process starts at bale opener which is now a days not installed in most of the spinning mills because the bales of different varieties of cotton are manually mixed in the form of mixing. This mixing is directly fed to the pre cleaner which is called by various names such as axi-flow by Lakshmi- Rieter makers and opener by Trustzler makers. From this machine via condensers it goes to the multi mixer and then the scutchers which are called as pre cleaners in the above diagram. From here via chute-feed the material is fed to carding in the form of lap to the condenser roller or feed roller of the card.
2.1 Photo of Blow room Department

(Courtesy: LMW Coimbatore)

Blow room is the starting of the spinning operation where the fibre is opened, cleaned, mixed, micro dust removed and evened thus passed to carding machine without increasing fibre rupture, fibre neps, broken seed particles and without removing more good fibers. The basic functions of blow room are opening, cleaning, dust removal, blending and evenly feeding the material on the card.

2.4.1 Functions of Blow Room

1. Opening
   o Opening is the first operation within the blow room in which the goal is always a high degree of openness of material with gentle treatment and a fiber loss as less as possible.
   o Opening is the first operation it means, tearing apart the compressed and matted cotton until it is very much loosened and separated into
small tufts with a gentle treatment, and a fiber loss as small as possible.

- Opening is also related to cleaning as where is opening there is also cleaning.

2. Cleaning

- Cotton contains up to 18% trash in most cases. To clean the material it is unavoidable to remove as much fiber as much waste.
- Therefore it is necessary to measure the amount of the waste removed and its composition. As it is of high importance also called cleaning efficiency.
- The cleaning efficiency always has to be optimized and not maximized, since the fiber quality (short fibers, neps) as well as fiber loss is always negatively affected by maximum trash removal.

3. Dust removal

To extract the contamination in the cotton such as leaf, stone, iron particles, jute, poly propylene, colored fibers, feather and other foreign material from cotton by opening and beating.

- An often underestimated task of the blow room line is the removal of dust. However, it is as important as the removal of impurities.
- De-dusting in the blow room happens by air suctioning only, either between the machines, e.g. by dust cages, dust extractors, etc., or within the machine by normal air separation.
- Every blow room machine must be capable of extracting dust, so that special de-dusting machines should be needed.
- The efficiency depends not only on the devices but also on the size of the flocks. The smaller the flocks, the higher is the efficiency.
4. Blending/Mixing

Mixing: It is generally meant as the intermingling of different classes of fibers of the same grade e.g. USA Pima grade, CIS

Blending: It is meant as the intermingling of different kinds of fibers or different grade of same fibers e.g. polyester & cotton, Viscose & cotton.

- Blending of fiber material is an essential preliminary in the production of a yarn.
- Fibers can be blended at various stages of the process. These possibilities should always be fully exploited, for example, by transverse doubling.
- However, the starting process is one of the most important stages for blending, since the components are still separate and therefore can be metered exactly and without dependence upon random effects.
- A well-assembled bale layout and even (and as far as possible, simultaneous) extraction of fibers from all bales is therefore of paramount importance.

Objectives of mixing or blending

- Economy
- Processing performance
- Functional properties

Even feed of material to card
To uniform feeding to the next stage such as carding machine.

2.5 CARDING

Carding is the second process in spinning. Carding is the heart of spinning. It is called as heart of spinning because the quality of yarn entirely depends on the carding effect on the fibers that are spun into yarn. Carding is a mechanical process that disentangles, cleans and inter-mixes fibers to produce a continuous web or sliver suitable for subsequent processing. This is achieved by passing the fibers between differentially moving surfaces covered with card clothing. It breaks up
locks and unorganized clumps of fibre and then aligns the individual fibers to be parallel with each other.

Common to all carders is card clothing. Card clothing made from a sturdy flexible backing in which closely spaced wire pins are embedded. The shape, length, diameter, and spacing of these wire pins is dictated by the card designer and the particular requirements of the application where the card cloth will be used. A later version of the card clothing product developed during the latter half of the 19th century and found only on commercial carding machines, whereby a single piece of serrated wire was wrapped around a roller, became known as metallic card clothing. Carding machines are known as cards. The card clothing which is metallic is mounted on licker-in roller, cylinder roller and doffer roller. The pitch length of the wire pins differs in these rollers. The pitch length of wire pins and also the height of the wire pins is bigger when compared to cylinder and doffer. In cylinder the wire pins are closer with smaller height when compared to licker-in roller. The wires on doffer roller are very small with very close pitch length and sharp pointed when compared to cylinder and licker-in. The quality of the sliver is measured in the form of hank. Depending on the count of yarn and type of yarn (combed or carded) that is to be spun the hank of sliver is determined. Usually for medium and finer counts (Above 30s) the sliver hank is maintained in between 0.125 to 0.140 hank. For coarser counts the hank ranges from 0.105 to 0.120.

2.3 shows Flow diagram of material in Carding

Source: LMW Machinery layout diagram
From the above flow diagram we see how the material is fed to the carding machine via chute-feed (feeder hopper). From these feeder hoppers the material enters the carding machine via condenser and feed rollers in the form of lap. There are three main rollers which bring about the carding effect (Cleaning, opening and combing) namely Licker-in roller, Cylinder and Doffer roller. Above the cylinder roller flats rotate over the cylinder and small fibers are eliminated along with dust and thrash. The flats also function as combing of fibers thereby bringing parallelization among fibers. The cleaned web of cotton flows over the doffer roller and this clean web is condensed into sliver and from the condenser delivery rollers (Drawing) the sliver is coiled into the cans to carry on to the next department.

2.2 Photo of Carding Machine

(Courtesy: LMW Coimbatore)

From the carding machine depending on the type of yarn to be produced different processes take place. For carded yarns the material is directly sent to Drawing process to draw-frame machines. For combed yarns the process is lengthy with inclusion of sliver lap, ribbon lap, super lap and combing processes before going to Draw-frame machines. This combing process is done to yarns which are sent to manufacture hosiery fabrics by knitting processes. The advantage of
Combed yarns is that they have very less twist inserted in the yarn which enables the knitted fabrics to absorb more moisture and sweat and also certain amount of elasticity in the fabrics.

For the carded yarns, the material from carding is directly fed into draw-frame machines. Now considering the process for combed yarns, from carding the sliver is fed to sliver lap machine. In sliver lap machine 6 to 8 slivers are fed from the creel stand to main machine which contains condensing rollers which condense these slivers into a single band of sliver lap.

The combing process is normally used to produce smoother, finer, stronger and more uniform yarns. Therefore, combing is commonly confined to high grade, long staple natural fibers. In recent years, combing has been utilized for upgrading the quality of medium staple fibers. In addition, a yarn made of combed cotton needs less twist than a carded yarn. However, these quality improvements are obtained at the cost of additional expenditure on machines, floor-space and personnel, together with a loss of raw material. Yarn production coast is increased by something under 1 US$/Kg of yarn (depending on the intensity of combing). To improve the yarn quality, the comber must perform the following operations:

- Elimination of precisely pre-determined quantity of short fibers;
- Elimination of the remaining impurities;
- Elimination of a large proportion (not all) of the neps in the fiber material;
- Formation of a sliver having maximum possible evenness;
- Producing of more straight and parallel fibers.

Elimination of short fibers produces an improvement mainly in staple length, but also affects the fineness of the raw material. The micronaire value of combed sliver is slightly higher than that of feedstock (elimination of dead fibers). Also the degree of parallelization might reduce the inter-fiber adhesion in the sliver to such an extent that fibers slide apart while being pulled out of the can – i.e. sliver breaks or false drafts might be caused.
2.6 COMBER

2.6.1 Preparation of stock for combing:

The raw material delivered by the card is unsuitable for combing both as regards form and fiber arrangement. If card slivers were fed to the comber, then true nipping by the nipping plates would occur only on the high points, with the risk that the nippers could not retain the less strongly compressed edge zones of the slivers. These could then be pulled out as clumps by the cylinder combs. A sheet with greatest possible degree of evenness is therefore required as in feed to the comber.

A good parallel disposition of fibers within the sheet is a further prerequisite. If the fibers lie across the strand, even long fibers are presented to the cylinder combs as if they were short fibers and they are eliminated as such. This represents unnecessary loss of good fibers.

2.6.2 Methods of preparation:

Conventional (Lap Doubling) method:
Sliver Lap (D=16 ... 24, V=1.1 ...2) and Ribbon Lap (D=6, V=6)

In the conventional (sliver lap/ribbon lap) method a number of card slivers 16 to 32 are fed to a sliver lap machine, which consists of three pairs of drafting rolls followed by two pairs of calender rolls. A pair of lap varying in weight from 50 to 70 g/m, the lap width of about 230 to 300 mm (9.5 to 12 inch) and diameter of 500mm and weight of to 27Kg. Draft ratio commonly is 1.5 to 2.5.
Laps from the sliver lap machine are taken to the ribbon lap machine. Most ribbon lappers are four heads (earlier 6 heads), four independent sections, each of which process a single sliver lap. Accordingly four thin sheets of from the various heads are led down over a curved plate, which turns at a right angles, inverts them and superimpose one upon the others. The drafts used in the ribbon lapper are about four, so the weight per meter of the ribbon lap is about the same as that of the sliver lap.
The super lap machine of Whitin (Sliver Doubling): e.g. Super lap from Whitin: Drawing (D=8 ... 10); V=6 ... 8) Super lap (D=60; V=3.5 .... 4.5)

2.4 Photo shows super lap machine of Whitin

About 20 drawing slivers are fed to a vertical 2/3 daft system, and drafted 3 to 5x. Three such units are assembled in the machine. The laps are super imposed (width of 293 mm =11.5 inch) and through a pair of calander rolls, the batt is compressed and the lap is formed.
2.4 shows flow diagram of Combing preparation (pre-drawing and lap forming)

The sliver-lap/ribbon-lap is no longer used in modern mills except in situations where very fine yarns from extra long staple fibers are produced. The breaker drawing/ lap-forming method is used for most combing preparation. This method is suitable for a wide range of fiber length from medium to long staple. It involves two steps: a standard drawing process in which a number of card slivers (typically 20 – 24) are drawn together to form a drawn sheet.
2.5 Photo of Comber machine (LMW make)

(Courtesy: LMW Coimbatore)
The basic elements of the combing machine are shown in figure 10. These are the feeding element, the nipper plate, the combing system and the detaching rollers. The feeding element consists of a feed plate and feed roll. The main function of the feeding element is to feed the comber lap in a series of short lengths. The nipper plate grips the fibers as a means of holding long fibers while the short fibers, neps, and trash are being removed. The combing system consists of two combs. The first one is a rotating bottom circular comb that performs the main combing action. The second one is a linear top comb that completes the function of the bottom comb through vertical combing movement. The detaching rolls are two pairs of gripping rolls that rotate forward and backward in intermittent fashion to hold and move the combed web for a net forward travel.

2.7 DRAW-FRAMES

Carded Slivers are fed into the Draw-Frame and are stretched/ Straightened and made in to a single sliver. Also fibre blending can be done at this stage. The cans that contain the sliver are placed along the draw-frame feeder rack, usually including eight pairs of cylinders (each pair is above the space occupied by a can), the lower cylinder is commanded positively, while the upper one rests on the lower one in order to ensure movement of the relative sliver that runs between the two.
2.6 Photo Draw frame machine (LMW)

(Courtesy: LMW Coimbatore)
2.7.1 Functions of the draw frame

- Drafting
- Equalizing
- Parallelizing
- Blending
- Dust removal
- Drafting:

  - The reduction of weight / yard of sliver and increase in length is called drafting. Or Attenuation of sliver without breaking is called draft.
  - Break draft: Draft b/w the 2nd and 3rd rollers is called break draft.
  - Main draft: Draft b/w the 2nd and front rollers is called main draft.

  1. Straightening of crimped and hooked fibers
  2. Paralleling of fibers
  3. To produce more uniform of sliver of definite wt/yd
  4. To reduce wt/yd of materials fed
  5. To make perfect blending/mixing of the component fibers

Within the sequence of m/c in cotton spinning mill, the draw-frame is the definitive compensation point for elimination errors. Inadequacies in the product leaving the draw-frame not only pass into the yarn, they are actually reinforced by drafting effects following the draw frame. The yarn is never better than the draw frame sliver.
At drawing stage, material passes not only one m/c but usually 2, arranged 1 after the other & combined to form a group. Processing in 2 passages is necessary completely to fulfill the requirements. The 2nd passage is often superfluous after combing m/c because then it does not normally generate any improvement in quality. As discussed the drawing process of slivers is done in two stages namely breaker and finisher. The drafting zone of draw-frame machines contain three metallic rollers which are called as bottom rollers and three top rollers with a synthetic rubber coating compressed by pneumatic pressure. The hank of the sliver here at the finisher draw-frames is maintained between 0.140 to 0.150.
2.8 SIMPLEX FRAME (SPEED FRAME)

The roving/Simplex frame is an intermediate machine between draw frame and ring frame the main objective of this machine is to convert sliver into thinner sliver for the convenience of subsequent processes. The sliver we obtain from draw frame is still thicker sliver which is not good for yarn manufacture. So the sliver thickness or the yarn count is reduced by this machine to the required level. But in this operation main drawback is that the reduction is somewhat so high and cannot be obtained from roller drafting mechanisms. The solution for this is to reduce the yarn count into a low level but not to the level required to the yarn manufacture which means the production of intermediate sliver which is called roving sliver.

Roving machine is complicated, liable to faults, causes defects, adds to production costs and delivers a product that is sensitive in both winding and unwinding. “Simplex is a necessary evil”, even than this machine is forced to use by the spinner for the following two reasons. Sliver is thick, untwisted strand that tends to be hairy and to create fly. The draft needed to convert this is around 300 to 500. Drafting arrangements of ring-frames are not capable of processing this strand in a single drafting operation to create a yarn that meets all the normal demands on such yarns. The hank of roving ranges from 1.6 to 2.15 depending on the count of the yarn to be spun. For coarser counts of yarn the hank of roving ranges from 0.90 to 1.10. For finer counts it ranges from 1.50 to 2.15. This roving is now carried to ring-frame department for final yarn preparation.

2.8.1 Objectives of speed frame

I. Attenuation of draw sliver to a suitable size for spinning.
II. To insert a small amount of twist to strengthen the roving.
III. To wind the twisted strand roving into a bobbin.
2.8 Photo of Speed – frame machine

2.8.2 Operation involved in speed frame:
I. Drafting
II. Twisting
III. Laying out
IV. Winding
V. Building motion

2.8.3 Parts of Simplex and their Functions

Following are the various parts and their functions for the Simplex Frame

1. **Bottom steel fluted rollers**
   
   The bottom rollers are made of steel and are mounted in roller stand. These are positively driven from the main gear transmission. For better carrying of the material in forward direction, these rollers are fluted into
   
   1. Axial fluted
   2. Spiral/inclined fluted
   3. Knurled fluted
Nowadays axial flutes are replaced by inclined flutes which result in better grip page of fibers as well as less wears of top rollers. Knurled flutings are on those rollers on which apron revolves.

2. Top rollers
There are two parts of top rollers,
 a. Arber (top rollers without rubber cot)
 b. Rubber cot

1. These are actually twin rollers having rubber cots for better grip page of fibers during drafting. ü Hardness of top rollers depends upon the type of material. Normally for cotton, less hardness is recommended as compared to polyester fiber. For polyester more hardness is better to avoid wear of the top rollers.(Rollers are replaced after 15-20 years). For better grip page, these rollers are grinded after certain period. So with the passage of time, diameter of these rollers will be reduced and behind the limits, these can’t be used. Hence old cots are replaced by new cots with the result of reduction of top roller diameter, arm pressure will be reduced which will result in less/undrafted material. With the result of grinding, surface of top rollers become rough. Hence on processing of sensitive fibers over the rough roller surface results in wrapping effect. To overcome this problem a chemical treatment is required which will smooth the surface.

2. Twist per unit length of roving depends upon the delivery rate. Turns per metre (twist) =Higher levels of roving twist, therefore, always represent production losses in Roving frame and possible draft problems in the ring spinning machine. But very low twist levels will cause false drafts and roving breaks in the roving frame. False Twisters are used on the flyers to add false twist when the roving is being twisted between the front roller and the flyer. Because of this additional twist, the roving is strongly twisted and this reduces the breakage rate. Spinning triangle is also reduced which will reduce the fibre fly and lap formation on the front bottom roller. Because of the false twister, the roving becomes compact which helps to increase the length wound on the bobbin. This compactness helps to increase the flyer speed also. Apart from inserting twist, the flyer has to lead the very Aprons
3. The upper aprons are short and made of synthetic rubber. The thickness of apron is about 1mm. Lower aprons are larger and made of same material as that of uppers. Aprons are used to support the material which is being drafted and ultimately to reduce the variation in the material i.e. material will be uneven. When a drafting force is applied, there is a chance of variation. So to reduce this variation, aprons are provided. In main drafting zone aprons are used for further control of the drawing sliver. In the zone the number of fibers is less and they are given draft so that any floating fiber content would occur fabric defects and it has to be avoided.

2. **Pressure arm**

Pressure is implemented on main drafting roller to improve the nip contact and higher nip. Since a high drafting is taken place, the possibility to make slippages is somewhat high. This is avoided and prevented to avoid long term variations in subsequent processes.

The top rollers are well pressed on bottom rollers by applying pressure through pressure arm. Pressure depends upon raw material and volume. Adjustment of pressure may be same for each roller or vary from zone to zone (Main, back or front zone). In pressure arm springs are used and somewhere pneumatic pressure is given. By applying more pressure, there are chances of fiber damaging while less pressure cause slippage, which will increase U% age of roving. In cotton material, more the moisture content more will be the arm pressure required. More moisture content in slier is due to, More moisture content in cotton (8.9). More R.H% (58-63).

3. **Cradle assembly**

It consists of
i. Cradle
ii. Top apron
iii. Steal roller
iv. Spacer
v. Cradle spring
It supports the material during drafting and reduces the variation due to drafting force. Spacer size change the distance between the aprons (bottom & top). For coarse material, bigger size spacer is used. Change of spacer size affect the U% age.

**Flyer**

Flyer is used to wind the roving on bobbin and to impart twist into the roving by revolving around the bobbin at a speed 700-1300 rpm. Flyer inserts twist. Each flyer rotation creates one turn in the roving. Sensitive strand from the flyer top to the package without introducing false drafts. Latest flyers have a very smooth Guide Tube set into one flyer leg and the other flyer leg serves to balance the flyer. The strand is completely protected against air flows and the roving is no longer pressed with considerable force against the metal of the leg, as it is in the previous designs. Frictional resistance is considerably reduced, so that the strand can be pulled through with much less force. If we use high precision flyers, it will result in the form of following advantages:

1. Dynamic flyers ensure excellent yarn quality and free from fluff accumulation and fibre choking.
2. Flyers are made from quality aluminum alloy, polished stainless steel tubes and steel parts.
3. Computer generated aerodynamic profile ensures minimum air turbulence and noise.
4. To facilitate well twisted roving false twisters are specially designed and manufactured.
5. Minimum vibrations in flyer are kept by high precision balancing at all rated speeds.
6. To maintain constant pressure, Pressers are made of heat treated special grade steel.
7. Higher return on investment on flyers.
4. **Condenser**

In Simplex machine two condensers are used in the drafting arrangement. The purpose of these condensers is to bring the fiber strands together. It is difficult to control, Spread fiber masses in the drafting zone and they cause unevenness. In addition, a widely spread strands leaving the drafting arrangement leads to high fly levels and to high hairiness in the roving. The size of condensers should be selected according to the volume of the fiber sliver.

5. **Top & bottom cleaners**

Cleaning is another important aspect of drafting zone. Since high draft is given to the sliver, short fibers can immune from the main flow of fibers and then may wind on rollers itself. If this process keep happening the drafting capability of the rollers are effected through contact area and lose grip. Hence tow aprons are used to clean each and every roller during drafting. In this machine two top and bottom cleaners are also used for the cleaning purpose.

6. **Bobbin Rail**

The bobbin rail is moving up and down continuously, so that the coils must be wound closely and parallel to one another to ensure that as much as material is wound on the bobbin. Since the diameter of the packages increases with each layer, the length of the roving per coil also will increase. Therefore the speed of movement of bobbin rail must be reduced by a small amount after each completed layer.

2.9 **Ring Spinning**

The Ring Spinning is the most widely used form of spinning machine due to significant advantages in comparison with the new spinning processes. The ring spinning machine is used in the textile industry to simultaneously twist staple fibres into yarn and then wind it onto bobbins for storage. The yarn loop rotating rapidly about a fixed axis generates a surface referred to as "balloon". Ring frame settings are chosen to reduce yarn hairiness and the risk of glazing or melting the fibre.
2.5 shows flow diagram of Technique of twist insertion in yarn at ring – frame machine

Ring Spinning is the oldest of the present day spinning processes. Fiber material is supplied to the ring-spinning machine in the form of roving. The fiber mass of the roving is reduced by a drafting unit. The twist inserted moves backwards and reaches the fibers leaving the drafting unit. The fibers lay around one another in concentric helical paths. The normal forces encountered by the fibers enhance the adhesive forces between the fibers and prevent fibers from flying or slipping past each other under the tensile strain.

It is the process of further drawing out roving to the final yarn count needed, inserting twist to the fibers by means of a rotating spindle and winding the yarn on a bobbin. These three stages take place simultaneously and continuously.

A mechanically driven spindle, on which the yarn package firmly sits, is responsible for twist. A stationary ring is around the spindle, which holds the traveler. Yarn from the drafting unit is drawn under the traveler, and then led to the yarn package. In order to wind the twisted yarn on a bobbin tube carried by the
spindle, the traveler is required to cooperate with the spindle. The traveler moves on the ring without any physical drive, but is carried along by the yarn it is threaded with. The rotation rate of traveler is lower than the spindle, and this difference in the speeds of traveler and the spindle enables the winding of the yarn on the tube. A controlled up and down movement of the ring determines the shape of the yarn package, called Cop or Bobbin. Ring spinning technology provides the widest range in terms of the yarn counts it can produce.

Ring spinning is a comparatively expensive process because of its slower production speeds and the additional processes (roving and winding) required for producing ring spun yarns. Ring spun yarns produce high quality and are mainly produced in the fine (60 Ne, 10 tex) to medium count (30 Ne, 20 tex) range, with a small amount produced in the coarse count (10 Ne, 60 tex) range. End uses include high quality underwear, shirting, towels. The fibers in the ring yarn are highly parallel and helical in nature, and the fiber arrangement is uniform along the thickness of the yarn. The yarn has a compact structure, with essentially no wrapper or hooked fibers. The self-locked structure is the result of intensive fiber migration, which in turn is influenced by the triangular geometry of the spinning zone and the high spinning tensions. The high axial strength of the yarn is the result of unique self-locked structure.

2.9.1 Basic Principles of Ring Spinning
Some of the basic principles of Ring Spinning are as follows:-

1. Drafting Mechanism
   To attenuate roving until the desired fineness is reached.

2. Consolidation (strength) Mechanism
   To impart strength to the fiber by twisting it.

3. Winding and Package forming Mechanism
   To wind up the resulting yarn in a package suitable for storage, transportation and further processing.
Ring spinning is the first stage of post spinning in which yarn produced from the roving installed on the hanger on the ring machine. Ring process is the heart of textile plant and there is lot of factors which has an effect on the yarn quality.

- Speed of machine makes a major role on the yarn quality, as the speed increase of ring machine, the imperfection (Neps 200%, Thick +50, Thin -50) of yarn increase.
- Hairiness is also affected in ring production process and mainly produced by the movement of burnt traveler and high speed of machine.
- CV of count is also very important and ring spinning process is the last stage of process where we can reduce the CV of yarn count.
- Imperfection of yarn count from quality point of view is so important that every customer required this quality standard, that imperfection should be as minimum as possible.
- Ring spinning process also effects on twist variation during manufacturing of yarn. It causes major problems during working in the next process.

### 2.9.2 Objectives of Ring Spinning

Following are the core objectives of ring spinning:

1. To draft the roving fed to the ring spinning frame i.e to convert roving into very fine strand called yarn.
2. To impart strength to the yarn by inserting the necessary amount of twist.
3. To collect twisted strand called yarn onto handy and transportable package by winding the twisted thread on a cylindrical bobbin or tube.
2.9 Photo of Ring-frame machine

(Courtesy: LMW Coimbatore)

The ring spinning frame, commonly called the ring, is the conventional spinning system and it transforms the roving from the roving frame into spun yarn using the operations of:

- Drawing
- Twisting
- Winding

In the last step of yarn production, the staple fibers are fed to the ring spinning frame, after passing through the blow room (opening and cleaning) and the carding frame, drawing frame and flyer (separation of individual fibers, parallelization, formation of a fiber tape). Here, the finished yarn is produced by drawing and rotating operations.
## 2.10 WINDING

The cop which is prepared in the ring frame is not suitable for further processing. So the yarn is converted into the shape of cone which is prepared in the winding. Practical experience shows that winding process alters the yarn structure. The factors which affect the yarn structure during winding are bobbin geometry, bobbin unwinding behavior, binding speed. This phenomenon does not affect the evenness of the yarn but it affects the properties of the yarn such as thick places, thin places, nep

### 2.10.1 Winding Process

After manufacturing of yarn, from different departments in the preparatory process and ring department, it is ready to make a shape into final cone form so that it can be shipped to customer for use. During winding process of yarn following objectives are met.

- Scanning and faults removing Electric Scanners (uster) are used for checking and elimination of yarn faults during winding process. This process is called Usterization of yarn. Such faults are called scan-cuts.
- Splicing of broken or cut yarn Auto splicing is done for broken yarn pieces to eliminate yarn knots and bad piecing.
- Bigger package Conversion of yarn from small ring bobbins to bigger yarn cones of different international standard or as per requirement of customer. During achieving above objectives or making of winding cones some faults are created during the process. These faults need to be controlled through monitoring and continuous study. Most of the winding faults are very dangerous for the next subsequent process which can be warping or knitting or doubling. We can face complains from customer of breakage of yarn during unwinding process.

In order to avoid any complaints from customers, faulty winding cones are separated during inspection by inspectors. Following three decisions are taken at this stage.

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• Use as it is: When the fault is of some minor category, and there is no risk of next process failure during unwinding. Decision is only taken by some senior person of quality.

• Rewind: Some faults can be removed after rewinding. But rewinding itself is costly affair and quality of cones also detritus after reprocessing.

• Degraded as B grade: If fault is of such nature that rewinding can’t remove that fault and there is doubt for customers to complains then such cones are downgraded to lower grade. Degrading cones in to lower grade is again financial loss to the company.

2.10.2 How to maintain good quality?

Following point should be considered for quality point of view

• Winding speed should be 1200 meter per minute for getting good quality.

• For getting good quality, yarn fault clearers device setting should be as close as possible in order to eliminate the disturbing yarn faults.

• In order to get good quality of yarn count channel setting should be less than 7%.

• Cone which we prepare for weaving purpose should have minimum fault for getting good quality, especially in the long thin places and long thick places.

• For getting good quality yarn, splice strength must be 75% more than of the yarn strength.

• Splice appearance should be good. Splice device should be checked twice in a week.

• To get better efficiency, cone weight should be 1.8 to 2.4.

• Yarn winding tension must not be high during winding. If we will keep it high then tensile properties will be affected such as elongation and tenacity.

• If waxing attachment is below the clearers, the clearers should be clean at least once in a day.

• Wax roller should rotate properly
Today most of the cotton spinning mills are removing cone winding machines and are replacing these machines by auto coner machines. The main reason behind this is to eliminate thick knots in the yarn and also improve evenness by removing neps and more importantly to increase production. After the implementation of auto coners the hard waste percentage in the department has considerably reduced from 3% to 0.95%.

2.10.3 Auto coner process

Yarn package winding is the completion of the yarn forming process and the starting point for various subsequent processes, from weaving or knitting to textile finishing. This interface function of winding is what makes the winding process so important. In winding, the course is set for high cost-effectiveness in the following stages of the textile production chain. At the same time, care is taken that the quality of the yarn wound will meet the demands placed on it by the finished articles. Textile-technological know-how crucial in this context is elaborated in cooperation with world-leading partners in textile machine engineering.
Typical features of the Autoconer performance are: extensive textile-technological expertise, consequent market and customer orientation, early recognition of changes in market conditions and requirements, and excellent customer advice and training service all over the world. These have contributed to the world-wide success of the Autoconer, from the first to the present generation. Translating this now-how into intelligent winding machine technology has made Schlafhorst for decades the innovation leader in the international arena.

This is true of the Autoconer yarn splicing technology with the modular-design splicer system and of the quality of the Autoconer yarn packages due to the innovative FX-series with its efficient modules Autotense FX, Propack FX, Variopack FX and Ecopack FX. Thanks to its ingenious modular concept, the Autoconer offers a convincing universality which enables the machine to produce yarn packages optimally suited for any of the textile production processes downstream of winding. The Autoconers function on computerized systems where automatic splicing takes place and continuous movement of over head cleaners help in maintaining clean and nep free yarn on the cones.

The whole spinning activity ends with winding process. To briefly discuss the above detailed processes we can summarize the main activities of all the departments as follows.

2.11 Photo of Schlafhorst auto coner machine

![Image of Schlafhorst auto coner machine]

Courtesy: Schlafhorst, Germany
2.11 Summary of total process

Blow room – Opening of cotton lints
Carding – Opening, cleaning and individualization of cotton fibers and condensing them into sliver form.
Combing – Combing of cotton fibers so as to parallelize them and condense them into more amount of fibers in single sliver with help of doubling of 6 to 8 slivers.
Drawing – The main function of drawing is to parallelize the fibers in the sliver by drafting technology so as to enable the sliver to get condensed into roving in the speed frame department.
Speed frame – Condensation of slivers into roving. And slight insertion of twist with help of flyers.
Ring frame – Insertion of twist with help of ring travelers and giving draft to the roving and formation of required count of yarn.
Winding – Transformation of yarn from ring spools to paper cones to enable packing and selling.

2.12 Packing

It is the post process of cotton spinning mill in which the cones of 1kg to 1.5 kgs are packed with 50 cones to 40 cones to form a bag of 50kgs to 60kgs. The packing of cones needs a lot of attention so as to eliminate any damages to cones while transportation. The packed bags of yarn are very well labeled with name of the spinning mill, count of yarn, gross weight and net weight of yarn packed with different colored inks to give identification to the bags.

The post spinning processes before weaving are reeling and doubling and warping. Reeling is an activity where the yarn is transformed into hanks over the reeling machine to enable easy dying process. The doubling of yarns is done with a combination of two to three yarns as per requirement of the fabric to be woven. Warping is a process undertaken at the sizing units to strengthen the yarn with help of size (wet process) and warping on warp beams.
2.13 Waste Collection Methods

The researcher will now discuss the various methods adopted by the mills to collect the process wastes of various departments over the ten year period. As is seen of the five mills only three mills have been working successfully up to now after their inception. So, in this chapter the researcher will discuss the various automatic collection methods adopted by the mills after modernization. In general, after modernization in all the three mills namely, M/S Jawahar Sahakar Sooth Girni, Dhule, M/S Loknayak Jayprakash Narayan Shetkari Sahakari Soot Girni Ltd. Shahada and M/S Priyadarshini Sahakari Soot Girni Limited, Shirpur, the waste collection was automatic through various pipelines and in a systematic categorized way as supplied by the machinery suppliers.

2.13.1 Waste collection methods in Blow-room

As the name of the department is blow room the process of flow material is by air pressure through the pipelines from machinery to machine. The pipelines adjusted in the blow room worked on pneumatical circuits which are controlled by stop motions, valves and sensors. The cotton process and the waste were separated at various stages in blow room and were flown to next department and waste chambers respectively. In waste chamber three outlet pipes connected from blow room department delivered the wastes namely droppings, willow and Scutcher droppings which were collected separately by gunny bags tied to the mouth of the pipelines. This method improved and maintained a pure waste from blow room which was actually required by the vendors in the market.

The amount of waste obtained in blow room is derived from the below formula; Amount of waste = Total processed cotton - Total lap fed to the carding / 100 The amount of waste obtained in blow room as per SITRA norms is 4% to 4.5% of total processed cotton in the department. The various wastes in this department are droppings, willow and dust
2.13.2 Waste collection methods in Carding

As the cotton process moved on to carding department the automatic waste collection through pipelines was also fitted by the machinery suppliers and these pipelines were directed to the waste chamber behind the blow room department for the collection. The carding wastes contained card flat strips, cylinder droppings, licker-in droppings and fan wastes. All these wastes were delivered separately by various pipelines which made the waste easily identifiable for its purpose in the market and there by maintaining the quality of waste.

The various wastes in this department are flat strips, licker-in droppings, lap pieces and cylinder droppings. The total waste percentage in this department ranges from 4% to 4.5% of the total processed material.

2.13.3 Waste collection methods in Combing

Combing is a very special process which is used for only combed and hosiery yarn production. In this department there are four sub processes namely; Sliver lap, Ribbon lap, Super lap and Combing processes. But the main waste (Comber noil) is collected at the combing machine over circular laps from each head of comber machine. This comber noil is rich fiber content and highly lustrous so, this is sold mainly to open-end spinning machines and ring frame machines working on carded coarser counts. The above said mills utilized this comber noil for re-processing at the mixing level to an extent of 5% to 10% of the total mixing that is to be processed.

In this department the major waste is the comber noil. This is very important waste which is clean in nature but short and medium length of fibers in it. This waste is around 10% to 12% of the processed material. The percentage of waste entirely depends on the quality of ginned cotton with uniformity percentage of fibers in it. The comber noil is used by the mills themselves for processing coarser carded yarns and remaining is sold to open end spinning mills. The ratio of self utilization to sale of comber noil is 20:80.
2.13.4 Waste collection methods in Draw-frame, Speed-frame and ring-frame departments

After modernization these mills effectively maintained perfect humidification conditions in all the above said departments. This humidification effect reduces the micro-dust and small fibers in the department to the maximum there by reducing sweeping wastes considerably. In speed frame and ring frame departments the machinery suppliers have attached continuous moving over head cleaners to the machines. These overhead cleaners blow and suck all the fiber wastes accumulated in the draft zones of spindles there by maintaining quality of the process roving and yarn respectively in these departments. The waste collected by these overhead cleaners was dropped automatically at the fan end of the machine for easy packing in gunny bag by the department sweepers.

Major wastes in these departments are fan waste and lapping collected by overhead cleaners attached to the machine in these departments.

2.13.5 Waste collection methods in Cone –winding

The major waste in the cone-winding is the hard waste. Other than hard waste very minute percent of micro dust is swiped in the department. The hard waste is generated by the winders while splicing the yarn after breakages at the winding stage.

In auto-coners the hard waste is generated due to the bottoms created at the ring frame level by the doffers at the time of mounting the spindles for re-building the cops.

As per SITRA norms the total percentage of wastes in various departments to the total processed material is as follows;
Blow – room : 4% to 4.5%
Carding : 4% to 4.5%
Combing : 6% to 8% (Comber noil)
Draw frame : 0.2% to 0.5%
Speed frame : 0.5% to 0.75%
Ring frame : 0.5% to 0.75%
Cone winding: 0.75% to 1.25% (Hard waste)

The above said percentages are applicable to the modernized spinning units which are practiced by the three successful mills in Khandesh.

After having discussed in detail the spinning process that is most commonly practiced in cotton spinning mills and the waste collection methods in various departments the researcher will now discuss the research methodology that is adopted for the research work in the next chapter.