A Review on Process Control in Speed Frame Machine

Suchit A. Surkar
Mechanical Engineering Deptt.
BDCE, Sewagram, Wardha
MS, India

Subhash B. Madavi
Mechanical Engineering Deptt.
BDCE, Sewagram, Wardha
MS, India

A.B. Tupkar
Mechanical Engineering Deptt.
BDCE, Sewagram, Wardha
MS, India

ABSTRACT
Speed frame process is an intermediate process in which drawn sliver is converted in low twist lea (cotton fibre) called roving. This paper embraces the discussion of the need for process control in speed frame machine for the improvement of quality of yarn produced. It includes a discussion of the key issue related to machine, including machine productivity, contribution to yarn quality, material handling, defects and their causes, as well as variety of other issues related to process control. Process control is primarily aimed at controlling process parameters such as speed, draft distribution, tension, twist and row variation.

Keywords
Speed frame, lea, yarn, productivity, Tension, twist, row variation.

1. INTRODUCTION
Product produced through speed frame is called as “Roving”, which is packaged on bobbin. Speed frame process is an intermediate process which normally comes after draw frame process. Speed frame process reduces the weight of yarn and inserts twist into it. Thus the integrity of draft strands is maintained. It is impossible to fed drawn sliver directly to the ring frame due to draft limitation. Hence it is required to reduce in two steps so that good yarn quality can be produced. Spinning performance gets drastically affected by the faulty roving preparations. Parameters adopted for roving has significant impact on spinning quality and production. Speed frame machine comprises of pairs flyers and spindles, each pair of which represents one roving unit. The rotation of flyer imparts twist to the fibrous strands.

Defect arising in drafting of roving introduces short term irregularity in yarn produced from it. Wrong selection of twist in the roving affects the spinning performance. The improperly built bobbin in roving leads to end breakage in ring frame process. The preparation of roving bobbin for the yarn spinning is of paramount importance for a spinning mill.

Process control in speed frame is mainly based on factors discussed below.

2. PROCESS CONTROL PARAMETERS
2.1 Distribution of draft
Straightening and elongation of fibre is known as drafting of fibre. The draft in roving machine can be calculated by using roved hank. The first drafting zone referred to as “Break Draft”, is in the range of 1.03-2.03 (for 3/3 rollers drafting), while the main draft is much higher and total draft ranges from 4-16.

Break draft reduces the inter fibre cohesion and frictional forces and thus facilitates fibre sliding over each other during further drafting. It is required to keep break draft as low as possible to avoid the problems associated with higher draft. These are as follows:

- It requires higher drafting forces which can create vibrations in drafting system back zone.
- Irregular roving like thick and thin places are produced.

For good it is required to control drafting fibre effectively, particularly short fibres floating between the nips of the front and back rollers. Aprons can be effectively used to control the flow of fibre.

Drafting forces initially increases with the draft and then suddenly decline as the draft increases further [1]. This is due to the fact that at lower level of draft, very little fibre slippage occur due to elastic behaviour of fibre strand and fibre are simply straightening out.

At higher level of draft, drafting forces generated is due to dynamic friction of fibre that is lesser than static friction. At higher draft and drafting speed, it is difficult to control fibre properly and hence the chances of fibre shuffling become less, thereby reducing the drafting force. It is found that drafting forces reduces with increasing roller settings. This is due to the facts that at lower roller setting, the control over the movement of fibre becomes more because of high inter-fibre cohesion. But as the roller setting increases, the inter fibre cohesion get reduced and, hence, the drafting force reduces.

2.2 Roving Twist
Rotating the fibrous strand about its own axis so that fibre get arranged in spiral form and thus bind each other together is known is process of twisting. The purpose of providing twist in roving is to give the strand sufficient strength to withstand the strain during unwinding in the creel of the ring frame. Twist is inserted by using flyers. Twist level depend on the flyer speed and delivery speed of the speed frame. Productivity of machine gets reduced due to increase in twist. Therefore it is generally used in the range as limited as possible. The relationship between the twist and the aforementioned factor is given as follows:

$$\text{Twist} = \frac{\text{Flyer speed or spindle speed (RPM)}}{\text{Delivery speed (m/min)}}$$

False twisting devices shown in figure 1 are placed on the flyers to add false twist when the roving is twisted between the front roller and the flyer. Because of this supplementary twist roving is strongly twisted and thus it reduces the breakage rate. False twisting device is also called “twist Crown”.

Figure 1: False twisting device

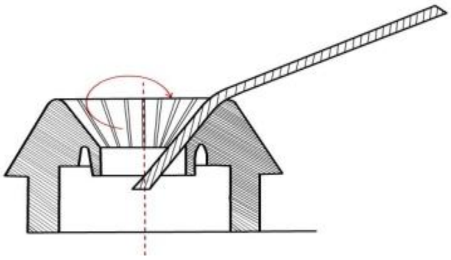

Figure 2: Twisting of Sliver

Appropriate selection of the roving twist is required for producing good quality yarn.

High roving twist may cause drafting problems in the ring frame, leading to the formation of thick spots in the yarn. To prevent this and improve the opening up of the twist, a higher break draft can be used at the ring frame, but this is at the cost of yarn evenness. Similarly, inadequate roving twist greatly increases the roving breakage rate at the speed frame. The optimum roving twist can be chosen by checking the roving strength at a gauge length of 5 cm. The roving strength depends upon the following factors.

- fibre length and fineness: longer and finer fibres give greater roving strength,
- parallelisation of the fibre: increased fibre parallelisation reduces roving strength,
- roving linear density: a coarser density produces roving with greater strength,
- twist per inch: roving strength is directly proportional to the twist per inch,
- Uniformity of twist: roving strength increases with the twist uniformity.

2.3 Roving Tension

Roving tension should be maintained at an optimum level to introduce uniformity. Low roving tension leads to the production of soft package, which frequently collapses, while the high roving tension produces a hard and compact package. However, excessive roving tension can cause false draft, roving stretch and roving breakage. Roving tension depends on the number of wraps on the pressure arm, with a greater number of wraps, producing a higher roving tension. Similarly, a bigger roving package operating at a higher speed also increases roving tension. In this case, the roving is sufficiently consolidated by use of a higher twist, to arrest roving stretch.

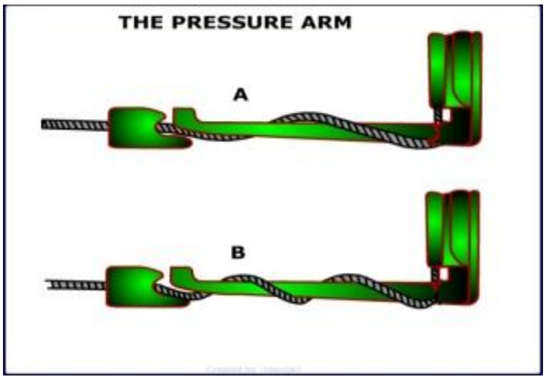

Figure 3: Number of wraps on presser arm

2.4 Condenser

Condenser placed in drafting zone prevents the fibre strands from spreading apart during drafting. Condenser can be classified as inlet condenser middle condenser, middle condenser, and floating condenser (figure 4). Inlet condenser is mounted on the reciprocating bar, and floating condenser is placed in main drafting zone, which significantly influences the quality of roving produced as well as running performance of the speed frame machine. The condenser size is selected based on the fibre being processed and the thickness of the material passing through the draft zone.

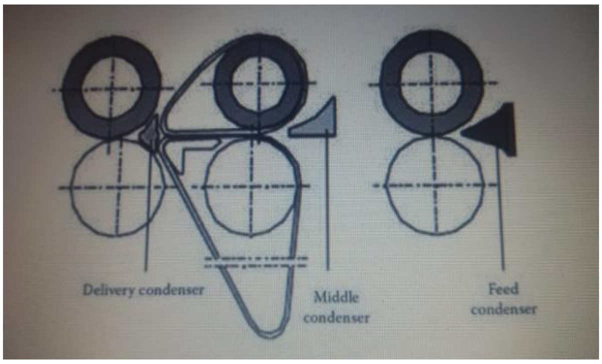

Figure 4: Different types of condenser

A wide ribbon width in the drafting zone causes more fly liberation, irregularity and hairiness of the roving. Use of condenser in the drafting zone restricts the ribbon width at the front roller nip, making the roving more compact and reducing breakage. Furthermore, the presence of the condenser increases inter-fiber friction, improving the roving quality by reducing fly liberation. However, use of the condenser can also cause irregularities in the draft. The fibers at the edge of the ribbon, which touch the surface of the condenser, decelerate during drafting, leading to a deterioration of roving evenness.

2.5 Spacer

The hank of the material, total draft and fiber bulk determine the spacer size. For example, 5–6 mm spacer size is used for producing roving of 1.4–1.6 Ne from the sliver of 0.16 Ne. The optimum selection of spacer size not only improves the yarn strength and evenness, but also reduces long thin and thick faults in the yarn.

2.6 Top roller pressure and hardness

The key considerations regarding top roller pressure and hardness on the speed frame are similar to those for the draw frame. Excessive pressure on the back top roller increases the resistance to roller movement, enhancing the risk of torsional vibration [1]. Such disturbances cause greater short term variation and roving irregularity. This can be counteracted by the use of softer cots, which give better speed frame performance. Cots with 80–850 shore hardness are generally used, and it is advisable to use softer cots for the front top roller and medium hardness cots at the back top roller.

2.7 Roller Setting

For minimizing the drafting difficulty it is required to optimize the rollers setting. The back zone roller setting should be slightly wider than the front zone setting, and care should be taken that the selected front zone setting is no wider than recommended, as this can increase the occurrence of long thin and thick faults in the yarn.

Similarly, a lower back zone setting increases the back zone drafting force, which may lead to torsional vibration, thereby increases roving unevenness. For combed cotton yarns, saddle gauges of 50 and 52 mm, for the front and back zones respectively, are commonly used. The bottom roller setting of 44 and 53 mm, for the front and back zone respectively, are used to allow the overhang. Manmade fibers require a wider setting than cotton due to the absence of short fibers.

2.8 Between Row Variation

The front row bobbins are slightly finer than those of back row, resulting in higher yarn count variation. Remedial measures can be taken to minimise row-to-row differences. The extension of the flyer top on the back row so that the roving meets the flyer top at the same angle of approach for both the rows is one method, whilst the use of different flyer top designs in each row can also produce a more effective twist in the front row. The improved designs of flyer and flyer top have eliminated the old concept of feeding the roving of front and back rows of the speed frame in different ring frames.

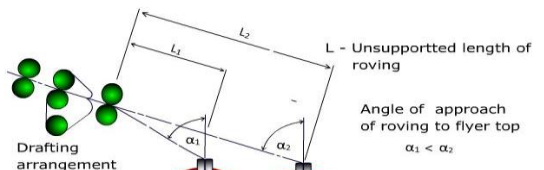

Figure 5: Thread path geometry at flyer top

3. BREAKAGE RATE

The productivity of the speed frame suffers due to the end breaks. The control of end breaks is thus of the utmost importance. Most of the breaks occur within the flyer, and although a higher production rate of the speed frame does not affect yarn quality, it does have a significant influence on the rate of end breakage.

End breaks within the flyer are mainly dependent on mechanical conditions, such as tendency to vibrate, lack of smoothness of the flyers and unevenness of the rove. Use of false twisters or twist-masters on flyer-tops increases the twist in the rove between the flyer top and front roller nip, and thus reduces breaks. The false twister with a small hole and greater depth is most efficient.

4. CONCLUSION

In a customer dominated market, the quality requirement of textile products is becoming ever more stringent, making the role of process control increasingly crucial. Studying these parameters quality of the yarn produced can be definitely controlled. However, the textile process engineer will still have a significant role to play, and therefore a thorough knowledge of process control is of paramount importance to cope with the impending challenges.

5. REFERENCES

[1] Chattopadhyay R (2002), *Advances in Technology of Yarn Productio* , New Delhi, NCUTE Publications.

[2] Klein W (1987), Short Staple Spinning Series, Vol 3: A practical Guide to Combing and Drawing, Manchester, The Textile Institute.

[3] *Process Management in Spinning* By R. Senthil Kumar.

[4] Carl A. Lawrence, "Fundamentals of Spun Yarn Technology", CRC Publications, 2003.

[5] P.R. Lord, Hand Book of Yarn Production: Science, Technology and Economics, Tailor and Francis, 2003.

[6] Eric Oxtoby, "Spun Yarn Technology", Butterworths, 1987.

[7] Grosberg P and Iype C, "Yarn Production-Theoretical Aspects"

[8] S.M Ishtiaque, R.S Rengasamy and A Ghosh ,Department of Textile Technology, New Delhi 110 016 , India ."Optimization of speed frame process parameters for better yarn quality and production". Indian Journal of Fibre and Textile Research, Vol 29,March 2004,PP 39-43.