Effect of Winding Parameters on Yarn Quality

Source: Textile Review

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By: Vaibhav Rane

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The demands on quality of yarn, fabric and garments are ever increasing to higher levels year after year. Due to continuous improvement in the yarn winding technology the slight variation in yarn quality reflects badly on the fabric and ruins its quality, which further reduces its price in domestic and international market. Therefore, it is necessary to produce the yarn of best quality, which is the basic raw material for woven and knitted fabrics.

The conversion of small ring cops to continuous length of several lakh meters of yarn of Automatic Cone Winding includes removal of objectionable yarn faults and many other kinds of faults like thick and thin places, slubs, crackers, spinners double, bad piecing, snarls, coloured fibres, seed coats & other contamination. If these defects are not removed, it can result into:

1. Poor fabric appearance, and
2. Breakage of yarn at every subsequent process i.e. warping to weaving.

The breakages in the subsequent processing like warping, sizing and weaving would result in:

1. Defective packages at warping and sizing.
2. Lowering of efficiency at all stages.
3. Introducing the fabric faults at weaving.

The loss of efficiency at every stage means increased cost of production and fault generation in weaving severely affects the fabric quality.

Thus, during clearing and winding the yarn on cross wound packages for warping, weaving or knitting it has been practically experienced by industry that there is deterioration of certain yarn characteristics like strength, elongation, hairiness etc. The imperfections also change. The process parameters thus have substantial influence on the final properties of the yarn.

Excessive tension in winding deteriorates some properties. The yarn in latest automatic winding machines is accelerated from zero meters per minute (mpm) to 1500 meters per minute (mpm) just, in a few milliseconds and reach up to 2500 mpm. While being pulled off the bobbin, dragged across several machine elements of different metallurgy and friction coefficient having edges and forced into a traverse motion at accelerated speed may affect yarn properties.

The factors that affect the yarn's physical properties during winding include - The count of yarn, frictional properties of yarn itself, winding speed, winding tension, winding process parameters, machine contact points, etc.

Internationally there are few automatic winding machine makers. At present following manufacturers offer the modern automatic winding machines with one or more models.

- Schlafhorst - Autoconer 338, AC5
- Murata-21C
- Savio - Espero, Orion & Polar

The claims are made by these manufactures with regards to the quality of wound yarn, efficiency and overall performance from these machines. Yet, the industry has experienced deviation in performances on various machines as against that claimed by machine manufacturers.

Optimisation of winding parameters should be based on sound technical experience. If a fault will not produce an unacceptable fabric defect and with negotiate the weaving or knitting machine elements without causing any machine stoppage, then it should not be cleared. It is true that an optimal clearing limit is very difficult to achieve in practice because it depends not only on a single factor. The optimum clearer limit is definable in terms of the following factors:

1. Quality of ring frame yarn
2. Type of fabric construction
3. Acceptance standard for fabric fault.
4. Method of fabric manufacturing. (14)

Changes in yarn quality after winding

During spinning, the yarn (fibrous mass) is twisted and wound in one direction. But during winding the yarn is unwound in from cops in the opposite direction (opposite to the direction in which it is wound on the cops). That affects yarn properties nearly to significant extent. (10)

The variation in imperfection level after winding ring yarn changes, hairiness of yarn increases during winding and it is greater for less hairy ring yarn. In fibre count like 50 Ne thick, thin places and neps increases significantly after winding. In carded yarn thin places and neps reduce due to winding because of the fall of foreign matters.

It is found that winding process increases imperfections and classimatt faults by 20-25 % as compared to ring yarn for 100 % cotton and PIC blend yarns.

Strong and positive correlation ($r = 0.98$) is found between normal and extra sensitive imperfections. Short thick faults showed good positive correlation with imperfections ($r = 0.85$ and 0.87). Other faults showed poor correlation ($r < 0.5$) with imperfections. (11)

In an inter mill research it is stated that there is deterioration in yarn properties after winding. Many mills have shown nominal increase in imperfections despite using very high speed winding machines (1300-1400 mpm), whereas in some cases the deterioration is to the extent of 1 50-190 per cent. Overall there is an increase in hairiness after winding ranging from 40-60 per cent.

It was also concluded that – for carded cotton yarns the CSP ranges from 21 00 to 2200 whereas for combed cotton yarns the range is 2600-2750.

The Rkm value of carded cotton yarns varies from 14.5 to 15.3 and for combed yarn the range is from 17.7 to 19.2.

The unevenness value (U%) increases only marginally as the yarn count becomes finer, the U% being 15.2 for 30s and 60 for 1 6s carded warp yarns. For combed cotton yarns the U% varies from 10.3 for 40s yarn to 13.7 for 100_s yarn.

The imperfection value increases after winding anywhere from 40 to 200 per cent as compared to ring yarns; in general, the increase is lower for hosiery yarns.

It is also found that the hairiness value measured by Uster Tester (UT 4) show that as the yarn becomes finer the hairiness comes down, due to presence of less fibers on the surface for finer yarns.

It was also suggested that in contrast to weaving yarns the strength of knitting yarn is secondary, as the loading placed on the yarn during knitting is less than that with weaving machine. (12)

Effect of Speed

Speed winding causes some deterioration in yarn properties such as imperfections and hairiness. Thick places increase by 6 to 24 % for different yarn counts and neps & hairiness between 13 to 29 %. (3)

Effect of Winding Tension

According to a theory it is suggested that increased winding tension will result in increased fibre transfer. They suggested that increased winding speed increase the damage and hairiness after winding. (4)

When winding tension is maintained from 8-10 per cent of single yarn strength, the deterioration in yarn quality is minimal, at this condition the imperfection increases after winding and is about 15 to 20 per cent in coarse/medium counts and 30-40 per cent in fine and superfine counts. (10)

Effect of Interaction of Speed and Tension

In case of breaking elongation tested for 40s Ne & 88s Ne the difference is more between cop and cone for higher speed and tension for both the counts. In this case of yarn tenacity the loss is more pronounced in wound yarn for finer counts. (10)

Hairiness

Effect of hairiness on warp

With high hairiness, the adjoining warp threads are more prone to cling together during weaving, making the sepration of warp sheet difficult. This result in more warp breaks, higher loomshed droppings and fabric defects like stitches. (5)

Studies by Raje (6) have shown that process of winding increases the hairiness of cotton yarn by 25% which confirmed the earlier findings of Lappage. (6)

Effect of yarn quality on Shuttle Looms

Number of investigators who have shown that a substantial portion of the warp breaks on a loom is attributed to lumps on the yarn such as slubs, neps or other protuberances which can affect the movement of adjacent yarn during shed change. If obstruction persists during operation of shed, tension in these yarns rise abnormally very high leading to eng breaks and sometimes leads to shuttle obstruction. Thus elimination of such thick places before weaving is of prime importance.

They also quoted that winding generates 100 to 400% hairiness on ring yarn. This hairiness is mainly responsible for 30 to 46 % warp breakages. [8]

Effect of yarn quality on Projectile Weaving Machines

In a research it is found that properties of gray yarn, tenacity increases as count increases; breaking force, elongation and breaking work decreases as count increases. The same trend is observed in unravelled weft yarn also from picking side and receiving side.

In this study, weft breaks increases as count decreases. Finer count shows the least breaks, coarser count shows the maximum breaks and medium count weft yarn breaks are between finer and coarser yarns.

In comparison of breaking force of gray yarn vs. weft breaks, it was found that weft breaks increases with decreasing breaking force for medium and fine count yarns. In breaking force of PSY (picking side yarn), RSY (receiving side yarn) vs. weft breaks, it was found that weft breaks increases with decreasing breaking force for medium count yarns. In comparison of tenacity of gray yarn vs. weft breaks, weft breaks increases as tenacity decreases for coarser, medium and fine count yarns, in tenacity of PSY, RSY vs. weft breaks, weft breaks increases as tenacity decreases for medium count yarns.

In comparison of elongation of gray yarn vs. weft breaks, weft breaks increases as elongation decreases for fine count yarns. In the elongation of PSY, RSY vs. weft breaks, elongation decreases as weft breaks increases for coarser and fine count yarns.

Comparing the breaking work of gray yarn vs. weft breaks, weft breaks increases as breaking work decreases for medium and fine count yarns. For PSY, RSY vs. weft breaks, weft breaks decreases as breaking work increases for medium count yarns. [9]

Effect of yarn quality on Air-Jet Weaving Machines

In the processing of staple fibre yarns on air jet weaving machines 60 to 80 % of stoppages are weft stoppages. Difficult to process on air jet weaving machines are weft yarns with low work capacity, a high degree of work capacity scatter, high elongation or very lively yarns. In order to prevent yarn breakages on pick arrival, yarn quality must be high and weft tension on pick arrival low. In this case high yarn quality means a high work capacity level, resulting preferably from greater strength. [7]

Effect of yarn quality on knitting

The fibre shedding behaviour of cotton spun yarn during knitting is influenced by the cone-winding operation. This fact was confirmed by conducting an experimental study, that shows the individual as well as an interaction effects of winding parameters of winding tension, winding speed and cradle pressure on overall generation of fibre fly in knitting process. The linear and quadratic effects of winding tension, winding speed and cradle pressure have found significant impact on fibre shedding behaviour of cotton yarn. It was also found that the linear effect of winding tension was not so high on generation of fibre fly as compared to the effects of winding speed and cradle pressure. The study also shows that average fibre shedding increased in all cases of two way interaction of winding parameters from a lower to medium value and decreased thereafter. Furthermore, it was observed that the generation of fly in the cone unwinding zone of knitting machines is affected by length distribution of protruding hairs from the yarn surface rather than level of hairiness of the yarn. So the optimisation of winding parameters may bring down the ill effects on yarn hairiness and fibre shedding.

Effect of yarn quality on economics

In a study by H.L.I. Lam and K.P.S. Cheng [13] it was stated that, the cost of single yarn break in winding and other subsequent process, it is estimated that warping becomes about 700 times more costly sizing about 2100 times more, and weaving about 490 times more. [13]

Origin of seldom-occurring yarn faults

During the spinning process, a card sliver with about 20,000 to 40,000 fibers in the cross-section is drawn to a yarn with about 40 to 100 fibers in the cross -section. During the spinning process it is not possible to keep the numbers of fibre in the cross-section constant at every moment.

This leads to random variation in mass or seldom occurring yarn faults. Only spinning mills with a permanent improvement process are able to keep these random variations within close limits.

Yarn faults caused by raw material and card

For natural fibers, they depend mainly on the physical properties such as fibre fineness, length and short fibre content. For synthetic fibers, the faults depend mainly on the disentanglement of single fibers. Insufficient disentanglement can lead to felted single fibre, which might be caused by softeners, oil additives, lubricants or climatic conditions.

Yarn faults caused by process prior to spinning

These faults are characterized by extreme diameters variation or poor friction of fibers. Often, it is a matter of fibre packages, which are caught in the draw box of prior processes and were not drawn apart. Therefore, they show a big increase of the mass or diameter in the yarn.

Yarn faults caused in spinning

Most yarn faults are caused by spun-in fly in the area of the spinning machine and by fibre residues, which cling to the draw-box or other parts of the spinning machine and which are swept away from time to time and are spun into yarn.

Furthermore, it is possible that different setting possibilities of the ring spinning machine, as e.g. draft or distance settings of the draw-box, have an influence on the number of seldom-occurring yarn faults.

General measures for reduction of all types of faults

- Reduce bottom and top front zone settings at speed frame
- Reduce top front zone setting at ring frame
- Check the card wire type and its condition
- Lift the apron bar at the speed frame

A& B Faults

- Use cottons having low seed coat content
- Use proper process condition at the card and comber.
- Use an additional draw frame passage.

C & D Faults

- Check condition of ring frame drafting system for roller eccentricity, cot diameter, conditions of apron and cot and top roller pressure.
- Check levels of fibre finish and crimp.
- Fibers should not be too long or too fine.
- Narrow the bottom and top front zone settings at the speed frame.

Special Faults

General measures for reducing E to I faults

- Use lower break draft at the ring frame
- Use narrower spacer at the speed frame
- Reduce the back zone settings at the ring frame
- Use higher roving T.M.
- Use wider feed plate to licker-in setting at the card.
- Use finer roving or lower draft at the ring frame
- Check for roller eccentricity, damaged cots and aprons.
- Use proper type and level of fibre finish
- Check conditions of cans and can springs.
- Ensure the effectiveness of overhead cleaners.
- Avoid poor piecing by proper training of workers.

Special measures for long thin H & I Faults

- Avoid bobbin variations by providing an extra pin on the bobbin wheel to provide a firm hold on the bobbin
- Avoid ratching by using appropriate winding wheel and rachet at the speed frame.
- Avoid creel stretch at ring frame by using higher roving T.M. and proper creel condition.

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The author is a Research Scholar with DKTE'S Textile & Engg. Institute, Ichalkaranji

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