

Comparative Study on Ring, Rotor and Air - Jet Spun Yarn

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ABSTRACT: The improvement the quality ring and rotor after doubling is depend upon single and double twist factor. S/Z rotor yarns have bigger diameter than S/Z twist factor. The twist over doubling of low twist rotor spun singles results in significant improvement in the tenacity of rotor yarn and the differences in the strength of ring and rotor spun yarns is considerably reduced. The breaking extension of doubled rotor yarns was greater than that of ring spun yarns for balance twist but lower for twist over twist doubling irrespective of twist multiplier of singles. Improvement in the imperfection of both type of yarn after doubling. In case of tenacity rotor yarn shows more improvement in the double yarn than ring double yarn.

KEYWORDS: Twist Factor, Twist Multiplier, Doubling, Strength, Breaking Extension

I. INTRODUCTION

The new spinning technologies introduced in late sixties and early seventies, only rotor spinning sustained its promise and in the year to follow, it's established itself as a worthy alternative to ring spinning in the coarse and medium count range. The reason for its phenomenal growth were very high productivity and amenability to automation and elimination of roving and winding processes.

The production of man-made fibre yarns on rotor machines has received increased attention. These yarns have not been well accepted as a substitute for ring-spun yarns. Rotor-spun yarns are inherently weaker than ring-spun yarns because of structural difference and the manufacturers are concerned about the weavability and fabric strength. Good results can obtained with plying of rotor yarn

Mehtani and Grover reported that twist over doubling of low twist rotor spun singles results in significant improvement in the tenacity of rotor yarn and the differences in the strength of ring and rotor spun yarns is considerably reduced. The breaking extension was of doubled rotor yarn for the was greater than that of ring spun yarn for the balance twist but lower for twist over twist doubling, irrespective of twist multiplier of singles

Hunter also reported a significant improvement in the tenacity of rotor-spun cotton yarns following doubling. Levy claims that the plying of rotor yarns leads to the improvement of the fabric quality. However, Kajuter expressed some doubt as to whether the use of plied rotor yarns in weaving can lead to any significant improvement in fabric quality. The present study aims at exploring this less investigated area of the characteristics of rotor double yarn spun verses ring double yarn spun.

II. LITERATURE SURVEY

Md Nakib –Ul- Hasan, Farhana Afroj, Mohammad Mufidul Islam, S. M. Zahirul Islam, Rashedul Hasan 1, This work presents a comparative study of the properties of yarns manufactured from identical raw material (100% cotton fiber), of 16 Ne & 20 Ne in conventional ring and modern rotor spinning frame. Mechanical properties e.g. tenacity, elongation%, TPI, hairiness and evenness e.g. unevenness, Thin/km, Thick/km, Neps/km, hairiness, CV of mass of both types of yarns were tested and compared. Ring yarns exhibit higher tenacity; whereas rotor yarns expose better result in rest of the tests. Experimentally, most of the yarn characteristics are superior in rotor yarn, except tenacity; tensile strength of ring yarn is 36.36% higher than rotor yarn.

A. Tenacity

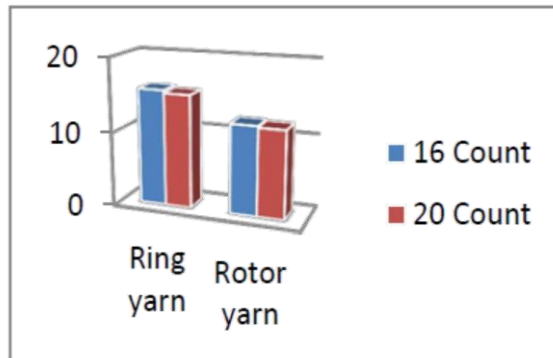


Fig. 1: Value of Tenacity for Ring and Rotor Yarn

B. Elongation

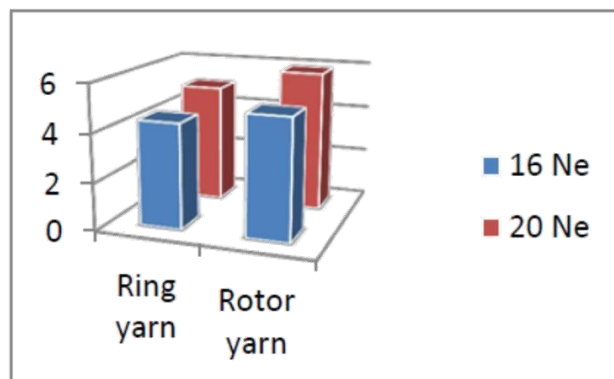


Fig. 2: Value of Elongation for Ring and Rotor Yarn

C. Hairiness:

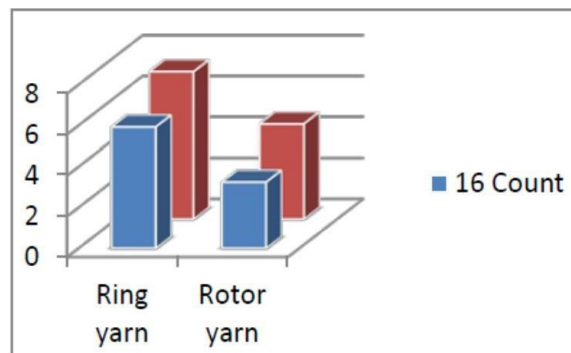


Fig. 3: Comparison of Hairiness of Ring and Rotor Yarn

The results show that the tenacity of the ring yarns expresses greater value than rotor spun yarn and the elongation% of the ring yarns has a significantly lower value than that of rotor yarn. The hairiness tests revealed an essential difference between the ring and the rotor yarn. Rotor yarn is less hairy compared to the conventional ring yarn. Unevenness of mass (1%, 3%) & their corresponding co- efficient of variation are higher for ring yarn with count than that of rotor yarn. Moreover, Index of irregularity also shows the same trend. Though thick place/km (+35%, +70%, +140%, +280%), neps/km (+280%, +400%) are higher in ring yarn, thin place/km in ring yarn are less than that of rotor yarn. The results are valid only within the experimental regions. This paper will become a good ally for those who are going to start spinning factory with ring or rotor frame

Sharif Ahmed, Md Syduzzaman, Md Sultan Mahmud, S. M. Ashique, Mohammad Mahubbur Rahman 2, This paper presents - Although ring spinning is the universal spinning system but main limitation of this system is its limited spindle speed which causes lower production rate. Now-a-days spinners are trying to finding out various alternative spinning systems among which only rotor and air-jet has established market value. So it is very important Spinners are

always trying to produce better quality yarn with low cost. But with the increase of quality cost also increase. Another important parameter is production time. Rotor is the cheapest technique and produced yarn evenness is also better than ring yarn. It is also a fast process. But limitation of rotor yarn is less strength of the produced yarn. If it is possible to increase rotor yarn strength then the yarn will be the best one. So researchers should give emphasize on rotor spinning process. As most of the time we consider yarn strength, almost all the yarns are produced in ring spinning machine as it gives strong yarn. Another reason for greater acceptance of ring yarn is that a wide range of count can be produced by for spinners to find out a suitable one according to end use and others economic aspects. Ring, Rotor and Air-jet spinning systems provide yarn with different structures and properties. Each system has its advantages and limitations in terms of technical feasibility and economic viability. We have produced 20's Ne, 100% cotton yarn from the above systems and their properties are tested by UT5 and lea strength tester. The main object of the project is to study the yarn properties (Um%, CVm%, Imperfection, Hairiness etc) of ring, rotor and air-jet spun yarn and compare among them. We observed how yarn properties are changed with the change of process. We analyzed the various yarn properties by the graphical representation

Main objectives of this study are as follows-

- To study different types of spinning methods.
- To explore the comparison among these spinning methods.
- To produce yarn using these methods.
- To test the yarn quality by testing machine.
- To compare the tested result and finally to find out- which spun yarn is the

Spinners are always trying to produce better quality yarn with low cost. But with the increase of quality cost also increase. Another important parameter is production time. Rotor is the cheapest technique and produced yarn evenness is also better than ring yarn. It is also a fast process. But limitation of rotor yarn is less strength of the produced yarn. If it is possible to increase rotor yarn strength then the yarn will be the best one. So researchers should give emphasize on rotor spinning process. As most of the time we consider yarn strength, almost all the yarns are produced in ring spinning machine as it gives strong yarn. Another reason for greater acceptance of ring yarn is that a wide range of count can be produced by ring spinning system.

Retd Jt Director (BTRA) & Consultant 3,- This paper presents the influence of fibre properties and preparatory and post spinning processes on yarn quality and spinning performance of rotor spinning is critically reviewed based on Research and development work over the years. Accumulation of micro dust and wedging of trash in rotor groove is one of main factors for end breakage rate and periodic irregularity in yarn. Though rotor yarn has lower strength, strength of weak places is comparable to that of ring yarn because of lower variability. Improvement in quality is more in coarse mixings. Addition of waste without affecting quality is possible. Lower card production rate improves rotor yarn quality. Size pick up is higher in rotor yarns and concentration and formulations have to be adjusted. Yarn and fabric appearance are better but tear strength is lower with rotor yarn

Yarn strength is generally lower in rotor yarns than ring yarns by 15 - 25% and the extent of difference depends upon quality of mixing, count and upon type of strength test (Lea or single thread). Manohar, Rakshit and Balasubramanian⁴ found that reduction in lea strength ranges from 16 - 22% with normal mixing and from 5 - 14% in waste mixing which means that the drop in strength is of much lower order with inferior mixing. Balasubramanian¹⁷ showed that the difference in strength between rotor and ring yarns depends upon the type of strength test, being more in single thread than in lea. This is because of higher lea ratio in rotor yarns which again is due to lower strength variability. Sultan and Elhawary¹⁸ confirmed that the extent of reduction in strength of rotor yarns compared to ring yarns can be brought down by spinning coarser counts from shorter cottons. Jameel¹⁹ et al reported that loss in strength of open end yarns in relation to ring yarns increases from 6 % in 10s to 12.5 % in 16s, 23.3 % in 20s and 19.4% in 25s. 20 tex yarn from P/C blend has higher tenacity than 30 tex from the same blend²⁰. Tenacity and elongation increase with increase in polyester content. Lower strength of rotor yarns is because of presence of hooked fibres, poor load distribution, low migration and lower spinning tensions²¹. Drop in strength of rotor yarn with respect to ring yarn varies with fibre length of material.

Rameshkumar C, Anandkumar P., Senthilnathan P., Jeevitha R., Anbumani N⁴, This paper presents the Ring, Rotor and Air vortex spinning systems provide yarn with different structures and properties. Each system has its limitations and advantages in terms of technical feasibility and economic viability. 30's Ne, 100% cotton yarns were produced from the above systems and knitted in single jersey machine. The Rotor Spun yarns found with frequent breakage during knitting. Comparatively good knitting performances have shown by the Ring and Air vortex yarns. Tensile, evenness and hairiness of the yarns and bursting strength, abrasion resistance, pilling, drapability and color matching of the knitted fabrics were studied. The Ring spun yarns have high strength, low imperfection, and good bursting strength. It has high 'S3' value. Abrasion resistance of Rotor and Vortex yarns made fabrics were found

higher than the ring spun yarns. Ring yarn knitted fabric has high bursting strength, Air-vortex yarn knitted fabric has poor drape due to stiffer yarn structure and the MVS yarn fabric has poor pilling resistance. Rotor, MVS yarns made fabrics have good abrasion resistance. Drapability of Vortex yarn knitted fabrics was poor than ring and Rotor yarn knitted fabrics. Good and equal depth of dye shade was found with Ring and Air vortex yarn made knitted fabrics. Ring yarn knitted fabric has shown smooth feeling than the two fabrics.

For the 30Ne, the ring spun yarn (Y1) has high strength (13.39 g/ tex), it has S3 value around 6621 and having low imperfections. The ring yarn fabric (F1) has good bursting strength (181.6 lbs/inch²). Abrasion resistance of rotor spun yarn fabric (F2) and vortex spun yarn fabric (F3) are 96.79% and 96.07% respectively, which is better than ring spun yarn fabric (92.31%). Drapability of F3 is found to be poor. It shows drape co-efficient of 0.324. Pilling is found to be high in case of F3. Ring spun fabric (F1) and vortex spun yarn fabric (F3) have similar depth of dye shade. The vortex spun yarn fabric (F3) shows bulky appearance and harsh feel than the other two fabrics

S. M. Ishtiaque, P Subramani, A Kumar & B. R. Das 5, This paper shows the effect of doubling on physical properties of regular ring-spun and compact yarns has been studied in terms of structural parameters, like fibre extent, spinning-in coefficient, fibre pair overlap length, packing coefficient and migration of fibres. The structural parameters, like fibre extent, spinning-in coefficient, fibre pair overlap length and packing density increase and migration parameters decrease after doubling for both the ring-spun and compact yarns. The percentage increase in tensile strength and percentage decrease in breaking elongation are found to be higher and lower respectively in ring-spun yarn than in compact spun yarn on doubling. Doubling process also reduces the hairiness of both ring- spun and compact yarns; the extent of hairiness reduction on doubling is higher for ring-spun yarn.

Compact yarn displays higher fibre extent and spinning-in coefficient than regular ring-spun yarn. Fibre extent and spinning-in coefficient increase after the doubling operation. Fibre extent is increased by 27.42% for single regular ring-spun yarn and 20.89% for compact yarn after doubling. The fibre pair overlap length values increase after doubling in both regular ring spun and compact yarns. Compact-spun yarn shows lower mean fibre position but higher root mean square deviation and mean migration intensity. After doubling, the mean fibre position, root mean square deviation and mean migration intensity values are reduced.

Packing coefficient increases by 18.14% for regular ring-spun yarn and 11.72% for compact yarn after doubling. Compact single yarn has higher tensile strength and breaking extension than regular single spun yarn. The increase in tensile strength on doubling is more in the case of regular ring-spun yarn than in compact yarn. But decrease in elongation-at-break is more in the case of compact spun yarn on doubling. Hairiness of compact yarn is lower than that of regular ring yarn. Doubling process reduces hairiness but reduction in hairiness at all measured lengths due to plying is more in case of ring yarn than in corresponding compact yarn.

Industrial Importance - The relationship established between yarn structural changes on doubling with the plied yarn mechanical properties will facilitate in engineering and controlling the doubling process. The manufacturing variables can be manipulated to achieve a particular degree of fibre disposition in yarn body to decide the plied yarn mechanical properties

Kolandaisamy Palaniswamy, Peer Mohamed 6,- This paper presents The effect of single-yarn twist and ply to single-yarn twist ratio on the evenness, hairiness and abrasion resistance of two-ply cotton yarn has been studied. The hairiness of two-ply yarn decreases as either the single- yarn or ply twist increases. The rate of reduction in hairiness with respect to twist is more for the single-yarn twist than for the ply twist, particularly for the finer two-ply yarn. Variation in hairiness decreases as the ply twist increases. Yarn-to-yarn abrasion shows a different trend as compared to yarn-to-emery abrasion at a low ply twist level. Two-ply yarn with 3/4 of the single-yarn twist shows the highest abrasion resistance in both yarn-to-yarn abrasion and yarn- to-emery abrasion. The abrasion resistance of the two-ply yarn depends on both single-yarn twist and ply twist. Single- yarn twist and ply twist have a more influential effect on the yarn-to-yarn and yarn-to-emery abrasion resistances respectively of cotton two-ply yarns.

The following conclusions have been drawn from the above discussions on the results of evenness, hairiness and abrasion resistance of cotton two-ply yarns with different levels of single-yarn and ply yarn twist.

- 1) The rate of reduction in hairiness with respect to twist is greater for the single-yarn twist than for the ply twist, particularly for the finer two-ply yarn.
- 2) Single and ply twist levels do not affect the evenness of two-ply cotton ring yarn.
- 3) The 9.8 tex × 2 cotton yarns produced with longer fibres exhibited better resistance to yarn-to-yarn abrasion than the 14.8 tex × 2 yarns produced with relatively short fibres. Hence the longer fibres seem to improve the yarn-to-yarn abrasion resistance.

- 4) The yarn-to-yarn abrasion resistance of two-ply yarn depends on both single-yarn twist and ply twist. However, single-yarn twist is ineffective on yarn-to-emery abrasion when the ply twist level is lower.
- 5) While single-yarn twist has more influence than the ply twist on yarn-to-yarn abrasion resistance, ply twist has more influence than the single-yarn twist on yarn-to-emery abrasion of ply yarn, particularly when the ply twist is increased from 1/3 to 1/2 the single yarn twist.
- 6) Yarn-to-emery abrasion resistance and yarn-to-yarn abrasion resistance are improved tremendously when the ply twist is increased from 1/3 to , and 1/2 to 3/4 of single-yarn twist respectively, at all single-yarn twist levels.
- 7) Two-ply yarn with 3/4 the single-yarn twist has low hairiness and high abrasion resistance against yarn as well as against emery, at all single-yarn twist levels. viii) The present study has revealed that a marginal increase of single-yarn twist level causes tremendous improvement in the yarn-to-yarn abrasion resistance of shorter fibre two-ply yarns. Increasing single-yarn twist by 10% increases the abrasive resistance of two-ply yarn with 3/4 the single-yarn twist up to 75%.

Tanveer Malik, T.K. Sinha & Yogita Agrawal 7, This paper presents the conventional spinning used in the early centuries has been modernized with the development of the modern spinning technique. The application of these yarns must be as per the end use of the fabrics. Today comfort is considered as fundamental property when a textile product is valued. The comfort characteristics of the fabrics mainly depends on the type of raw material used, thermal behavior, moisture absorption, heat transmission, heat perspiration etc. The behind this project is to compare the comfort properties of different types of fabrics which are made from various yarns. There is difference in yarn properties, yarn structure etc. due to the different spinning systems. These all factor influence the comfort properties of fabrics. Basically three types of spinning systems (ring, rotor and air-vortex) are used for producing yarn and after that the help of plain power loom, fabrics are made.

- 1) The yarn produced by the rotor spinning shows, the highest level of imperfections with maximum unevenness and uster level, the presence of wrapper fibres on the rotor yarn supposed to be reason for the same.
- 2) Fabric woven from the ring yarn shows the maximum amount of contraction, this is due to the low ability to withstand the vibrations on the loom, due to which stresses is to be seems in the yarn which result in fabric contraction. On the other hand rotor and vortex yarn have good ability to withstand such vibrations
- 3) It has been seen that the values of the drape coefficient and bending length/ modulus is maximum the fabric made from the rotor yarn as weft, the possible reason for such comparatively high values can be stiffer characteristics of the rotor yarn. And on the same time fabric made from ring yarn shows lower value of the same which may due to the high twist factor present in the ring yarn.
- 4) The value of the air permeability evaluated is highest for the fabric made from air vortex yarn; the high packing factor is expected to be the possible reason for this. The lowest value for the same is for the fabric made from rotor yarn which can be due to bulky and voluminous structure of the root yarn.
- 5) The water absorbency is seen to be highest for the rotor yarn fabric; the high porous structure can be the reason for such result.

G K Tyagi & K N Chatterjee 8, This paper presents the polyester- cotton yarns shows substantial improvement in tenacity, breaking extension and unevenness on doubling. The improvement depend upon polyester content and singles and double twist factors. S/Z rotor yarns have bigger diameter than S/Z ring yarns. The diameter of S/Z rotor yarns decreases as the doubles twist factor increases, the decreases being less in polyester – majority yarns.

1) *Nominal and Measured Twist:*

In rotor yarns, the difference between the actual and nominal twists is quite considerable. For polyester-cotton rotor yarns, the measured twist is lower than the machine twist, and the twist loss with increase in twist factor. The increase in twist loss with increase in tex twist factor. The increase in twist loss with increase in twist factor occurs because high twist extends the length of yarn formation zone, which leads to an increase in the incidence of wrapper fibres at the yarn periphery.

2) *Tenacity:*

The tenacity of both types of yarn improves substantially as a result of plying. However tenacity indices shows the existence of well-marked differences between these yarns. For rotor yarns, the improvement in tenacity appears to be maximum for yarns plied from low twist singles and consistently decreases with an increase in singles twist factor.

3) *Breaking Extension :*

The breaking extension values of polyester-cotton ring and rotor spun plied yarns in general S/ Z rotor yarns have higher breaking extension than their ring counterparts. The higher breaking extension of S/Z rotor spun yarn may be accounted for by the higher extensibility of the constituent singles and the higher contraction caused during doubling due to their bigger optical diameter. Ramakrishnan and Padmanabhan reported an increase

proceeded by a decrease in breaking extension of S/Z cotton rotor yarns with increase in doubling ratio from 0.4 to 1.6. However, this study shows that this not so. This breaking extension of rotor yarns increases as the doubling twist factor increases up to 38.28 and it is higher for 67:33 polyester-cotton yarns.

4) *Yarn Evenness:*

S/Z polyester-cotton rotor yarns are more regular than the corresponding ring spun yarns owing to the better evenness of singles in former. With regards to single twist factor, the U% values exhibit an upward trend for both these yarns. In case of rotor yarns, U% is lower, as expected, at lower twist factor and it increases as the tex twist factor increases, because of more unfavorable formation of wrapper fibres on the yarn core which adversely affect U% due to their contribution to the mass regularity of the yarn. Increase in polyester fibre content increases the unevenness. The incidence of wrapper fibres in polyester majority yarns help explain the anomalously higher U% at lower singles twist factor and may be a factor limiting the magnitude of improvement in the characteristics of plied yarn.

5) *Imperfection:*

There is general reduction in imperfection on doubling. With regard to the contribution made to this effect, fibre proportion, yarn type, and singles and doubles twist factor are the most relevant parameter for frequency of imperfections. For the rotor spun yarns, the result depend more on the fibre stiffness and singles twist factor as the doubling twist factor influences mainly the magnitude of improvement.

6) *Yarn Diameter:*

S/Z rotor yarns exhibit bigger diameter than their ring counterparts. The diameter of both their ring counterparts. The diameter of both ring and rotor spun ply yarns appears

to be quite sensitive to both singles and doubles twist factors. The sensitiveness of the diameter of both these yarns to the change in doubles twist factor is maximum with soft twisted singles. An increase in doubles twist factor causes a slight decrease in yarn diameter owing to the increased packing coefficient.

III. CONCLUSION

From the above all discussion and results it can concluded that Ring-spun yarn contains envelope twist, twisting in the fibers from outside to inwards, whereas rotor-spun yarn in contrast has core twist, twisting in the fibers from the inside to outwards. Rotor spun yarn is therefore more voluminous, more open & rougher than ring spun yarn. After doubling the tenacity of both types of yarn improves substantially. The breaking extension rotor yarns increases as the doubling twist factor increases. Rotor yarns are more regular than the corresponding ring spun yarns owing to the better evenness in the singles in the former. In case of the imperfection it shows general reduction on doubling of ring and rotor yarn.

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