TO STUDY POLYESTER/VISCOSE BLENDED DOUBLE YARN PROPERTIES SPUN FROM DIFFERENT SPINNING TECHNOLOGY

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UNDER THE GUIDANCE OF

PROF. M.S.KULKARNI

Promoting Excellence in Teaching Learning & Research

D.K.T.E. SOCIETY'S
TEXTILE AND ENGINEERING INSTITUTE, ICHALKARANJI
(An Autonomous Institute)

Year 2021-22

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A

Project Report

Submitted In Partial Fulfillment of the Requirement for Degree of

BACHELOR OF TECHNOLOGY
In
TEXTILE PLANT ENGINEERING

OF

Shivaji University, Kolhapur

BY

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CERTIFICATE

This is to certify that the project entitled, "**TO STUDY POLYESTER/VISCOSE BLENDED DOUBLE YARN PROPERTIES SPUN FROM DIFFERENT SPINNING TECHNOLOGY"** which is submitted herewith in the partial fulfillment of requirement for the award of the Bachelors' Degree of Technology in **Textile Plant Engineering** of Shivaji University, Kolhapur. This is the result of the original work completed by

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under my supervision and guidance and to the best of my knowledge and belief the work embodied in this project has not formed earlier the basis for the award of any degree or similar title of this or any other University or examining body.

PROF. M.S.KULKARNI
Guide

PROF. (Dr.) U. J. PATIL
HOD Textiles

PROF. (Dr.) P. V. KADOLE
Director

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Abstract

Double yarns have wide application range especially in men‘s suiting. Use of blended yarns in such application is increasing day by day. New spinning technologies such as vortex spinning is becoming more popular. Hence, an attempt is made to study p/v blended double yarn properties spun from different spinning technology. Ne 30/1, ring, single nozzle vortex and double nozzle vortex yarns spun from the varying blend proportion of polyester/viscose were used for doubling.

All the single yarns were plied on Two-for-one twister keeping all the parameters constant. The double yarns were evaluated for physical properties. The result were evaluted at 95% level of confidenace using minitab statistical tool.

Chapter 1

Introduction

Two-For-One or TFO for strengthening and reducing unevenness of ring yarns. Doubling reduces unevenness of single yarns and the strength of the doubled yarn is correspondingly better than the single yarns. In this article Ring Doubling, Two-For-One (TFO) twister, quality required by yarn to get best doubled yarn are discussed. Two-For-One (TFO) is a two-stage process where the yarns are doubled and then twisted. In TFO process two or more single yarns are twisted in order to enhance the properties of the end-products such as strengthening the yarns. Generally, the wax is applied to yarns before the first twisting stage in order to reduce the friction on yarns.

Objectives of doubling :

- To increase the strength of the yarn
- To increase smoothness, evenness, lusture, uniformity, and compactness of yarn.
- To obtain the better deposition of a twist.

Doubling avoids unevenness and the strength of doubled yarn is correspondingly better than the single thread. So doubled yarn are preferred. The purpose of producing doubled yarn is to improve yarn uniformity, abrasion resistance, tenacity and flexural endurance. This is also an essential process for further production of balanced yarn. In this technique two or more yarns are twisted together to form single yarn. This operation known is also known as folding, twisting or plying. It is estimated that 25% of the spun yarns are doubled. Doubler winding is a preparatory operation, and doubling is the final one in the production of ply yarns. The manmade and blend yarns are plied to get improvement in the yarn uniformity, imperfections and tenacity. Production of doubled yarn is two-stage process.

1) Doubling

2) Twisting

In spinning, the purpose of doubling is to join together two or several yarns to give them a twist that improves the strength and evenness than can be obtained in a single yarn of the same count. So, doubling is a value addition process which enhances the strength and uniformity. There is reduction in yarn hairiness after doubling due to entrapping of the protruding fibres between constituent yarns. Twist plays an important and significant role on the yarn quality and its production. It provides the cohesion between the fibres and give strength to the yarn, further, the amount of twist plays vital role for finished consumers good which determines appearance, durability and serviceability of fabric.

1.2 OBJECT:

To study polyester/viscose blended double yarn properties spun from different spinning technology.

1. To ply the polyester/viscose blended yarns spun form different spinning technology.
2. To evaluate double yarn properties at 95% level of confidence.

1.3 SCOPE:

Double yarns have wide application range especially in men‘s suiting. Use of blended yarns in such application is increasing day by day. New spinning technologies such as vortex spinning is becoming more popular. Hence, an attempt is made To study p/v blended double yarn range properties spun from different spinning technology.

Chapter 2
Literature Review

2.1. General:

The work of legendary personalities always helps us in designing our work and what to do and what not to do. Therefore, it is of prime importance to carry out literature survey in detail to avoid repetition of work, at the same time it helps us in selection of material and parameters for our work. The literatures were referred from the Research Journals, Books and some web sites.

2.2 Literature:

Kolandaisamy Palaniswamy, Peer Mohamed [1] had conducted experimental work on or ply twist increases effect of single yarn twist and ply to single yarn twist ratio on the hairiness and abrasion resistance of cotton two ply yarn. 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. Unevenness, imperfection and hairiness of two-ply yarn are lower than that of single and double-rove spun yarn. The abrasion resistance and weavability of two-ply yarn are superior to those of single and double-rove spun yarn. 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. 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.

N R Halari, A K Rakshit, S K Chattopadhyay and M Bhowmick [2] had carried out study on effect of twist level and twist direction of core (double) yarn on dref-3 spun yarn.In this article attempt has been made to understand the behavior of friction spun yarn by introducing doubled yarns as core with diversity in twist level and direction. the DREF-3 friction spun core yarns using different cotton varieties were weaker compared to the similar ring and rotor yarns. So, in general when staple fibres are introduced as the core material, the friction spun yarns have lower strength. _Z' twisted 15tex (40s Ne) parent yarn has been used for doubling purposes. To examine the effect of doubling, three twist levels are chosen, viz. 50, 60 and 70 % of the parent yarn twist for both the directions viz. S and Z. The twist direction of the doubled yarn used as core is found to be the influential factor for the breaking force and elongation of the friction spun yarn. There are some samples of doubled yarns are prepared. These samples are tested for the count, twist, breaking force and elongation.

Mr.K.R.Patil, Mr.kulabhaskarsing, Prof.P.P.Kolte, Prof.A.M.Daberao [3] its works on Effect of Twist on Yarn Properties. In this experiments provides information about the physical or structural properties and the performance properties of the yarn. The number of tests required for textile yarn has grown. Yarn testing plays a crucial role in gauging product quality, assuring regulatory compliance and assessing the performance of textile materials. As a result the testing of yarn is increasingly varied, in this introductory chapter describes the importance, scope, current status and future trends in yarn testing. The TPI (Twist per Inch) were affected by various yarn properties. It was found that an increase in TPI in many cases causes of yarn properties affect.

Sadaf Aftab Abbasi, Mazahar Hussain Peerzad, Rafique Ahmed Jhatial [4] have studied the experiment titled characterization of low twist yarn: effect of twist on physical and mechanical properties : the amount of twist plays vital role for finished consumers good which determines appearance ,durability and serviceability of fabric.

twisting mechanism including twist distribution and propagation has attracted the increasing interest of researchers in textiles and apparel. Twist gives shape of the yarn as the fibre strand leave the front roller nip of a ring frame. Simpson and Fiori reported that yarn twist affects yarn properties and spinning efficiency of normal blended yarn. also worked out on the relationship between diameter, twist, and count. They found that turns per inch in any cross section are approximately inversely proportional to the number of fibers in that part. . In this research, yarns made of four twists (170, 190, 210 and 230 tpm (turns per meter) were investigated in order to determine the effect of twist on physical and mechanical properties of low twist yarn. The yarn properties: tenacity, breaking force, elongation, mass variation, hairiness in the yarn were studied. Three counts (30, 40 and 50 tex) were manufactured with various twist levels. It was observed that the strength of yarn was affected with an increase of the twist and count. The yarn manufactured with 230 tpm and 50 tex count shows better yarn strength as compared with other twist levels and yarn counts. Further, it was found that reduction in twist improves the evenness of yarn.

Chetan R . Sonkusare , Sumant Kumar , Prof.Vaishali D. Shah , Prof. Ashwin I . Thakkar , Prof.Parthiv R.Patel. [5] have studied on the subject titled comparing the ring and rotor after doubling is depend upon single and double twist factor. 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.

S M Ishtiaque , P Subramani, A Kumar & B R Das [6] had carried the experiment titled structural and tensile properties of ring and compact plied yarns. 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.

Ozdemir "the effect of twisting number on tenacity properties", Indian Journal of Fibre & Textile Research [7] in this studies the influence of twisting method on the properties of Ne 39/1 and Ne 26/1 combed cotton yams, plied two and three times on ring, two-for-one and balloonless twisting machines, has been studied. The yarn tenacity, breaking extension, work of rupture, twisting variations, hairiness (S3) and hairiness index values of the resultant yarns have been evaluated. The results, evaluated statistically, show that the plying and twisting methods influence the physical properties of plied yam The yarns twisted on balloonless twisting machines have lower hairiness and tenacity values than those of the yarns twisted on other machines while the yams twisted on two-for-one twisting machines attain higher hairiness and twisting variance values than those of the yams twisted on other machines. In terms of tenacity, the highest improvement obtained after plying occurs in the yarns twisted on two-for-one twisting machines while the lowest improvement is observed in the yarns twisted on balloonless twisting machines. Contrarily, the yarns twisted on ring and balloonless twisting machines show the highest improvement in hairiness and twisting variance values.

Subrata Kumar Saha, B. Jamal Hossen [8] it studied in Optimization of doubling at draw frame for quality of carded ring yarn. Sliver has a huge impact on yarn quality parameter like evenness, imperfection index, Cvm%, U% of yarn. In general doubling means the increase in weight per unit length. Doubling is a process used in yarn manufacturing by which a single product is produced from a several intermediate feed product. The study was performed on 0.12 hank card sliver which was used to produce 24/1 Ne carded yarn. At first the number of doubling in the breaker and finisher drawing was 6, 7, and 8 respectively. The paper is to find out whether the change of number of doubling has any effect on yarn quality or to find out the suitable number of sliver doubling in passage 1 and passage 2.

P. Gourkar , U. Malu[9] studied about Effect of twist direction of double yarn on tensile properties of yarns/fabrics. Twisting is a very essential process in the production of staple fiber yarns, twines, cord and ropes. Twist may be defined as spiral disposition of the components of a yarn which is usually the result of relative rotations of 2 ends. Twist is generally expressed as number of turns/unit length of yarn, e.g. turns/m. Twist is inserted to the staple fiber yarns to hold the constituent fibers together, thus giving enough strength to the yarn, producing a continuous length of yarn. Twist in the yarn has a 2-fold effect. Firstly, twist increases cohesion between the fibers by increasing lateral pressure in the yarn, thus giving enough strength to the yarn. Secondly, twist increases helical angle of fibers and applies maximum fiber strength to the yarn. in this research, yarns with different twist directions were made on Sirius 2-for-I twister by Savio Macchine Tessili SpA, Pordenone/Italy, and an attempt is made to show that not only twist plays an important role in deciding the double yarn properties, but also direction of twist. The results showed that double yarns with same twist direction i.e. unidirectional twist double yarns exhibit more strength, elongation, coefficient of friction and abrasion resistance. This study proves how twist direction affects the tensile properties of double yarn and fabric prepared from double yarn.

SG VINZANEKAR and A G JOGDEV[10] study about A Study of Rotor-spun Doubled Yarns. The behaviour of rotor-spun doubled yarns differs from that of ring-spun doubled yarns. A D/S twist ratio of 0.8 yields consistently the best double yarn quality index for Sover Zply cotton yarns. Loose wrapper coils get disturbed and disintergrated by the action of doubling traveller. Rotor-spun ply yarns have higher snarling twist than their ring-spun counter parts.

A. F. W. Coulson &G. Dakin [11] DOUBLED YARNS. PARTS I TO V. This series of papers deals mainly with the effect of singles twist, doubling twist and doubling tension on the following physical properties of the folded yarn: strength, extension, snarling tendency, take-up and doubling twist. Part I deals specifically with two-fold yarns, twisted S on Z, spun from a mediumstaple American cotton, a carded Sakel cotton and from viscose rayon staple (Fibro). Particular emphasis is laid on the effect of singles and doubling twist on the above physical properties of the doubled yarn; doubling tension is, however, shown to be important and the need for further work on the effect of doubling tension is indicated. Part II deals solely with the effect of doubling tension on one type of folded yam—on 80s/2 combed Sakel, spun with a twist factor of 3·2Z and doubled with a twist factor of 5·5S. Both ring- and mule-spun singles were used. The doubling tension was varied by changing the traveller weight, spindle speed and ring diameter, and tests are described showing the effect of varying these factors both separately and simultaneously. In Part III, doubling tension, as determined by traveller weight and spindle speed, is included as a variable along with twist—both singles and doubling—for 80s/2 combed Sakel cottons, twisted both S on Z and Z on Z. The singles yarns were spun with a range of soft twists only, but a wide range of doubling twists was used. Two cottons were used, one ring- and the other mule spun. In Part IV, the work is extended to include manifold yarns. These yarns were of coarse count spun from comparatively short cottons and may be divided into two groups : (1) 12s/2 and 12s/3 Oomras and Texas, and (2) two, three, four, five, six and seven-fold 24s Texas. The singles were all mule-spun with twist factors of 3·0, 3·5 and 4·0 and folded S on Z with twist factors up to 10. The doubling tension was varied for the 12s/2 and 12s/3 only : some consideration is given to the structure of manifold yarns with special reference to ‗over-riding‘ ends. In Part V, cabled yams are dealt with. Yarns of 80s count, Z twist, were first spun with three different twist factors, 2·5, 2·75 and 3·0. These were then doubled two-fold to make 80s/2 twisted Z on Z with a range of doubling twist factors. Each of these was cabled three-fold, S twist, with a range of cabling twist factors to produce cabled threads of various combinations of singles, preparing and cabling twists, all twisted S on Z on Z. All the cabled yarns were tested for the usual physical properties, and the paper concludes with a discussion on the feasibility of producing strong sewing threads with twists other than those conventionally used.

Basal, G., Oxenham, W.[12] Effects of some Process Parameters on the Structure and Properties of Vortex Spun.Yarn The effects of a number of process parameters, including the nozzle angle, nozzle pressure, spindle diameter, yarn delivery speed, and distance between the front roller and the spindle, on the structure and properties of vortex spun yarns were investigated. A modified version of the tracer fiber technique (J. Text. Inst.,43, T60-T66, 1952) combined with the Image Analysis Application Version 3.0 (B.A.R.N. Engineering) was utilized to explore yarn structure. The migration behavior of fibers was characterized using the migration parameters introduced by Hearle et al. (Text. Res. J.,35, 329-334,788-795, 1965). The results showed that the short front roller to the spindle distance caused better evenness, low imperfections, and less hairiness. High nozzle angle, high nozzle pressure, low yarn delivery speed and small spindle diameter reduced hairiness as well. High nozzle angle, high nozzle pressure and low speed also led to higher fiber migration. Surprisingly nozzle angle, nozzle pressure or delivery speed did not have any significant effects on yarn tensile properties. This is believed to be caused by the relatively small differences between the levels of these parameters used in the trials. The present study provides a window into the vortex spinning technology, but further research needs to be conducted to establish a ―process-structure-property model‖ for vortex yarns.

Simpson, J., and Fiori, L.A.,[13] "How Yarn Twist Affects Yarn Uniformity and Imperfections". The improvement in uniformity and decrease in imperfections obtained with decreased twist might be due to the measuring principle of the Uster Evenness Tester rather than to any spinning phenomena.

SADAF AFTAB ABBASI*, MAZHAR HUSSAIN PEERZADA*, AND RAFIQUE AHMED JHATIAL*[14] Characterization of Low Twist Yarn: Effect of Twist on Physical and Mechanical Properties The amount of twist plays vital role for finished consumers' good which determines appearance, durability and serviceability of fabric. In this research, yarns made of four twists (170, 190, 210 and 230 tpm (turns per meter) were investigated in order to determine the effect of twist on physical and mechanical properties of low twist yarn. The yarn properties: tenacity, breaking force, elongation, mass variation, hairiness in the yarn were studied. Three counts (30, 40 and 50 tex) were manufactured with various twist levels. It was observed that the strength of yarn was affected with an increase of the twist and count. The yarn manufactured with 230 tpm and 50 tex count shows better yarn strength as compared with other twist levels and yarn counts. Further, it was found that reduction in twist improves the evenness of yarn.

Arindam Basu & Rajanna L Gotipamul[15] Quality characteristics of polyester/viscose and polyester/cotton two-ply yarns.The inter relationship between the characteristics of single and double yarns made of polyester/viscose and polyesterfoton has been studied. The major yam characteristics, such as unevenness, imperfections, single yarn strength (RKm), strength CV, elongation at-break and yarn hairiness, of double yarns are found to be related to the respective properties of single yarm. The mass CV%, total imperfections, single yarn strength, elongation-at-break and hairiness of double and single yarns are highly correlated. Thick places and single yarn strength CV show medium correlation.

Palanisamy Ganesan, G. Thilagavathi [16] studied the influence of twists on dimensional stability. In this work, they studied the influence of twist direction and relaxation on dimensional stability of the fabric by varying the arrangement of the warp and weft combinations of S and Z twist yarns. The study reveals that the Z warp and S weft yarn combination shows less shrinkage % as compared with the other type of the combinations.

P.B Malakane, J.R. Nagala [17] studied on doubling process parameters like spindle speed, doubling ratio and doubling tension are effect on double yarn properties. Doubling ratio influences the double yarn evenness, strength and elongation% significantly. They concluded that process parameters like spindle speed, doubling ratio effect on yarn.

A. Alamdar-Yazdi [18] studied the effect of yarn twist direction on the formability of woven fabrics. In this study, they investigated the effect of yarn twist on the formability of woven fabric. They manufactured 28 plain woven fabrics with the help of solo spun yarn as warp and weft. The results revealed that the fabric with z twist warp and z twist weft shows higher formability as compared with the fabric with z twist warp and s twist weft thread.

Ayano Koyrita Banale [19] studied the effect of yarn twisting and de- twisting on comfort characteristics of fabrics. In this research work, they studied the influence of yarn twisting and de-twisting on the comfort property of the fabric. For this work, nominal yarns of 23 Tex with 669 TPM and 15 Tex with 827 TPM were produced. Moreover, one more set of yarns with excess twist of 197 TPM and 276 TPM were produced for 23 Tex and 15 Tex yarns respectively. Further, the de twisting process was used for removing out the excess twist inserted in 23 Tex and 15 Tex yarns and it was called as modified yarns. At the end of the study, it was found that the modified yarns exhibit higher yarn diameter, softness and less flexural rigidity in relation to that of the nominal yarns. Further, it was seen that the fabric with modified yarns (de-twisting process) shows positive effect with respect to fabric thickness, tightness factor, compressibility and wicking height. But, it shows reduction in other properties such as air permeability, stitch density and water vapours permeability.

A.F.W. Coulson et al [20] studied thoroughly Doubled Yarns in five parts. In their exhaustive study, they had examined the influence of single yarn twist, doubled yarn twist on the characteristics of doubled yarn. In the first part, they critically studied doubled yarns twisted S on Z and produced from medium staple American cotton, a carded Sakel cotton and viscose rayon staple wherein they investigated influence of single and double yarn twist on double yarn properties such as strength, elongation, snarling etc. In second part of the study, they studied the influence of doubling yarn tension on the 80s/2 double yarn properties. For the study, the tension during doubling process was changed by changing the parameters such as traveller weight, ring diameter and spindle speed. In the third part, the study was conducted to examine the combined influence of doubled yarn tension factor along with the single and double yarn twist. Yarns were twisted with S on Z and Z on S twist. In fourth part of the study, different cabled yarns were considered and the doubling tension was only varied to understand its influence on the cabled yarn properties. At the end, in the fifth part of their study, they studied the influence of twist direction inserted at single, doubled and cabled yarn manufacturing stages on the cabled yarn properties used for sewing application.

N Ramakrishnan & A R Padmanabhan [21] studied in Direction of doubling and its influence on the tensile properties of ring and open-end doubled yarns. The effect of singles twist, doubling twist and direction of doubling twist on the mechanical properties of open-end (OE) and ring doubled yarns was investigated. J-34 cotton was spun into 16s count using five levels of singles twist ranging from 14.0 to 22.0 tpi and the yarns were doubled to four levels of D/S ratio varying from 0.6 to 1.2 in both S on Z and Z on Z directions. The nature of change in mechanical properties due to doubling was generally similar for both OE and ring doubled yarns. However, their magnitude differed. The strength realization and breaking elongation of OE yarns were higher by about 25% 20% respectively than those of the corresponding ring doubled yarns.

KR SALHOTRA [22] studies about Some Quality Aspects of Ply-spun Yarns. Studies carried out in the last couple of years have shown that the ply spinning can be easily adapted to the cotton sys tem of spinning. The quality of yarn thus produced has been found to be far superior to that of the conventional single yarn and quite comparable to that of the two-fold yarn. However, its abrasion resistance seems to be lower than that of the two-fold yarn. Formation of thin places and the necessity of complete removal of piecenings during winding could be two other important limiting factors.

KR SALHOTRA and NC GHOSH [23] Relationship between Imperfection Count in Single and Ply Yarns. The relationship between yarn unevenness of single and ply yarns is well known. In this paper, equations have been derived for relating thick places, thin places and neps in single and ply yarns.Doubling of yarns is employed as a means of improv ing certain desirable yarn and fabric characteristics. In regard to yarn it includes, besides other character istics, the evenness of yarn and its imperfections. To quantify such an improvement some theoretical or empirical relationships between single and ply yarn characteristics should be of help. One can then easily work out the specifications needed in single yarns so as to meet those stipulated for the ply yarn.

S Dhamija et al. [24] studied the performance characteristics of mercerized ring and compact spun yarns produced at varying level of twist and traveler weight. The ring and compact spun yarn properties were characterized by changing the twist factor, linear density and traveler weight. In the study, they investigated that the ring yarns are softer because of the low flexural rigidity as compared with the compact yarn. However, the compact yarn shows better result with regard to the tensile strength, loop strength, knot strength, breaking extension and abrasion resistance. Moreover, the positive effect of the mercerization was predominantly observed in case of the compact yarns along with the low twist factor spun yarns.

Wei Huang [25]: An approach to predict the tensile strength of a two-ply yarn from single filament yarn . It is considered that the strength of the ply yarn consisting of continuous filaments mainly depends on the properties of the single yarn and the cohesion forces among the single yarns, thus a mathematical model with relatively few parameters under given assumptions is established to predict the tensile strength of a two-ply yarn from single filament yarn. Relative relationships of the tensile force part and the interaction part are developed, respectively. The single yarn is tested to obtain fundamental data e.g. yarn strength and breaking elongation. After two strands of filament yarns are twisted into the ply yarns under different twist levels, the tensile strength, breaking elongation and structure parameters are measured or calculated for verifying the model later. Finally, the results show good agreement with the experimental values, and this model can be used to predict the performance of the finished strand yarns in actual productions.

Tasnim N. Shaikh [26]: Compact Yarn as a Replacement of Doubled Yarn in Apparel Fabric an Analytical Snap. Regularity is the prime consideration for the yarn used for apparel fabric as it imparts not only desired better appearance but also additionally improvement in mechanical properties as well as aesthetic appeal. That's why doubled yarn has enjoyed a dominating position in this sector since long although costly due to its longer production route. Contrariwise in past few years regular and low hairy compact yarn has created a landmark for the singles in the commercial market. This fabulous performance is the outcome of better fiber integration caused by fiber condensation done just before twisting. The present experiment was thereby conducted to analyze its caliber as a double yarn replacement in the apparel sector.

Eva Moučková1 , Iva Mertová1 , Petra Jirásková1 , Gabriela Krupincová1 , Dana Křemenáková2 [27] studies about This paper analyzes the relationship between technological parameters of spinning of 100% CV Vortex yarns of different counts and its selected geometrical parameters (a lead of helix of wrapping fibre ribbon, yarn diameter) as well as yarn properties. The number of twist of wrapping fibre layer is determined. The effect of the yarn delivery speed, hollow spindle diameter, and the main draft on the hairiness, mass irregularity, tenacity, elongation, resistance to abrasion and bending rigidity of Vortex yarn is observed. The yarn properties are compared with the properties of open-end rotor spun yarns. Slivers of the same spinning lot were used for the production of both kinds of yarn. The results showed that the delivery speed in combination with spindle diameter affects yarn diameter, hairiness and abrasion resistance. Mass irregularity and imperfections of yarn is mainly affected by the main draft of drafting unit. Technological parameters of spinning do not affect the level of bending rigidity of the Vortex yarn. Tested rotor spun yarns had a larger diameter, higher hairiness, lower tenacity and higher elongation, lower mass irregularity and number of imperfections, higher abrasion resistance and lower bending rigidity compared to tested Vortex spun yarns.

Lekhani Tripathi and Bijoya Kumar Behera[28] studies about Comparative Studies on Ring, Compact and Vortex Yarns and Fabrics. Ring, Compact 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. In this research, 40‘s Ne, 52:48 Polyester/Cotton blended yarns were produced on ring, compact and vortex spinning systems and woven fabrics were manufactured using these yarns [1]. The vortex yarn is poor in strength and elongation and is also having more irregularities and uneven compared to ring and compact yarns. The vortex yarn being porous has a higher diameter compared to ring and compact yarns, whereas the hairiness of vortex yarn is significantly low compared to ring yarn. The Comfort properties and Handle characteristics of the fabrics were studied apart from the other properties of the yarns and fabrics. Vortex yarn fabrics exhibit better absorbency, good air permeability, abrasion and pilling resistance. The hand values of the vortex yarn fabrics are not so satisfactory compared to ring and compact yarn fabrics; however, its other properties can be utilized for some specialized applications where fabric handle has a very least role to play.

A. F. W. Coulson & G. Dakin [29] study in THE EFFECTS OF DIFFERENCES IN DOUBLING TENSION ARISING FROM CHANGES OF TRAVELER SIZE, SPINDLE SPEED, AND RING DIAMETER. The present paper is intended to show the effect of doubling tension on the strength, extension, snarling tendency, doubling twist, and, to a smaller extent, lustre, of an ordinary wet-doubled yam, and to examine the relative advantages of the different ways in which this tension may be produced. An 'ordinary' wet-doubled yam is defined to be one in which two similar singles, spun Z-way, are ring-doubled S-way. The work has been done on one type of thread only, an 80s/2 combed Sakel, spun with a twist-factor of 3-2 in the singles (28-6 tums per inch) and doubled with a twist-factor of 5-5 (34-6 tums per inch) ; both mule-spun and ring-spun singles have been used. The results are considered applicable to two-fold yams designated in the trade 'usual' and 'hard' manufacturing threads. ' - The doubling tension was varied by changing the traveller weight, ; spindle speed, and ring diameter, and tests are described showing the effect of varying these factors both separately and simultaneously. Strength and Extension - The strongest doubled yam is obtained by employing the highest doubling tension possible in practice, obtained by increasing the traveller weight, the spindle speed, or the ring diameter, these being in decreasing order of importance within the practical range of each. The most extensible thread is obtained by using the lowest tension practicable whilst doubling. Hence it is impossible to increase both extension and strength by any change of tension, and a compromise must be sought By keeping the tension during doubling approximately the same as in present mill practice, but obtaining this tension by a different method, an equally strong and extensible thread can be made, with an increased production. Lustre. A high tension during doubling produces a more lustrous yarn than a low tension. Snarling Twist. For threads doubled from mule-spun singles, snarling twist falls either to a minimum, or constant value, as the doubling tension is progressively increased ; the tension at which this minimum or constant value is obtained approximates to that used in practice. For threads doubled from ring-spun singles, the effect of doubling tension on the snarling twist is uncertain, the results being too erratic to allow of definite conclusions. Doubling Twist. The turns per inch are fewer when the tension is high than when it is low.

J. Ochola, J. Kisato, L. Kinuthia. J. Mwasiagi and A. Waithaka [30] Study on the Influence of Fiber Properties on Yarn Imperfections in Ring Spun Yarns. Fiber to yarn conversion process has been affected by several factors which include properties of raw material, level of technology, machinery and skill of machine operators. In cotton fibre spinning, the cost of raw material plays an important role, since it accounts for over 50% of the total cost of the ring spun yarn. Yarn imperfection (neps, thick and thin places) on the other hand is an important yarn parameter which affects yarn and fabric processing, and quality parameter. In this study, the relationship between fiber properties and yarn imperfections has been investigated using statistical and Monte Carlo techniques. The linear regression analysis developed models that generated coefficient of regression (R) value of 0.68, 0.65 and 0.68. respectively for neps, thick and thin places, respectively. The sensitivity analysis for statistical models showed that yarn twist, micronaire value, fiber maturity, trash area, fiber length, fiber strength and fiber yellowness are the influential factors for affecting yarn imperfections. Others factors that included trash grade, fiber uniformity, spinning consistency index, fiber reflectance, yarn linear density, trash content, fiber elongation and short fiber index should also are considered while studying yarn imperfection of cotton ring spun yarns.

J.-H. Lin,I.-S. Tsai,W.-H. Hsing &Z.-Z. Yang [31] studies about The Influence of the Twist Direction on the Physical Properties of a Plied Yarn in a Rotor Twister. The influence or the twist direction on the physical properties of a piled yarn is studied. Theoretically, a plied yarn should have a better performance before exceeding the twist limitation when a singles yarn and a plied yarn are being twisted. In this case, the twist direction of the plied yarn was opposite to that of the singles yarn. The singles yarn is partially untied in the twisting process and influences the physical properties of the plied yarn. In this study, the influence of the twist direction on the physical properties of plied yarn in the latest successfully developed rotor twister is discussed. From the experimental results, before exceeding the extreme limit of the twist, a Z-twist-direction plied yarn made from Z-twist-direction singles yarn has 24–61% higher strength, 42–88% more elongation, 5–60% higher twisting tension, a lower twist CV%, and a higher elongation of twisted yarn than an S-twist-direction plied yarn based on the same linear density of 29.5-tex ring-spun yarn.

D. E. Henshaw [32] study in SELF-TWIST YARN. A new type of yarn structure, which has been named self-twist yarn, is described. It is a two-ply structure in which both the strand and plying twists alternate S and Z along the yarn. The strength properties of the yarn and their dependence on the various yam parameters are given for 60/64s wool fibres, and it is shown that the strength can approach that of conventional yarns.

Chapter 3
Plan of work

3.1 Introduction

This chapter deals with the material used and methodology used for producing the yarn and testing of the same. After studying the literature, the design of experiment is done using Taguchi L9 orthogonal array. The details of material and methodology are given in detail below.

3.2 Material

Ne 30/1, ring, single nozzle vortex and double nozzle vortex yarns spun from the varying blend proportion of polyester/viscose were used for doubling.

3.3 Methods

1. Parallel winding
Make **-**SSM Winding machine
Speed –400 MPM
Type of winding – Digicone
Yarn count –Ne 30/1

2. Two-for-one twister Savio
Make **-** Savio
Model – Sirius
Spindle speed – 8000RPM
TPI – 12.0
Threading – Pneumatic

Design of experiment:

For Conducting trials statistical experiment was done. Two factors, type of spinning technology and blend proportion with three variables each were selected. Taguchi L9 orthogonal array was used for designing the experiment. Result were analyzed at 95% level of confidence.

Table No. 1 – Design of Experiment

Sr.No	Blend Proportion	Technology of Spinning
1	50/50	R/S
2	50/50	MJS
3	50/50	J-20
4	67/33	R/S
5	67/33	MJS
6	67/33	J-20
7	80/20	R/S
8	80/20	MJS
9	80/20	J-20

3.5 Testing

a) Single yarn testing

Single yarn, which in raw material for doubling is tested for physical properties. Below table shows the physical properties tested along with the test standard.

Table No. 2 - Tests and Tests Standards for Yarn Testing

Sr.No	Test	No Of Observations	Standard
1	Count	20	ASTM D 1907-01
2	Strength	10	ASTM D 2256-02
3	Elongation	10	ASTM D 2256-02
4	U%	10	ASTM D1425-96
5	Hairiness	10	ASTM D 5647-07
6	Yarn to Metal Friction	10	ASTM D3108-13
7	Yarn Abrasion (RRI)	10	ASTM D6611-16
8	Yarn Diameter (mm)	50	ASTM D1069-17

Single yarn test Results:

Below table shows the tests results of Ne 30/1 yarn used for doubling.

Table No. 3 - Single yarn test Results.

SINGLE YARN TEST RESULTS															
Sr.No.	Blend Propertion	Technology of Spinning	Count	Tenacity (gm/tex)	Elongation(%)	U%	Thin(-50%) / km	Thick (+50%)/ km	Neps(+200%) / km	IPI/Km	H.I	S 3	Yarn Abrasion	Yarn to Metal Friction	Yarn Diameter (mm)
1	50/50	R/S	30.18	16.6	8.61	10.64	4	48.8	64.3	117.1	5.49	79.2	2149.07	0.2	0.16
2	50/50	MJS	29.7	13.9	8.61	10.47	4.3	66.8	114	185.1	6.2	43.5	3412.07	0.28	0.19
3	50/50	J-20	30.7	13.0	6.78	10.64	3.5	51.5	99.3	154.3	3.59	0	679.93	0.29	0.21
4	67/33	R/S	29.36	18.7	10.13	10.11	1.3	33.3	47	81.6	5.33	90.4	2388.17	0.31	0.21
5	67/33	MJS	30.5	11.7	7.90	10.25	1	50.3	122.3	173.6	5.91	51.5	3695.63	0.35	0.18
6	67/33	J-20	30.62	12.5	7.89	10.84	2	55.8	66.8	124.6	3.08	0.2	181.06	0.3	0.20
7	80/20	R/S	30.4	21.8	9.77	10.95	8.8	29.8	52.3	90.9	5.76	87.7	3939.92	0.31	0.16
8	80/20	MJS	30.7	16.8	10.80	10.42	7.5	39.2	111.4	158.1	5.98	46.3	4557.16	0.32	0.18
9	80/20	J-20	30.4	12.7	6.80	10.83	1	41	36.8	78.8	3.51	3.7	542.77	0.3	0.20

Chapter 4
Results and discussion

4.1 Introduction: -

As discussed in plan of work of samples with different blend proportion of polyester/viscose, spun with from different yarn spinning technology were twisted on TFO and tested for all its physical characteristics.

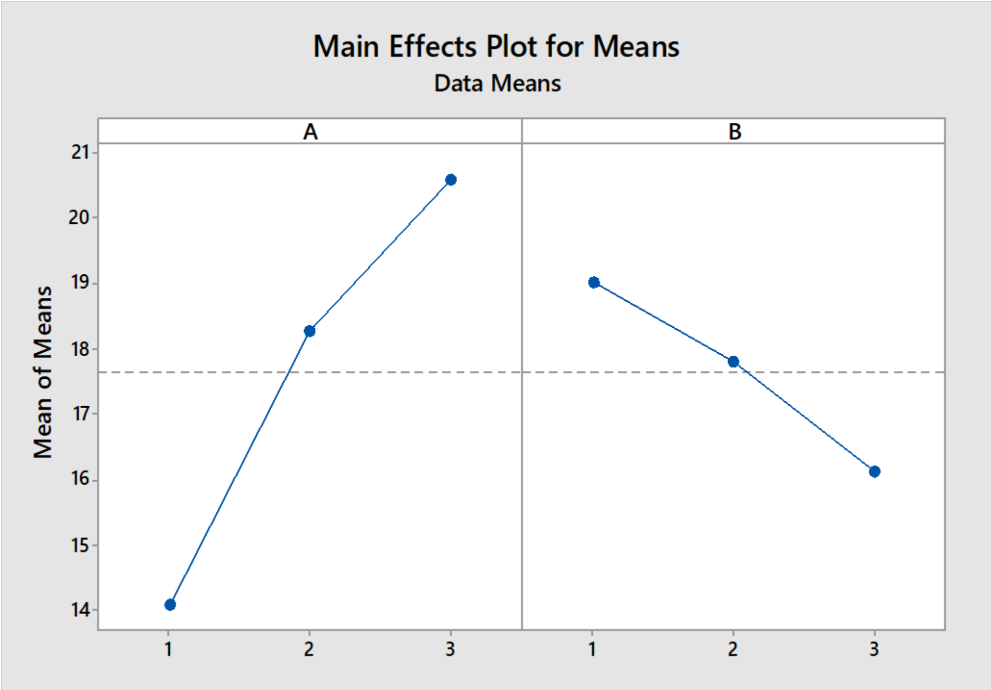
Double yarn Test Result:

Below table shows summarised results of all trials conducted

Table No. 4 - Double yarn Test Result.

Sr.No.	Blend Propertion	Technology of Spinning	Count	Tenacity (gm/tex)	Elongation (%)	U%	Thin(- 50 %) / km	Thick (+ 50 %)/ km	Neps(+ 200 %) / km	IPI/Km	H.I	S3	Yarn Abrasion	Yarn to Metal Friction	Yarn Diameter (mm)
1	50/50	R/S	14.59	16.5	12.76	8	0	6.5	8	14.5	7.59	36.6	1700.3	0.28	0.28
2	50/50	MJS	14.35	13.4	10.30	8.58	0	13.5	6	19.5	7.38	44	1705.5	0.28	0.25
3	50/50	J-20	14.85	12.4	9.60	8.86	0	20.3	5.5	25.8	5.28	0	2117	0.29	0.31
4	67/33	R/S	14.18	19.2	12.35	8.16	0	13.8	11.3	25.1	7.52	23	2205.3	0.31	0.25
5	67/33	MJS	14.75	19.1	13.11	8.26	0	11.3	17.3	28.6	7.34	29.4	1187.4	0.28	0.28
6	67/33	J-20	14.81	16.5	11.07	8.43	0	16.5	8.3	24.8	5.61	0.2	2280.9	0.29	0.29
7	80/20	R/S	14.7	21.3	12.52	7.87	0	8.3	10.5	18.8	7.95	35.6	2556.8	0.28	0.26
8	80/20	MJS	14.85	21.0	14.12	8.02	0	17.8	19.5	37.3	7.17	8.4	2497.8	0.29	0.28
9	80/20	J-20	14.7	19.5	11.81	7.74	0	14.8	6.5	21.3	5.72	2.2	1948.1	0.32	0.30

4.2.1. Strength:



Graph 1. Effect of Parameters on Yarn Strength

A: BLEND PROPORTION

B: TYPE OF SPINNING TECHNOLOGY

Analysis of Variance

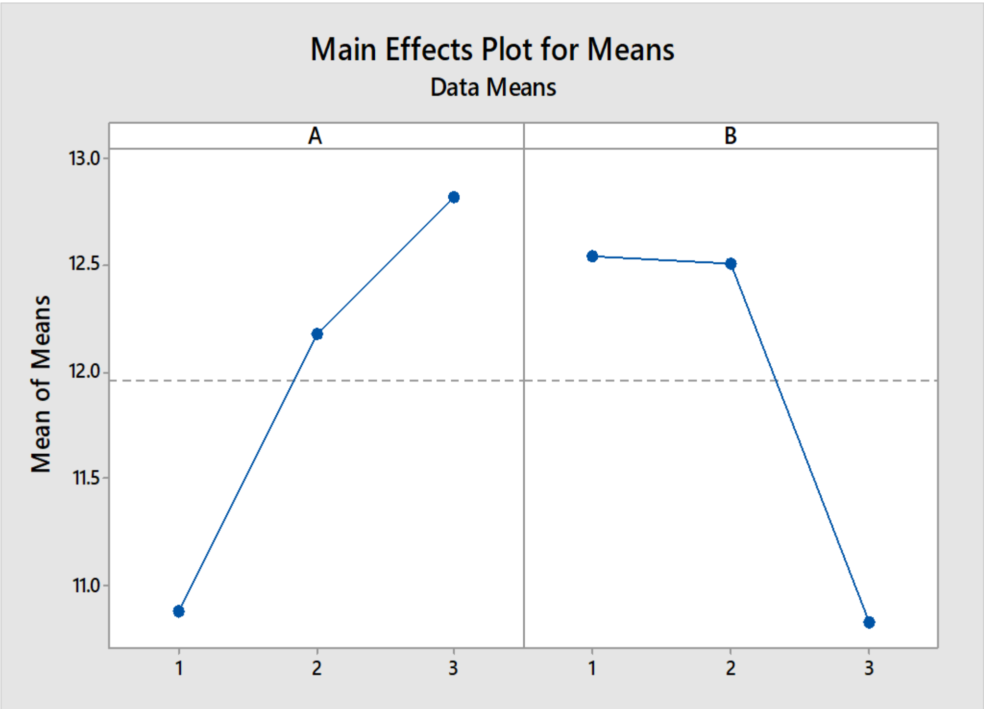
Source	DF	Adj SS	Adj MS	F-Value	P-Value
Blend Proportion	2	64.901	32.4503	41.59	0.002
Technology of Spinning	2	12.674	6.3369	8.12	0.039

When the single yarns are twisted during plying, the twist is applied in opposite direction to that of single yarns. This results in parallelization of fibres and more fibres share the load when it is applied on the yarn. This results in increased yarn tenacity.

From statistical analysis, it can be observed that blend as well as t technology affects yarn strength significantly. Ring spun yarns are stronger than air jet spun yarns spun from both the technologies. The reason being the structure of the yarn. Ring spun single yarn exhibits more strength than vortex spun yarns, as a result ring spun double yarn shows more strength. But, percent increase in strength is more with vortex yarns (both) in comparison with ring spun yarns. At a given level of twist, the cohesion between yarns spun from vortex technology might be increasing to a greater extent against ring spun yarn. As expected, increase in polyester content increases the strength of yarn.

When the single yarns are twisted during plying, the twist is applied in opposite direction to that of single yarns. This results in parallelization of fibres and more fibres share the load when it is applied on the yarn. This results in increased yarn tenacity.

4.2.2.Elongation:



Graph 2. Effect of Parameters on Yarn Elongation

A: BLEND PROPORTION

B: TYPE OF SPINNING TECHNOLOGY

```
Analysis of Variance

  Source                    DF   Adj SS   Adj MS   F-Value   P-Value
  Blend Proportion          2    5.830    2.915      2.50     0.198
  Technology of Spinning    2    5.775    2.887      2.47     0.200
```

Graph 2 shows the effect of parameters on yarn elongation%. Parameters under study have no significant influence on double yarn elongation. But, the trend is similar to yarn strength. Ring yarn because of its helical structure, shows better elongation against vortex yarns.Thedoubling twist also causes some shrinkage, resultingin increased yarn elongation-at-break.

4.2.3. U% :

Graph 3. Effect of Parameters on Yarn Unevenness

A: BLEND PROPORTION

B: TYPE OF SPINNING TECHNOLOGY

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Blend Proportion	2	0.5681	0.28403	4.20	0.104
Technology of Spinning	2	0.1909	0.09543	1.41	0.344

According to law of doubling, each and every process of doubling reduces the irregularity in the material.It has been observed that yarn U% after doubling reduces significantly. Both the parameters i.e. blend proportion and yarn spinning technology have no significant influence on yarn unevenness.

4.2.4. Imperfection:

Graph 4. Effect of Parameters on Yarn Imperfection

A: BLEND PROPORTION

B: TYPE OF SPINNING TECHNOLOGY

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Blend Proportion	2	73.41	36.70	0.96	0.457
Technology of Spinning	2	121.50	60.75	1.59	0.311

A thin place in single yarn, which was identified due to its lower than -50% mass, will become -25% after doubling. In that case, it will not be considered as thin places after doubling. Similarly, if a thick place comes beside a thin place during doubling the resultant yarn will not show any thick place. Hence, the total imperfections after doubling reduces significantly. Yarn spinning technology and blend proportion do not have significant effect on yarn imperfection.Though total imperfections seems to be more with higher proportion of polyester, percent drop is more with higher proportion of polyester. Yarn spinning technology does not show any particular trend.

4.2.5. Hairiness Index

Graph 5. Effect of Parameters on Yarn Hairiness Index

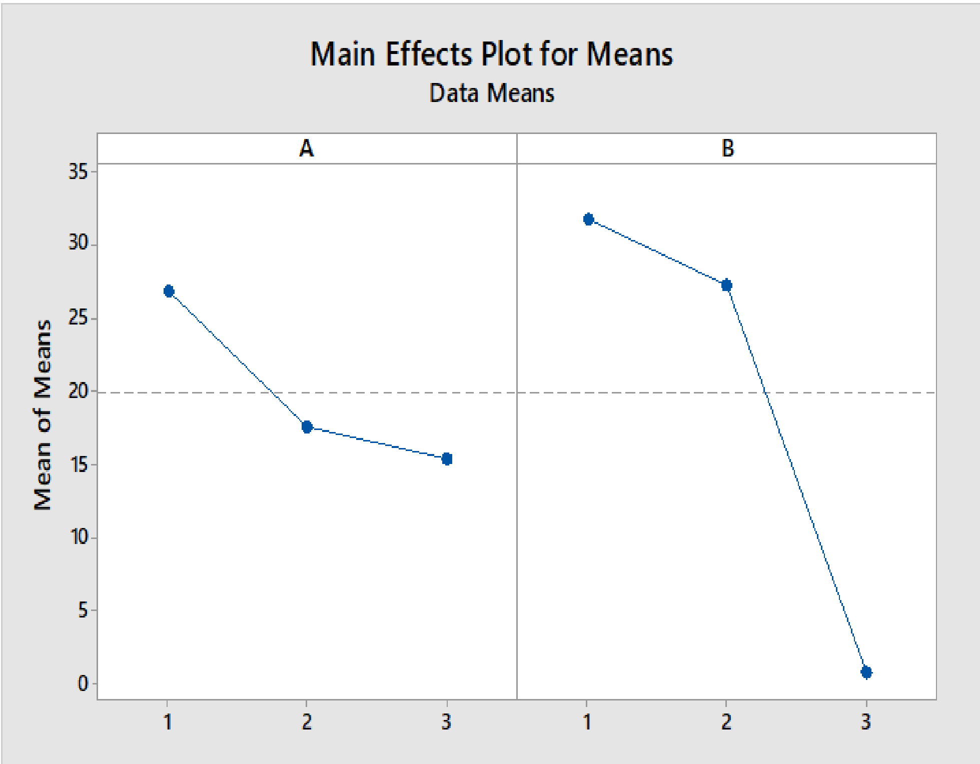
A: BLEND PROPORTION

B: TYPE OF SPINNING TECHNOLOGY

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Blend Proportion	2	0.05927	0.02963	0.67	0.561
Technology of Spinning	2	7.87220	3.93610	88.98	0.000

4.2.6. Hairiness (S3)



Graph 6. Effect of Parameters on Yarn Hairiness (S3)

A: BLEND PROPORTION

B: TYPE OF SPINNING TECHNOLOGY

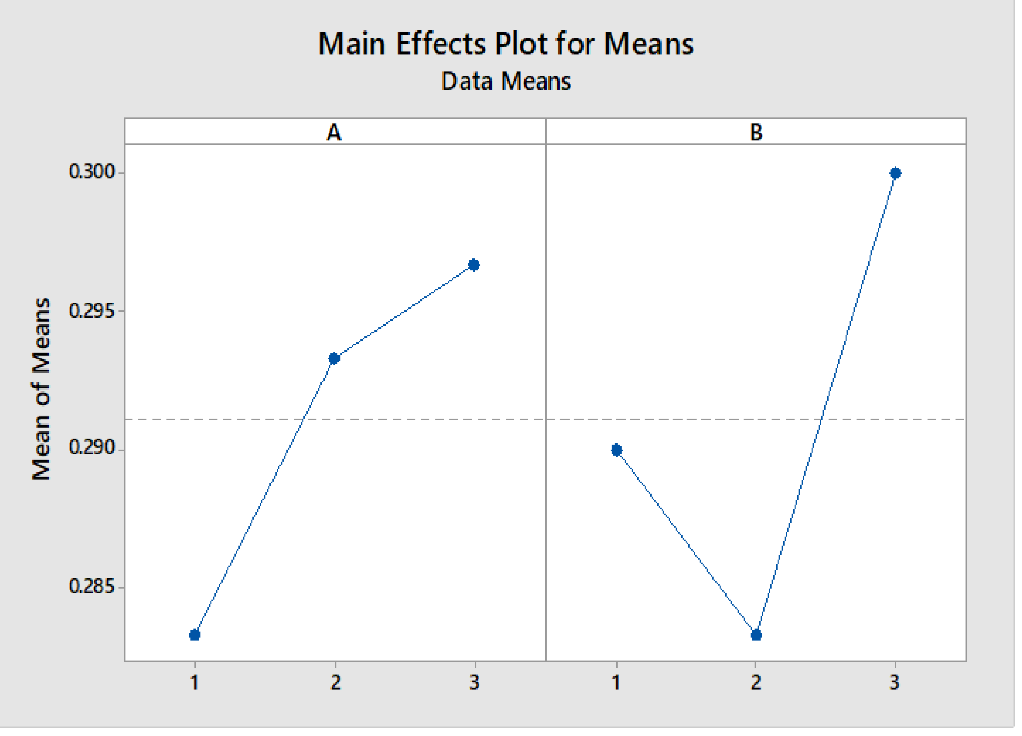
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Blend Proportion	2	223.1	111.6	0.83	0.498
Technology of Spinning	2	1677.3	838.7	6.27	0.059

Yarn hairiness index measures total length of protruding fibres per unit length and has no unit. During doubling, long protruding fibres may get embedded inside the yarn structure and length of protruding fibre after doubling might get reduced. For example, a protruding fibre has length of 5 mm in single yarn, after doubling, it may become 2mm. Also, there is some opening of yarn due to surface abrasion of the yarn during parallel winding and doubling on the TFO. This results in increase in number of protruding fibres after doubling. As a result, there will be increase in Yarn Hairiness Index, but drop in S3 value (Number of Fibres protruding in the range of 3 to 15 mm per 100mtr).

Technology of Spinning has significant influence on Yarn Hairiness Index as well as on yarn S3 value. Basic ring spun yarn has more hairiness as compared to vortex yarns, hence the same trend is observed after doubling. Percent reduction in S3 value is maximum with ring spun yarn and minimum with singe vortex yarn.

4.2.7. Yarn to Metal Friction



Graph 7. Effect of Parameters on Yarn to Metal Friction

A: BLEND PROPORTION

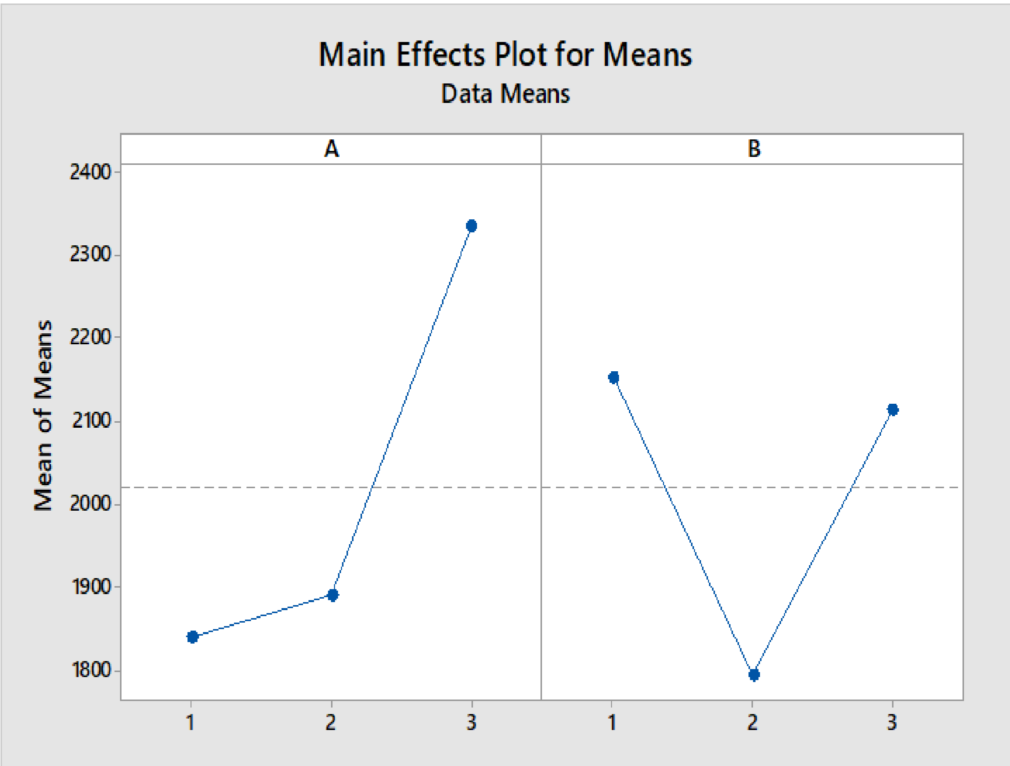
B: TYPE OF SPINNING TECHNOLOGY

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Blend Proportion	2	0.000289	0.000144	0.59	0.596
Technology of Spinning	2	0.000422	0.000211	0.86	0.488

Yarn spinning technology and blend proportion have no significant influence on yarn to metal friction after doubling.Percent change in yarn to metal friction after doubling is also insignificant.

4.2.8. Yarn Abrasion



Graph 8. Effect of Parameters on Yarn Abrasion

A: BLEND PROPORTION

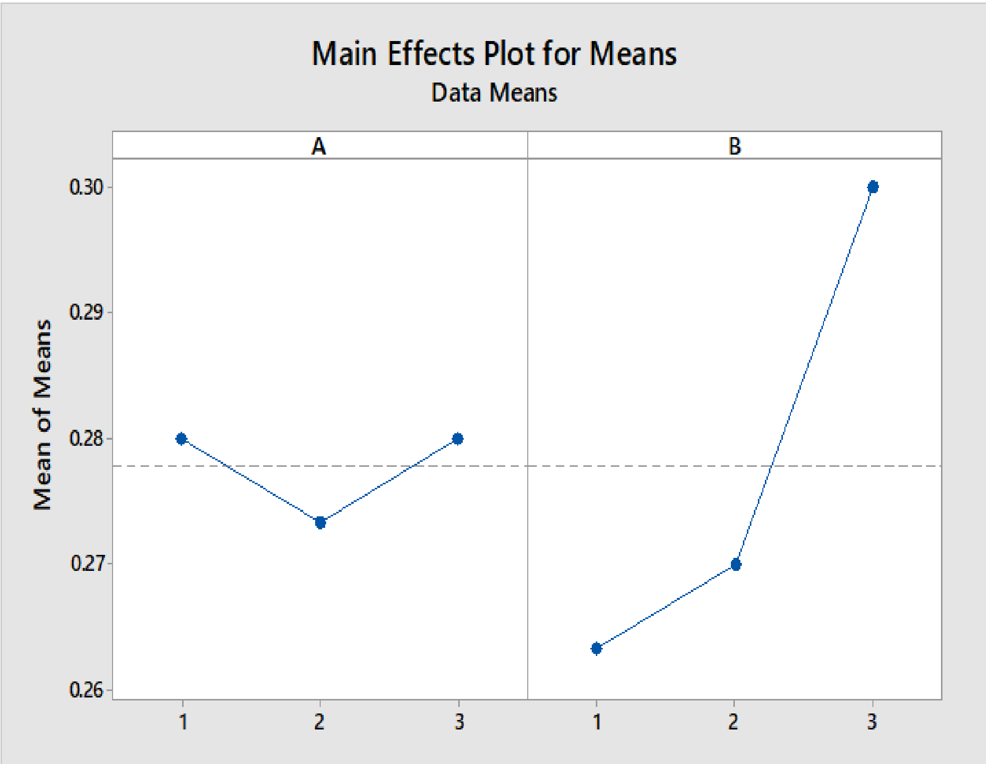
B: TYPE OF SPINNING TECHNOLOGY

Analysis of Variance

Source	DF	AdjSS	Adj MS	F-Value	P-Value
Blend Proportion	2	442150	221075	1.03	0.434
Technology of Spinning	2	230521	115260	0.54	0.620

Yarn abrasion resistance is the important factor as far as weave-ability of the yarn is concerned. Resistance of the yarn in terms of number of strokes required to break the yarn when rubbed against the emery roller are recorded. Blend proportion as well as yarn spinning technology have no significant influence on yarn abrasion. With increase in polyester content, increase in yarn abrasion resistance is noticed, this may be due to inherent property of polyester fibre.

4.2.9. Yarn Diameter



Graph 9. Effect of Parameters on Yarn Diameter

A: BLEND PROPORTION

B: TYPE OF SPINNING TECHNOLOGY

Analysis of Variance

Source	DF	Adj SS	AdjMS	F-Value	P-Value
Blend Proportion	2	0.000089	0.000044	0.15	0.865
Technology of Spinning	2	0.002289	0.001144	3.89	0.115

After doubling yarn becomes coarser and hence diameter of the yarn also increases. Increase in yarn diameter depends on packing density of yarn which in turn depends on amount of twist. As vortex yarns are bulkier than ring yarn, after doubling also, yarn diameter of vortex yarns is more than ring spun yarn, but percent increase in all the samples is almost same.

Chapter 5
Conclusions

After testing various physical and surface properties of polyester/viscose blended yarn spun from different technology at 95% level of confidence, following conclusion are drawn.

1. Yarn spinning technology has significant effect on strength and hairiness of yarn even after doubling. Single yarn structure may be the reason for the same.
2. Blended proportion, though has significant effect on single yarn properties, after doubling the effect is statistically in significant.

Hence, it can be concluded that polyester/viscose blended double yarns spun from different spinning technology do not differ in yarn properties except yarn strength and hairiness.

Reference

1.KolandaisamyPalaniswamy, Peer Mohamed, Effect of single yarn twist and ply to single yarn twist ratio on the hairiness and abrasion resistance of cotton two ply yarn, AUTEX Research Journal, Vol. 6, no. 2, June 2006.

2.N R Halari, A K Rakshit, S K Chattopadhyay and M Bhowmick, study on effect of twist level and twist direction of core (double) yarn on dref-3 spun yarn, Indian Journal of Fiber and Textile Research, Vol. 40, June 2015, pp. 137-139.

3.Mr.K.R.Patil, Mr.kulabhaskar sing,Prof.P.P.Kolte,Prof.A.M.Daberao, effect of twist on yarn properties, International Journal on Textile Engineering and Processes, Vol. 3, Issue 1 January 2017.

4.Sadaf Aftab Abbasi, Mazahar Hussain Peerzad, Rafique Ahmed Jhatial, characterization of low twist yarn: effect of twist on physical and mechanical properties, Mehran University Research Journal of Engineering and Technology, Vol. 31, no. 3, July 2012.[ISSN 0254-7821].

5.Chetan R .Sonkusare ,Sumant Kumar , Prof.Vaishali D. Shah , Prof. Ashwin I . Thakkar ,Prof.ParthivR.Patel, Effect of weave construction on tear strength of woven fabrics, Comparing the ring and rotor after doubling, IJSRD-International Journal For Scientific Research & Development, Vol. 3, Issue 02, 2015.

6.S M Ishtiaque , P Subramani, A Kumar & B R Das, structural and tensile properties of ring and compact plied yarns, Indian Journal of Fiber and Textile Research, Vol. 34 , September 2009, pp. 213-218.

7.Ozdemir ―the effect of twisting number on tenacity properties‖, 2000, 34-40.

8.Subrata Kumar Saha, Jamal HossenOptimization of doubling at draw frame for quality of carded ring yarn International Journal of Engineering & Technology IJET-IJENS Vol: 11 No: 06.

9.P. Gourkar , U. Malu ― effect of twist direction of double yarn on tensile properties of yarn/fabric‖ Melliand International 23(3):146-148 sept 2017.

10.SG VINZANEKAR and A G JOGDEV ―study about A Study of Rotor-spun Doubled Yarns‖ Indian Journal of Textile Research Vol. 13, june 1988, Pp. 58-62.

11.A. F. W. Coulson &G. Dakin―DOUBLED YARNS. PARTS I TO V‖Journal of the Textile Institute (1957) 17-21.

12.Basal, G., Oxenham, W. ―Effects of some Process Parameters on the Structure and Properties of Vortex Spun‖Textile Research Journal, vol. 76, 6: pp. 492-499.

13.Simpson, J., and Fiori, L.A. "How Yarn Twist Affects Yarn Uniformity and Imperfections"Textile Research Journal, vol. 45, 2: pp. 136-137.

14.SADAF AFTAB ABBASI, MAZHAR HUSSAIN PEERZADA, AND RAFIQUE AHMED JHATIAL ―Characterization of Low Twist Yarn: Effect of Twist on Physical and Mechanical Properties‖Mehran University Research Journal of Engineering & Technology, Volume 31, No. 3, July, 2012 [ISSN 0254-7821] 553.

15.Arindam Basu&Rajanna L Gotipamul ―Quality characteristics of polyester/viscose and polyester/cotton two-ply yarns‖ Indian Textile of Fiber and Textile Research Vol. 31, June 2006, Pp. 279-285.

16.Palanisamy Ganesan et al. studied ―the influence of twists on dimensional stability‖

17.P.B.Malakane, J.R.Nagala studied on―Influence of Doubling Process Parameters on Double Yarns Characteristics‖ Department of Textile, D K T E‘s Textile and Engineering Institute. Textile Trends (2019)

18.A. Alamdar-Yazdi studied―the effect of yarn twist direction on the formability of woven fabrics‖The Journal of The Textile Institute Volume 101, 2010.

19.AyanoKoyritaBanale studied ―the effect of yarn twisting and de- twisting on comfort characteristics of fabrics‖ Indian Journal of Fibre and Textile Research Vol. 40, June 2015, Pp. 144-149.

20.A K W Coulson and G Dakin, ―Doubled yarns, Parts I to V, The Journal of Textile Institute, Vol. 48, T203-T332 (1957).

21.N Ramakrishnan & A R Padmanabhan studied in ―Direction of doubling and its influence on the tensile properties of ring and open-end doubled yarns‖ Indian Journal of Textile Research Vol. 14, June 1989, Pp. 66-70.

22.KR SALHOTRA studies about ―Some Quality Aspects of Ply-spun Yarns‖ Indian Journal of Textile Research Vol. 12, December 1987, Pp. 197-200. TO STUDY THE PROPERTIES OF DYED P/V BLENDED DOUBLE YARN D.K.T.E. Society’s Textile and Engineering Institute, Ichalkaranji Page 25

23.KR SALHOTRA and NC GHOSH ―Relationship between Imperfection Count in Single and Ply Yarns‖ Indian Journal of Textile Research Vol. 12, June 1987, Pp. 103-105.

24.S Dhamija et al. studied ―the performance characteristics of mercerized ring and compact spun yarns produced at varying level of twist and traveler weight‖. Indian Journal of Fibre and Textile Research Vol. 32, Sept 2007, Pp. 295-300.

25.Wei Huang :―An approach to predict the tensile strength of a two-ply yarn from single filament yarn‖The Journal of The Textile Institute Volume 108, 2017.

26.Tasnim N. Shaikh ―Compact Yarn as a Replacement of Doubled Yarn in Apparel Fabric an Analytical Snap‖Journal of Textile Engineering & Fashion TechnologyVolume 1 Issue 5 – 2017.

27.Eva Moučková1 , Iva Mertová1 , Petra Jirásková1 , Gabriela Krupincová1 , Dana Křemenáková2 ―PROPERTIES OF VISCOSE VORTEX YARNS DEPENDING ON TECHNOLOGICAL PARAMETERS OF SPINNING‖ AUTEX Research Journal, Vol. 15, No 2, June 2015.

28.Lekhani Tripathi and Bijoya Kumar Behera studies about ―Comparative Studies on Ring, Compact and Vortex Yarns and Fabrics‖ Journal of Textile Science and Fashion Technology September 2020.

29.A. F. W. Coulson & G. Dakin study in ―THE EFFECTS OF DIFFERENCES IN DOUBLING TENSION ARISING FROM CHANGES OF TRAVELER SIZE, SPINDLE SPEED, AND RING DIAMETER‖ Journal of the Textile Institute Transactions, 48:7-8, T233-T257.

30.J. Ochola, J. Kisato, L. Kinuthia. J. Mwasiagi and A. Waithaka Study on ―the Influence of Fiber Properties on Yarn Imperfections in Ring Spun Yarns‖ Asian Journal of Textile 2(3):32-43, 2012.

31. J.-H. Lin,I.-S. Tsai,W.-H. Hsing &Z.-Z. Yang ―The Influence of the Twist Direction on the Physical Properties of a Plied Yarn in a Rotor Twister‖ The Journal of The Textile Institute Volume 89, 1998.

32. D. E. Henshaw ―SELF-TWIST YARN‖ The Journal of The Textile Institute Volume 60, 1969