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Original Research Article

Uster Imperfections of 35% Cotton and 65% Polyester Blended Yarn for 40Ne, 50Ne and 60Ne Ring Spun Yarn

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Abstract: Imperfection or thick, thin and neps of yarn is a foremost problem of yarn manufacturing which create difficulties from fabric construction to end product development for customer and Imperfection of yarn has an adverse effect on fabric structure, uneven outcome during dyeing and printing as well as influencing handfeel and comfortness of end product. A standard production process of 35% Cotton and 65% Polyester Blended Yarn for 40Ne, 50Ne and 60Ne Ring Spun Yarn was maintained for a specific customer in a spinning mill and imperfections of 40Ne, 50Ne and 60Ne Ring Spun were measured by uster tester and thin (-50%), thick (+50%), neps (+200%) were tested and variation of 40Ne, 50Ne and 60Ne Ring Spun Yarn was observed to understand the variation of count versus yarn imperfection where finer yarn showed higher thin, thick and neps comparing to coarser yarn and a sequence of thin, thick and neps were resulted for three types of cotton and polyester blended yarn which can be distinguished as thin, thick and neps of 40Ne < thin, thick and neps of 50Ne < thin, thick and neps of 60Ne and such way imperfection index of yarn also showed higher for fine yarn comparing to coarser yarn which can be noted as imperfections of 60 Ne > imperfections of 50 Ne> imperfections of 40 Ne. So it can be decided that imperfection level of finer yarn is more significance in uster capacitance comparing to coarser yarn.

Keywords: 35% Cotton and 65% Polyester Blended Yarn, 40Ne, 50Ne and 60Ne Ring Spun yarn, Imperfection, Thick, Thin and Neps.

YARN IMPERFECTION VERSUS FABRIC QUALITY

If we contemplate the future, we have got think about yarn. Tomorrow's textiles demand excellent quality of yarn and at long last everyone seems to be recognizing the trend. While it is often difficult to get someone to tell you what "excellent" yarn is, the parameters are becoming more visible. Weavers are now faced with the evenness requirements knitters have faced, more if they have air jets. All shuttleless looms demand yarn that is superior in strength, evenness and consistency. That holds true for the quality of the package as well. Knitters are now facing increasing quality demands themselves because of tighter stitches and fine gauge machines.

Thick and thin places of yarn can result in irregular loop sizes and distorted loops. Neps can result in missed stitches and consequently holes in the fabric. Yarn irregularity can give rise to stripiness, streakiness or cloudiness according to the wavelength of the variation available. Patterning will result if periodic variation is present in the yarn. In a study it was observed that 31% yarn fault as a percentage of total fault for manufacturing of end product with 65% polyester and 35% cotton fabric.

Research and development on yarn imperfections

Yarn imperfections (neps, thick and thin places) are an impotant yarn parameter which affects yarn and fabric processing and quality parameters. A yarn with more imperfections will exhibit poor appearance grade, lower strength and poor performance in weaving is likely to produce fabric with low quality. The maximum weavable cover factor is always lower when using irregular thickness filling yarn than when using regular thickness yarn with the same average count [1]. The USTER evenness tester is used widely in the technical world for yarn evenness testing. This method uses the change of capacitance is used as its working principle. The yarn is fed through two capacitance plates at a certain speed, with several capacitance plates available to be selected according to the count of the yarn. When the yarn enters in to the capacitor region with a certain speed, the capacitance of the polar plates will increase, and the change of the capacitance is analogous to the actual volume of the yarns in the polar plate. Thick places, thin

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places, neps and the CV% of the yarn will be indicated according to the capacity variation. While the Uster Tester has many advantages of measuring the evenness of the yarn and providing a variety of additional information, the capacitance of the plates may be affected by atmospheric conditions and by variations in the blend, thus resulting in erroneous readings [2].

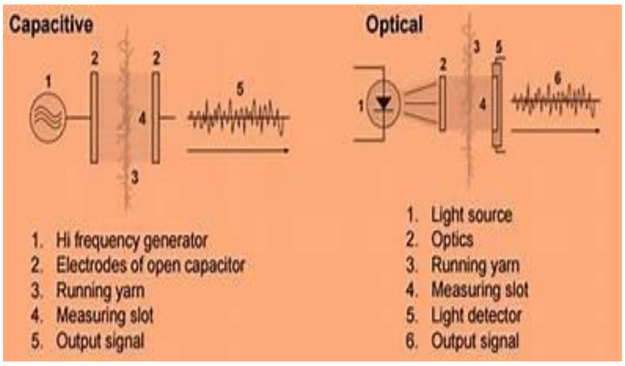

Fig-1: Difference between capacitance and optical method of yarn imperfection testing [8]

Yarn neppiness, one of the most important aspects of cotton yarn quality, has signifcant influences on the downstream processes; therefore it should be well controlled. In this study, in order to examine the changes in nep count during the production of yarn, cotton materials from different origins have been investigated at some parts of the production line of carded yarn. Moreover, to predict of the yarn NEP count from fbre properties measured by HVI and AFIS instruments, the regression equations were obtained by means of multiple regression analysis. In order to see the validity of each equation, the correlations between the measured and estimated yarn NEP counts were obtained. Places in yarns. This can lead to a loss ofspinning effciency, weaving and knitting machine stoppage and fabric defects. While manufacturing knitted fabric, when transferring yarns from bobbins to knitting needles, neps in yarns can block the holes of yarn guides and needle hooks, resulting in yarns breaking. Therefore, the knitted fabricproduced will have a hole, which minimises the value of the product. Neps on the surface of a fabric can cause undyed or unprinted spots during dyeingor printing. The most disturbing effect of these white spots is that they cannot be recognised until dyeing or printing. This problem becomes very troublesome, especially when dealing with dark colours. Neps sometimes contain immature fibres, which are usually weaker than normalfbres. This weakness can lead to fibre fragments breaking off, which creates excessive fibre dust fly and lint deposits [4].

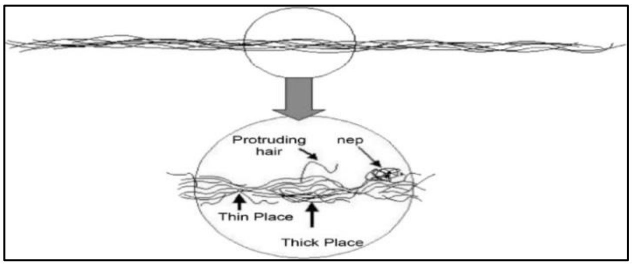

Fig-2: Schematic appearance of thick, Thin, neps and protruding hair in yarn [3]

Failure of spun yarn is also influenced by raw material characteristics, twist & its variation in yarn apart from the presence of yarn fault (thick or thin faults). The fiber cross-section irregularities form only a small fraction of the yarn unevenness and are due mainly to the difference in the number of fiber per yarn cross-section [9]. Such variation in the number of fibers in cross-section may lead the variation in twist distribution along the length of yarn. A thin place containing less number of fibers forms a potential weak point affecting the strength of the yarn, economy of production and also the aesthetics of the final product. So it is necessary to keep the number of thin places at minimum level for cost reduction and improved post spinning efficiency. In the present study, an attempt has been made to investigate the variation of the strength of a yarn at thin places despite having higher inter-fiber cohesion due to twist concentration and how far the mass reduction is compensated by twist accumulation in thin places. Such study may help in exploring the possibility of widening the acceptable limits of thin places in a yarn. The twist in the yarn at the thin places was measured using the formula

$$\text{TPM} = \frac{\tan\alpha}{\pi d} \times 1000$$

Where , TPM = Twist Per Meter, d = Diameter of yarn, and α is the twist angle [5]

Neps and trashes contained in cotton, which were not removed during processing in the process of sliver preparation get into the yarn and can be a source of yarn neps. But not all of them are the reason of yarn faults. Neps and trash particles of appropriate small sizes are not visible on the yarn surface and in the same way they are not registered by the measurement device as yarn neps. Only these neps and trashes contained in the fiber stream are registered as yarn neps, whose size is bigger than the given critical value. While manufacturing knitted fabric, when transferring yarns from bobbins to knitting needles, neps in yarns can block the holes of yarn guides and needle hooks, resulting in yarn breaking. Neps can create white spot during dyeing and it cannot be removable by any post treatment process [6].

Materials Used

Machine used during production of blended spun yarn

- Carding machine: Trutzschler-03
- Drawframe machine: TOYOTO (DX- 10)
- Simplex machine: TOYOTO (FL- 100)
- Ring frame achine: TOYOTO (RX- 10)

Table-1: RH% and temperature observed during production

Department	RH%	Temperature (°C)
Blow room	50 (Cotton) 55(Polyester)	35 (Cotton) 29 (Polyester)
Carding	55 (Cotton), 58(Polyester)	43 (Cotton) 37 (Polyester)
Drawframe	56	35
Simplex	57	36
Ringframe	50	35
Winding	62	33

Theoretical concept for imperfections of yarn

Thin places, thick places and neps are known as imperfections. All these are not permanently present in the yarn, but they appear all of a sudden may not present for a certain length of yarn. It is the question of how frequent they appear. An individual thin place or individual nep is not a disturbing fault, but if there are too many neps or too many thin places it can disturb the appearance of any fabric.

A thin place of -50% mean the cross-section of the yarn at the thin place is only 50% of its mean cross section or less. A thick place of +50% means the cross-section of the yarn at the thick place is 150% (Cross-section is 100% + 50%) of its mean cross section or more. +200% Neps indicates the cross-section at the neps is 240% of the mean cross-section of the yarn or more. For ring spun yarn imperfections in the yarn refer to the total number of thin places (-50%), thick places (+50%) and neps (+200%) present per 1000 metre of yarn the less imperfections in the yarn, the better the appearance of the fabric.

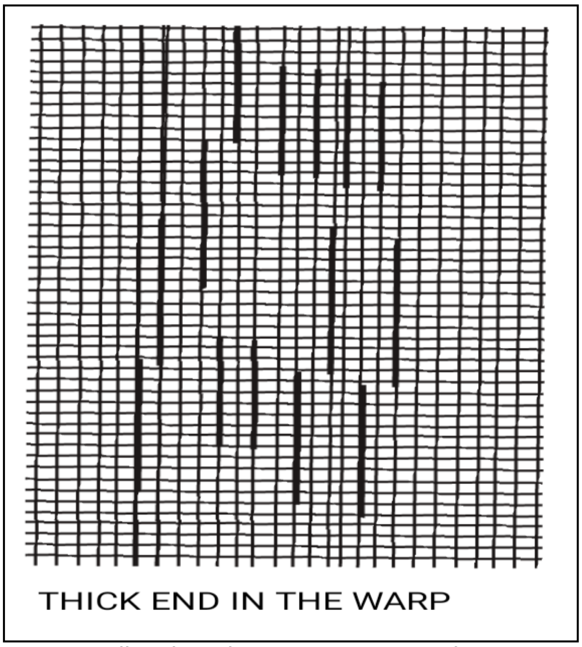

Fig-3: Effect of warp fabric due to thick places of yarn [7].

Uster Testing Method: Capacitive method
The capacitance of a parallel plate capacitor is determined using the following equation:

$$C = \frac{\varepsilon_\circ \varepsilon_r S}{d}$$

Where, C is the capacity
$\varepsilon_\circ = 8.854\times 10^{-12}$
ε_r = Dielectric relative constant (1 for vacuum)
S = Plates area (m^2)
d = Distance between plate.

Equation shown that if the dielectric constant is changed, the capacity also change when the yarn is inserted between the plates

Testing Standard: ISO 2649, DIN 53 817

Testing Machine:

Machine Name	USTER® TESTER 5
Company Name	USTER TECHNOLOGY AG
Origin	Switzerland
Model	S-400

Method of Experimentation

Standard production parameters from blow room lap to finished yarn production were maintained during the whole spinning process of 40Ne, 50Ne and 60Ne ring spun yarn of 35% cotton and 65% polyester blended yarn produced from same quality cotton and polyester fibre and sliver blending process was continued in drawframe stage of spinning. 40Ne, 50Ne and 60Ne ring spun yarn of 35% cotton and 65% polyester blended yarn were tested with Uster Machine to find the variation of three types of yarn considering the major parameters of yarn qualities like Thin, Thick, Neps and Imperfection Index (IPI) of spun yarn. Ex-periments were performed at temperature 20˚C ± 2˚C. To investigate the changes in neps, thick and thin content of the fibre stream during yarn manufacturing, an experimental study was carried out in a Bangladeshi spinning mill on a carded yarn production line.

Process of sample testing in uster tester

As per uster standard, ten samples were tested for each parameter like Thin, Thick, Neps and Imperfection Index (IPI) of spun yarn of 40Ne, 50Ne and 60Ne ring spun yarn. First, second, third and fourth samples were tested from top portion of yarn cone. Fifth, sixth and seventh samples were collected from middle portion of yarn cone. Eighth, ninth and tenth samples were collected from inner portion of yarn cone.

RESULTS AND DISCUSSIONS

A sequence of thin, thick and neps were resulted for three types of cotton and polyester blended yarn which can be distinguished as thin, thick and neps of 40Ne < thin, thick and neps of 50Ne < thin, thick and neps of 60Ne and such way imperfection index of yarn also showed higher for fine yarn comparing to coarser yarn which can be noted as imperfections of 60 Ne > imperfections of 50 Ne> imperfections of 40 Ne. In this experiment, it can be detected that the imperfection level of finer yarn is more significance in uster capacitance comparing to coarser yarn.

Table-2, 3&4 and Figure-4 & 5

As per uster experiment thin places of 40Ne, 50Ne, 60Ne was fluctuated more than other parameters of yarn imperfections. The crosssectional area of thin places have less number of fibre where more twisting occurred during twist formation and should result in higher cohesion between the fibers comparing to places where higher number of fibre remains. Due to having blending of cotton and polyester fibre, the fibre properties of both fibres are not same and the mixing of fibre in all places of cross sectional area in yarn are not same, as a result sensor of capacitance may be varied. Thus the uneven blending of cotton and polyester fibre in sliver formation in sliver blending stage may influence the thick and thin places of 40Ne, 50Ne, 60Ne which may be the technical limitation of blending yarn production in spinning.

Table-2, 3&4: Figure-6

In blending of 35% cotton and 65% polyester fibre, due to having higher percentage of synthetic fibre, neps production was less but remaining very small fibre on the yarn surface may be showed in capacitance for finer count yarn 60Ne comparing to coarser count yarn 40 Ne. As per the experimental study of 35% cotton and 65% polyester blended yarn the capacitance of uster tester will count less neps in the coarse yarn and more neps in fine yarns.

Table-2: Thin, Thick, Neps and Imperfection Index (IPI) for 40 Ne cotton and polyester blended yarn

Sample No	Thin (- 50%)	Thick (+50%)	Neps (+200%)	Imperfection Index(IPI)
1.	5.8	158.3	92.7	256.8
2.	2.8	140.4	81.2	222.4
3.	2.5	140.2	80.5	223.2
4.	3.1	150.3	85.4	238.8
5.	3.7	145.4	82.7	231.8
6.	4.3	145.6	86.4	236.3
7.	2.7	142.4	87.7	232.8
8.	2.8	150.5	89.4	241.7
9.	2.0	149.6	91.8	243.4
10.	5.8	143.2	92.5	241.5

Table-3: Thin, Thick, Neps and Imperfection Index (IPI) for 50 Ne cotton and polyester blended yarn

Sample No	Thin (-50%)	Thick (+50%)	Neps (+200%)	Imperfection Index (IPI)
1.	7.8	166.3	97.6	271.7
2.	3.8	150.4	91.2	245.4
3.	3.5	147.2	80.5	231.2
4.	4.1	160.3	90.6	255
5.	3.7	146.4	86.7	236.8
6.	4.3	155.6	88.4	248.3
7.	5.7	162.4	97.7	265.8
8.	2.8	160.5	93.4	256.7
9.	3.0	152.6	95.8	251.4
10.	3.0	152.3	93.4	248.7

Table-4: Thin, Thick, Neps and Imperfection Index (IPI) for 60 Ne cotton and polyester blended yarn

Sample No	Thin 50%)	Thick (+50%)	Neps (+200%)	Imperfection Index (IPI)
1.	9.8	170.3	97.9	287.8
2.	6.8	160.4	97.2	264.4
3.	6.5	152.2	88.5	247.2
4.	7.1	163.3	95.4	265.8
5.	8.7	156.4	97.7	265.8
6.	7.3	155.6	90.4	253.3
7.	8.7	153.4	99.7	259.8
8.	7.8	159.5	93.4	260.7
9.	9.0	160.6	98.8	268.4
10.	8.6	160.6	97.5	266.7

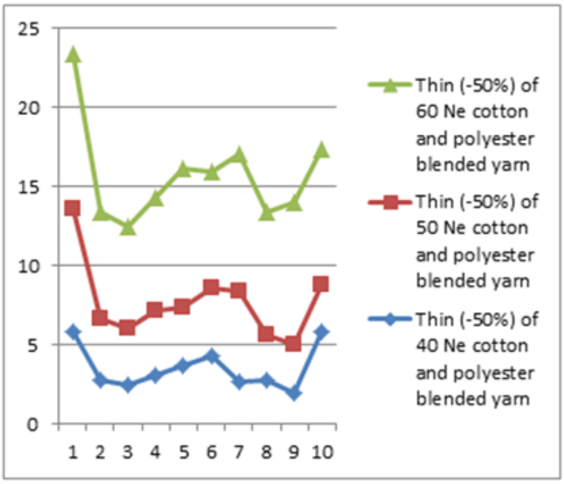

Fig-4: Variation of Thin (-50%) for 40 Ne, 50 Ne, 60Ne cotton and polyester blended yarn

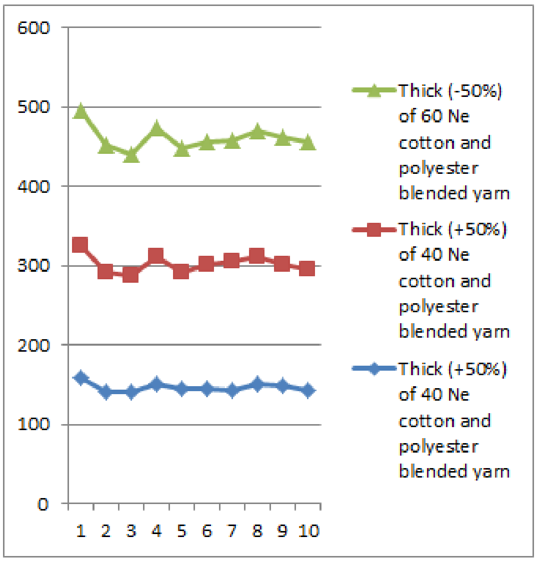

Fig-5: Variation of Thick (+50%) for 40 Ne, 50 Ne, 60Ne cotton and polyester blended yarn

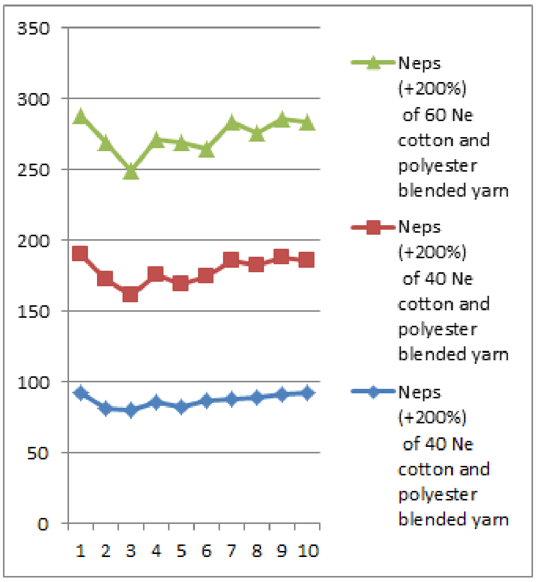

Fig-6: Variation of neps (+200%) for 40 Ne, 50 Ne, 60Ne cotton and polyester blended yarn

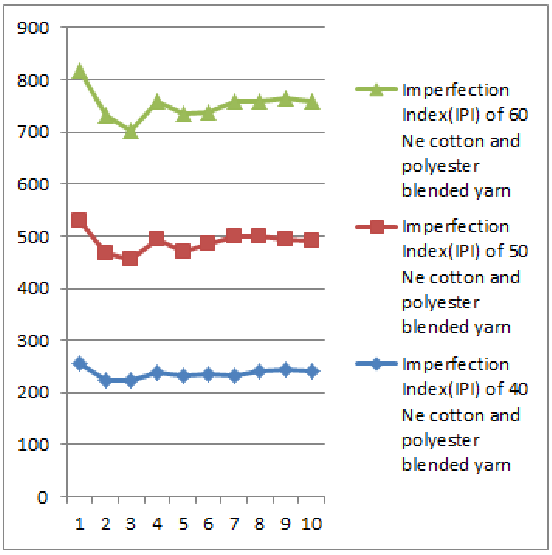

Fig-6: Variation of imperfections for 40 Ne, 50 Ne, 60Ne cotton and polyester blended yarn.

Table-2,3&4: Figure-6: In case of polyester cotton blended yarn the differential response of the two components to twist may help in getting more compacted structure. Polyester component due to its flexibility may be able to help cotton component to get integrated in the structure in a better manner leading to a more compacted structure. Polyester having better migratory behavior might also have helped packing of the cotton component. Circular cross-section and better migration behaviour of polyester may have helped the fibre packing in the combination of 35% cotton and 65% polyester blended yarn resulting better compactness of fibers in yarn formation was observed the less variation of yarn imperfection level for 40 Ne, 50Ne and 60Ne. A combination of 35% cotton and 65% polyester blended yarn for the production of 40 Ne, 50Ne and 60Ne, the twist and its flow in the fiber assembly are to be influenced by the number of fibers in the cross-section. Any variation in the number of fibers in the cross section influences the twist flow through the yarn which may fluctuate the yarn imperfection level of 40 Ne, 50Ne and 60Ne when it was tested with capacitance method of uster tester. An electric capacitance is used for yarn testing and for cotton and polyester blended yarn, the dielectric constant of fibre is different and portion to portion in yarn the cotton and polyester fibre presency also different which may change the result.

CONCLUSION

Blending of 35% cotton and 65% polyester fibre is a unique blending, normally used for the production of shirt and trouser for making a comfortable based product with lower cost. So quality can be enhanced by applying proper quality of fibre blending considering the fibre diameter and length, controlling the moisture during production, appropriate twist setting, unique production parameters from blow room to finished yarn, supervision and ensuring quality in section to section to ensure same quality of yarn for different count with same quality of fibre and same blending percentage for making a greater customer satisfaction.

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