ANALYSIS OF THE IMPERFECTION INDEX (IPI) VALUE OF CARDED YARN PRODUCED BY USING DIFFERENT DIAMETER SPACERS ON THE RING FRAME SPINNING MACHINE

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ABSTRACT

One of the significant parameters of yarn is the Imperfection Index (IPI). This IPI value can be controlled using different diameter spacers because the spacer diameter makes a massive difference in yarn production. Imperfection Index represents whether the produced yarn has good strength, fineness, and appearance or not. That is why Imperfections have a decisive influence on the utility and market value of yarn. This research is primarily aimed at not only how to curb the Imperfection Index using different spacers of different diameters but also to see how various diameters of the spacer have a relatively good influence on controlling yarn imperfections. In the experiment, Ne 30/1 carded yarn was produced each time using three different spacers. The test specimens have been examined by using a USTER TESTER 5. Then, the properties of the generated yarns were compared to analyze the spacer diameter's effect on the characteristics of the yarn in the ring frame. The best result has been obtained from this experiment using a low diameter spacer, which is a yellow color spacer with a diameter of 2.2 mm. Hence, we concluded that Imperfection Index would be high if we use a high-diameter spacer

Keywords: Imperfection Index, Ring frame, IPI, Uster Tester, Spacer.

INTRODUCTION

The textile industry is mainly associated with the manufacture of yarn and cloth, Where "Yarn is a material of considerable length and a comparatively limited cross-section consisting mainly of fibers or filaments with or without twisting" [1]. In addition, yarn manufacturing is the first stage of textile processing that converts the fibers into yarns. It is one of the subsections of backward linkage of clothing industries. The yarn can be classified based on spinning techniques such as ring, compact, rotor, air-jet, and friction. Nowadays, ring spinning is mostly used because of its simplicity, flexibility, and economics in commercial production. Since industrialization, the ring-spinning method has been commonly used to produce yarn because there are major benefits available in this method. It is a widely applicable method by which yarn of any desired fineness with optimum characteristics, particularly about structure and strength, can be generated [2]. Approximately 90 percent of the world's spinning industry uses ring spinning to allow it the most prominent short-staple fiber process [3].

Furthermore, it is essential to produce yarn without any fault. Indeed, some major parameters are mainly responsible for several yarn faults, such as Imperfection index (IPI), Coefficient of variation of mass (CV %), Hairiness index, Periodic defects, Classimate faults. The imperfection of yarn is known as one of the most major factors as it has a major influence on the yarn properties. Moreover, Imperfections can be defined as the total number of neps, thick and thin places in a given length of yarn. Imperfection, a common fault of yarn, is known for thin, thick places and neps in 1000 meters of yarn. Evenness Tester, namely Uster Tester 5, is required to

calculate the IPI of yarns with the results of different yarn evenness parameters. Thin and thick places refer to imperfections within the measuring sensitivity range (±50% with respect to the mean value of cross-sectional yarn size), while neps are classified as the yarn imperfections which may exceed the 200% limit [4]

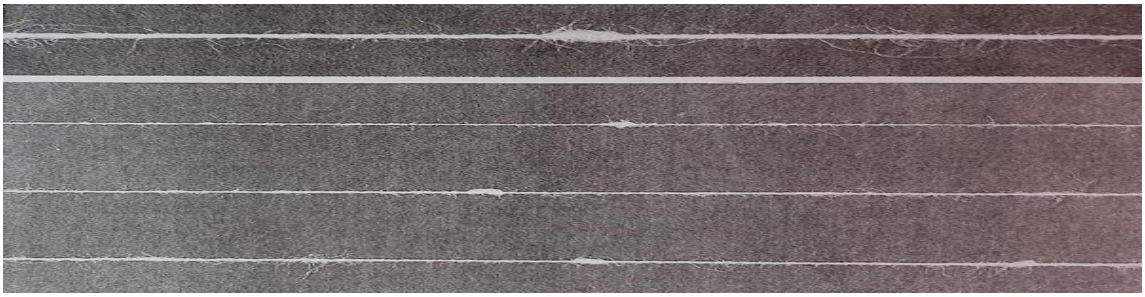

Figure 1: Imperfection Index of yarn [5]

Additionally, there are some reasons for which the yarn imperfection index may increase(Shaikat, 2021):

- With the increase in break draft, the yarn imperfection increases.
- The yarn imperfection also increases due to the increasing roving twist multiplier for the same yarn count.
- Fibre rupture is critical that significantly affects yarn quality and processability. Fiber rupture will have a huge impact on imperfections and irregularity in the yarn.
- The blow room stage's efficient opening improves fiber cleaning and yarn properties such as yarn tenacity and total imperfections.
- The increase in imperfections at higher openness is due to overbeating than that which is necessary.
- The yarn unevenness and imperfections increase with the increase in card production rate.
- The increase in the card's delivery speed will substantially increase the sliver's unevenness and imperfections. Incorrect brake draft increases yarn U%, imperfections, and neps.
- Yarn imperfections and hairiness index increase with the thicker lap.
- Yarn imperfections have an increasing trend with an increase in the feed amount.

Sharieff and Vinzanekar said that 'For ring-spun yarn, imperfections adversely affect yarn and fabric quality. A yarn with far more imperfections may show worse grade quality, poorer weight, and poor knitting efficiency is likely to yield a low-quality fabric. A buyer should have a decent idea about the imperfection index value of their required yarn; otherwise, they will have to suffer a lot in the imminent procedure of textile product production. The fair idea is to avoid so many major problems between different production sections like knitting, dyeing, and even in the spinning section; on the other hand, the knitting section will face several issues, such as yarn's breakage during knitting fabric. The dyeing section mostly meets shade variation on dyed fabric, which eventually becomes the main reason for the significant loss of a particular company. That is why we report here how to control the imperfections index using different spacers of different diameters and tests them by using USTER TESTER 5 and also to see how different diameters spacer has a relatively good influence on controlling yarn imperfections.

METHODS AND MATERIALS

Materials

30 Ne carded yarn was used for the test, and 30/1 carded yarn is produced in the ring frame machine using three different diameter spacers. Our experiment's raw product is produced using 100% cotton, collected

from the African country Mali. The table indicates the general properties and parameters of the fibers of that cotton which was assessed by the Uster- HVI instrument at the standard testing condition.

Table 1: Properties of tested cotton fibers

Quality parameters	*Spinning Consistency Index*	*Mic (µg/inch)*	*Maturity*	*Length (mm)*	*Uniformity Index*	*Short Fibres Index (%)*
Value	126	4.29	0.88	28.46	81.3	8.0
Quality parameters	*Elongation (%)*	*Moisture (%)*	*Reflectance (%)*	*Yellowness (+b)*	*Trash content*	*Strength (gm/Tex)*
Value	3.3	7.0	72.8	10.0	0	30.9

Machine and Parts

Ring Frame

The ring frame of Cetex "Laboratory Spinning Unit LSE 2000" was used in the experiment. The best three performing spindles were used for producing the required 30's card yarn.

Table 2: Parameters of the ring frame

Spindle speed	15000 rpm
Roller setting	45x65 mm
TPM	750
Compact device	EliTeR
Drafting device	3-over-3

Spacer

The spacer is the element that determines the distance between the apron and the bottom apron at which the short fibers are primarily governed [6]. We set up three different diameter's Spacer for three different particular spindles to get three distinct samples for the experiment.

Table 3: Spacer Diameter (mm)

Color	*Yellow*	*Violet*	*White*
Diameter	2.2	2.5	2.8

Figure 2: Spacer of different diameters

Uster Tester-5

Here, Uster Tester-5 was used to determine the yarn's unevenness and imperfection index at a speed of 400 m/min. The experimental parameters were CVm%, thin places (-50%), thick places (+50%), neps (+280%), and hairiness which is assessed by Uster tester 5. Yarn diameter can be calculated by the capacitive method.

Methods

For the test, we took three different carded (KH) yarn samples produced from the ring frame machine, and each type of sample has ten specimens of 1000m length, which we got from the ring machine by using different diameter spacer. One by one, all testing specimens were passed through the Uster tester machine so that we could get our required values for our projected work, such as Thick%, Thin%, Neps% according to yarn diameter.

The whole test is done by The USTER TESTER 5, where the yarn is passed through two capacitive plates, and on the basis of capacitance changes, the diameter of the yarn passing through the plates is analyzed.

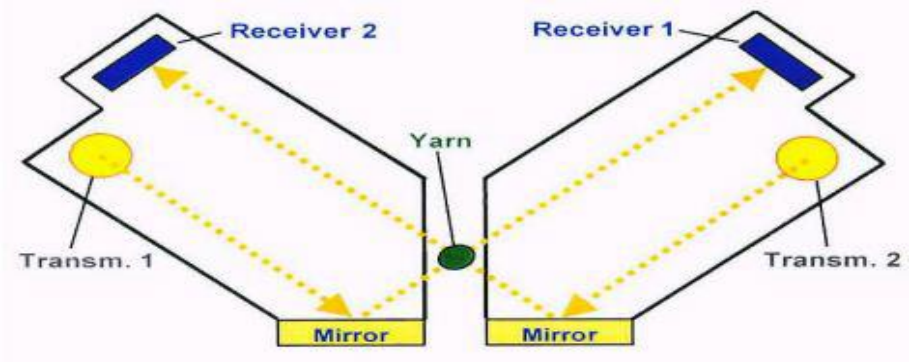

Figure 3: OM sensor of Uster 5 [7]

For each color diameter spacer, separate ten, length of 1000m, specimen was taken for conducting the test.

Suppose the diameter of any specific portion along the length of the yarn shows a value +50% more than the actual diameter of that particular place (selected before by requirement). In that case, those increased places of diameter are counted as the Thick Place of yarn. This is how ten specimens (produced by a specific diameter spacer out of three, for example, white color spacer) of 1000 m long carded ring yarn were passed through the Uster Machine to get an average value of yarn thick places percentage. Again if the diameter of any specific position of the Yarn is less than 50%, we can say -50% thin places, which means the yarn diameter is decreased than the actual diameter is denoted as Thin Places of Yarn. The same as if the percentage of some specific place's diameter of the yarn is more than 200% and another condition is if those places were 3mm long, then such places are considered neps of the yarn. The number of (+280%) neps per 1000 meters of the tested yarns is considered instead of +200% neps for rotor spun yarns, Where +280% neps indicates the cross-section at the nep is 280% of the mean cross-section of the yarn or more. This is how the main calculation conducted by Uster tester 5, which is the primary data to examine the IPI of a yarn lot, and we mainly get our required IPI values by the summation of the average value of testing yarn thick places percentage, thin places, and neps percentages. One thing we should know that the greater the value of the IPI we will found, the lower will be the evenness of that yarn and vice versa. So, we can say that a lower IPI value represents good quality yarn.

RESULTS AND DISCUSSIONS

After testing the required specimen in the Uster tester machine, bellows reports are found.

For Yellow Color Spacer

Table 4: Imperfection properties of yellow color spacer (for 2.2 mm)

Sample No.	*U%*	*Thin -30% /km*	*Thin -40% /km*	*Thin -50% /km*	*Thick +35% /km*	*Thick +50% /km*	*Neps +200% /km*	*Neps +280% /km*	*Rel. Cnt ± %*
1	12.22	3330	347.5	7.5	1323	247.5	175.0	22.5	-5.7
2	12.27	3090	340.0	10.0	1225	217.5	157.5	27.5	-3.5
3	11.66	2740	275.0	10.0	1075	232.5	172.5	35.0	-3.6
4	12.07	2958	250.0	2.5	1210	242.5	182.5	20.0	-2.0
5	11.91	3045	307.5	7.5	1295	282.5	172.5	45.0	-2.7
6	11.45	2273	165.0	5.0	1038	155.0	145.0	30.0	6.6
7	11.85	2480	212.5	10.0	1228	262.5	190.0	35.0	1.6
8	11.75	2670	297.5	12.5	1075	207.5	132.5	12.5	-1.6
9	11.47	2068	165.0	2.5	920	165.0	137.5	10.0	7.9
10	11.80	2586	262.5	5.0	1163	245.0	150.0	27.5	3.0
Mean	11.85	2724	262.3	7.0	1155	225.8	161.5	26.5	0.0

Therefore, for this yellow colour Spacer, the average value of ten test specimen of 1000 m long yarn is (-50%) thin places is 7.0, (+50%) thick places is 225.8, and the neps (+200%) is 161.5, and summation of all three value are representing the IPI value for the test sample of the yellow colour spacer is 394.6 (7.0 + 225.8 + 161.5 = 394.6)

For Violet Color Spacer

From the table 5, for this violet color spacer, the average value of ten test specimen of 1000 m long yarn is (-50%) thin places is 13.5, (+50%) thick places is 277.3, and the neps (+200%) is 163.5, and summation of all three value are representing the IPI value for the test sample of the violet color spacer is 454.3 (13.5 + 277.3 + 163.5 = 454.3)

Table 5: Imperfection properties of violet color spacer (for 2.5 mm)

Sample No.	*U%*	*Thin -30% /km*	*Thin -40% /km*	*Thin -50% /km*	*Thick +35% /km*	*Thick +50% /km*	*Neps +200% /km*	*Neps +280% /km*	*Rel. Cnt ± %*
1	12.35	3163	392.5	15.0	1403	322.5	217.5	12.5	-1.0
2	12.18	3120	285.0	7.5	1408	347.5	190.0	40.0	-0.3
3	12.53	3595	455.0	25.0	1545	352.5	205.0	55.0	-3.3
4	11.97	2845	332.5	5.0	1255	222.5	147.5	37.5	-0.1
5	11.78	2600	230.0	10.0	1125	190.0	117.5	25.0	3.7
6	12.32	3443	415.0	20.0	1530	362.5	217.5	25.0	-3.7

7	12.11	3368	292.5	17.5	1305	227.5	122.5	22.5	-3.0
8	11.64	2428	215.0	7.5	1125	232.5	137.5	30.0	6.1
9	11.84	2733	285.0	17.5	1215	247.5	100.0	20.0	4.2
10	12.16	3075	320.0	10.0	1268	267.5	180.0	35.0	-2.5
Mean	12.09	3037	322.3	13.5	1318	277.3	163.5	30.3	0.0

For White Color Spacer

Table 6: Imperfection properties of white color spacer (for 2.8 mm)

Sample No.	*U%*	*Thin -30% /km*	*Thin -40% /km*	*Thin -50% /km*	*Thick +35% /km*	*Thick +50% /km*	*Neps +200% /km*	*Neps +280% /km*	*Rel. Cnt ± %*
1	12.53	3535	465.0	15.0	1640	345.0	225.0	40.0	-1.1
2	12.52	3523	450.0	22.5	1563	305.0	172.5	12.5	-1.0
3	12.14	3168	327.5	10.0	1445	337.5	212.5	35.0	0.4
4	12.52	3308	382.5	7.5	1390	310.0	225.0	35.0	1.3
5	12.30	3183	387.5	10.0	1403	290.0	170.0	30.0	5.9
6	12.31	3253	372.5	5.0	1380	300.0	197.5	27.5	0.7
7	12.92	4030	600.0	25.0	1695	450.0	257.5	50.0	-2.3
8	12.88	3930	475.0	17.5	1725	387.5	255.0	27.5	-1.4
9	12.51	3715	472.5	15.0	1610	407.5	217.5	60.0	-0.6
10	12.45	3723	462.5	20.0	1515	360.0	185.0	40.0	-1.9
Mean	12.51	3537	439.5	14.8	1537	349.3	211.8	35.8	-0.0

Hence, for this white color spacer, the average value of ten test specimen of 1000 m long yarn is (-50%) thin places is 14.8, (+50%) thick places is 349.3, and the neps (+200%) is 211.8, and summation of all three value are representing the IPI value for the test sample of the white color spacer is 575.9 (14.8 + 349.9 + 211.8 = 575.9).

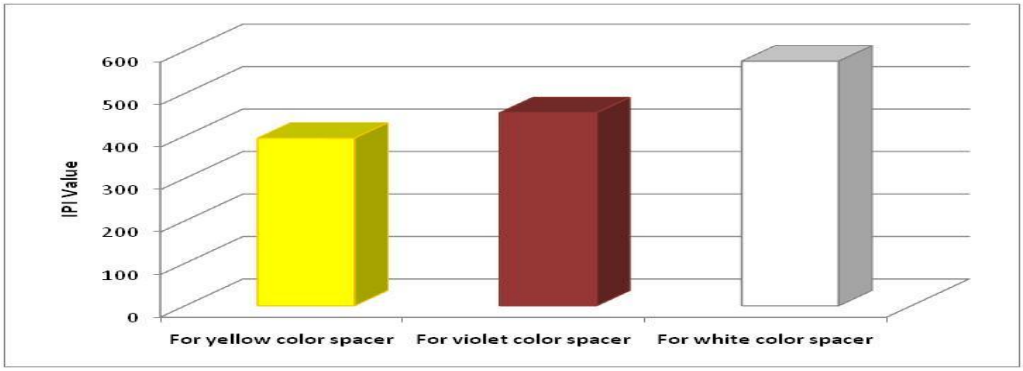

Figure 3: IPI values for different diameter spacers

From the above three Spacer's results, we can understand that the yellow Spacer's sample has a better IPI value than the other two spacers. From the results, another thing is cleared that the lower the diameter is, the best will be the quality, evenness of the Carded Yarn. Less diameter spacer is responsible for less IPI value. On the other hand, the worse sample is white color spacers yarn because its IPI is so high than the rest of the two Spacer's samples.

CONCLUSIONS

We got three particular imperfection index values for each of the spacers in the experiment by using three different size spacers in a ring spinning machine. From those results, we can conclude that the best result has been obtained using a low diameter spacer, a Yellow colour spacer with a diameter of 2.2 mm, which ultimately results in an almost minimum IPI value than the other two spacers. We know the Imperfection index (IPI) values are directly related to the yarn evenness, and the less the number of IPI, the best will be the yarn quality.

In this project work, we endeavor to discover how the IPI value of any particular Yarn, like Carded yarn, can be controlled by using a different spacer, and in the end, we found the result. Furthermore, We can decide that there's a significant correlation between spacer diameter and yarn imperfection index in a ring spinning.

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