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Determination of suitable traveller for definite yarn count: A comparative study

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Abstract

The traveller imparts twist to the yarn and enables winding of the yarn on the cop. Yarn quality parameters can be improved by proper traveller weight selection which results in reducing yarn breakage, mass variation, twist variation and hairiness. High contact pressure (up to 35N/mm) is generated between the ring travellers during winding, mainly due to centrifugal force the pressure includes strong frictional forces which in turn lead to significant generation of heat. This is the kernel of the ring/ traveller problem. The low mass of the traveller does not permit dissipation of the generated heat in the short time available. Uster Evenness Tester 5 was used to determine the yarn properties such as unevenness, percentage, imperfection index, hairiness, standard variation of hairiness. Traveller number 5/0 was the best for card 30 Ne compare between traveller number 4/0 Most preeminence fact is that, the traveller speed remained same both for 5/0 and 4/0.

Keywords: Traveller; Yarn quality; Imperfection Index; Hairiness; Mass variation; Twist Variation; Uster Evenness Tester 5

1. Introduction

If we analyze the overall spinning process, we can see that count of yarn and traveller both has preeminence on spinning process. Yarn count is a number that represents the diameter of fineness [1] of yarn.Traveller is mainly used to impart twisting, winding, thread guide etc. At this experiment, as speed is important factor. When machine run at maximum speed, traveller has higher tendency to wear out. However, as long as end breakage does not occur unevenly there is a strong tendency to keep the speed of spinning up & replace traveller to maximum speed. Light weight travellers are recommended for spinning the fine yarn and heavier weight traveller for coarser yarn spinning.

Objectives

The objectives of this paper are to discuss process control activities related to the use of ring frame machine. Process control is primarily aimed at controlling machine or process parameter such as types of ring traveller, speed of ring traveller, specification of ring traveller, notation of ring traveller.The process control activities related to the use of the ring frame are discussed in detail in the following sections.

2. Background Study

The ring spinning machine was first invented in 1828 by the American Thorp. In 1830, another American scientiest, Jenk, contributed the traveller rotating on the ring [2].There have been many development has done in ring spinning

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machine for the last years but the basic concept remained unchanged. The Traveller are normally three types, they are: OS –Type, C-Type, G-Type

2.1. Various Parts of Ring Traveller

Toe gap: This will vary according to traveller number and flange width of the ring.

Height of bow: It should be as low as possible for stable running oftraveller. It should also have sufficient yarn passage.

Ring contact area: This area should be more, uniform, smooth and continuous for best performance.

Inner width: This varies according to traveller profile and ring flange.

Wire section: It plays an important role for yarn quality, life of traveller.

Yarn passage: According to count spun the traveler profile to be selected with required yarn passage.

2.2. Salient Features of a Ring Traveller

- Generate Less Heat.
- Dissipate Heat Fast.
- Have Sufficient Elasticity For Easy Insertion And To Retain Its Original Shape After Insertion.
- Friction Between Ring And Traveller Should Be Minimal.
- It Should Have Excellent Wear Resistance For Longer Life.
- Hardness Of The Traveller Should Be Less Than The Ring.

2.3. Traveller Speed

The speed by which the traveller moves around the ring = Π DR NT m/min

- Since traveller does not have a drive on its own but is dragged along behind by the spindle. High contact pressure (up to 35 N/ mm2) is generated between the ring and the traveller during winding, mainly due to centrifugal force.
- This pressure leads to generation of heat. Heat produced when by the ring traveller is around 300 degree celcius. This has to be dissipated in milliseconds by traveller into the air.
- Low mass of the traveller does not permit dissipation of the generated heat in the short time available. As a result the operating speed of the traveller is limited.
- The maximum attainable speed of traveller without getting damaged is known as "Limiting Speed of Traveller".
- 70 ft/sec. (22 m/sec) – Conventional Ring- traveller.
- 120 ft/sec. (35 m/sec) – H.S. Ring- traveller.

2.4. Limitations of Ring –Traveller Spinning System

- When the spindle speed is increased, the friction work between ring and traveller increases as the 3rd power of the spindle rpm. Consequently if the spindle speed is too high, the traveller sustains thermal damage and fails. This speed restriction is felt particularly when spinning cotton yarns of relatively high strength. [4]
- If the traveller speed is raised beyond normal levels, the thermal stress limit of the traveller is exceeded; a drastic change in the wear behavior of the ring and traveller ensues. Owing to the strongly increased adhesion forces between ring and traveller, welding takes place between the two. These seizures inflict massive damage not only to the traveller but to the ring as well. The traveller temperature reaches 400^{O}C to 500^{O}C and the danger of the traveller annealing and failing is very great.

All together restricts spindle speed, thereby production of ring frame.

2.5. Traveller Count

- It represents weight of ten equal type of travellers in grains.
- OLD System: 10 travellers weigh 10 grains then traveller count = 1
- ISO System: Weight of traveller in mgm OR Weight of similar 1000 travellers in gm.
- 10 travellers weigh <10 grains then traveller is said to be the "Ought traveller" or"Nought traveller". Denoted by N/0; where N represents traveller count.
- Higher the count heavier the traveller

2.6. Specification of Traveller

- A ring traveler is specified by the followings- a) Traveller no.: 1, 2, 3, 1/0, 2/0, 3/0 etc.
- Cross section of the wire and shape
- Flange no.
- Surface finish- Stainless steel made,
- Carbon finish,
- Nicle finish etc.

2.7. Notation of Traveller

A traveller can be notified as follows-

3/0 MS/hF

5/0 MS/FF

7/0 HI-NI/ hf

Here,

3/0- Traveller number MS- Mild steel

Hf- Half flange FF- Full flange

HI-NI- High Nicle Finish

2.8. Traveller Number or size of Traveller:

Here, if the weight of 10 travellers is 10 grains then the number of those traveller is 1and so on.

Table 1 Recommended traveler no. for various yarn counts

Count (Ne)	Traveller No.
16	2/0
20	1/0-2/0
30	3/0-4/0
40	6/0-8/0
50	10/0-12/0
60	13/0-15/0
80	16/0-19/0
100	19/0-20/0

2.9. Factors Considered for Selection of a Traveller

- **Yarn count:** Higher the yarn count, lower will be the traveler weight.
- **Spindle Speed:** If the spindle speed is high, then the yarn tension will be high.So lighter traveler should be used to minimize tension.
- **Ring dia:** For same spindle speed and count, with the increase of ring diameteryarn tension as well as frictional area increases. So traveler should belighter.
- **Empty bobbin dia:** When empty bobbin dia decreases, winding angledecreases resulting a higher yarn tension. So a light traveler should beused.
- **Lift of bobbin:** If the lift of bobbin increases yarn tension will be higher. Sotraveler weight should be less.
- **Cross section of traveler:** We know, if frictional area increases, lighter traveler should be light.

For flat frictional area increases, traveler weight decreases.

For semicircular, frictional area decreases, traveler weight increases.

For circular, frictional area decreases, traveler weight increases

3. Material and methods

3.1. Materials

Two types of ring traveller i.e 4/0 and 5/0 were used for prodcing **30Ne carded yarn** in "PAHARTALI TEXTILE & HOSIERY MILLS" Pahartali, Chittagong.

3.2. Testing of samples

USTER TESTER – 6 was used to determine the unevenness and imperfection (IPI) of the yarn at a speed upto 800 m/min. The observed parameters were U%, CVm%, thin places (-50%), thick places (+50%), neps (+200%) and hairiness. The imperfection (IPI) is the sum of number of mass increase (thick place), mass reduction (thin place) and short mass increase (neps). Tensile properties viz., yarn tenacity, count strength product (CSP) and elongation (%) were measured at Uster Tensojet-4 at a speed of 200 m/min. Average of ten tests were taken for final result at each trial. Lea strength tester was used to find the lea strength tester. Count strength product (CSP) was calculated by multiplying the yarn count with Lea strength according to the British Standard (1985). Equation 1 was used to measure CSP. [2-12]

CSP = Yarn count × Lea strength

Conditioning time should be at least 48 hours or until their moisture content reaches equilibrium with that of the laboratory atmosphere. All experiments were performed at temperature 27 ± 1°C and relative humidity 65 ±2%. Yarn imperfection is the summation of thin place, thick place and neps per kilometer of yarn.

Yarn imperfection = Thin places + Thick places + Neps


USTER HVI 1000


USTER AFIS PRO 2


USTER 6


STRENGTH TESTER

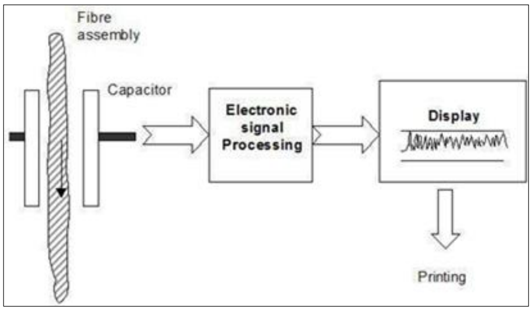


Figure 1 Principle of Uster evenness tester

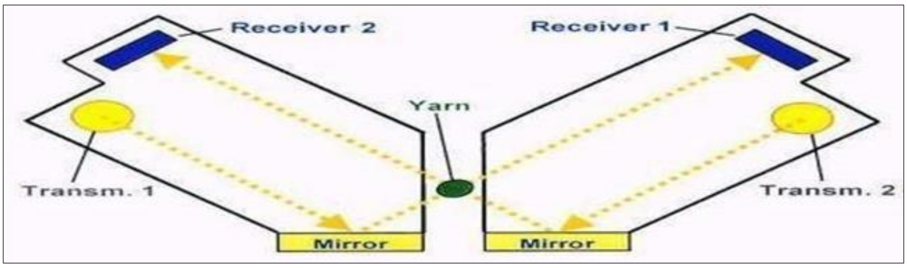


Figure 2 Principle of OM sensor Uster 6

3.3. Ring spinning frame

Spinning is the final step of yearn manufacturing process. The working procedure of ring spinning frame is taking the roving comes from simplex and produced yarn by reducing the weight of unit length. Ring is attached around bobbin. The traveler rolling on ring and enfold the yarn on bobbin. Ring spinning frame plays the vital role to spinning the yarn so it is called Ring spinning frame.

Figure 3 Ring spinning frame

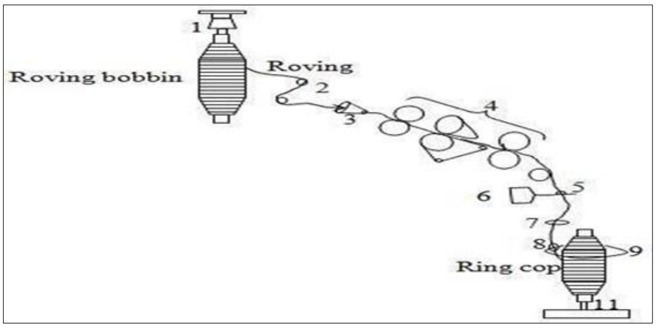


Figure 4 Material passage diagram of ring frame

Table 2 Technical specification of modern ring spinning frame

No	Description of parts	Specification
01	Roller and angle	45˚
02	The distance between center of lappet hook and center of front roller.	66.50 mm
03	Gage	70.00 mm
04	Tube length (gage -70.00 mm)	201, 220, 230 mm
05	Mechanical speed	25,000 mm
06	Count	From 5.5s to 120s
07	Twist/inch	From 4 to 55
08	Draft system	Double apron 3 roller to arm.
09	Number of spindle	From 96 to 1008
10	Main motor	Down 15KM, High 37KM
11	Ring lowering motor	0.35KW
12	Suction motor	0.35KW
13	Pantograph drive	2.20 KW
14	Horizontal transport belt	2×0.12 KW (Geared motor)
15	Inclined transport belt	2×0.185 KW (Geared motor)
16	Tube feeding	2.5 Minutes
17	Doffing time	2.5 minutes
18	Bobbin discharge speed	60 (30+30) Minutes
19	Compressed air consumption	iter/minute

3.4. Main Parts of Ring Frame

- **Roving Bobbin:** Inserted in holders.
- **Roving Guide:** To feed roving correctly.
- **Creel:** To hold the roving bobbin over the roller beam.
- **Guide Rail:** Guide the roving into the drafting.
- **Drafting Arrangement:** For drafting of material.
- **Yarn Guide:** To guide the yarn to give path to the yarn.
- **Spindle:** Hold the yarn loosely or tightly.
- **Traveller:** Help in the insertion of twist in yarn.
- **Ring:** Guide the circular run of the traveller.
- S**eparator:** Separate the yarn to avoid entanglement of yarn duringballoon formation.

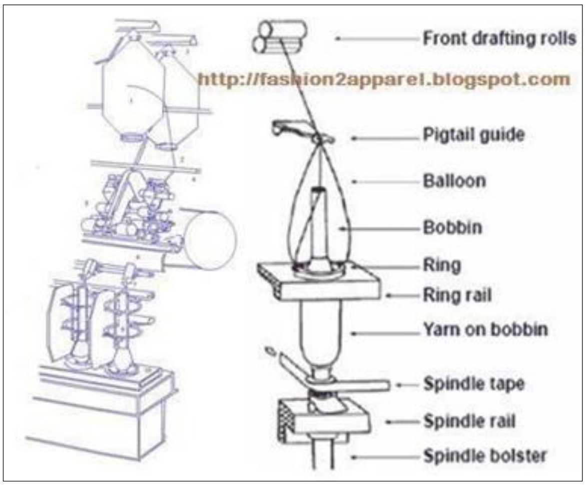


Figure 5 Different parts of ring spinning frame

3.5. Feature of a good ring

- Exact roundness.
- Best quality raw material.
- Good, but not too high, surface smoothness.
- An even surface.
- Good, even surface hardness, higher than that of the traveller.
- Long operating life.
- Correct relationship between ring and bobbin tube diameters.
- Perfectly horizontal position.
- It should be placed exactly centered relative to the spindle

Figure 6 Good ring

3.6. Ring cop

Yarn is wound around ring cop by cop building mechanism. There are approximately 100-200 gm yarn present in every ring cop

3.6.1. Technical data

- Spindle per machine = 480 -1016
- Spindle speed = 12,000 – 20, 000 rpm
- Draft = 15- 45
- Yarn count = 1- 120 Ne
- Production (machine/hr) = 22-30 kg
- Ring cop weight = 180 – 250gm

3.6.2. Cop Shape

- The cop, the typical package shape on the ring spinning machine, consists of three clearly distinguishable buildup sections
- The lower, rounded base (A)
- The middle, cylindrical section (Z) and
- The conical nose (S)

4. Results and discussion

4.1. Yarn quality found in ring frame (using 5/0 traveller)

Table 3 Yarn quality found in ring frame

N0.	U %	CVm	CV m 10m %	DR 1.5m 5%	Thin - 40% /km	Thin - 50% /km	Thick 35% /km	Thick +50% /km	Neps 140% /km	Nep s 200 % /km	C.S.P	IPI	Tota l IP Stand. /km
01.	11.16	14.10	3.32	22.93	195	5	955	140	1448	233	2690	378	378
02.	11.08	14.08	2.43	18.80	88	3	760	103	1213	185	2780	291	290
03.	11.18	14.15	1.83	15.41	125	3	878	123	1370	198	2797	324	323
04.	11.27	14.31	2.86	23.31	85	0	745	95	1208	170	2710	265	265
05.	11.22	14.21	2.33	21.80	93	0	835	165	1300	193	2715	358	358
06 Mean	11.18	14.17	2.55	20.45	117	2	835	125	1308	196	2738	323	323

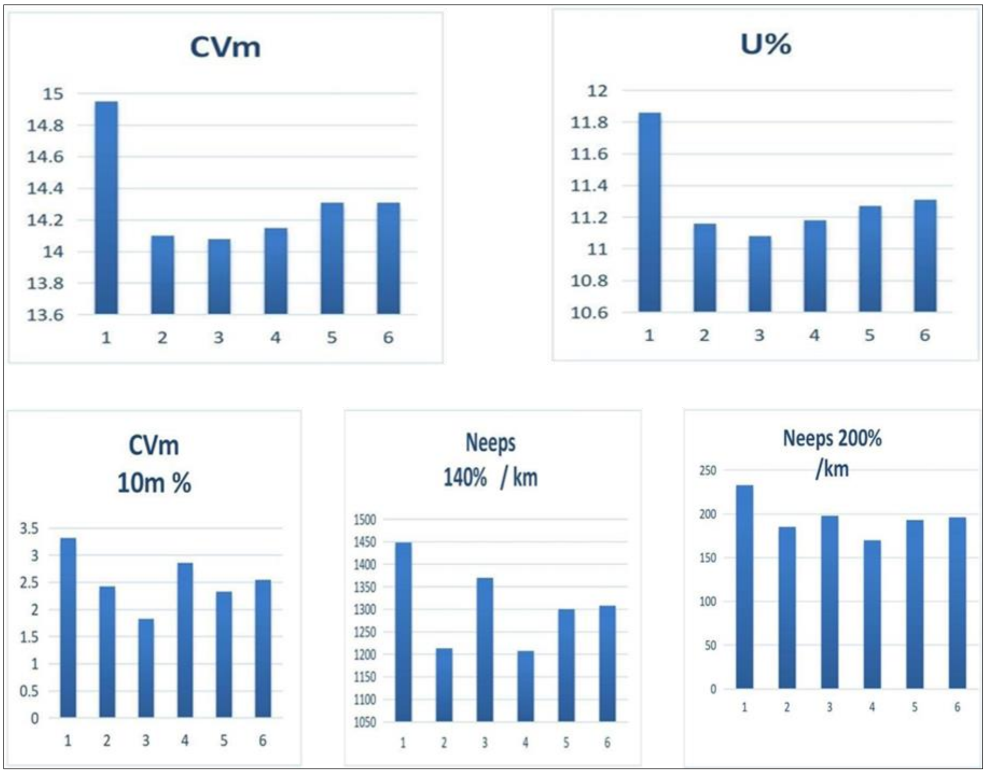


Figure 7 Yarn quality found in ring frame

4.2. Yarn quality found in ring frame (using 4/0 traveller)

Table 4 Yarn quality found in ring frame

N0.	U %	CVm	CVm 10m %	DR 1.5 m 5%	Thin - 40 % /km	Thin - 50 % /km	Th i ck 35 % /km	Thick +50 % /km	Neps 140 % /km	Neps 200 % /km	CSP	IPI	Tota l IP stand . /km
01.	11.42	14.61	1.94	13.91	93	0	890	150	1,448	295	2665	445	445
02.	11.32	14.41	1.72	13.16	120	5	833	135	1,598	320	2770	460	460
03.	11.15	14.25	1.80	12.41	140	8	995	210	1,710	345	2780	563	563
04.	11.29	14.45	2.10	18.42	115	0	930	163	1,665	323	2690	395	485
05.	11.38	14.42	2.12	12.78	110	0	905	133	1,575	298	2705	431	430
06 Mean	11.31	14.42	1.93	14.13	116	3	911	158	1599	316	2725	477	477

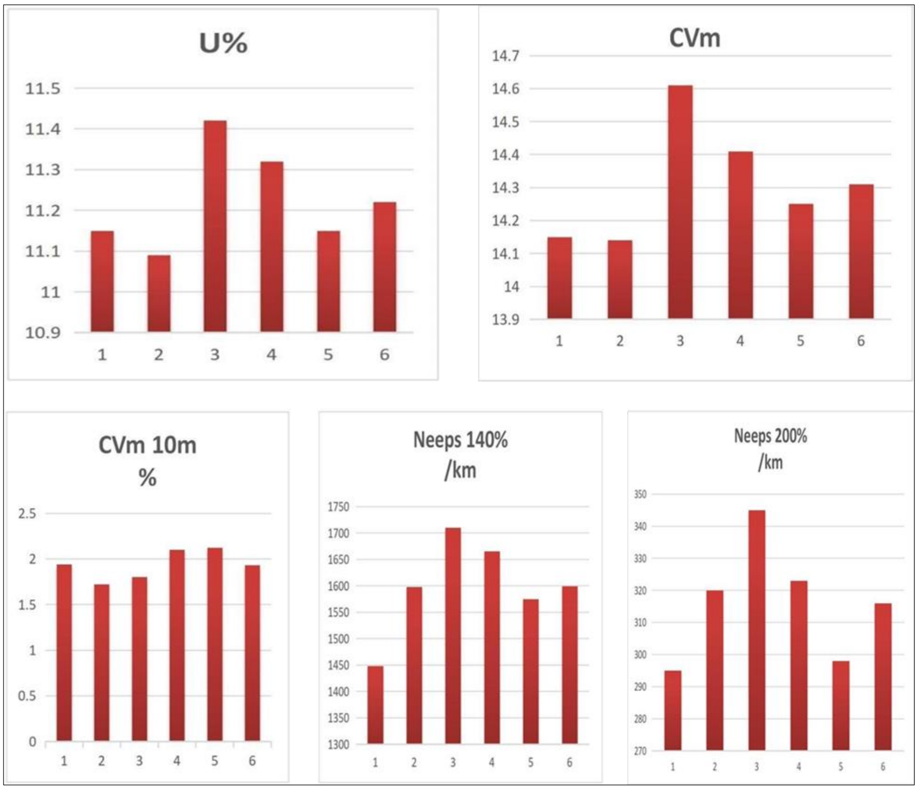


Figure 8 Yarn quality found in ring frame (using 4/0 traveller)

4.3. Analysis

4.3.1. Yarn Unevenness (U %)

Spinning method has significant effect on the yarn evenness. Unevenness is an important statistical tool, for the measurement of evenness properties of carded yarn [13]. The lower the U % value, the more even is the yarn and the more even it will look in the product. Figure-6 shows the unevenness (U %) value of 30Ne carded yarn

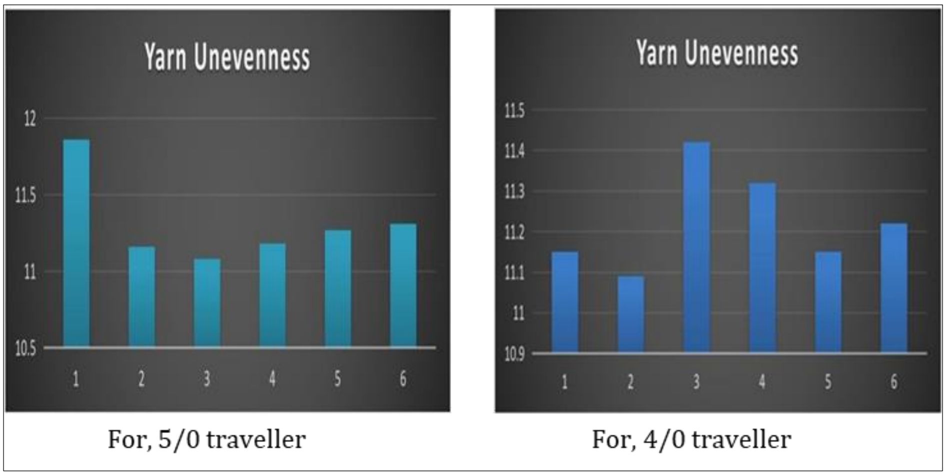


Figure 9 Yarn Unevenness (U %)

Here, if we compare the value of yarn unevenness (U %) between 5/0 & 4/0 traveller, then we can see that U% value of 5/0 traveller comparatively lower than 4/0 traveller. So, according to these value we found that 5/0 traveller is more suitable for 30 Ne carded yarn.

4.3.2. Yarn Irregularity (CVm %)

The measure of variation of yarn linear density or the variation of its mass per unit length is termed as yarn irregularity. Generally, yarn irregularity points out to the variation of yarn count along its length. Yarn irregularity is denoted by CV which means the co-efficient of variation [13]. It was formed that the higher the CV %, the higher the yarn irregularity. Yarn irregularities and unevenness work as a vital parameter of yarn. Irregularities is mainly caused by improper doubling, drafting, using more short length fiber than their particular length, drafting arrangement, roller, pressuring system etc. In this project using above parameter in processing we were able to get lower level of U % and CVm % value that greatly affect in achieving higher lea strength and C.S.P value of this 30Ne carded yarn. **Figure-5** shows the CVm% value of 30Ne carded yarn.

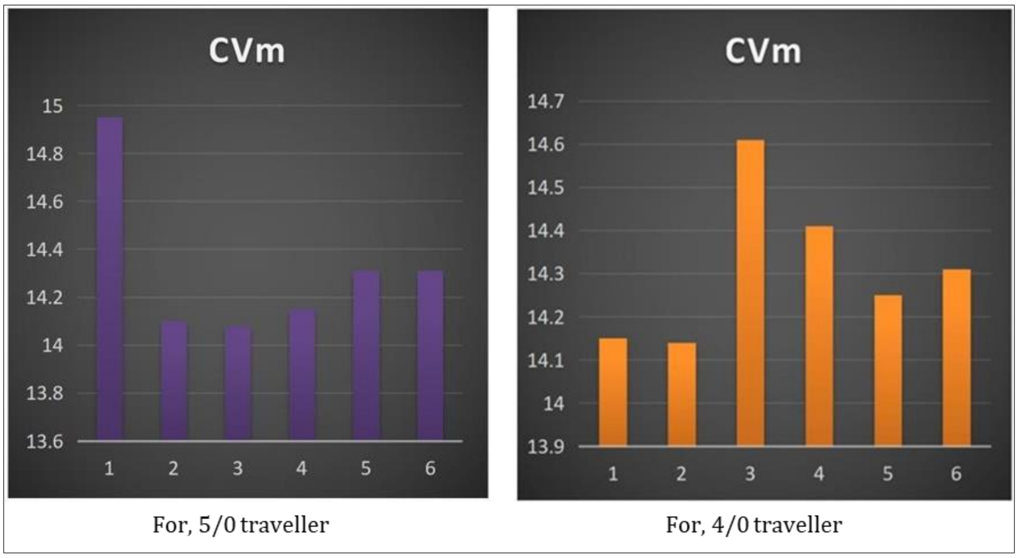
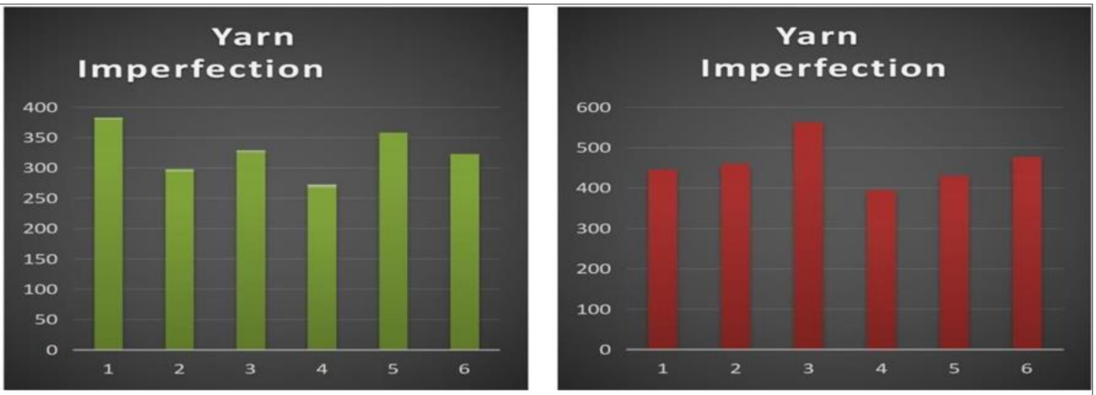


Figure 10 Yarn Irregularity (CVm %)

Here, if we compare the value of yarn irregularity (CVm%) between 5/0 & 4/0 traveller,then we can see that CVm% value of 5/0 traveller comparatively lower than 4/0 traveller. So, according to these value we found that 5/0 traveller is more suitable for 30 Ne carded yarn.

4.3.3. Yarn Imperfection (IPI)

Yarn imperfection is the summation of thin places (-50%) per kilometer, thick places (+50%) per kilometer, neps (+200%) per kilometer [14]. It is a good indicator of yarn quality that shows how this yarn will perform in the subsequent process such as weaving, knitting, dyeing and printing. Yarn imperfection is mainly caused by improper doubling and drafting, improper [15] drafting arrangement in draw frame, simplex and ring frame, improper pressuring system, faulty T.M and TPI selection, incorrect spacer selection etc. Yarn imperfection is the main fault of yarn that directly affect in yarn strength, lusture properties. In this project we get very lower range of imperfection value which provide greater strength of final yarn and reduce end breakage rate in winding by controlling the process using above parameter. Figure-8 shows the imperfection value of this 30Ne carded yarn.



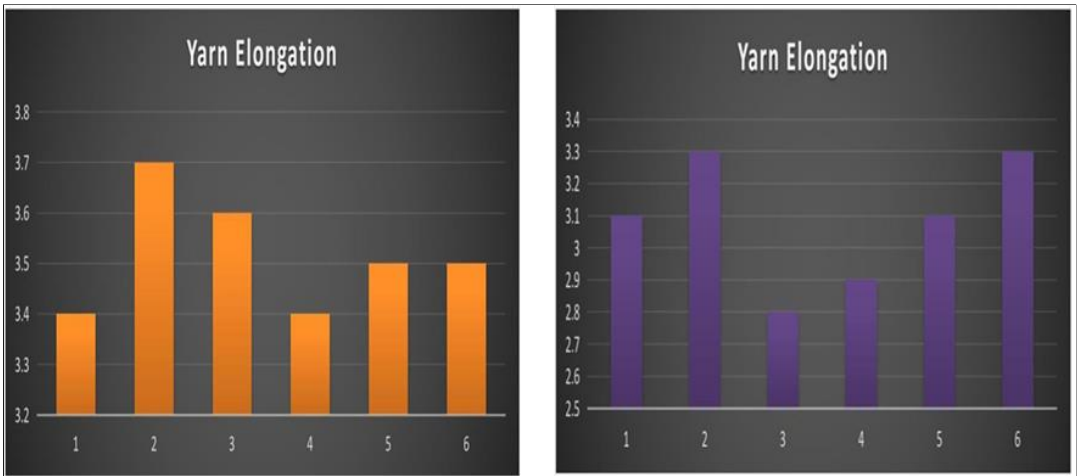
For, 5/0 traveller

For, 4/0 traveller

Figure 11 yarn Imperfection (IPI)

4.3.4. Yarn Elongation

Elongation is specified as percentage of the starting length. The elastic elongation is of decisive importance since textile product without elasticity would hardly be useable. They must be able to deform and also return to shape. Higher the value of elongation higher the ability of yarn [14] to return to its previous shape. In this project we used such kind of parameter of different machines involve in manufacturing this 30Ne combed yarn that able us to get suitable value of Elongation (E %). **Figure-9** shows the elongation (E %) of this 30Ne carded yarn.



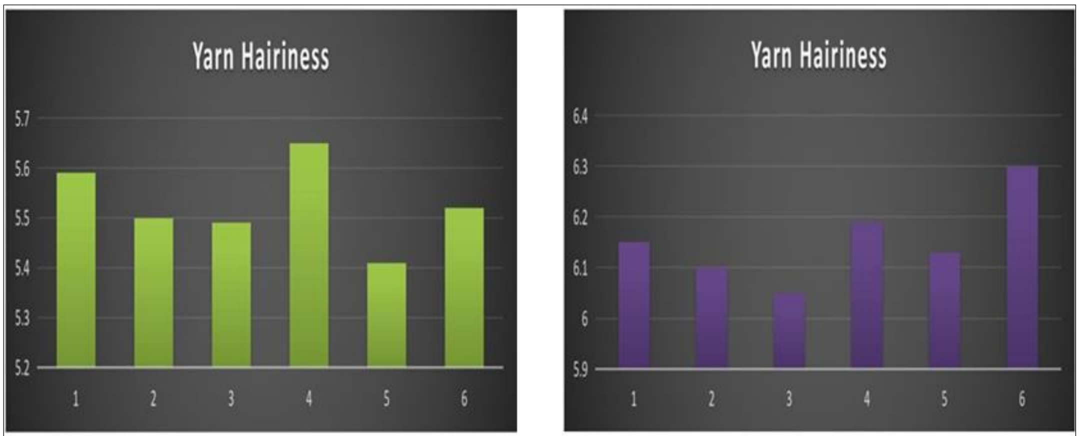
For, 5/0 traveller

For, 4/0 traveller

Figure 12 Yarn Elongation

4.3.5. Yarn Hairiness

Hairiness means the summation of the length of all projecting fibers in yarn body. One of the important factors for the comfortability of end product, especially apparels is hairiness [16]. Hairiness is mainly caused by using fibers which length is below than particular length or breaking the long fiber in processing (fiber growth). During this project we used comber machine which main object is removing noil (short length fiber) and by removing 18 %(approx.) We achieve appropriate hairiness index for this project yarn. Figure-10 shows the hairiness index value of this 30Ne carded yarn.



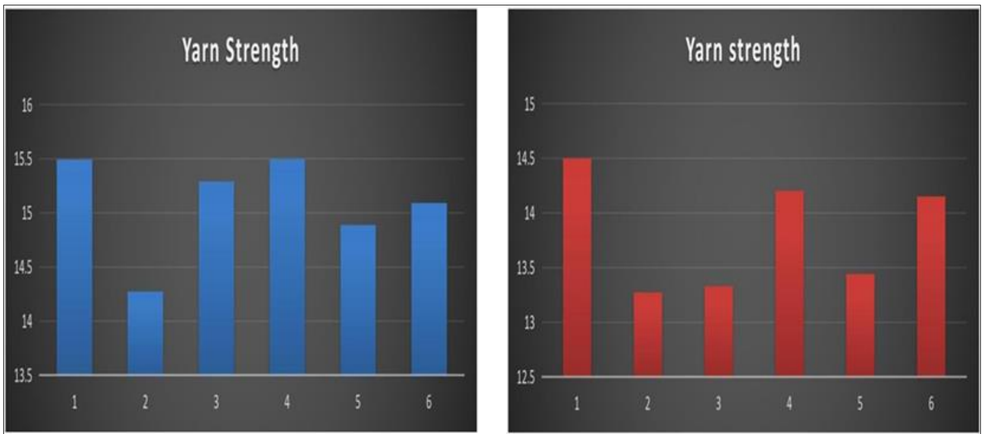
For, 5/0 traveller

For, 4/0 traveller

Figure 13 Yarn Hairiness

4.3.6. Yarn Strength

Tensile testing of yarns is used to determine the breaking force elongation and toughness, of the yarn. Breaking tenacity, a ratio of the breaking force to yarn. Controlling process by using above parameter we were able to keep imperfection, unevenness, irregularities, hairiness value in range that affect the tensile strength of the yarn. **Figure-11** shows the tensile strength (Tenacity CN/tex) value of 30Ne carded yarn.



For , 5/0 traveller

For, 4/0 traveller

Figure 14 Yarn Strength

4.3.7. C. S. P (Count Strength Product)

C.S.P (Count Strength Product) is a number which is derived by multiplication of the yarn lea strength in lbs. and yarn count (cotton count system). The higher the value of C.S.P the better the yarn is. C.S.P is the main parameter that indicates the probable performance of the yarn. The main purpose of all works presenting in this project including raw materials selection, machine arrangement, settings, speed etc for controlling the project is to attain maximum level of C.S.P of this combed yarn. In this project we achieved desired level of C.S.P by ensuring homogeneous mixing and blending, removing neps, noil, dust, foreign particles, selecting proper parameters (draft, speed, pressure, drafting arrangement etc). Figure-12 shows the value of this 30Ne carded yarn.

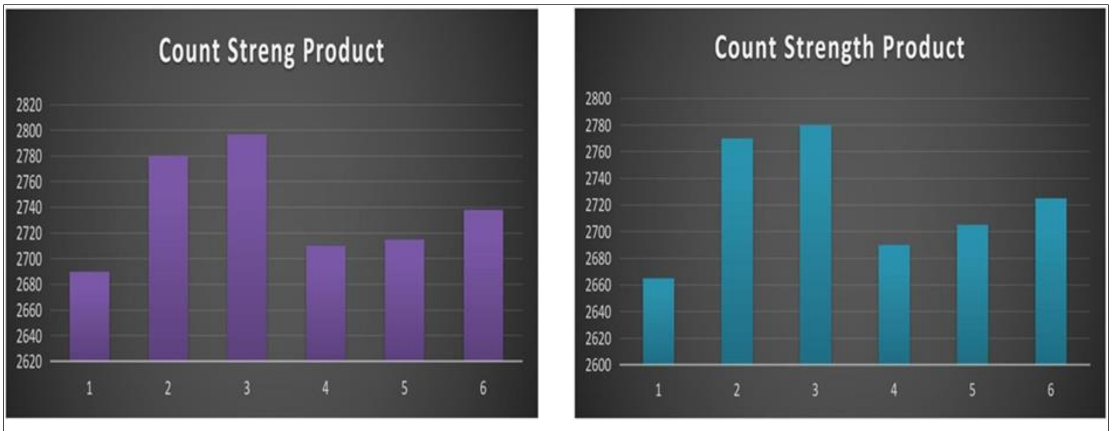


Figure 15 C.S.P (Count Strength Product)

5. Conclusion

It has been observed that the traveller 5/0 gave optimum hairiness, evenness, strength and elongation values for 30Ne card yarn compare with 4/0 traveller. For traveller 5/0 as well as 4/0 speed remain same.Then, we consider the overall yarn properties a comparative study can be done by using the different traveller number of specific against the same count yarn. If we want to use 4/0 traveller fo 30 Ne card we need to research on traveller mechanism, speed and wire profile.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

None.

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