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Effect of Winding Speed on Yarn Properties

MD Zahidul Islam
Department of Yarn Engineering, Bangladesh University Of Textiles

ABSTRACT
Due to ever increasing emphasis on better quality of fabric for the highly competitive market and process performance, yarn has to meet the standards in respect of yarn faults, hairiness, CV% etc., besides traditional quality standards. The winding speed has a significant impact on the quality of yarn as well as productivity of the winding process. Higher winding speed put more stress and strain on the yarn and also increase degree of abrasion with different machine parts. The winding speed has a predominant effect on yarn properties such as imperfection, hairiness, CV% etc. In this work, two yarns of 22 Ne carded hosiery and 22 Ne combed hosiery were wounded in the Autoconer winding Machine at the speed of 1400 m/min, 1500 m/min and 1600 m/min respectively. The yarn was then tested by Uster tester-5. It was revealed that, among three winding speed, yarn imperfection and CV% was the highest at the winding speed of 1600m/min. It was also revealed that highest hairiness value occurred at the highest winding speed.
Keywords-Autoconer, Hairiness, Imperfection, Spinning, Unevenness

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I. INTRODUCTION

According to Textile Institute "A product of substantial length and small cross-section consisting of fibers and/or filaments with or without twist is called yarn." "A staple spun yarn is a linear assembly of fibers where the individual fibers are small in cross-section and short in length(usually thousand times longer than diameter);held together usually by the insertion of twist, to form a continuous strand. It is used for interlacing or inter-looping in processes such as weaving knitting and sewing". Spinning is an ancient textile art in which plant, animal or synthetic fibers are drawn out and twisted together to form yarn. For thousands of years, fiber was spun by hand using simple tools, the spindle and distaff. Only in the High Middle Ages did the spinning wheel increase the output of individual spinners, and mass-production only arose in the 18th century with the beginnings of the Industrial Revolution Revolution.[1]

Yarn winding is the final stage of the yarn- forming process and the starting point for various subsequent process, from weaving or knitting to textile finishing. Yarn manufactured and package from ring spinning are not in the optimum condition to be used to form fabrics. Package size, build and other factors make it necessary for the yarn to be further processed to be prepare it to be handled efficiently during fabric formation. Yarn winding can be viewed as a packaging process forming a link between last few elements of yarn manufacturing and the first few element of fabric manufacturing process. This interface of winding is what makes the winding process so important. The ring spinning operation produces a ring bobbin containing just few grams of yarn, which is unsuitable for the efficiency of further processing such as warping, weaving, and knitting. The winding process converts the ring bobbin of several grams into dense yarn package of several kilograms, which can unwind the subsequent operation without interruptions. [2]

The increase of winding speed from 1000 to 1400m/min increases the imperfection by 40-60% in combed counts and 65-85% in carded counts. The yarn hairiness increase with the increase in winding speed from 20% to 35% in combed counts and 30-45% in carded counts. The loss in efficiency due to yarn breakage is higher at winding speed of 1500m/min compared to 1000m/min. [3]

During clearing and winding the yarn it has been practically experienced by industry that there is deterioration of certain yarn characteristics like strength, elongation, hairiness etc. Irregularity can adversely affect many of the properties of textile materials. There is deterioration in terms of U% and IPI values and hairiness from ring frame bobbin to cone due to abrasion of yarn with various contact points in yarn path. [2]

A yarn with higher unevenness directly affects the cost of production, the likelihood rejection of a product, and the profit. The selection of process parameter in winding such as winding speed, auto speed, tension, etc., should be done in such a manner that the final yarn would attain the satisfactory quality. [2]

Fiber migrate even during the winding process, increasing yarn hairiness afterwards and a higher winding tension and/or higher yarn velocity leads to more fiber migration and hence more severe yarn hairiness. [4]

The purpose of the work was to investigate the deterioration of the yarn properties after winding in terms of CV%, U%, imperfectionand hairiness.

II. LITERATURE REVIEW

2.1 Brief History of Spinning

Seven thousand years ago spinning was already well established as a domestic craft. At that time and until the early Middle Ages spinning was an incredibly slow and tedious task. Throughout this period the spinning of one ounces of cotton into a yarn suitable for the weaving of what we would now regard as a fairly heavy apparel fabric would keep as spinner busy for several weeks. A revolutionary change had come in spinning when ring spinning machine was invented by an American named Thorp in 1828, and Jenk another American – added the traveler rotating around the ring in 1830. In the intervening period of more than 170 years the ring spinning machine has undergone considerable modification in detail, but the basic concept has remained the same. [5]For many years any noteworthy further development hardly seemed possible, yet a significant process of evolution took place during this time. The productivity of the ring spinning machine increased by 40% since the late nineteen-seventies. This has been achieved by using smaller ring and cop formats introducing piecing in the winding department substantial improvements in rings and traveler. Commercial rotor spinning began in 1967 in Czechoslovakia. Rotor spinning has been characterized from the outset by incomparably higher production potential than ring spinning. This potential has been steadily increased by the continuous rise in rotor and winding speeds. Rotor-spun yarns have therefore always been successful where they could be manufactured more cheaply than ring-spun yarns and proved suitable for the range of application in question. [1]

2.2 History of Winding

In the most primitive type of spinning tufts of animal hair or plant fiber are rolled down the thigh with the hand and additional tufts are added as needed until the desired length of spun fiber is achieved. Later the fiber is fastened to a stone which is twirled round until the yarn is sufficiently twisted, whereupon it is wound upon the stone and the process repeated over and over.

The next method of spinning yarn is with the spindle, a straight stick eight to twelve inches long on which the yarn is wound after twisting. At first the stick had a cleft or split in the top in which the thread was fixed. Later, a hook of bone was added to the upper end. The bunch of wool or plant fibers is held in the left hand. With the right hand the fibers are drawn out several inches and the end fastened securely in the slit or hook on the top of the spindle. A whirling motion is given to the spindle on the thigh or any convenient part of the body. The twisted yarn is then wound on to the upper part of the spindle. Another bunch of fibers is drawn out, the spindle is given another twirl, the yarn is wound on the spindle and so on.

In medieval times, poor families had a such a need for yarn to make their own cloth and clothes that particularly all girls and unmarried women would keep busy spinning and spinster became synonymous with an unmarried woman.

Most authors agree that the practice of spinning fibers to form thread and yarns has been in existence for over 10,000 years. The spinning wheel, the tool most commonly associated with the art of spinning, was not introduced to Europe until in the late middle ages/early Renaissance. Thus, the drop spindle was the primary spinning tool used to spin all the threads for clothing and fabrics from Egyptian mummy wrappings to tapestries, and even the ropes and sails for ships, for almost 9000 years.

The oldest actual “tool” used for spinning threads were common rocks. As the first spinners were nomadic tribes from pre-agrarian societies, it is unlikely that they would have carried their rocks from camp to camp and would use stones found at each new site for their spinning. A leader thread would be spun by twisting the fibers between the fingers to a desired length, then the resulting thread would be tied around the rock. The rock could then be rotated to spin the fibers as they are played out between the fingers. Spinning with rocks is still done in remote parts of Asia among the nomadic tribes.

Medieval spinners often used a distaff, (a stick with a fork or ornate comb on the tip used to hold long-staple fibers while spinning) to hold their fibers while they were spinning with a spindle. This stick was usually held under the left arm according to most pictures – meaning that the spinners would have had to set their spindles in motion with their right hand, and feeding their fiber with the right hand. [6]

In October 1979, Murata machinery limited introduced No.7-II automatic winder with Mach splicer at ITMA’79 the 8th international exhibition of Textile Machinery, held in Hanover, Germany. This was the world first automatic winder equipped with an air splicer for cotton.

By using compressed air, Mach splicer splices a yarn without knots. With the launch of Mach

splicer the world textile industry entered the age of knotless yarn.
The 2.5-millionth Autoconer winding unit was put into operation in 2017. The history of the Autoconer is characterized by a long list of ground-breaking inventions that have always increased customer benefits.

Autoconer 107, the first product generation of the Autoconer, radically changed workflows in thepackage winding sector.Autoconer 138: the invention of splicing technology, it astounded the textile world in 1976 with its separate mechanical, electric and pneumatic functions and in 1978, the innovative splicer mechanism revolutionised yarn joining: the splice replaced knots for the first time. In 1987, Schlafhorstbrought the Autoconer 238 onto the market, the first winding machine with single winding unit drive. This led to increased flexibility and quality in the spinning mills. The Autoconer 338, with new drives and sensors went into production in 1997, while the starting pistol also sounded for the development of intelligent FX technologies. Autotense FX, the first online yarn tension control, is still the undisputed industry benchmark today. In 2007, Schlafhorst introduced the textile industry to the world of digital yarn displacement for processing bobbins. The Autoconer 5 revolutionized the production of process-optimized packages with its drumless yarn displacement system PreciFX.

Autoconer 6-self-optimizing and E^3 certified came in 2015. With the Autoconer 6, Schlafhorst presented an automatic package winder with self-optimized process cycles. It is E^3 certified because it gives spinning mills the world over threefold added value in the fields of energy, economics and ergonomics. [7]

2.3 Defining Different Terms

2.3.1 Spinning

TheSpinning process basically consists of three stages.

i. Reduction of yarn strand thickness from the supply roving (or sliver) to the required yarn count.
ii. The prevention of further fiber slippage-usually by twist insertion.
iii. Winding on to package which is convenient for handling and which protects the yarn.

2.3.2 Yarn Evenness/Unevenness

Non-uniformity in variety of properties exists in yarns. There can be variation twist, bulk, strength, elongation, fineness etc. Yarn evenness deals with the variation in yarn fineness. This is the property, commonly measured, as the variation in mass per unit length along the yarn, is a basic and important one, since it can influence so many other properties of the yarn and of fabric made from it. Such variations are inevitable, because they arise from the fundamental nature of textile fibres and from their resulting arrangement.

2.3.3 Um%

The average value all the deviations from the mean which is expressed as a percentage of the overall mean is called percentage of mean deviation (PMD). This is termed Um% by the uster.

2.3.4 CV%

The coefficient of mass variation CV % is the ratio of standard deviation of mass variation divided by average mass variation. The higher the CV value is the more irregular the yarn. A coefficient of variation (CV) is a statistical measure of the dispersion of data points in a data series around the mean. The coefficient of variation represents the ratio of the standard deviation to the mean, and it is a useful statistic for comparing the degree of variation from one data series to another, even if the means are drastically different from one another.

2.3.5+50% Thick place,−50% Thin place, +200% Neps

The frequently occurring yarn faults are thin place, thick place and neps. These faults are defined as those deviating from the average value by a pre-determined reference value. Generally these imperfection are measured at sensitivity level of −50, 3, 3.With reference to this levels, a thin place is a region where the yarn cross-section is less than half the cross-sectional size of the average portion. A thick place similarly is that region where the cross-sectional size is bigger by 50% of the average size. A small but sharp thick place is defined as neps. These are the number of faults within one kilometer length, where mass values are taken from each centimeter of length. We considered(+50%) thick place, (-50%) thin place and (+200%) neps. These values mean average value of the mass + mentioned percentage of that mass.

2.3.6 Hairiness

Hairiness is characterized by the quantity of freely moving fiber ends or fiber loops projecting from yarn surface. In term of measurement hairiness corresponds to the total length of protruding fibers in one unit length of one centimeter.

2.3.7 Imperfection Index (IPI)

Summation of +50% thick place, -50% thin place and +200% nepsis termed as imperfection index or IPI.

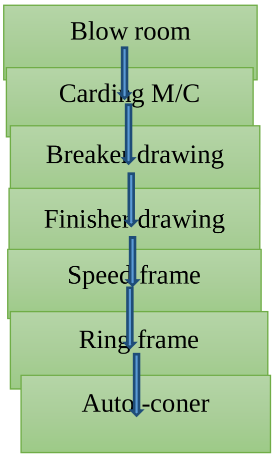
III. METHODOLOGY

There have two types of paper work one is survey type and another is experimental type. For this paperwork an exploratory (Experimental Type) research was used. The steps were taken for this research work were given below-

- Yarn production
- Winding by autoconer
- Sample preparation
- Test

Ne 22 carded and combed hosieryyarns ware produced by Ring frame m/c.Then yarn was wounded by Schalfhorstautoconer and test was performed by uster tester 5.

Process Flow of Carded Yarn Production



Process Flowchart of Combed Yarn Production

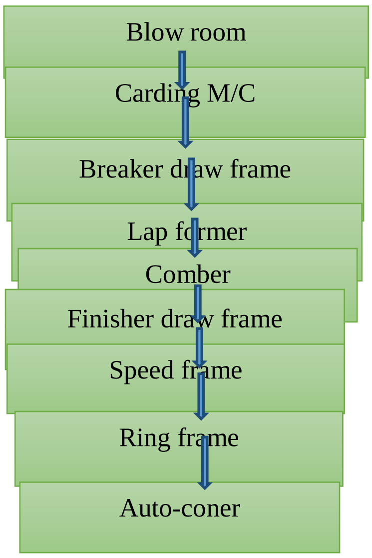


TABLE-1: Machine Parameter of Back Process

Serial no	Machine	Parameters
1	Carding	Count -69.5 grains/yd
2	Breaker Draw frame	Count-69.5 grains/yd
3	Finisher Drawframe	Count-71.5 grains/yd
4	Speed frame	Count-0.8 Ne TPI-1.15
5	Comber M/c	Lap weight-1200 grains/yd
6	Ring frame	Count-22/1Ne combed, TPI-17.15 Count-22/1 Ne carded,TPI-19.25

TABLE-2: UsterAfis Pro Report

Sample type	Nep Cnt/gm	Nep µm	SCN Cnt/gm	SCN µm	SFC(w) %<12.7	UQL (w) mm	SFC %<12.7	Mat. Ratio
Raw cotton	229	726	13	1592	6.9	28.7	21	0.92

IV. RESULTS AND DISCUSSION

TABLE-3: Yarn Properties of 22/1 Ne Combed Hosiery at Different Winding Speed

Parameter	Ring bobbin	Auto cone(speed m/min)		
		1400	1500	1600
U%	10.15	11.3	11.70	11.88
CV % 1 cm	13.10	13.75	14.25	14.40
CV% 10 m	2.1	2.17	2.28	2.35
Neps (+200%km)	68	88	98	105

Thick place (+50%)/km	65	75	80	85
Thin place(-50%)/km	1.8	2.5	2.75	2.8
Imperfection Index(IPI)	134.8	165.5	180.75	192.8
Hairiness	3.25	4.10	4.25	4.55

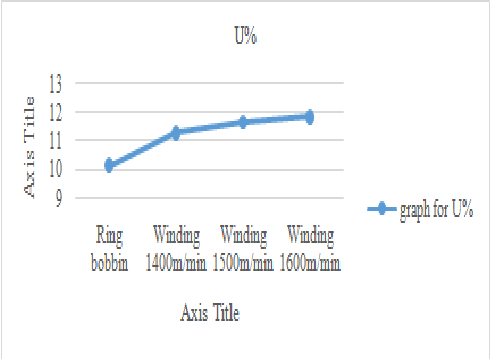


Fig-1: Effect of winding speed on U%

From figure-1, It displayed for the 22's combed hosiery, U% of ring bobbin was 10.15 which increased to 11.3, 11.70 and 11.88 in the winding M/c at the winding speed of 1400m/min, 1500m/min and 1600m/min respectively. Higher windingspeed means higher production as well as higher irregularity on the yarn. U% increased up to 17% in the cone package than ring bobbin.

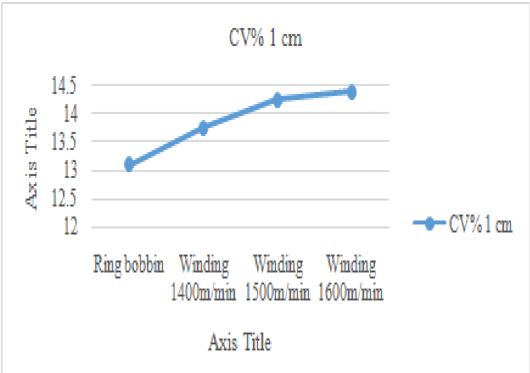


Fig 2: Effect of winding speed on CV% 1cm

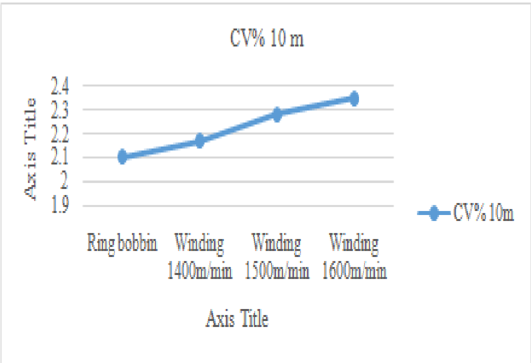


Fig 3: Effect of winding speed on CV% 10 m

In the figure 2 and 3 CV% 1cm and CV% 10m was increased in the cone package than ring bobbin. CV% 1cm and CV% 10m was the highest at the winding speed of 1600m/min. CV% 1 cm and CV% 10 m increased in the cone package than ring bobbin up to 9% and 11% respectively.

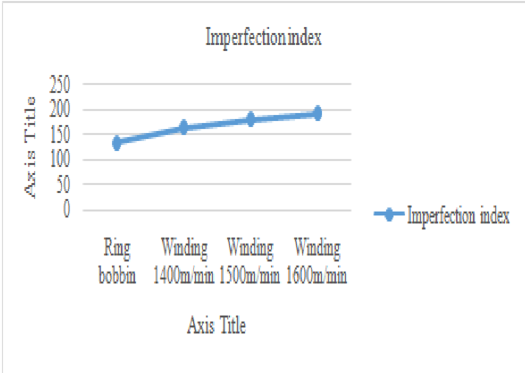


Fig 4: Effect of winding speed on imperfection index.

From the figure-4, it was displayed that highest imperfection index revealed at the winding speed of 1600m/min.

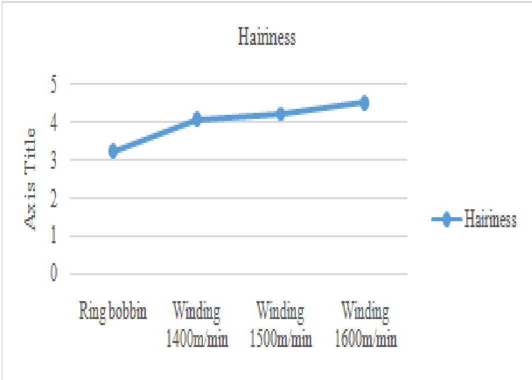


Fig 5: Effect of winding speed on hairiness.

Hairiness of ring bobbin was 3.25 which was increased to 4.10, 4.25 and 4.55 at the winding speed of 1400 m/min, 1500 m/min and 1600/min respectively. Hairiness was the highest at the winding speed of 1600 m/min because of higher the winding speed higher the stress and strain on the yarn. Hairiness value increased 40% in the wounded combed yarn than ring yarn at the winding speed of 1600m/min.

TABLE-4: Yarn Properties of 22/1 Ne Carded Hosiery at Different Winding Speed

Parameter	Ring bobbin	Auto coner speed (m/min)		
		1400	1500	1600
U%	11.05	12.95	13.10	13.45
CV % 1 cm	14.07	14.94	15.35	15.5
CV% 10 m	2.2	2.27	2.35	2.55
Neps (+200%km)	210.5	238.3	273.8	320.3
Thick place(+50%)/km	85	95	108	114
Thin place(-50%)/km	5	7.5	8.4	9.5
Imperfection index (IPI)	300.5	340.8	390.2	443.8
Hairiness	3.4	4.4	4.7	5.05

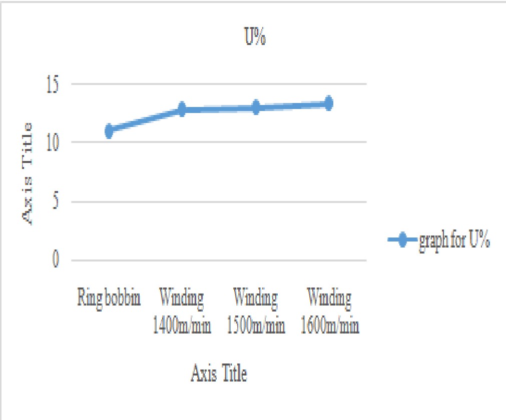


Fig 6: Effect of winding speed on U%

From figure-6, It was displayed for the 22's carded hosiery, U% of ring bobbin was 11.05 which increased to 12.95, 13.10 and 13.45 in the winding M/c at the winding speed of 1400m/min, 1500m/min and 1600m/min respectively. U% increasedin the woundedyarn than ring yarn up to 21%.

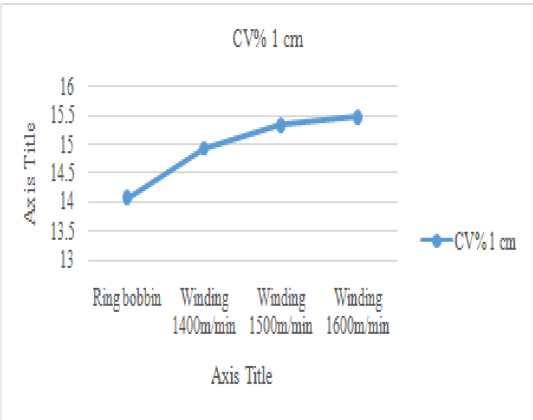


Fig 7: Effect of winding speed on CV% 1cm

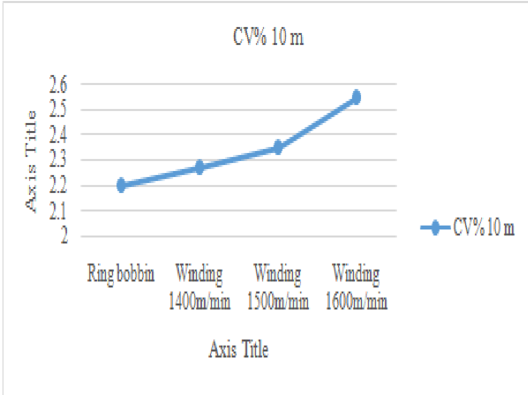


Fig 8: Effect of winding speed on CV% 10m

In the figure 7 and 8 CV% 1cm and CV% 10m was increased in the cone package than ring bobbin. CV% 1cm and CV% 10m was the highest at the winding speed of 1600m/min. CV% 1cm and CV% 10 m increased in the wounded yarn than ring yarn up to 10% and 15% respectively.

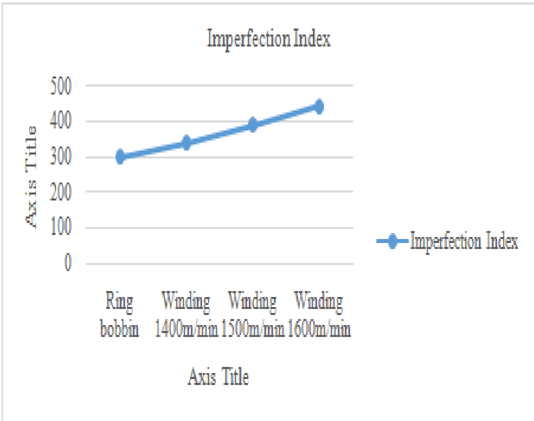


Fig 9: Effect of winding speed on imperfection index

From the figure-9, it displayed that highest imperfection index revealed at the winding speed of 1600m/min.

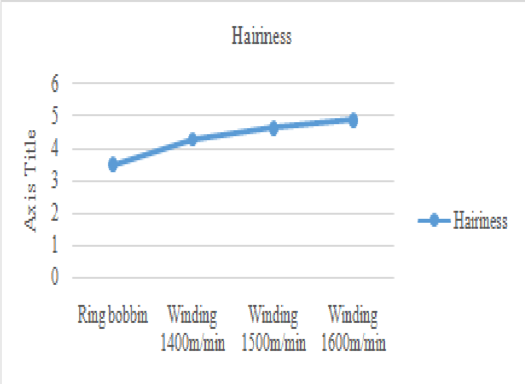


Fig 10: Effect of winding speed on hairiness

Hairiness of ring carded was 3.4 which was increased to 4.4, 4.7 and 5.05 at the winding speed of 1400 m/min, 1500 m/min and 1600/min respectively. Hairiness was the highest at the winding speed of 1600 m/min because of higher the winding speed higher the stress and strain on the yarn. Hairiness value increased up to 49% in the cone package than ring yarn at the winding speed of 1600m/min. Hairiness value more increased in the carded yarn than combed yarn.

From the above figures it was concluded that all properties of carded yarn much more deteriorated than combed yarn.

V. CONCLUSION

The spun yarn have objectionable faults such as thick and thin place. The appearance of a fault in the finished product, that is a woven or knitted fabric is largely determined by it's size. Depending on the size or dimension and the frequency of the fault these are divided into frequent yarn faults and seldom-occurring yarn faults. Frequent yarn faults are also called as imperfection. This type of fault does not adversely affect subsequent production process and quality of end product. Seldom-occurring yarn faults differ above all in their larger mass or diameter variation and size which can lead the difficulties in subsequent production stages or defects in end product.This type of fault are detected and eliminated by yarn clearing system. The removal of fault must be carried out in winding department due to low cost compared to subsequent weaving preparatory process. The IPI values always increase in the wounded yarn. The major limitation is that, the more the winding speed more the productivity but moreimperfection and hairiness value on the yarn. Due to this reason, winding speed should be optimized in such a manner so that maximum yarn production with minimum number of yarn defects are possible to achieve.

REFERENCES:

[1]. Elizabeth and Barber (1995). Hand Spinning, Women's Work: The First 2000 years. Women Cloth and Society in Early Times, ww Norton and Company.

[2]. Senthil Kumar, R,. Quality requirements of ring cop of modern cone winding. The Indian Textile Journal, May 2008, http://www.indiantextilejournal.com/articles/FAdetails.asp?id=1179, Accessed date: November 12, 2013.

[3]. Chellamani, K.P., Pasupathy, R., and Vittopa, M.K., Factors influencing yarn quality change during high speed winding. SITRA 52(1):3-6 May 2007.

[4]. Rust, J.P. and Peykamian, S., Yarn hairiness and the process of winding. Textile Research Journal 62(11): 685-689, 1992.

[5]. Melissa Mall (2012). The History of Yarn

[6]. http://textilelearner.blogspot.com

[7]. http://www.technofashionworld.com/2-5-millionth-autoconer-operation/

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