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Speed Triangle Analysis of Added Irregularity

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Abstract: *The term irregularity covers the variation in any measurable yam property—weight per unit length, diameter, colour, twist and strength as well as those characteristics which denote features of irregularity. The variation of weight per unit length is fundamental and it is defined as the basic irregularity and the other irregularity are dependent upon it. The parameters in drafting operation that influence limit irregularity were analyzed. In this paper, a geometric approach- the speed triangle was introduced to evaluate the mechanical limit irregularity. Two variance equations for float fiber and draft level were proposed in determining limit irregularity.From the geometrical analysis, the mechanical parameters can be optimized for minimum irregularity.*

Key words:*Draft Triangle, Irregularity, Degree of floating length, Fiber displacement, Degree of draft.*

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I. Introduction

The basic irregularity depends on parameters of processing and inherent characteristics of fiber itself. There is high correlation between basic irregularity and other types of irregularity, such as variation in diameter, twist and blend component. The weight irregularity is the basic irregularity which is usually measured from the variation in the number of fibers per unit length of the cross section of the fiber strand.Irregularity can be traced down in two categories[1], [2],one is "size of irregularity" denoted by CVm% in spinning sector and second one is the spectrum of irregularity.

Many authors discussed about the causes of generating the irregularity [3-10],[24]. Principally two sources bear the prime role,first one isthe variation in material properties and second one is the variation in machine processing conditions. There is capacitance or optical type sensors to measure the actual irregularity with their relative opportunities and limitations [11],[12].There is possibility of measurement of theoretical minimum irregularity from the evaluation of machine process condition and fiber properties variation. The magnitude of minimum irregularity depends not only at the degree of optimization of machine's process parameter but also at the degree of least variation of fiber properties. Therefore, practically limit irregularity which is also known as limit irregularity vary from position to position of spinning process.

TOTAL IRREGULARITY

Contribution by one drafting assembly to overall irregularity can be calculated by

$CV_{delivery}^2 = CV_{feed}^2 + CV_{Addition}^2$ (1)

Foster and Anderson [14] proposed an equation for the contributions of machined added irregularity:

$CV_{delivery}^2 = CV_{feed}^2 + a\,(D-1)$ (2)

Where, $CV_{delivery}$ & CV_{feed} = Irregularity of delivery and fed fiber assembly, D = Applied draft, a = A factor.

Thus, the irregularity is attributed to the value $\sqrt{a\,(D-1)} = CV_{Addition}$ which equivalents to drafting wave [15].

THEORETICAL LIMIT IRREGULARITY OR MINIMUM IRREGULARITY

The total theoretical minimum irregularity also follows the additive rule of variances as

$CV_{Output\text{-}minimum}^2 = CV_{Input\text{-}minimum}^2 + CV_{Addition\text{-}minimum}^2$ (3)

Irregularity is added to the product during drafting operation and the minimum irregularity is added from two sources and they are defined(a) fiber limit irregularity and (b) mechanical limit irregularity.

$CV_{Addition\text{-}minimum}^2 = CV_{Fiber\text{-}minimum}^2 + CV_{Mechanical\text{-}minimum}^2$ (4)

FIBER LIMIT IRREGULARITY

Two fiber parameters govern the theoretical minimum fiber irregularity and these are; (1) the variation in the number of fibers per unit length of the cross section, (2) The variation in the fiber fineness in the cross section.Many researchers in the past investigated the irregularity of spun yarns under several assumptions. Martindale [10] studied the irregularity of yarn caused by random fiber arrangement. It is generally accepted that the most uniform arrangement of fibers that can be obtained with current process machinery is one in which fibers are randomly or ideally distributed. The ideal fiber strand is the package of fiber, long in length where the probability of finding a fiber is the same at all points along its length. As a result, the probability of finding a fiber in any particular place is very small and it, therefore follows that the number of fibers in the cross section must be distributed according to the poisson distribution following normal curve. According to Martindale [8] minimum fiber irregularity:

$$CV_{Fiber\text{-}Min}\% = \frac{100}{\sqrt{n}}\sqrt{1+0.0004CV_d^{\,2}} \quad (5)$$

For natural fiber, Foster [14] proposed the following formula:

$$CV_{Fiber\text{-}Min}\%^2 = \frac{(100)^2}{n} + \frac{CV_f^{\,2}}{n} \quad (6)$$

$CV_{Fiber\text{-}Min}$=Minimum irregularity of fiber strand, n=The average number of fibers, CV_f&CV_d =Coefficient of variation of fiber The both formula have the generalized form:

$$CV_{Fiber\text{-}limit}\% = \frac{100a}{\sqrt{n}} \quad (7)$$

Where, a =the fiber irregularity factor and $a=\sqrt{1+0.0004CV_d^{\,2}}$ or $a=\sqrt{1+0.0001CV_f^{\,2}}$ andtypicalvalue a=1.02,1.06,1.12 & 1.30 for synthetic, cotton, wool and flax fiber [13].

II. Mechanical Limit Irregularity

The mechanical limit irregularity is produced by displacement or re-arrangement of fibers in “out-order form” into the cross-section.In roller drafting, this displacement take place due to drafting force that is generated due to drawing the fiber strand by the draft rollers with higher linear speed.

In drafting devices, the back zone prepares the fiber strand for proper operable in front zone and the front zone bears the main responsibility of drafting to reduce the linear density to desired yarn count.The definition and contribution of drafting force were discussed by various authors [16-22].

The strand in drafting is attenuated when the fiber fringe moving at the faster speed slides with respect to the strand entering the drafting zone. The drafting force is built up to overcome the frictional constraint.

The drafting tension of the strand is determined by the frictional forces acting on fibers undergoing a slippage motion. The draft force is equal to slippage resistance force. In this context, slipping motion of fibers in the drafting zone is very important point to explain irregularity [25-30].

The displacement is the phenomenon of slippage of a fiber from the fiber strand. In this case, slippage resistance forces in term of cohesion force play the important role to determine the order and degree of slippage. To explain and understand the fiber displacement in a drafting zone we should look into the phenomenon of fiber slippage due to drawing by faster roller. In case of phenomenon of displacement, the floating slipping length plays the vital role in determining the irregularity to be produced. Under above discussion of fiber displacement, the following points of occurrence are important:

1. Ideal pulling out/Perfect pulling out: In this case fiber will be displaced or slipped individually or evenly.
2. Non ideal/Non perfect pulling out: Fiber will be displaced due to pulling out force in group and unevenly.

The above two factors are related to cohesion of fiber strand. The slippage happens due to re-arrangement of fibers around the axis of fiber strand. Ideally, the front roller should pull-out (event of slippage,displacement) fibers from the strand in the drafting zone individually. The condition for pulling-out [20] a single fiber is:

$$F \gg G \quad (8)$$

Where, F is the pulling force (drafting force) on the fiber by the front rollers due to friction, and G is the griping force (cohesion force) by the strand on the embedded fiber.

$$G = gw + g\lambda \quad (9)$$

Where, g_w is the transverse pressure from the machine parts in contact with the strand such as aprons or pressure bars, if present and g_λ is the internal lateral pressure determined by the strand structure. From the equation-8 & 9, the total gripping force is related to the characteristics of the strand and the machine parameter.

The mechanical limit irregularity can be engineered from the degree of irregularity of slipping motion of fibers in the drafting zone. In this context, there are two factors that govern the mechanical limit irregularity:

(a) Degree of floating slipping length due to uncontrolled displacement of the fibers;

(b) Degree of draft in term of linear speed ratio of drafting rollers that generate necessary draft force for displacement of the fibers.

As added limit irregularity follows the additive rule of variance, this can be represented geometrically by right triangle of a single drafting zone as shown in Figure-1.

For ideal drafting conditions, i.e. ideal pulling-outthe degree of floating length can be represented by base BE and corresponding impact on variation can denoted by CV_{FL}%. The necessary length of force for pulling-out the fibers in term of draft is represented by CE and corresponding impact on variation is denoted by CV_{DL}%.

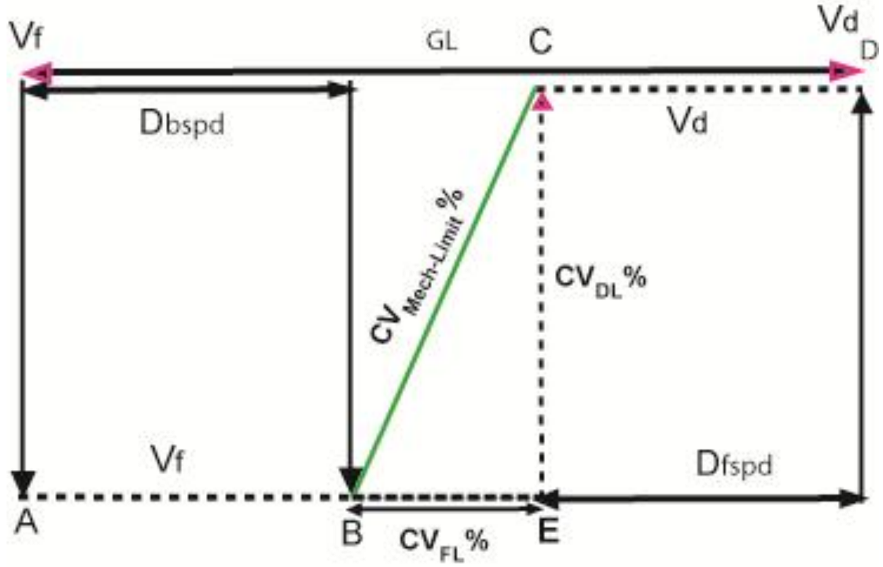

Fig. 01: Speed Triangle

Where, GL= Gauge length(length of draft zone),V_f,V_d and V_{ff} =Back roll, front roll and float fiber speed [V_d>V_{ff}>V_f], D_{bspd}, D_{fspd}&D_{ffspd}(BE) =Distance of fiber at back roll, front roll and float speed,B=The acceleration point where fiber speed up at the speed of between V_b and V_f.C=The acceleration point of fiber at the speed V_d, BC=The mechanical limit irregularity. From simplified speed triangle geometry:

$$BC^2=BE^2+CE^2 \text{ or}$$

$$CV^2_{\text{Mech-Limit}}\%=CV^2_{FL}\% \quad +CV^2_{DL}\% \quad (10)$$

The terms of CV_{FL}%&CV_{DL}% can be calculated from:

$$CV_{FL}\%=[GL\text{-}ML]\cdot\frac{CV_{L(n)}\%}{ML} \quad (11)$$

$$CV_{DL}\%=[FL+ML]\cdot\frac{CV_{DL}\%}{ML} \quad (12)$$

Here ML& FL=mean & floating length,$CV_{L(n)}$&CV_D%=CV% of mean length and draft.

Regarding the floating lengthunder displacement, there is probability of two under mentioned events:

1. Degree of floating slipping length is greater than zero, i.e. CV_{FL}%> 0

Natural fiber belongs to variation in fiber length distribution and very important factor to the production of irregularity (31). Therefore, all fibers travelling between two pairs of draft rollers are not gripped by the front roll simultaneously. In other word, short fiber will have long floating slipping length for displacement due to draft tension around the fiber strand. During this floating slipping, fiber neither move at back roll speed nor at the front roll speed but a complex phenomenon of speed is produced which is defined also as floating condition and fiber speed at this time distance is between V_b<V_{ff}<V_f. Thus floating slipping length for uncontrolled displacement will contribute to irregularity to be produced.

2. Degree of floating slipping length equal to zero, i.e. CV_{DL}% =0,

Staple length of manmade fibers is equal. In this case, fiber will reach at front roll speed just leaving the back roll speed. There is no floating slipping length for uncontrolled displacement.Therefore, contribution of fiber displacement at float speed to the irregularity to be produced will be zero.ie,CV_{FL}%=0.

In that case, irregularity to be produced will be characterized by the intensity of velocity ratio which causes event of slippage of fibers within the strand and expressed as

$$CV^2_{\text{Mechanical-minimum}}=CV^2_{\text{Degree of draft}} \quad (13)$$

In analysis of effect of draft, it is to be noted that degree of draft is main source that causes the event of slippage and the reduction of the fibers in strand cross-section through displacement around the fiber strand.The weightage of contribution of this parameter to the irregularity is significant. The intensity of velocity ratio in term of degree ofdraftinfluences the dispersion of displacement of fibers.

III. Conclusion

Many researchers analyzed the possibility of limit irregularity to be produced owing to variation in fiber properties. The fiber strand bearing the unevenness is produced from variation in fiber properties and variation in mechanical process parameter. In this paper, efforts were given in analysis of irregularity from view point of mechanical process parameter. Statistically, two important parameters CV_{FL}% and CV_{DL}% are responsible for determining the mechanical limit irregularity. The analytical assessment of $CV_{Mechanical\text{-}Min}$% will assist in designing and manufacturing the machine that will produce the best favorable irregularity.

It is modeled to carry out the experimental studies on the mechanical limit irregularity theory and statistical analysis on practical studies will enrich the proposed theory.

Reference

[1] P. A. Grosberg, and C.Iype, *Yarn production, theoretical aspects*(Textile Institute, UK 1999).
[2] R. Furter (Eds.), *TheUster® Tester 5Application Handbook*(Uster® Technologies AG, June 2006).
[3] D. R. Cox, and J. Ingham, Some causes of irregularity in worsted drawing and spinning, *J. Text. Inst*., 41,1950.
[4] P. A. Grosberg, The short-term irregularity of roller-drafted yarns and slivers, *J. Text.Inst.,*49, 1958.
[5] P. A. Grosberg, Cause of irregularity in roller drafting, *J. Text. Inst.,*52, 1961.
[6] P. A. Grosberg, Cause of irregularity in roller drafting, *J. Text. Inst.,*53, 1962.
[7] P. A. Grosberg, and W.L. Yang, The Cause of Sliver Irregularity in Gilling, *J. Text. Inst.*, 65, 1974.
[8] J. G. Martindale, A Review of The Causes of Yarn Irregularity, *J. Text. Inst.*, 41, 1950.
[9] M. W. H. Townsend,&D. R. Cox,The Analysis of Yarn Irregularity, *J. Text. Inst.*, 42, 1951.
[10] J. G. Martindale, A New Method of Measuring The Irregularity of Yarns With Some Observations on The Origin of Irregularities in Worsted Slivers and Yarns, *J. Text. Inst*., 36, 1945.
[11] Technical specification winding for sales and customers, *USTER®Quantum 3-Technical Data-, UQC\SE-649*,September 2010.
[12] Facts-Optical Yarn Clearing, *Loepfe Yarn Master®*,Article-045910/003e.
[13] T.Jackowski and I. Frydrych, What I learnt in fiber quality: Practical experience, *58th Plenary Meeting of the ICAC*,Charleston, USA October 1999.
[14] G. A. R. Foster, *Manual of Cotton Spinning: The Principles of roller Drafting and the Irregularity of Drafted Materials*(The Textile Institute, UK, 1958).
[15] C. A. Lawrence, *Fundamentals of Spun Yarn Technology*(CRC Press, 2003).
[16] H. R. Plonsker, and S. Backer, The dynamics of roller drafting, part 1: Drafting force measurement, *Text. Res. J.*, 37,1967.
[17] D. S. Taylor, The measurement of fiber friction and its application to drafting force and fiber control calculations, *J. Text. Inst.*,46, 1955.
[18] J. S. Olsen, Measurement of sliver drafting forces, *Text. Res. J.*, 1974.
[19] B. Cavaney, and G. A. R. Foster, Some observations on the drafting forces of cotton and rayon-staple slivers, *Shirley Inst. Memoirs*, XXVII, 1954.
[20] N. Pan, Drafting behavior *Text.Res. J.*, 25, 1955.
[21] Q. Lin, W.Oxenham,& C. Yu: A study of the drafting force in roller drafting and its influence on sliver irregularity, *J. Text. Inst.*, 102, 2011.
[22] J. G. Martindale, Cotton sliver or roving: Measurement of drafting force, *J. Text. Inst*. 38, 1947.
[23] W. Klien, *Manual of Textile Technology*, Vol. 3 (The Textile Institute, UK, 1987).
[24] M. Gunay, Characterization and quantification of woven fabric irregularities using 2-D anisotropy measures, NCSU, USA July 2005.
[25] J. McVittie, and A. E. De Barr, Fibre motion in roller and apron drafting, *Shirley Inst. Memoirs*, 32, 105, 1959.
[26] D. S. Taylor, Some observations on the movement of fibres during drafting, *J. Text. Inst.*, 45, 1954.
[27] D. S. Taylor, The motion of floating fibres during drafting of worsted slivers, *J. Text.Inst.*, 46, 1955
[28] D. S. Taylor, The velocity of floating fibres during drafting of worsted slivers, *J. Text.Inst.*, 50, 1959.
[29] G. A. R. Foster, Fibre motion in roller drafting, *Shirley Inst. Memoirs*, 25, 1951.
[30] D. R. Cox, Theory of drafting wool sliver I, *Proc. of The Royal Society*, A, 197, 28, 1949.
[31] H. Wakeham, Cotton fibre length distribution - An important quality factor, *Text.Res. J.*, 25, 1955.
[32] N. Balasubramanian, Upgrading by apron drafting, *Text. Res. J.*, 32, 1962.
[33] K. Fujino, Y. Shimotsuma, and T. Fujii, A study of apron-drafting, Part I: Experimental studies, *J. Text. Inst.*, 2, 1977.

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