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ORIGINAL ARTICLE

Influence Of Centrifugal Force On Yarn Characteristics

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ABSTRACT:

"The practical paper is an applied concept of physics in textiles. The Research study shows the effect of yarn tension on yarn characteristics at ring frame stage which is very much dependent on centrifugal force (C.F.).The C.F on ring traveler varies by varying its mass. Due to varying circular motion of ring traveler, tension in yarn is varying in nature and results are correlated with yarn characteristics like fineness, strength, elongation and variation in mass per unit length. In study it is observed that an increase in centrifugal force decreases CSP, tenacity, thick places, thin places & neps& decrease in centrifugal force gives initially increase in yarn quality index then further increase in C.F.gives the trend of decrement in yarn quality index".

KEYWORDS:

Centrifugal Force (CF), Yarn Quality Index (YQI), Traveler, Tenacity.

INTRODUCTION:

When a body of mass m moves on a circular path Fig.(1), it experiences a force towards centre of the circular path known as centripetal force and to balance this centripetal force a centrifugal force exists on mass towards outward direction. Mathematically it is quantified by following formula.

C.F. = mv2/r
= mr ω2

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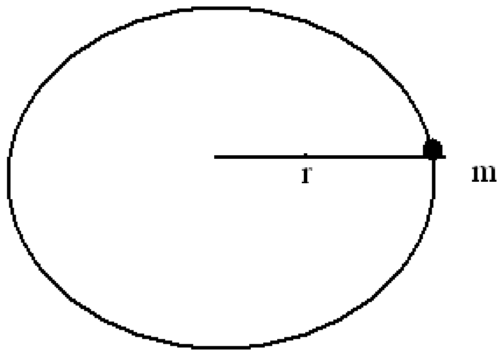

Fig-1.

Where 'r' is radius of circular path & 'ω' is angular velocity of body.

In spinning department, for preparation of yarn from fibre, ring frame machine is required. The design of ring spinning machine is such that the fibres after having been transformed in to a yarn has to travel a-long distance before reaching the package. Fig-2 shows path of yarn from front roller nip to package can be divided in to three zones viz-

(i) Spinning zone,
(ii) Balloon zone
(iii) Winding zone.

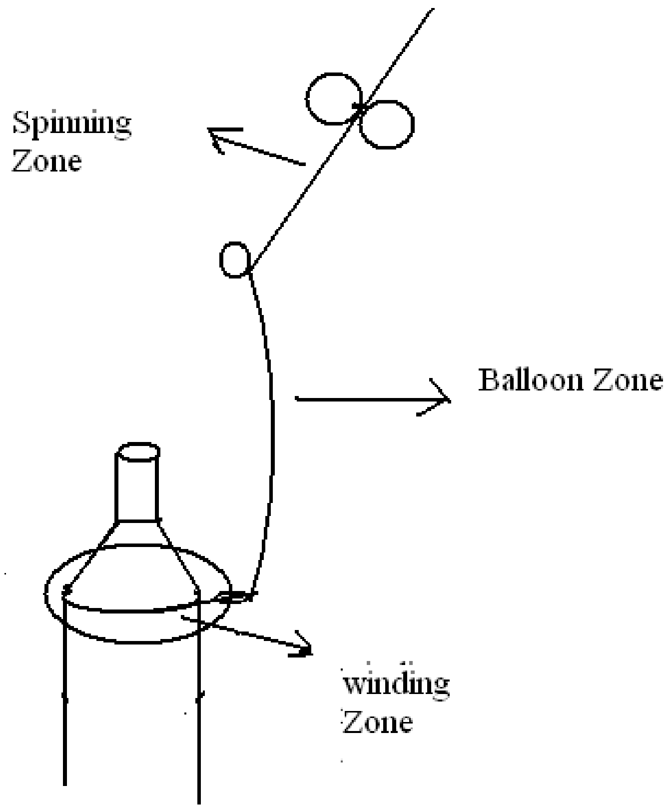

Fig-2

The requirement of tension in these three zones is different. As a result any machine parameter that alters the tension in one zone also affects the tension in other zone. The tension level and its variation with respect to space and time and the parameters governing tension important to explore further. On ring spinning machine, the traveler of mass 'M' rotates on circular ring caused generation of C.F. (FZ) which is balanced by centripetal force (FN)

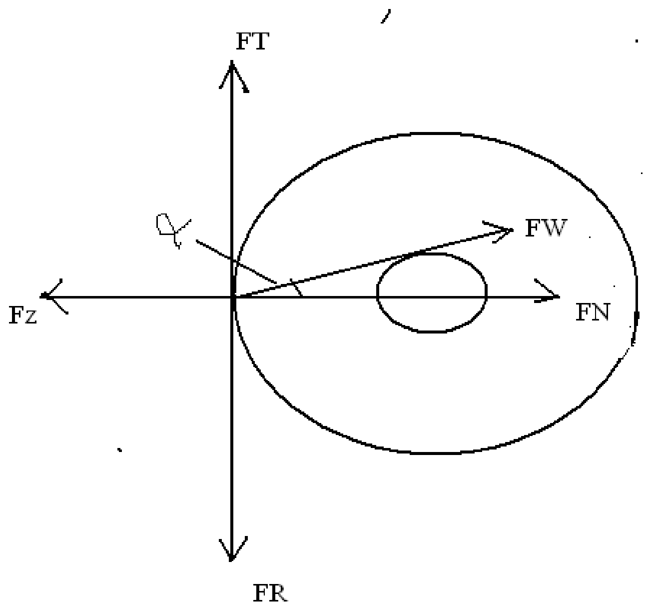

Fig3

In present paper an attempt has been made to optimize the C.F. in ring spinning to produce best quality of yarn.

THEORY USED:

Krause has made a simplified analysis to determine the winding tension by considering only traveler mass, its rotational speed, ring diameter, ring traveler friction. Various forces acting on the traveler in the plane of the ring is shown in Fig-3. The winding tension (FW) is acting at the tangent to the circumference of cop at an angle α with respect to the line joining the traveler & package center. This force can be resolved in two perpendicular components FT & FN where

$$FT = FW \ \sin\alpha \quad \ldots\ldots\ldots\ldots\ldots\ldots 1.$$
$$FN = FW \ \cos\alpha \ldots\ldots\ldots\ldots\ldots\ldots\ldots 2.$$

FT will cause to rotate the traveler & FN acts normal to the surface of the ring will pass the traveler against the ring surface.

If the traveler of mass 'M' rotates at a speed 'ω', the C.F. 'FZ' will act on the traveler would be

$$Fz = M \frac{d_R}{2} \omega^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots 3$$

Where dR is the diameter of the ring.
The forces Fz & FN act opposite to each other. Hence the net force with which the traveler will be pressed against the ring surface is given by

$$Fz - FN = M \frac{d_R}{2} \omega^2 - F_W \cos\alpha \quad \ldots\ldots 4$$

The traveler will experience resistance to its movement. This frictional resistance will be

$\mu(Fz - FN) = FR$……………………..5.

Under equilibrium state

$FT = FR$

$\Rightarrow FW \, Sin\, \alpha = \mu\,(Fz - FN)$

$$= \mu\,(M \frac{d_R}{2} - F_W \, Cos\, \alpha\,)$$

$$-> F_W \, Sin\, \alpha + \mu\, F_W \, Cos\, \alpha = \mu\, M \frac{d_R}{2} \omega^2$$

$$-> F_W = \frac{\mu M d_R}{2(Sin\alpha + \mu Cos\alpha)} \omega^2 \text{………6}$$

$$= \frac{\mu M d_R}{2 Sin\alpha} \omega^2 \text{……………………7}$$

(Since $2\mu\, Cos\, \alpha$ can be ignored)

The winding tension in terms of rotational speed (NL) of the traveler would be

$$FW = \frac{2\pi^2 \mu M d_R N^2_L}{Sin\alpha} \text{……………8}$$

PREPARATION OF SAMPLES:

Polyester Viscose 65:35 blended 30's yarn samples were prepared on modern ring frame.The samples were prepared in following three categories:

(i) Sample A →with traveler weight 50 mg.

(ii) Sample B →with traveler weight 45 mg.

(iii) Sample C →with traveler weight 40 mg.

MACHINE PARAMETERS:

Ring Frame: G-5/1 of Laxmi Reiter.
Spindle RPM: 18500
Ring dia 40 mm.
Traveler nos. for samples

Sample A →2/0

Sample B →3/0

Sample C →4/0

CALCULATION:

DATA GIVEN-

Coefficient of friction between ring & Yarn, $\mu = 0.22$,
Average angle $\alpha = 650$
Ring Dia dR = 40 mm
Spindle RPM NL= 18500

(a)Yarn Tension for sample A-
178.34gm

(b) Yarn Tension for sample B-
160.51gm

(c) Yarn Tension for sample C-
142.67gm.

RESULTS & DISCUSSION-

(i) Count & CSP-

From table of yarn characteristics, it is clear that a change in tension at ring frame does not affect the fineness (count) of yarn significantly but fig-1,indicates that product of bundle strength (lea strength) & count of yarns i.e.CSP continuously decreases with respect to increase in tension in yarn. This decrease in CSP might be due to shifting of viscose fibres towards core of yarn as the strength of polyester is greater than the viscose. Strength of the yarn is dependent of characteristics of fibres which are mainly in core of yarn.

Yarn Characteristics

S.No.	Yarn Parameters	Sample-A	Sample-B	Sample-C
1.	Count	29.98	30.01	30.15
2.	CSP	3912.39	3961.32	3768.75
3.	Tenacity (gm/tex)	19.10	19.66	20.61
4.	Elongation	10.125	10.75	9.87
5.	YarnUnevenness (U%)	10.23	10.3	10.53
6.	CV% of UValue	1.8	2.5	2.8
7.	Imperfections(Thick places+thin places+neps)	76	102	120
8.	YQI(yarn quality Index)	18.9	20.51	19.31

Table

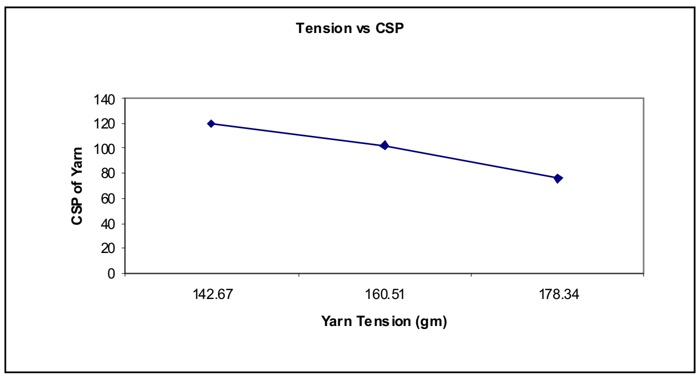

Fig-1

(ii) Strength and Elastic property-

Table-1 & fig-2 shows that mass stress at break also known as breaking tenacity initially decreases rapidly with increase in tension in yarn. Further increase in tension also gives the trend of decrease in Tenacity. This is due to migration of low tenacity fibres to core of yarn. Best results of elastic properties are observed when tension is 160.51gm

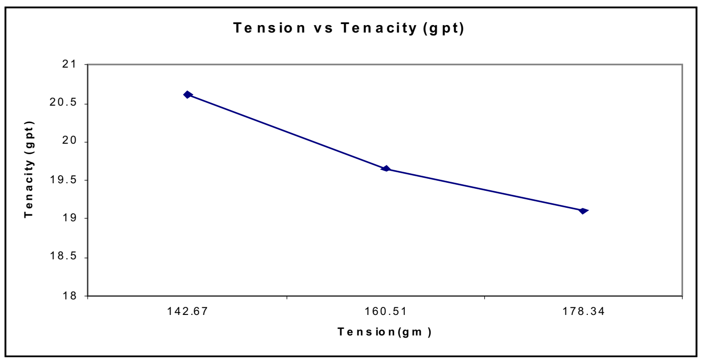

Fig-2

(iii)Yarn Quality Index & Imperfections-

From fig- it is clear that an increase in yarn tension exhibits decrease in imperfection (thin places, thick places & neps) continuously. An increase in yarn tension cause stretch in yarn which is helpful to minimize the unevenness of yarn through better fibre orientation..

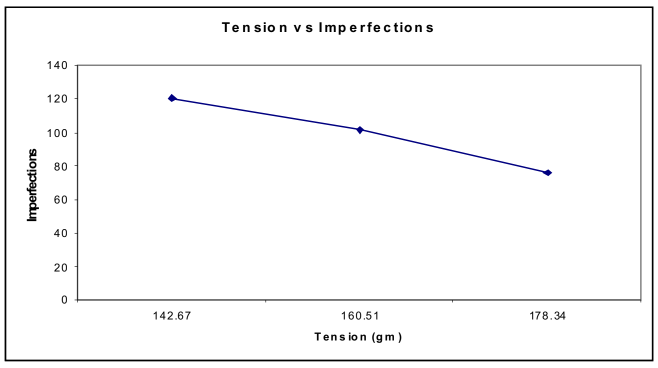

Fig-3

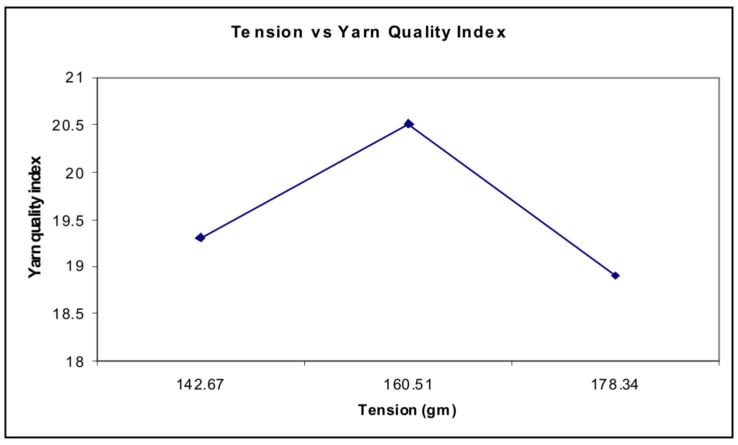

Fig-4

CONCLUSIONS-

On the basis of above fig, table & results and discussion, it may be concluded that-

1.Yarn tension plays an important role on yarn characteristics at ring frame spinning machine stage. Yarn tension is very much dependent on centrifugal force applied on ring traveler during spinning of fibres into yarn.
2.For the production of 30's yarn, best quality of yarn can be achieved by using traveler weight 45mg.

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