



Appendix-3

MAT LAB Program:

INPUT

1. $D = [30 \ 50 \ 60 \ 75 \ 100 \ 150 \ 200 \ 250 \ 300]$; Yarn Denier
2. $K = [5792 \ 4887 \ 4544 \ 4132 \ 3621 \ 2945 \ 2533 \ 2249 \ 2057]$;
Optimum False-Twist(tpm)
3. $p = \text{polyfit}(D, K, 3)$
4. $f = \text{polyval}(p, D)$
5. $\text{table} = [D' \ K' \ f' \ (K-f)']$
6. $\text{plot}(D, K, 'o', D, f, '-')$

OUTPUT

1. $D = \quad 30 \quad 50 \quad 60 \quad 75 \quad 100 \quad 150 \quad 200 \quad 250 \quad 300$

2. $K = \quad 5792 \quad 4887 \quad 4544 \quad 4132 \quad 3621 \quad 2945$
 $\quad 2533 \quad 2249 \quad 2057$

3. $p = 1.0e+003 *$

$p_1 = -0.0000 \quad p_2 = 0.0002 \quad p_3 = -0.0546 \quad p_4 = 7.1538$

4. $f = 1.0e+003 *$

$5.7078 \quad 4.9394 \quad 4.6082 \quad 4.1720 \quad 3.5908 \quad 2.8666 \quad 2.5252$
 $2.3251 \quad 2.0249$

5. $\text{table} = 1.0e+003 *$

D	K	f	error (K – f)
0.0300	5.7920	5.7078	0.0842

0.0500	4.8870	4.9394	-0.0524
0.0600	4.5440	4.6082	-0.0642
0.0750	4.1320	4.1720	-0.0400
0.1000	3.6210	3.5908	0.0302
0.1500	2.9450	2.8666	0.0784
0.2000	2.5330	2.5252	0.0078
0.2500	2.2490	2.3251	-0.0761
0.3000	2.0570	2.0249	0.0321

*** + 003 means out put quantity 1.0e should be multiplied with 10^3 .**

PUBLICATION DETAILS

1. DECISION LETTER OF TEXTILE RESEARCH JOURNAL ON
MANUSCRIPT SUBMITTED FOR PUBLICATION.
2. LETTER FOR TEXTILE RESEARCH JOURNAL
CONTRIBUTOR FORM.
3. FINAL MANUSCRIPT SELECTED FOR PUBLICATION

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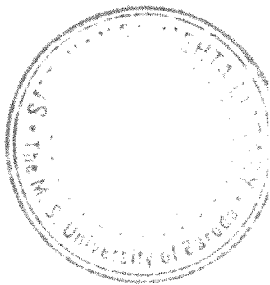
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Dr. Dong Zhang

Editor in Chief, Textile Research Journal

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FINAL MANUSCRIPT SELECTED FOR PUBLICATION



MECHANICAL CRIMP
TEXTURISING:-
A NOVEL CONCEPT.

INTRODUCTION:

The packing density of the filaments in the zero-twist stretch yarns is very low and the filament segments between points of entanglement are very long. This combination results in relatively high mobility of filament segments along the yarn axis and in any direction away from the yarn axis¹. The relatively high mobility of the filaments means that the stretch yarn structure is easily deformed and that yarn has poor dimensional stability, in general. The flattening out of the yarn structure occurs rather easily, under normal bending or compressional deformations. The spreading of filaments changes the yarn cross-sectional shape to a rather flat, ribbon like structure or one that is quite elliptical. This collapse of the filament bundle permits a much greater area of contact with other surfaces, resulting in greater friction and discomfort in apparel applications. In the textured filament yarns, the individual crimped filaments can move laterally, rotate, or can decrimp independent from the other filaments in the structure. Snagging of the individual filaments by a rough surface or sharp edges is greatly facilitated because of the mobility and crimp in the filaments. When the bending, compressional and snagging stress is removed, the filaments often do not fall back into their original alignment, resulting in a false or pseudo entanglement. With a rather small amount of twist in the textured stretch filament yarns, however, most of these problems are minimized¹. With sufficient twist in the textured yarn structure, the problems are completely overcome, as it moves closer to the desirable spun yarn structure¹.

Apart from the use of heat, which adds to the cost of processing, the attainment of the favorable crimp configuration by classical concept of false twist texturing, from the undesirable flat configurations of synthetic filament yarn adversely affects cost effectiveness of the product. Added to this major difficulties have been observed in cleaning and maintenance of the heater, even variation caused in temperature results in product faults and limits the process only for thermoplastic synthetic filament yarn. Therefore the novel concept of mechanical texturing has been thought-off with the accent on lower manufacturing and maintenance costs, by the obviation of heat from the process and desirable textured yarn structure is locked with sufficient twist. This not only makes new product versatile in terms of raw material but also helps in getting the desired spun yarn like performance, as well as elimination of need of post twisting or intermingling to overcome the problems of snagging on loom.

Process in brief:

Pre twisted FDY (Fully Drawn Yarn) flat multifilament yarn has been subjected to the higher false twisting (depending on yarn fineness) action under the condition of underfeed (depending on ductility of parent yarn). The torque caused due to high level of false twisting, forces the filaments to follow helical path at a certain angle (depends on magnitude of twist and denier per filament) to the filament yarn longitudinal axis. Internal stresses arising in single filaments tend to bend the filament and take the shape of spatial helical spring. After the yarn has passed through the false twisting unit, the initial twist would reassert itself and lock the already formed crimping convolutions in position.

Methodology:

Brief Description of the Lab Model:

Apparatus:

A schematic diagram of the apparatus is shown in Figure 1. The pre-twisted yarn passes over a positive take up roll and guide before passing several times around a nip roller and steel roller, so as to regulate feeding and tensioning of the yarn. The wraps of yarn are separated by means of separator located between them. From here the yarn is drawn by means of guide rolls and twist trapper wheel into the texturising zone. Where it passes through a false-twist spindle, which revolves in a direction such as would temporarily remove the yarn twist. It is then taken up by a nip apron delivery system. Speed of this roll has been set faster than nip roll as per amount of underfeed required with the help of speed regulator. Finally yarn passes through a separator guide to the positive take up roller before being wound onto a bulked yarn package.

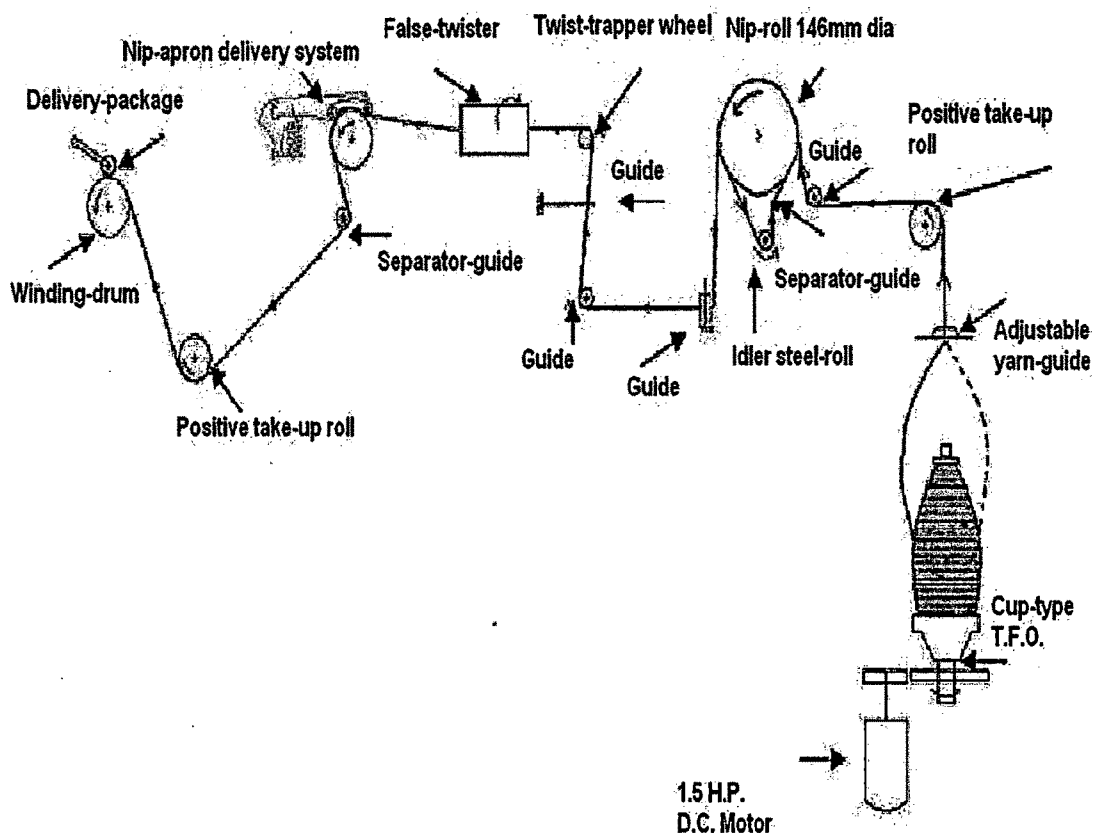


FIGURE 1. Mechanical-crimp texturing apparatus.

Experimentation:

Texturing was carried out on mechanical crimp texturing apparatus (Figure 1). The parent yarn used was fully drawn polyester- multifilament yarn of 100-denier (111.11dtex) /48-filaments with a tenacity of 4.01gpd (4.54 cN/tex), breaking elongation of 45%, percentage boiling water shrinkage of 6.6% and 0.9 % spin-finish. The basic machine parameters chosen for the study were as follows:

Pre twist: Two Levels (tpm):- Low: 119 and High: 591
 Percentage under feed = 25,
 Delivery speed = 150 m/min,
 Amount of false twist: 3937 (tpm)*.

-
- The optimum false-twist level K (tpm) has been calculated using the following experimentally derived expression based on Heberlein2 advance formula.

$$K=800+\frac{4,50,000}{D+60}$$

Textured yarns were checked for level of texturising introduced as well as mechanical parameters after conditioning for 24 hours at standard atmosphere for tropical region6, 7, viz; 65% ± 2% relative humidity and 27oC± 2oC temperature and results are given in Table-I. Mechanical properties were checked on Instron tensile tester 1121 model, using gauge length of 500mm and cross-head speed of 300mm/min. The DuPont3 method was used to measure the stability of curls.

Burnip et al⁵., introduced the concept of bulk factor (Θ) for measuring the bulk of false-twist textured yarns. Looking at the similarity in crimp characteristics responsible for bulk, same method was adopted for measuring bulk of the newly engineered yarn. Since this method is not a part of routine quality check procedures, brief mention of it is given here.

Method of measurement of Bulk factor:

Parent as well as textured yarns was tested for diameter on Erma scope projection microscope using magnification of 100X. Fifty readings were averaged for each yarn sample. Since the applied tension affects the diameter considerably, a standard loading of 0.00536 g/denier as suggested by Burnip et al⁵. was used throughout. This had demanded precision in the sample preparation.

Sample Preparation: The sample yarn was mounted horizontally in the jaws of a small clamp fixed on the platform of the microscope, the free ends of the sample being affixed to the piece of the spun yarn with a piece of self-adhesive tape. The spun yarn was the part of simple pulley weighting system. When thirty seconds had been elapsed after jointing the two yarns, a standard tension of 0.00536 g/denier was applied to the yarn in test for diameter measure. The method of joining the two yarns by simple pressure adhesion ensured any sudden stretching of the yarn during the application of tension was eliminated.

The length of the yarn “l” was measured in millimeters using scale under the standard tension conditions mentioned above. The sample was then released by cutting with a razor blade at the clamped end and by removing self adhesion tape at the free end, and weighted on a milligram torsional balance for measuring mass “m”.

The assumption that the textured yarn is of circular cross-section although textured yarn contains real twist in the present case, found insufficient to cause a flattening of the yarn. The specific volume v was therefore given by

$$v=\frac{\pi d^2l}{4m}$$

Where d = mean yarn diameter in millimeter
l = length of sample in millimeter
m = mass in milligram.

In order to assess the amount by which the specific volume of a filament yarn had increased on texturising, the term “bulking factor (Θ)” was defined as the ratio of the specific volume of the textured yarn to the specific volume of the parent filament yarn before texturising.

Results and Discussions:

Property \Pre twist	Low	High
Linear Density (dtex)	91	92
Tenacity (cN/ dtex)	3.40	4.01
% Extension	25.52	22.13
% Instability	4.61	1.63
Twist per Meter	112	602
Bulk factor (Θ)	19.95	11.53

Table I: Properties of mechanical textured yarn.

Photographic views Figure 2 (a-b) represent structure of both the samples, taken at a magnification of 100X.



Figure 2 Photographic views of mechanical textured yarn.

- It can be seen that higher deformation forces (due to false-twisting action) and increased tension, results in increased crimpiness of the resultant yarn. On locking newly acquired crimpiness of the configuration by basic twist, longer lengths of crimped filaments get compacted into shorter length. Higher the pre-twist for identical crimping more will be the compactness of structure as well as shortening of the length. This shortening of length results in increased linear density (denier) of textured yarn. In addition, increased compactness ensured firmness of the structure thereby reducing instability. However at both the selected levels of pre twist, instability values fall within the acceptable 5% limit suggested by DuPont³ for successful texturing.
- Different path length among the constituent filament, resumed on texturing results in the drop of tensile strength of the product yarn. Where as, underfeed and locking twist both together increase yarn tenacity due to improved orientation and filament cohesion by the development of lateral forces respectively⁴. For identical raw material, crimp level and underfeed level, yarn with higher twist likely to exhibit higher tenacity. Increased mutual cohesion between filaments prevents a weak place in one filament, which is being extended less than the neighboring filaments, thus delays the occurrence of rupture and therefore increases the breaking extension of yarn after texturing^{1, 4}. Higher mobility at less locking twist level

resulted in more increase in extension value as compared to the compactly packed structure of higher pre twist textured yarn. Bulking factor Θ is the ratio of the specific volumes of the yarn after and before texturing⁵. For rest of the process variables being constant low twist structure found to be more voluminous than compactly packed high twist structure. Likely to earn better cover with soft handle for the fabric as compared to crispy crepe feel as in the later case.

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