



Chapter v

Conclusion

5.0 CONCLUSION:

It is observed that texturising process offers an alternative route than spun yarn for bulking flat multifilament yarn. Versatility in terms of raw-material makes the process true for large domain of end users. Even simplicity of production process reduces burden of maintenance and storage also facilitates in declining the product cost. Targeting the same an innovative concept of texturising has been developed. The bulking action of the newly developed" mechanical crimp texturising method" is thought to be a consequence of the combination of two novel features. (i) Using a twisted yarn as feed to the texturing process under the condition of under feed and (ii) Texturing by high false twisting without heating.

Various machine components were identified after under going several successes as well as failures during pioneer trials. Based on these findings, final lab set up for the production of desired mechanical crimp textured yarn was established. Series of experimentations have been carried out to evaluate the influence of various process-parameters and material-parameters on the performance of the product yarn. Performance of the newly engineered yarn during weaving and finishing has been checked by using it as weft on the loom. Costing of the innovative yarn has also been carried out to study its cost effectiveness. Conclusions drawn out of entire work done are as follows:

1. It can be observed from the microscopical- view, structural characteristics of new yarn categorized it as an intermittent structure to that of false twist textured yarn and air jet textured

yarn. Number of curls on the surface of the product yarn are well bound by real twist, gives it a very close resemblance to spun yarn as well as air jet textured yarn.

2. Based on the simulation in production process as well as product structure methods and standards were adopted for the evaluation of new product. Mechanical properties, physical properties and bulk were measured by same systems those used for false twist textured yarn. While stability of the newly acquired structure has been measured and analysed by methods and standards followed for the measure of instability of loops of air jet textured yarn.
3. Performance of the new product has been evaluated with the respective standards in the first phase of experimentation. Measures of tenacity, percentage reduction in tenacity and percentage extension values of innovative yarn made up of 100d/48fils. has shown good agreement with the false twist textured yarn standards. However low tenacity value reported in the present case as compared to suggested standard value is mainly due to the low tenacity value of parent yarn itself. Twenty percent increase in the denier value as compared to feeder yarn denier of 79d (after under feed of 25%) has been reported for the selected pre-twist and false-twist levels. Percentage Instability of the product yarn in the present study is found within the acceptable Du Pont limit of 5% (established for air jet textured yarn). Comparison of bulk value was not made due to difference in the method adopted for the measure of bulk used in the present study as compared to those used for commercial textured yarns. Improved orientation on under

feeding has increased boiling water shrinkage of mechanical textured yarn than the parent yarn. Shuffle towards amorphous region on deformation caused during texturing has enhanced dye uptake of the product yarn hose as compared to parent yarn during TKD (Tube Knitting and Dyeing) test, also given confirmation of the texturing. Absence of any signs of unlevelness (barriness), has confirmed uniformity of texturing effect.

4. 100d/48fils. FDY yarns at 25% underfeed has been used through out to study the effect of process variables on innovative textured yarn. For all the selected false twist levels tenacity value has been reduced with the increase in pre-twist level from 2 turns/inch to 6 turns/inch, but when it has been raised further to 8-turns/inch, comparatively higher tenacity value is observed. On twisting lateral forces developed among the filaments adds to strength whereas diversion of filaments from yarn axis reduces strength. The resultant impact of both the contributory factors have decided tensile strength of the product yarn. Initially at low pre-twist level effect of lateral forces is subdued by constituent filaments diversity from axis. But at the later stage they become dominating, resulted in the improvement of tenacity value of the product yarn. Due to better conditions of texturing at higher false-twist level irrespective of pre-twist level textured yarn has exhibited higher extension value. As a consequence bulk as well as dye pick up of textured yarn also get improved at higher false twist level for all values of pre-twist chosen during the study. However bulk of the product yarn gets subsidies with the increase in pre-twist amount

because of increased compactness. High working tension caused at higher false twist level, improves orientation resulted in increased boiling water shrinkage of respective textured yarn. At the combination of low pre-twist level and low false-twist level loose and easily extensible textured yarn structure has been formed. Low degree of entanglement of such yarn has resulted in highest instability value.

5. There was no adverse effect observed on the performance of newly textured yarn for the selected speed levels chosen for the study within the limitations of lab model machine. Yarn denier, bulk factor and extension have increased steeply with the increase in the texturising speed from 50 m/min to 100 m/min. But further rise from 100m/min to 150 m/min has caused some declination in these values, which has remained almost constant at 200m/min speed. Better texturising properties were found at 100m/min speed which has been mainly attributed to better mingling effect, rather than increased degree of crimping, as per observation made during microscopical study. Improved orientation due to increased tension at higher texturising speed has also prevented larger drops in tenacity values.
6. With reduction in the bulking zone length from four inch to one inch, quality parameters of the innovative yarn get shifted towards the desirable one. It was mainly attributed to the formation of well-intermingled higher number of small curls at a constant pre-twist level, under the action of higher distortion forces (tension) while working with shorter bulking zone. Although preferable for the given set-up owing to increased

filament rupture further reduction in the bulking zone value was not possible.

7. Heberlein advance formula has been restructured by modifying variable constant "2,75,000". This modification is based on trials conducted on fully drawn polyester yarns of different fineness, viz; 100d/48fils., 150d /72fils., 200d/96fils., 250d/120fils. and 300d /144fils. at constant pre-twist level (twist factors $24 \text{ tex}^{1/2} \cdot \text{turns/cm}$).

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

Formula, so obtained is established as an empirical formula for mechanical crimp texturising for polyester yarns after confirming its significance with respect to different dpf yarns as well as by processing same yarn, viz; 100d/48fils. at different twist levels.

Even using mathematical tool, with the help of practically derived values new empirical formula has been established as follows for the innovative texturising process.

$$K (\text{tpm}) = 7153.8 - 54.6D + 0.2 D^2$$

Where "K" is the optimum false-twist level and "D" is the polyester parent (flat) yarn denier.

8. Highest bulk, instability, extension and declination in tenacity values were reported for soft silk like textured yarn produced lowest pre-twist along with optimum false-twist level by keeping

rest of process and material parameters optimum. Post heat set textured yarn has not shown any marginal change in its bulk property, but instability has been reduced as compared to similar non-heat set textured yarn almost by 25%. Denier as well as mechanical properties of heat set yarn were also found to be better, along with reduction in boiling water shrinkage due to heat relaxation.

9. Two distinct groups of yarns, viz; Nylon and Polyester of different yarn denier, denier per filament, cross-sectional shape, type of finish and number of filaments within each group were used to study their effect on the structure and properties of mechanical textured yarns. At comparable false twist level formation of uniform small size curls for finer filament yarns irrespective of type of material used in the form of closed or crossed curls have yield curls of higher frequency thereby exhibited higher bulk factor (Θ) and increased linear density. Presence of more number of finer filaments during bulking has enhanced degree of intermingling; thereby 70d polyester yarn has exhibited better stability and bulk as compared to equivalent nylon yarn but with coarser constituent filaments. Nylon yarn with finer and trilobal cross section filaments has executed poor strength realization compared to others as they were more prone to drawing and twisting action resulted in more obliquity inside the yarn structure. As a consequence of this finer dpf and trilobal cross-section nylon yarn has executed highest extension at break. Percent spin finish value for all the samples under study were almost identical. No profound difference in the behavior for either group of yarn has been noticed for negligible

difference in spin finish. Thus limitations of availability of the sample has restricted in exploring response of some material variables like spin-finish, dull yarn etc towards new system.

10. Finer single end yarn has exhibits smaller curls with a higher crimp frequency at a constant pre-twist level resulted in increased bulk, denier, extension, instability and reduction in tenacity.
11. With the increase in number of filaments of same fineness, more efficient intermingling is observed, thereby yarn with two fold constituent filaments is found more stable than single yarn. But further increase in the number of ends from two-end to three-end, the yarn instability value has again increased. This has happened due to excessive increase in the filament frictional contact that has reduced its mobility. Also use of coarser yarn has reduces area of contact between filament and false twist spindle (magnetic-pin) during texturising, resulted in poor mingling as well as crimpiness.
12. All the fabrics under consideration prepared either from the textured yarns or feeder yarns were all plain woven. Hence the effect of different weave is not reflected in this study. The constructional parameters (reed, warp count, pick density) for all the fabric samples were also kept identical. Thus fabric properties were greatly influenced by type of weft used and its characteristics.
13. Higher fabric width shrinkage was exhibited by the fine denier weft yarn with higher boiling water shrinkage and crimp properties. Owing to better crimp properties and higher boiling water shrinkage false-twist textured weft yarn fabric has

executed highest fabric width shrinkage. While post heat set mechanical textured weft yarn fabrics were end up with less fabric width contraction due to heat stabilization of part of boiling water shrinkage of mechanical textured yarns.

14. Finished fabric sett values have been changed in direct proportion to width shrinkage, although kept constant on the loom. Constituent yarn deniers also get increased in direct relation to their crimping power and twist contraction apart from their shrinkage during wet processing, this effect was more profound with textured weft yarn fabrics as compared to flat feeder one. As a consequence of increased sett value and constituent yarn deniers, fabric thickness and weight per unit area have been increased. Rise in these values is more with coarser textured weft yarn fabric. Contradictory behaviour has been observed for false-twist textured weft yarn fabric mainly attributed to its greater mobility, not allowed it to sustain weaving and finishing stresses without getting deformed.
15. Independent of amount of pre-twist pertained by yarn and whether it was post heat set or not, mechanical textured weft yarn fabric has exhibited higher physical-bulk as compared to equivalent fineness false-twist textured weft yarn fabric. This is due to presence of real twist in newly designed yarn allowed it to resist more to the stresses imposed during weaving and finishing as compared to mobile twist-free false-twist textured yarn structure.
16. Higher fabric bulk was observed with higher pre-twist single end as well as double end 100/48 weft-yarns fabrics as compared to respective low pre-twist weft yarn fabrics. As

compact weft yarn structure at higher pre-twist level has enforced constituent warp to follow longer bend length, resulted in increased warp linear density for constant finished fabric sett. This was resulted into more increase in weight per unit area and thickness of fabric. Post heat setting for mechanical textured weft yarn has released torque of yarn before weaving and thereby resulted in low values of fabric width-shrinkage, fabric sett value as well as constituent yarns denier on finishing. This has diminished bulk of the fabric.

17. For identical material and process parameters high pre-twist textured weft yarn fabric, viz; F2 and F4, has exhibited more strength as well as CAF value as compared to low pre-twist textured weft yarn fabric, viz; F1 and F3. This is mainly due to preferable increase in cohesive forces amongst constituent filaments in yarn matrix, allowed to delay rupture. Fabric with higher warp crimp has executed higher warp way strength and hence type of warp was kept constant for all fabrics under study, there was no pronounced difference found in the weft crimp value. Extension that took place in warp and weft direction was usually of higher order of magnitude than the extension of constituent yarns.
18. Grouping of threads on width wise shrinkage and yarn strength in the direction under consideration have played an important role in deciding tear behavior of the fabric. Thereby fabrics woven with low pre-twist textured weft yarns, viz; F1 and F3 have exhibited comparatively lower rise in tear strength as compared to high pre-twist mechanical textured yarns, viz; F2 and F4. Textured filler yarn fabrics have shown higher tear

strength value as compared to their respective flat feeder filler yarn fabric except for false twist textured yarn. Increase in tear strength of fabric on the use of mechanical crimp texturised weft yarn was mainly attributed to increase in weft-shrinkage and higher weft yarn strength owing to pre-twist. Although weft-shrinkage was more, weaker false twist textured yarn fabric was unable to show rise in tear strength as compared to stronger feeder weft yarn fabric.

19. For all the selected samples higher abrasion resistance value was accounted for untextured feeder yarn fabrics as compared to textured filler yarn fabrics due to the flat surface offers larger cover area at the point of abrasion. Higher mobility of false twist textured yarn has allowed it to undergo for more abrasion cycles for complete abrasion as compared to compact mechanical textured yarns. With increase in pre-twist, yarn became more compact, held more tightly against abrader, and resulted in reduced number of abrasion cycles for the selected group. Presence of higher number of similar filaments incorporated for coarser feeder weft yarn into a fabric has conferred better abrasion resistance.
20. Reduction in the air permeability values for all the fabrics, woven with textured weft yarn in comparison with respective feeder weft yarn fabrics was recorded. Mainly attributed to porosity of the constituent yarns and air gaps between the constituent yarns after interlacement. Fabric woven with higher pre-twist textured weft yarn has exhibited higher air permeability than the fabric woven with low pre-twist textured weft yarn. Low air permeability was recorded for coarser weft yarn fabric as

- compared to finer weft yarn fabric. Textured weft yarn on heat setting has shown reduction in air permeability as compared to respective non-heat set textured weft yarn fabric.
21. Low bending rigidity and drape values were recorded for limpy and light-weight structure of false-twist textured yarn fabric as compared to respective flat yarn fabric. Presence of pre-twist in mechanical textured yarn has added to stiffness thereby increased drape and stiffness values of the fabric. Rise was more at higher pre-twist level. Textured yarn on heat setting has exhibited more stiffness values in the present study.
 22. Warp yarn used being identical for all the textured as well as their respective parent yarn samples. Thereby compared to parent weft yarn fabric for textured weft yarn fabric uniform rise in warp-way crease recovery angle has been reported, viz; 123° to 128° . While weft-way crease recovery angle has been increased in direct proportion to bending rigidity or thickness of the fabric under consideration.
 23. Higher knitted hose bulk was reported for low pre-twist textured yarn produced at the same false-twist level. Bulk has been reduced on increasing pre-twist level due to increased compactness. For equivalent process and material parameters, post heat setting of textured yarn has reduced knitted hose bulk further. Thickness value has been increased in direct proportion to false-twist for a constant pre-twist level.
 24. Cost per kg. of the newly designed product (excluding other costs) is found to be higher than cheaper false-twist textured yarn as well as mechanical air jet textured yarn. However this comparison is not realistic as cost values considered for

commercial systems are coming from full flange shop-floor production data whereas for the new system refers to single head lab model machine only. This difference has created a drastic gap for major contributors to the product cost, viz; power values as well as delivery speed for equivalent yarn, for lab apparatus. Optimisation of size and mass of machine variables and use of sophisticated driving modes will allow increased output speed as well as reduction in power consumption. This will make this fascinating product further economical and to the valid comparison.

Recommendations for Future work

This concept of texturising is a completely new one, there is no precedence or any recorded observations on its performance. Hence there are several areas, which can be focused and studied in details to get innovative and interesting results. But those were left for further studies, and not included in the present work, e.g. "Effect of type of false-twister".

As the results suggest, the role of false-twist in improving texturising quality is attributed to the characteristic differences in yarn geometry. The behaviour of parent yarn of various bending rigidity and torsional rigidity have pre-dominant effect on the product yarn structural characteristics at identical false-twist and pre-twist levels. Thus under proper texturising conditions, blended yarns with very uniform blend uniformity can be produced. Similarly blend variations to produce fancy effects can easily be achieved through manipulations of the texturising process. Thus, a wide range of variations in the colour and texture can be achieved through suitable choices of filament types and proportions, and different levels of pre-twist, false-twist and under feed conditions. Such a study to explore the blending potential of innovative texturising process is needed to further the scope of mechanical crimp textured yarns as replacements for spun yarns.

Presence of pre-twist in textured yarn structure imparts compactness. Thus yarn possessing moderate bulk and well locked curls found compatibility as sewing thread as well as embroidery thread without the fear of snagging at needle. Similarly in the absence of undue obstruction to needle movement, fabric produced out of newly textured yarn as filler can offer better option for the basic

cloth for embroidery. Thus assessment of innovative yarn produced at different pre-twist as sewing thread as well as embroidery thread and base-fabric for embroidery should form the basis of future studies.

However characterization of bulk needs more detailed scrutiny as none of the methods developed so far are totally satisfactory.

It is no more be exaggerating to mention at outset that, the present work just show the beginning of new concept only. Systematic and intense work on this concept will open up a new horizon, which is worth exploring.