

## **CHAPTER- 5**

### **RESULTS AND DISCUSSIONS**

#### **5.1 COMPARATIVE PROPERTIES OF PET MOTHER YARN 240/12**

After modifying the PET FDY spinning line, 240/12 mother yarn is taken in production. All chemical and physicals testings are made in respective laboratories. Physical testings of new spinning line mother yarn and imported TOPLON mother yarn are also carried out. Test results are summarized in table no. 5.1 and following observations are made.

- i) The coefficient of variation in denier results of modified line mother yarn is on the higher side as compared to the new spinning line and imported TOPLON mother yarn which may be due to combining of 6 ends from two spin packs and then winding the yarn bundle of 240/12 on one package at take-up. Whereas in the case of a new spinning line and imported TOPLON mother yarn all 12 filaments are taken from single spin pack.

However, results are within the control limit of  $\pm 3$  s.d. (standard deviation)

In the case of modified mother yarn --  $\pm 2.30$  s.d.

In the case of new spinning line mother yarn --  $\pm 2.0$  s.d.

In the case of imported TOPLON mother yarn --  $\pm 1.64$  s.d.

Industrial practice is to accept  $\pm 1.5\%$  from target value i.e. acceptance limit for 240/12 denier is  $\pm 3.6$  denier.

- ii) Tenacity (g/d) and % elongation results at break are comparable with new spinning line mother yarn and imported TOPLON mother yarn as such no significant difference is observed.

- iii) In table no. 5.1 Sr.no.3, T-10 (tenacity at 10% extension) values are given which has its significance in downstream operations. It indicates the strength of the mother yarn in further operation where 5-10% extension takes place.
- iv) Results of % Uster of imported TOPLON mother yarn is on better side as compared to indigenous mother yarn. However, results are comparable but the difference in the results observed may be due to following reasons:-
- a. In modified line mother yarn 12 filaments are taken from two spin packs whereas in the case of new spinning line mother yarn and imported TOPLON mother yarn all the 12 filaments are taken from a single pack.
  - b. Present modified line is running on old modified winders and also quench air velocity is high i.e. 0.8 m/s in place of 0.5 m/s which is creating more turbulence in quench zone causing higher % Uster.
- v) There is hardly any difference in boiling water shrinkage values of modified yarn, new spinning line yarn and imported TOPLON mother yarn which is as expected. Boiling water shrinkage is a manifestation of the thermal history of polymer and drawing.
- vi) Oil pickup % (OPU) and uniformity of spin finish application on the surface of the filaments is very important for downstream operations of mother yarn i.e. performance at splitting stage and other further operations.

The spin finish application system is modified from jet spray system to kiss roll application system which is best suited for uniform application throughout the surface of the filaments. It helps greatly in the splitting of the mother yarn to produce monofilament 20/1.

Shore hardness of all three sources of mother yarn bobbins is around 55<sup>0</sup> which is sufficient for transportation and smooth unwinding, however,

there is further scope to produce packages up to 60<sup>0</sup> shore hardness which further helps to avoid transit damage.

**Table 5.1 Comparative properties of modified, new spinning line and imported TOPLON mother yarn**

Sr. No.	Properties	Unit	Modified FDY line		New spinning line mother yarn	Imported TOPLON yarn
1	Denier	Number	Average	241.17	241.02	241.06
			SD	0.766	0.665	0.547
			CV	0.317	0.276	0.227
			Target	240.5	240.5	240.5
2	Tenacity	Grams/denier	-	4.57	4.70	4.75
3	T-10	Grams/denier	-	3.51	3.65	3.70
4	Elongation	%	Average	26.58	26.7	26..28
			SD	1.37	1.06	0.85
			CV	5.17	4.0	3.2
			Target	26	26	26
5	Uster	%	Average	1.6	1.5	1.4
6	Shrinkage (boiling water) SH	%	Average	6.57	6.0	5
			Target	6.5	6.0	6.0
7	OPU	%	Average	0.89	0.90	0.90
			Target	1.0	1.0	1.0
8	Shore Hardness	Degree	Average	53	53	55

## **5.2 SPINNING PERFORMANCE**

Data of spinning performance of mother yarn of modified line and new spinning line are summarized in table no. 5.2

**Table 5.2: Spinning performance of modified and new spinning line mother yarn**

Item	Modified machine	Original machine
Breaks/Ton	1.2	0.8
Waste %	2.5	1.5
Full bobbin %	90	93
% Efficiency	97.5	98
% First grade	94	98

The performance of modified line is slightly inferior as compared to new spinning line mother yarn which can be due to following reasons:-

Being a new product, operators are not trained enough

In modified quench chambers with higher quench air velocity creating more flickering of filaments ultimately causing more breaks.

In modified line % waste is higher by 1% which can be further reduced by further optimizing quench conditions and thus controlling the spinning line tension. In due course of time operators will become used to operate modified line on this denier and thus further reduction in % waste at spinning is possible.

### **5.3 COMPARATIVE PROPERTIES OF MONOFILAMENT OF DIFFERENT SPINNERS**

Looking the results of monofilaments of different spinners it is observed that results are quite comparable and performance of weavers in downstream operations was found to be quite comparable except performance at the splitting stage.

**Table 5.3: Properties of monofilaments of other spinners**

Sr. No.	Supplier	Product	MONO YARN PROPERTIES				
			Den.	% Elong.	Ten.(GPD)	T10(GPD)	% BWS
1	GARDEN (modified)	240/12 FB PET	20.07	25.43	4.63	3.34	8.75
2	TOPLON (imported yarn)	300/10 SD PET	29.87	32.56	4.07	2.77	7.74
3	TOPLON	300/15SD PET	20.03	27.5	4.58	3.3	8.02
4	TOPLON	300/10 SD	30.03	27.39	4.56	3.31	8.21
5	TOPLON	200/10 SD PET	20.03	24.92	4.69	3.58	8.75
6	J.KORIAN (new spinning line)	240/12 SD PET	19.93	24.76	4.35	3.46	9.96
7	SHUBHLAXMI (new spinning line)	240/12 SD PET	19.89	24.16	4.64	3.53	8.04

## **5.4 SPLITTING PERFORMANCE:**

The most crucial aspect in the production of monofilaments through mother yarn is its performance at the splitting stage. Therefore utmost care is to be taken at spinning on following points:

- (a) Quenching should be slow, proper and sufficient.
- (b) The spin finish should be applied properly throughout the surface of the individual filaments.
- (c) Special spin finish oil (low friction and low cohesive type) is required which helps in the splitting of filaments from yarn bundle.
- (d) All the filaments in the yarn bundle should maintain parallelism without any twist and turns to avoid any problem in splitting of mother yarn into monofilaments.

In the following table comparative performance of imported, original and modified line mother yarn at the splitting stage is given. From the study, it is very much clear that the performance of imported mother yarn at splitting stage is quite superior as compared to original and modified line mother yarn. However, the performance of modified line mother yarn is quite comparable with original line mother yarn.

**Table 5.4: Comparative performance of 240/12 PET mother yarn of different spinners at splitting stage**

Supplier	Product	Length / Per kg	Breaks /Creel	Remarks
Toplon	240/12 SD	450000 meter	2 ~ 4	Toplon imported mother yarn
	240/12 Brt.	450000 meter	4 ~ 10	
J Korian	240/12 SD	450000 meter	10 ~ 12	Original line mother yarn
Subh Laxmi	240/12 SD	450000 meter	10 ~ 12	Original line mother yarn
Welspun	240/12 SD	450000 meter	10 ~ 12	Original line mother yarn
Geelon	240/12 SD	450000 meter	12 ~ 16	Modified FDY line mother yarn
Garden	240/12 SD	450000 meter	12 ~ 30	Modified FDY line mother yarn

It is clear from the table 5.4 that splitting performance of semi-dull and bright 240/12 of the same spinner (imported TOPLON) is not same and there are more breaks in case of bright 240/12 mother yarn which may be due to its special cross section.

Modified 240/12 mother yarn of Garden, performance is comparatively poor as compared to original line mother yarn of J. Korian, Subhlaxmi, and Welspun company. It may be due to our limitation of quench chamber length and old modified winders at take-up. However, the quality of monofilament 20/1 form modified line yarn is comparable from monofilaments of original line mother yarn.

Items like groove guides, traverse guides, tension bar guides, oil rollers, spinnerets and quench chambers for modification are imported from CERATEC (South Korea). Old winders are modified at garden itself by incorporating 4 end traverse cam arrangement of winding instead of 8 end bi rotor winding system.

## **5.5 COSTING OF MATERIALS REQUIRED FOR MODIFICATION OF PET FDY LINE**

Cost of different items required for modification both imported and indigenous are summarized below in table 5.5

**Table 5.5 Costing of materials required for modification (1 USD = Rs.68 )**

QTY Imported Items	DESCRIPTION	USD/Per Unit	USD
26	Winder modification	8000	208000
50	Groove Guide for Mother Yar	165	8250
1000	Traverse guide for Mother Yar	2	2000
50	Tension Bar guide for Mother Yar	70	3500
75	Bar guide fixing unit for Mother	40	3000
50	Groove guide fixing unit for Mother	40	2000
24	Oil Roller (Dia.180xL260mm) for Mother	1050	25200
300	Spinneret	45	13500
24	Quench chamber for mother yar	2580	61920

**Total= USD 327370**

**= Rs 22261160**

Indigenous items

Miscellaneous, tension meters, guides and brackets

**=Rs2000000**

**Grand total = 24261160**



## **5.6 INDUSTRIAL APPLICATIONS OF PET MONOFILAMENT**

Following are the industrial applications of PET monofilaments:

- Filter cloths, Zippers, Brushes, Sport-industry, Automobile industry, Agriculture-industry, Geo textiles, Medical Textiles ,Air bags, Heavy duty tires, Intimate apparels, Swim wears, Dress materials, Sarees and other technical textiles.

Following is the list of Technical textiles where PET monofilaments are used:

- Electrical cables, 3D printer filament, Eye wear retainers, Industrial fastening systems, Threads, woven or knitted narrow fabrics, Double wall tank inter layers, Braid reinforce medical tubing, Circular knitting needle cables, Waste water filtrations treatment systems, Braided ropes and cords , Mist eliminators/ stack scrubbers, Auto mobile air filter structure, Woven flexible conduit, Fish hatchery pond protective netting, Dental applicators, Automobile fabrics, Non-roll waste-bands, fishing nets, mosquito nets, Weather seals ,Various medical devices, Ultra-violet stabilized, Infusion flow reinforcement textiles, Hook and loops fastening systems , whisker disk.

## **5.7 FABRIC TESTING AND RESULTS**

240/12 PET mother yarn, produced on modified FDY Spinning line, is supplied to different consumers near Surat. Weavers are using 20/1 PET mono filaments after splitting 240/12 mother/parent yarn.

These mono filaments after splitting at high-speed splitters are used to prepare different quality of fabrics by using various yarns as WEFT on power looms. Normally simple plain weave is taken for such fabrics.

A very famous quality of 20/1mono x 20/1mono, known as bolting cloth is used as filter cloth in the industry.

20 fabric samples are collected from the market where 20/1 mono PET is used as WARP or WEFT on the different type of looms to produce various type of qualities.

Six fabric samples are tested for bursting, tensile and permeability test at the textile lab of Textile Engineering Department of MS University Vadodara.

Results are summarized in the following table.

**Table No 5.6 Results of Bursting Strength in Kg/cm sq.**

Sample No	Readings	Average Kg/cm sq
1	8.91,8.04,9.03	8.66
6	9.28,9.56,8.96	9.26
17	9.33,9.69,9.00	9.34
18	10.08,9.59,9.99	9.88
19	10.65,10.63,10.86	10.71
Knitted Sample	6.08,5.93,5.86	5.95

**Table No 5.7 Air permeability values in m<sup>3</sup>/m<sup>2</sup>/hours at 100 Pascal's.**

Sample no	Observations	Average
<u>1@100</u> Pascal's	4900,5000,5200,5200,5100	5080
<u>18@100</u> Pascal's	3700,4000,3800,4200,3700	3880
<u>19@50</u> Pascal's	4800,4400,4800,4200,4200	4480

**Table no 5.8 Tensile Strength (Strip width 2cm.)**

Date	Batch Reference	Sample Reference	Speed m\m	Maximum Load in kgf	Deflection of max. load in mm.	Gauge Length in mm
3/20/2017	Sample 1	WARP	100.00	5.7877	18.079	10
3/20/2017	Sample 1	WARP	100.00	6.1457	22.497	10
3/20/2017	Sample 1	WARP	100.00	5.3658	19.645	10
3/20/2017	Sample 1	WEFT	100.00	21.709	20.162	10
3/20/2017	Sample 1	WEFT	100.00	21.786	24.499	10
3/20/2017	Sample 17	WEFT	100.00	22.353	26.773	10
3/20/2017	Sample 17	WARP	100.00	9.2380	33.300	10
3/20/2017	Sample 17	WARP	100.00	9.1920	37.884	10
3/20/2017	Sample 17	WARP	100.00	9.3652	34.218	10
3/20/2017	Sample 17	WEFT	100.00	18.199	9.0294	10
3/20/2017	Sample 17	WEFT	100.00	17.459	9.4052	10
3/20/2017	Sample 6	WEFT	100.00	19.373	9.8053	10
3/20/2017	Sample 6	WARP	100.00	14.384	48.624	10
3/20/2017	Sample 6	WARP	100.00	13.531	46.624	10
3/20/2017	Sample 6	WARP	100.00	17.383	47.606	10
3/20/2017	Sample 6	WEFT	100.00	16.524	19.170	10
3/20/2017	Sample 6	WEFT	100.00	16.859	19.296	10
3/20/2017	Sample 19	WARP	100.00	7.2194	18.505	10
3/20/2017	Sample 19	WARP	100.00	6.4141	25.161	10
3/20/2017	Sample 19	WARP	100.00	5.7078	25.204	10
3/20/2017	Sample 19	WEFT	100.00	25.095	20.769	10
3/20/2017	Sample 19	WEFT	100.00	26.289	29.162	10
3/20/2017	Sample 19	WEFT	100.00	26.455	26.037	10
3/20/2017	Sample 18	WEFT	100.00	28.762	29.060	10
3/20/2017	Sample 18	WEFT	100.00	26.925	26.045	10
3/20/2017	Sample 18	WARP	100.00	28.380	25.903	10
3/20/2017	Sample 18	WARP	100.00	8.8332	26.760	10
3/20/2017	Sample 18	WARP	100.00	8.0575	27.724	10
3/20/2017	Sample 18	WARP	100.00	8.7915	29.584	10

