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TEXTILE DEVELOPMENT CENTRE, PHASE II

DP/EGY/77/008

EGYPT

# Technical report: Production of Polyester Fibre*

Prepared for the Government of Egypt by the
United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Ivan-Kresimir Spanič
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United Nations Industrial Development Organization
Vienna

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V.85-32383

## EXPLANATORY NOTES

The monetary unit of Egypt is the pound (LE). During the period covered by this report, the value of the Egyptian pound was as follows:

| | |
|---|---|
| 06.08.1985 | US$ 1 = LE 1,253 |
| 21.09.1985 | US$ 1 = LE 1,330 |

In addition to abbrevations in common use, the following are also used in this report:

| | |
|---|---|
| PES | Polyester Fibres |
| M.R. | Misr Rayon Co. Kafr El Dawar |
| T.D.C. | Textile Development Centre |
| T.S. | Technical Service |
| D.M.T. | Dimethyl Terephthalate |
| E.G. | Ethylene Glykol |
| C-Type | Polyester Fibres Cotton-Type |
| W-Type | Polyester Fibres Woollen-Type |
| P.O.Y. | Partially oriented yarn |

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## ABSTRACT

The title of the project is 'TEXTILE DEVELOPMENT CENTRE PHASE II' and the number of the project is DP/EGY/77/008. The duration of mission was eight weeks. The purpose of the mission was to visit the only PES producer M.R. in Egypt, to study all the quality claims raised by local and foreign customer from its PES production and in addition give practical advice on how these problems can be overcome and how to increase the quality of the product.

In this report is presented a long list of the practical advices. The objective of these advices is to keep the technological parameters in necessary limits to insure the PES production of good quality. Besides this there is also a list of improvements: filtration E.G., filtration D.M.T. - melt, filtration $TIO_2$ - suspension, decreasing $TIO_2$ content in fibre, pressure-measuring in spinning-packs, delivery-testing of spinning pumps, tow-spraying with water, instruction for cleaning of finish-system and instruction for determinations of crimps stability and crimping degree. All these improvements will facilitate the production and increase the quality of PES. From the economical point of view there are proposals for waste from air quench ducts, for knives-grinding and for regeneration of total waste by production of black spun-dyed W-type PES. Also is pointed out the need of increased T.S. activity and co-operation with customers. Further follows the findings at textile mills and advices for processing. At the end some activities for T.D.C. such as fibre testing, short-term application trials, standards for PES and investigation of Egyptian market for the benefit of producers as well as consumers in Egypt are mentioned.

## TABLE OF CONTENTS

ANNEXES

## INTRODUCTION

M.R. started with PES production in 1981 according to 'know-how' from 'Rhone-Poulenc' France and engineering from 'Citex' France. The capacity per year is 26000t; 86% high tenacity and high-modulus C-type and 15% standard antipilling W-type. Polymerization is continuous and starts from D.M.T. and E.G. The reactor for pre-esterification and reactor for glykol-removing are common and after there are two polycondensation lines for C-type and one polycondensation line for W-type. In addition is melt-(direct)-spinning; two spinning lines for C-type and spinning-line for W-type. Further follows two drawing-lines for C-type and one drawing-line for W-type. There is also a department for tow dyeing and conversion into tops.

In 1984 M.R. started also with polyester filament production, according to 'know-how' from 'Rhone-Poulenc' France. They start from chips and produce 10t/day POY which is textured.

I visited M.R. 15 times and had discussions with factory engineers.

The processing of PES is new for Eygptian textile mills. Besides this they have a lot of claims on the PES quality. Therefore, I visited also 5 textile mills to see and find out the reasons for claims either in the quality or the inadequate processing of PES in question.

# I. VISITS TO MISR RAYON

## A. POLYMERIZATION

### 1. Findings

a) EG-feeding without filtration. Eventual impurities reach in the polymer. This clogs the packs-filter and shortens the packs-life. Also may damage the spinning pumps.

b) DMT-feeding without filtration. The same effect as in 1a).

c) $TiO_2$ suspension feeding without filtration suspended $TiO_2$ particles tend to form agglomerates although the $TiO_2$ powder is during the manufacturing treated wth one suspension - additive. The same effect as in 1a).

d) The $TiO_2$ content in semi-dull fibre from 0,50± 0,01% is too high. This causes the increasing number of breakages during the spinning and drawing. Further, the damage effect through the abrasion is bigger on the coiller, six roller capstan, stand I, II and III, calender and crimper. Especially it shortens the exchange cycle for the knives on the cutter and damage all parts on the processing machines.

e) The $TiO_2$ content in the feeding solution fluctuates from 20% - 24% causing the fluctuation of $TiO_2$ content in fibre from 0,41% - 0,62% so high $TiO_2$ content variation in the fibre during the production and processing.

f) The fluctuation of polymer viscosity on

| | | |
|---|---|---|
| C-line | $[\eta]$ | = 0,628 - 0,653 |
| W-line | $[\eta]$ | = 0,526 - 0,633 |

is too high and causes the different spinnability and drawability of melt polymer and fibre, and end result is the variation in the fibre properties.

g) Different raw materials suppliers. This causes the difference in the quality of feeding material which may have bad influence on the production. It is well known that quality of raw material may vary even from the same producer. Further entering-quality-test does not always give all the necessary analysis dates.

### 2. Recommendations

a) Install before EG-feeding two 50$\mu$-filters (one standby) basket or candle type from glass fibres or metal sieves.

b) Install before D.M.T. feeding two 100$\mu$-filters (one standby) basket or candle type from glass fibres or metal sieves.

c) Install before $TiO_2$ suspension feeding two 50$\mu$ filters (one standby) basket or candle type from glass fibres or metal sieves.

d) Decrease the $TiO_2$ content in the semi-dull fibre to 0,40%. It should be done step wisely. On the first step to 0,45% and on the second step to 0,40%. Contact the finish supplier for eventual correction in the finish composition or content level.

With the decreasing of $TiO_2$ content from 0,50% to 0,40% should be achieved by the next objectives:

- the production cost will decrease for about 50,000 LE per year at actual price level;
- the damage through abrasion will decrease during the production and processing.

e) The $TiO_2$ feeding suspension should have concentration from 20-22%.

f) The utilities for steam ejectors water steam and cooling water to ejector condenser should be in necessary limits e.g.

| | | |
|---|---|---|
| steam pressure | $\geqslant$ | 10 bar |
| cooling water | $\leqslant$ | 14$^{o}$C |

In this case the polycondensation reaction will take place accordingly and fluctuation of average polymer molecular mass will varies less e.g. less variety in the viscosity and better spinning and drawing phases.

g) Conclude the long range contract with the D.M.T. and E.G. supplier and price should be agreed every quarter on the world level. Do not change $TiO_2$ and catalysts supplier when their products are giving good production results also in the case that the prices are higher.

## B. SPINNING

### 1. Findings

a) Open windows on the spinning machine level. The cooling of spinning machine is uncontrolled and may cause the breakages during the spinning or changes the drawability of tow, and end effects may be the variation in the fibres characteristics.

b) Three spinning positions on C-line 3 were uncovered with the insulation. The troubles are caused as in 1.a) above.

c) On the C-line 3 three spinning positions are not operating. So in one batch the flow of melt is not constant and is partially obstructed. It prolongs the dwell of the melt part on the high temperature and unavoidably the thermal degradation reactions take place. The result is the dropping of the average molecular mass and the melt viscosity. Also the cross linking between the molecular chains may occur and the gel quantity may increase. All efforts mentioned before may cause troubles in the spinning phase thus increasing breakages and decreasing the packs life e.g. the increasing of the pack exchange ratio. Also this changes the drawability of filament, caused by different orientation during the spinning.

d) The upper part of the air quench duct around the spinnerets is plenty of dust (powder of terephthalic acid and oligomers). Especially during the spinneret cleaning this may fall in the tow and cause trouble later.

e) The lower part of the air quench duct is not closed in the same manner on all positions as it should be. If the bundle of the formed filaments do not fall steadily then this car result in breakage or at least in unparallel distribution of the individual filaments in the tow. Later, during drawing, filament to filament frictions is increased which can cause breakage of individual filaments. Also unparallel distribution of the filaments in the tow hampers the smooth drawing procedure which results in the variation of drawing degree and ultimately variation in final fibres characteristics.

f) The take up machine has plenty of undrawn filament which may fall in the tow and either obstruct the drawing phase or remain undrawn causing the dyeing defect in fibre.

g) The tow coiller is damaged and this directly generates filament breakages. The ends of broken filament appear in the final product as undrawn fibre and dyeing defect. Also these ends obstruct the drawing and crimping phases and may be the cause for the fused fibre. Since the undrawn fibre or partially drawn fibre have lower softening point so the probability for fusing is bigger than at normally drawn fibre.

h) The device for can rotation is making deviations so the depositing of tow is irregular with all troubles mentioned in the case of unparallel filament distribution in the tow.

i) The overloading of 2nd roller of capstan on the take up machine.

j) The finish system is not properly cleaned. The finish components are fats and oils emulsified in the water. With increased wear and tear the finish components are accumulating deposits in the system. On the one hand this results in irregular finish of the fibre and on the other the finish components are degradating. Both effects cause extreme changes on the characteristics of the finish itself and also on the quality of the fibre. The result will cause problems in the production and certainly during processing of the fibre in the textile mills.

k) No measuring of pressure of the melt in the pack is practised. Without this measuring it is impossible to follow the quality of polymer melt delivered from the polymerization department nor to organize time pack exchange, necessary to avoid the deformations of spinnerets and to control the pack assembling.

l) Owing to the above mentioned deficiencies, spinnerets are damaged frequently and cannot be utilized.

m) There is no control of spinning pumps delivery, resulting in increased slippage in the pumps and in decreased delivery. The result fineness fluctuation of the fibre and also the fluctuation of the end characteristics.

n) The entering door for the area where the cans are located is open continuously. During the tow formation for the drawing section uncontrolled streams of air are coming in directly on the tow. The movement of the individual filament in the partially dried tow is irregular, with all its negative influences on the drawing phase.

o) Low moisture content in the tow causes the same effect as under 2.0.

p) The wasting of the waste from the air quench duct is simply a loss of money.

q) The manager of the spinning department has not received any training by Rhone-Poulenc. Action to send him to a 2-3 man-month training course should not be delayed.

## 2. Recommendations

Many defects can be avoided by implementing the following recommendations:

a) Close the windows and take care that the temperature on this level should be at least 30-35°C.

b) All spinning positions must always be covered with insulation whether they are in operation or not.

c) Check if all spinning positions are ready for operation as soon as possible.

d) Clean the upper part of the air quench duct periodically.

e) Close the backside of all air quench ducts as it was originally installed.

f) Periodically clean the take-up machine.

g) Replace the coiller.

h) The maintenance crew should repair the can rotating device.

i) If the maintenance department cannot repair the 2nd roller overloading then replace the existing motor with a stronger one.

j) The spin finish system has to be cleaned periodically every one or two months according to the next procedure: circulate for 3 hours 10% NaoH water solution at 70-80°C. Proceed at first with hot water 70-80°C circulation for the next 2-3 hours and after with ambient water temperature for 1-2 hours.

k) Contact the pack supplier and agree about production quality of 10 packs special designed to insure the melt pressure measurement in the packs. Instrument engineering staff will have to make the necessary connection. The pressure indicator to be placed on the spot on the bench and the pressure recorder in the control room. Measure the pressure at the end positions of the bench and on the first and third bench. When the pack pressure reaches 200 bar exchange the pack.

l) With measuring under 2.k) the deformation of spinnerets will be avoided.

m) Purchase the testing device for the spinning pumps to measure metering accuracy and slippage before the spinning pumps are employed in the virtual spinning process. Send the specifications of existing pumps (for staple fibre and filament) to the firm:

Feinprüf GmbH
Postfach 1853
D-3400 Goettingen
Federal Republc of Germany

Tel.: (0051) 7073-0
Telex: 96845.

n) Keep the entering door closed.

o) Make a construction to insure spraying water on the tow leaving the coiller. Take care about dwel time of cans to avoid the water on the can bottom.

p) Contact firm 'Condux' in F.R. Germany or another similar producer and agree about delivery one special machine - so called "compounder" for removing bulky waste from air quench ducts by transforming it into granules by heat and pressure so the waste from air quench ducts should be ready for selling.

## C. DRAWING

1. Findings

a) There is no possibility to check the temperature on the roller surface. Actually the temperature on the roller surface of stand II, calender and stand III is unknown. So it is very difficult to regulate the drawing phase and it is impossible to make the slight change in the heating ratio with objective to improve some final characteristics.

b) The surfaces of the roller stand II on the W-line and both c-lines are damaged and have channels caused by the $TiO_2$ abrasion. This directly causes the filaments breakages and irregular drawing with all negative effects already mentioned under 2.e).

c) The crimper on the W-line was not operating correctly. Half of the tow was crimped well and the other half was very poorly crimped. Uneveness in the crimping degree gives the fibre different opening performance and processing troubles.

d) The upper crimper plate on the W-line is damaged and generates the filaments breakages. The broken filaments appear in the final fibre as the overlength fibre or may increase friction during the crimping resulting in overheating and possibility for fusing.

e) There is no device to sharpen the knives for the cutter.

f) Used and blunt knives from the cutter are rejected. It is loss of money.

g) Manager of drawing department was not trained at the Rhone Polenc in France.

h) There are too many breakages in the drawing sections of all lines. These interruptions in the production process cause a large deviations in the final fibre characteristics. Besides this cause the fibres to fuse.

i) On ceramic tow guides in the cans creel I found undrawn filaments, which may fall in the tow and either obstruct the drawing phase or remain undrawn or partially drawn causing the dyeing defects in fibre.

2. <u>Recommendations</u>

a) Purchase a transportable instrument for measuring the temperature on the roller surface.

b) Repair the surface of the roller stand II.

c) Control the crimping effect on the tow and make readjustments of the crimper when necessary.

d) Inspect periodically all crimper surfaces and replace them, if necessary.

e) Purchase the grinder for the knives grinding. Now, after cutting 15-20 bales knives are replaced and rejected. With a grinding device knives could be resharpened 4-6 times which save costs and increase the cutting quality.

f) Save used and blunt knives till grinder is purchased.

g) Contact the Rhone-Poulenc to send the manager of the drawing section for training in France for some months.

h) To avoid frequent breakages in the drawing section, it is necessary to keep all technological parameters within the limits according to know how or experience.

i) Periodically clean the cans creel.

## D. CHEMICAL AND TEXTILE CONTROL

### 1. Findings

a) There is a need for an additional apparatus to determine the finished fibre content. The actual method does not always give absolute finish content on the fibres. Since the role of finishing is extremely important it is necessary to know the actual finish content. Also it is recommendable to have a possibility to control the routine analysis.

b) No analysis for crimps stability and crimping degree is carried out. The crimps stability has an extremely big influence on the processibility of the fibres. Therefore, it is necessary to measure these characteristics. The crimps number per length can be the same for two bales of fibre, but due to the variety in the crimps stability there may be difficulties during processing in cotton textile mills.

c) The air-conditioning in the textile laboratory is not sufficiently controlled. Therefore testing results are not reproducible.

d) Both laboratories are too small.

e) It is unusual that the entrance to the textile laboratory is through the chemical laboratory. Evaporation from the chemical laboratory is entering into the textile laboratory and this may change the air-conditioning and testing results. Also it is unusual that the laboratories have no possibility of getting daylight.

f) The expensive gas-chromotograph in the chemical laboratory needs maintenance. The instrument will soon be out of order due to corrosion.

g) Sampling of the final products for textile laboratory needs to be introduced. Representative sample for the analysis have to be collected. At present production personnel take the samples and it may occur that the samples are not representative.

### 2. Recommendations for testing methods

a) Determination of finish content (refer to Annex I).

b) Determination of the crimping degree and crimp stability (refer to Annex II).

c) Displace the control instrument for the air to the opposite side of the air inlet.

d) Find another office for the engineer in the textile laboratory. His actual office should be used for expanding more space for the textile laboratory.

e) Find another entrance to the textile laboratory in the new factory plan. A chemical laboratory should be located somewhere in the middle of the factory and the textile laboratory at the end of the drawing section near the baling. Make sure there is daylight for both laboratories.

f) Maintain and displace the gas chromotograph.

g) Sampling should be organized in such manner that representative samples for the analysis are tested.

## E. TECHNICAL SERVICE IN M.R.

### 1. Findings

a) At present M.R. Technical Service has insufficient engineers i.e. only three chemical and one textile engineers. They are dealing with customers' claims and applications problems for viscose rayon, polyamid 6, polyester staple fibre, tow, tops and filament. The present staff cannot cope with the amount of customers' claims in particular now that the Egyptian textile industry is not sufficiently familiar with PES/cotton blending. Therefore, the customers get insufficient technical assistance for T.S.

b) There is insufficient control over production delivery. Some physical and chemical properties are irregular which make it difficult for the Technical Service staff to advise spinning mills. Actually consumers have very poor and sometimes no information about the PES fibre they use.

### 2. Recommendations

a) There is need for at least two chemical engineers and one textile engineer only for advising mills in PES application and processing. Those engineers have to be well skilled and should have experience in PES production and processing in textile mills. In case of claims or some applications problems they should have enough information to advise either the production department or the customers.

b) Publish one prospect as soon as possible.

## F. GENERAL REMARKS

### 1. Technological parameters

At actual production level I would advise maximum engagement of all management staff to meet the predetermined technological parameters. It also means that for so some period a permanent control (through day and night) of all technological parameters will have to be carried out even if it would require to put engineers in shifts to facilitate the smooth production.

### 2. Productions of black spun dyed W-type PES

Actually one part of the PES waste is sold and a large part is wasted. From an economical point of view the best solution would be to install a special production line for the production of black spun dyed W-type PES, so called 'black line'. In this case all polyester waste would be regenerated. The production line for the black spun dyed PES will consist of the equipment for the chemical regeneration of waste by glycolysis and black chips, complete with the spinning and drawing equipment. The capacity of the 'black line' should be planned on the following facts:

- amount of the waste from the polyester staple fibre and filament production is X t/day;

- for the synthesis of chips 50-70% of the glycolised reaction product is used, which depends on experience and 30-50% fresh raw materials. The amout of fresh raw materials is Y t/year;

- take into account also the amount of waste from new planned capacities, Z t/year.

The capacity of batch wise polycondensation should be X + Y + Z t/year. The spinning and drawing line should have the same capacity.

Considering that the price of black fibre is 4-7 times higher than the actual waste price it is not necessary to comment on the final financial effect.

## II. VISITS TO TEXTILE MILLS

I visited 5 textile mills (see Annex III) where PES is blended with cotton. After long discussions we had with mill experts and after having seen the mill departments I can summarize the remarks of the customers as follows:

a) Different opening performances of fibre between the bales of the same lot. This can easily be estimated that either according to the different height of opened bales or by taking the fibres sample in the hand and observe the degree of opening. When the opening is bad then you can see plenty of fibre bundle. The possible causes for this may be:

- crimps variation of fibre;
- different stability of crimps;
- different finish - content of fibre.

b) Too high moisture content could be felt by hand touch. This is caused by insufficient drying.

c) Frequent appearance of fused fibres.

The big fused fibre bundles are caused by insufficient cleaning and not separating the tow after longer stops in the drawing section.

The small fused fibre bundles are caused by

- overheating during drawing or crimping;
- cutting with the blunt knives.

d) Variations in crimp figures are caused by irregular crimping process.

e) Sometimes a very low crimp stability occurs so that after carding the fibres is without crimp or with a very low crimp. This again is caused by irregular/uncontrolled crimping.

f) Very often fibre overlength occurs. The causes are

- cutting with the blunt knives;
- breakages of individual filaments during drawing;
- mechanical damaging of filaments due to the scraped metal surfaces on stands or crimper.

g) Fibres tend to develop electrostatic charging. The possible causes are:

- uncorresponding finish content on fibres;
- uncorresponding air-conditioning in the room;
- insufficient spare parts for the synthetic fibre processing equipment.

h) There is a very great difference in the processibility of fibres, even in the same lot. The cause is excessive fluctuation of technological parameters during the production. This decreases the effeciency of the machines.

i) Sometimes the processibility of the fibres may be excellent for 2-3 days. During that time the technological parameters are kept in the necessary limits.

j) Production receives very poor or no help from M.R. The cause is lack of engineers in the T.S. of M.R.

k) Bad processibility of the fibres. The possible causes are

- bad fibre quality;
- uncorresponding air-conditioning in the room;
- insufficient spare parts for the synthetic fibre processing equipment.

l) All customers are seeking for bigger amounts of PES of good quality.

At the time of the visit practically in all mills (except Mahala) the air-conditioning was not controlled as it is necessary for the blends processing. Also all mills are using low grade cotton.

In all the mills (except Mahala) the spinners do not analyse the actual yarn composition and in all the mills (without exception) they do not determine the distribution of the fibres in the cross section of the yarn.

To facilitate the processing of cotton PES blends I would advise the cotton textile mills to:

- blend as much as possible bales of PES during opening;
- keep the air-conditioning as shown in Annex IV;
- ensure that all machines are supplied with parts necessary for synthetic processing;
- make all adjustment on the machines necessary for synthetic processing;
- introduce the analysis of blends composition as shown in Annex V;
- introduce the analysis of the distribution of fibres in the cross section of yarn;
- ask from T.S. help for eventual addition of finish or its components.

## III. T.D.C.

At this moment the PES production and processing is a novelty in Egypt. It is normal that in this early stage there are many problems in connection with product quality, as well as with processing in the textile mills. Therefore, the role of T.D.C. is of great importance. It is equipped with up-to-date equipment and a very ambitious staff. In accordance with the aforementioned I would recommend the following activities for T.D.C.:

### A. Fibre quality testing

1. In addition to the equipment installed an apparatus for the shrinkage determination on 130$^{o}$C in 2,5 bar water steam and 15 mins. treatment is needed.

Producer: LEQUEUX S.A.
Typ 24208
64 Rue guy Lussac
Paris
FRANCE

2. Since good skilled staff is not present I recommend one month training for two engineers in one well organized laboratory for PES testing (e.g. Institute of Textile Technology (TTI) in Wuppertal in F.R.G.).

### B. Short-term application trials

1. In the case of claim on PES quality and processibility I suggest to do the following:

- take the representative PES sample from the claimed lot in the presence of M.R., customer and T.D.C. representatives;
- process samples at T.D.C. in the presence of M.R., customer and T.D.C. representatives;
- evaluate the results.

2. Even when the quality of PES fibre is excellent one can expect remarks on processibility. In such cases there would be a need of slight changes in the finish composition. The objective is the modification of fibre to fibre friction or fibre to metal friction e.g. fibre to fibre cohesion or fibre to metal cohesion and the modification of electrostatis charging. The aforementioned improved opening performance of fibre, web cohesion, sliver cohesion, anti-static behaviour etc.
This problem cannot be solved without close co-operation between M.R., customer and T.D.C. as well as corresponding equipment.

Therefore, it is necessary to install equipment at T.D.C. for testing fibre to fibre and fibre to metal friction in static and dynamic state.

This equipment should have the following devices for

- extraction of the original finish;
- finishing;
- measuring of friction.

Such equipment is not available on the market and should be constructed by T.D.C.

But most finish suppliers have similar equipment, as well as some institutes. The best and the shortest way to obtain such equipment is to send two engineers for 1 month training abroad.

C. Activities recommended for the immediate future

According to my opinion two projects are very important for Egypt:

1. Set standards for PES quality

Now having some experience in the PES production and processing it is time to set standards for PES quality. T.D.C. should first collect all necessary documentation at the institute as described in Annex VI. Thereafter the representative of M.R., customers and T.D.C. should prepare standard for PES staple fibre quality.

2. Investigation of Egyptian market potential

It is necessary to assess the actual total PES consumption in Egypt as well as the planned consumption. Moreover, all possible fields for applications complete with specifications and quantities should be listed. These data will be for the benefit of the eventual producer as well as for potential customers. Furthermore, those dates provide a very good basis for the extension plans of the production programme.

## IV. SEMINAR

I held seminar for mills and T.D.C. engineers about:

Polyester fibre production

- Schemes for the polyester fibre and filament production.
- Technical filament.
- The role of finish.
- New trends in the polyester fibre and filament production.
- The lecture (as described in Annex VII).

## V. CONCLUSION

According to my opinion the factory for PES production in M.R. is modern and well designed and it offers the possibility to produce fibres of very high quality. However, much is still to be done to achieve the goal of high and consistent quality. Therefore, I suggest that after 3-5 months an expert on PES production for the duration of 2-3 months should visit M.R. Such an expert will be expected to co-operate with the factory experts to solve all daily production problems and optimize the products quality, and besides will also assist in conceiving and preparing the plan for the envisaged extension of the production capacity.

I was assigned to T.D.C.

The National Project Manager is Eng. Magdi El Aref and also the General Manager of the Textile Consolidation Fund.

My counterparts from T.D.C. were

- Eng. Abd El Hamid Khairallah
  for dyeing and finishing.

- Dr. Hosney M.M. Hassanin
  for spinning and weaving.

## ACKNOWLEDGEMENT

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ANNEX I

## Determination of finish content

1. Representative fibres are subjected to atmospheric standard conditioning of 20°C and 65% relative air humidity for at least 24 hours.

2. Use the Soxhlet-extraction apparatus with round bottom flask of 500 ml.

3. Select the solvent with finish-supplier.

4. Dry until constant weight is achieved, precise weighting of flask is required and weight it with o.1 mg accuiracy.

5. Weight 16-20 g fibre-specimen with 0.1 mg accuracy and place in the sleeve.

6. Feed 400 ml of the respective solvent in the flask.

7. Boiling of the solvent must be arranged in a corresponding way. Make 12 overflow procedures.

8. Distill of the solvent.

9. The residue of extration found in the flask is dried at 35-40°C till constant weight is achieved and weight with accuracy of 0.1 mg.

10. The finish-content on the fibre is determined to the extracted fibre weight.

ANNEX II

## CRIMPING DEGREE

1. -take 10 fibres

   -every fibre preload with 2 mg /tex

   -measure the length A (mm)

2. -load fibre with additional 50mg /tex

   (total load 2mg /tex + 50 mg /tex)

   -wait for 30 seconds

   -measure the length B (mm)

$$CD = \frac{\overline{B} - \overline{A}}{\overline{B}} \times 100$$

CD- crimping degree

$\overline{A}$, $\overline{B}$-arithmetical average value of length

## CRIMPS STABILITY

1. -remove the load of 50 mg /tex
   (load of 2 mg /tex remains)
   -wait for 120 seconds
   -measure the length C (mm)

$$CS = \frac{\overline{B} - \overline{C}}{\overline{B} - \overline{A}} \times 100$$

CS- crimps stability
$\overline{A}, \overline{B}, \overline{C}$ - arithmetical average value of length

ANNEX III

Survey of visits to textile mills

| Date of visit | Name of firm | Consumption of PES t/ day | Remarks |
|---|---|---|---|
| 19.08.85 | Misr Beida Dyers Kafer El Dawer | 5 | -converting<br>-tow to tops |
| 01.09.85 | E.S.C.O. Cairo | 2 | -C-type<br>-blend 50:50<br>-GIZA 69,70 |
| 07.09.85 | MISR SHIBIN El Kom | 8 | -C-type<br>-blend 65:35<br>-GIZA 81 |
| 08.09.85 | MISR Kafr El DAWER | 6 | -C-type<br>-blend 65:35 |
| 14.09.85 | MISR MEHALLA El KOBRA | 6 | -C-type<br>-blend<br>50:50<br>65:30<br>-GIZA 75 |

ANNEX IV

[illegible]

| [illegible] | [illegible] | | [illegible] | |
|---|---|---|---|---|
| | [illegible] °C | [illegible] | [illegible] | [illegible] |
| Blow room | 24-30 | 50-60 | 24-30 | 60-70 |
| Carding | 24-30 | 50-60 | 24-30 | 60-70 |
| Drawing | 24-30 | 50-55 | 24-30 | [illegible] |
| Roving | 24-30 | 50-55 | 24-30 | 55-65 |
| Spinning | 24-30 | 45-50 | 24-30 | 55-60 |
| [illegible] | 24-30 | 60-70 | 24-30 | 60-70 |

## ANNEX V

### Quantitative Chemical Analysis of [illegible]
### [illegible] Fibres with Cotton

[illegible] is removed from the sample. About 0.5 g of the sample is cut into small pieces. Bone dry weight is determinated. It is then treated with 100 ml of 75 percent $H_2SO_4$ , (w/w) at 50 °C fore one hour . The sample is then transferred to a weighed sinter glass crucible and washed first with 75 percent $H_2SO_4$ and then several times with cold water, twice with dilute ammonia and then thoroughly with cold water, The bone dry weight of the residue is then determinated.

ANNEX VI

ORGANIZATIONS AND COMPANIES THAT ISSUE TEXTILE STANDARDS

International

Bureau Internationale pour la Standardisation de la
    Rayonne et des Fibres Synthetiques (BISFA)
Lautengartenstrasse 12
CH- 4010 Basel,
Switzerland

[illegible] Products Association International
600 Endicott Buildings
St. Paul, Minnesota 55101
United States of America

Council of European Economic Community
200 rue de la Loi
B-1040 Brussels
Belgium

International Standards Organization (ISO)
1rue de Varembe
1211 Geneva 20
Switzerland

International Wool Textile Organisation (IWTO)
Castlegate
Bradford, Yorkshire BD1 1LB
United Kingdom

Pan American Standards Commission
c/o Argentine Standards Institute (IRAM)
Chile 1192
Buenos Aires
Argentina

Zellweger Ltd.
(Uster Standards)
CH- 8610 Uster
Switzerland

National

Eighty-seven countries have national organizations that issue textile standards, sometimes as part of a general series. Many of these are members of the ISO and issue equivalent national standards. Some of the most widely used are:

American Society for Testing and Materials (ASTM)
1916 Race Street
Philadelphia, Pennsylvania 19103
United States of America

Association francaise de normalisation (AFNOR)
Tour Europe
Cedex 7
92080 Paris-La Defense
France

British Standards Institution (BSI)
Textile Division
10 Blackfriars Street
Manchester M3 5DR
United Kingdom

Deutscher Normenausschuss (DNA)
Burggrafenstrasse 4-7
1000 West Berline 30

Ministry of Trade
Cotton Arbitration and Testing General Organization (CATGO)
Alexandria
Egypt

National Bureau of Standards
Washington.D.C.
United States of America

POLYESTER FIBRES PRODUCTION

Table 1

Textile Fibres World-Production

| Fibre | 1975 | | 1980 | | 1981 | | 1982 | | 1983 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1000 t | % | 1000 t | % | 1000 t | % | 1000 t | % | 1000 t | % |
| Natural | | | | | | | | | | |
| - Cotton | 11 757 | 49,70 | 14 260 | 48,16 | 15 422 | 49,59 | 14 677 | 49,93 | 14 525 | 47,94 |
| - Wool | 1 538 | 6,50 | 1 581 | 5,34 | 1 609 | 5,17 | 1 616 | 5,50 | 1 606 | 5,30 |
| - Silk | 47 | 0,20 | 56 | 0,19 | 57 | 0,18 | 55 | 0,18 | 55 | 0,18 |
| Total | 13 342 | 56,40 | 15 903 | 53,69 | 17 088 | 54,94 | 16 348 | 55,61 | 16 186 | 53,42 |
| Man-Made Cellulosic | | | | | | | | | | |
| - Filament | 1 136 | 4,80 | 1 161 | 3,92 | 1 104 | 3,55 | 1 032 | 3,51 | 1 038 | 3,43 |
| - Staple and tow | 1 823 | 7,71 | 2 081 | 7,03 | 2 100 | 6,75 | 1 917 | 6,52 | 1 974 | 6,51 |
| Total | 2 959 | 12,51 | 3 242 | 10,95 | 3 204 | 10,30 | 2 949 | 10,03 | 3 012 | 9,9[illegible] |
| Synthetic | | | | | | | | | | |
| - Filament | 3 763 | 15,91 | 4 732 | 15,97 | 4 803 | 15,44 | 4 482 | 15,25 | | |
| - Staple and tow | 3 590 | 15,18 | 5 744 | 19,39 | 6 007 | 19,32 | 5 618 | 19,11 | | |
| Total | 7 353 | 31,09 | 10 476 | 35,46 | 10 810 | 34,76 | 10 100 | 34,36 | 11 115 | 36,64 |
| Total Man-Made Fibres | 10 312 | 43,60 | 13 718 | 46,31 | 14 014 | 45,06 | 13 049 | 44,39 | 14 115 | 46,58 |
| Total Textile Fibres | 23 654 | 100,00 | 29 621 | 100,00 | 31 102 | 100,00 | 29 397 | 100,00 | 30 301 | 100,00 |

Table 2

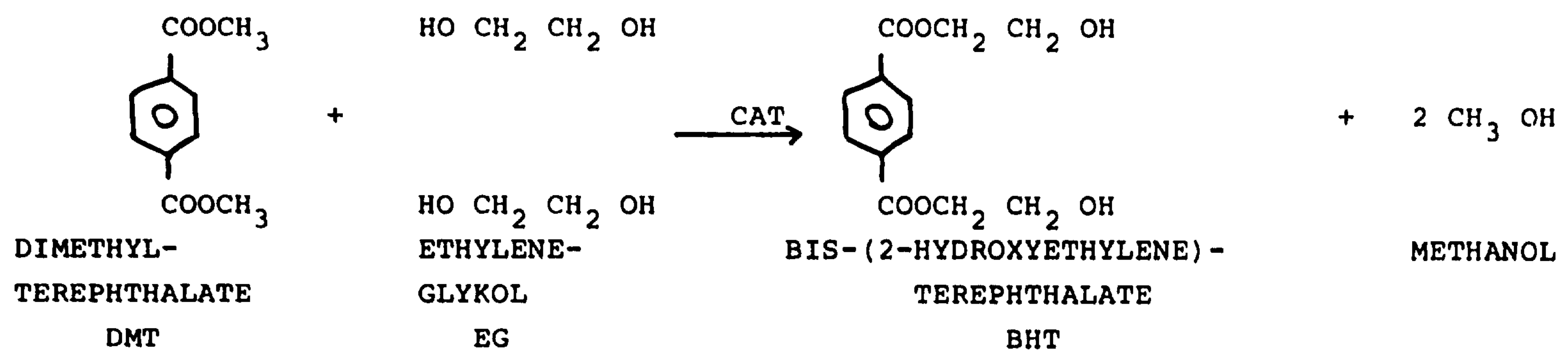
Man-Made Fibres World-Production

| Fibre | 1960 | | 1970 | | 1982 | | 1983 | |
|---|---|---|---|---|---|---|---|---|
| | 1000 t | % | 1000 t | % | 1000 t | % | 1000 t | % |
| **Cellulosic** | | | | | | | | |
| - filament | 1 130 | 49,7 | 1 390 | 17,2 | - | - | - | - |
| - staple | 1 520 | 53,4 | 2 180 | 26,9 | - | - | - | - |
| - total | 2 650 | 93,1 | 3 570 | 43,1 | 3 300 | 24,2 | 3 013 | 21,6 |
| **Polyamid** | | | | | | | | |
| - filament | 110 | 3,9 | 1 670 | 20,6 | - | - | - | - |
| - staple | 20 | 0,7 | 220 | 2,7 | - | - | - | - |
| - total | 130 | 4,6 | 1 890 | 23,3 | 3 000 | 22,1 | 3 176 | 22,7 |
| **Polyester** | | | | | | | | |
| - filament | 10 | 0,4 | 640 | 7,9 | - | - | - | - |
| - staple | 30 | 1,1 | 1 000 | 12,3 | - | - | - | - |
| - total | 40 | 1,5 | 1 640 | 20,2 | 5 300 | 39,0 | 5 575 | 39,8 |
| **Polyacrilonitril** | | | | | | | | |
| - total | 20 | 0,7 | 1 000 | 12,3 | 2 000 | 14,7 | 2 227 | 15,9 |
| **TOTAL** | | | | | | | | |
| - filament | 1 260 | 44,2 | 3 700 | 45,6 | 5 600 | 41,1 | - | - |
| - staple | 1 590 | 55,8 | 4 410 | 54,4 | 8 000 | 58,8 | 13 991 | 100 |

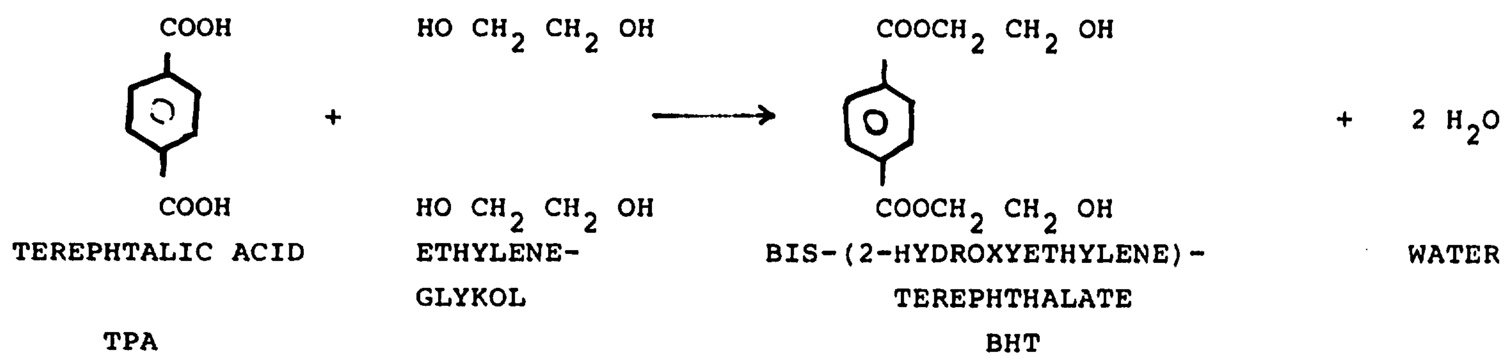
## SYNTHESIS OF POLYESTER POLYMER

### 1. PREPARATION OF BIS-(2-HYDROXYETHLENE) - TEREPHTHALATE

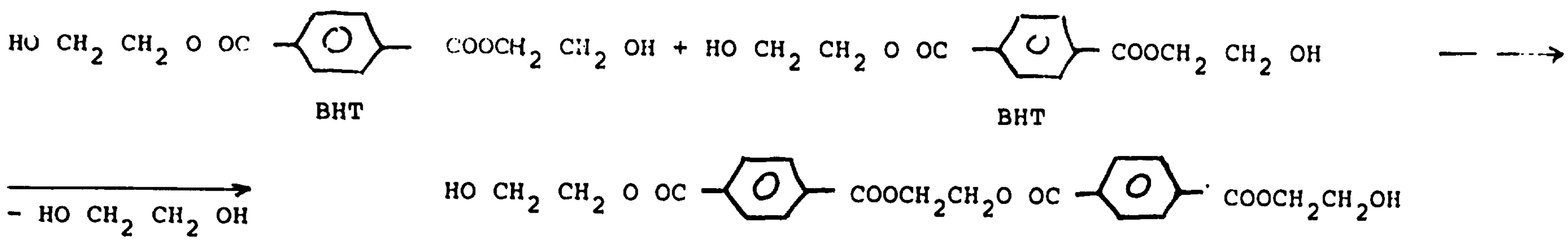
**A. PREESTERIFICATION**




**B. ESTERIFICATION**

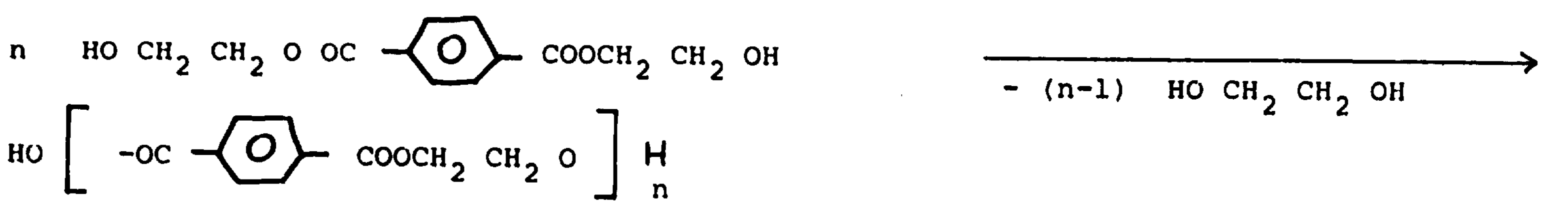


2. POLYCONDENSATION




DI-BIS-(2-HYDROXYETHYLENE)- TEREPHTHALATE
DIMER

SUMMARY REACTION




POLYETHYLENE GLYKOL TEREPHTHATE

POLYESTER POLYMER
PES POLYMER
PES

$\overline{DP}$ = 80 - 120 $\overline{M}$ = 18000 - 22000

- FOR STAPLE LOWER LIMIT
- FOR FILAMENT UPPER LIMIT

# STAPLE FIBRES

## I. Discontinous Processes

1. Synthesis of polymer – batchwise } Chips → Spinning } Undrawn Cable → Finishing drawing crimping termosetting → Cutting } Staple Fibre / → Depositing tow → Converting } tops

2. Synthesis of polymer – batchwise – continous } Chips → Spinning → – // –

3. Synthesis of polymer – continous } melt of polymer → Direct Spinning or Melt Spinning } Undrawn Cable → – // –

## II. Continous Processes

4. Synthesis of polymer – batchwise – continous } Chips or Melt of polymer → Compact-Spinning Plant / → Inline Plant

- no depositing cans
- Spinning, drawing, crimping is effected continously within the plant. (PP, PA: PES Fibres).
- it is slightly modified BCF process
- for crimping is used special unit (air or steam combined with edge crimping process).
- production speed 1000-1500 m/min.

## FILAMENT

All synthetic fibres: 50% Textured yarn; 25% Flat yarn; 25% Twist

Batchwise - Polymer - Synthesis
Continous - Polymer - Synthesis

1. Spinning "low speed" 800-1200 m/min } undrawn yarn → Stretching } drawn yarn "flat yarn" → Texturing } textured yarn

2. Spinning "low speed" 800-1200 m/min } undrawn yarn → Draw Texturing 100-200 m/min S.R.= 3,4-3,5 →
   - Sequential Draw Texturing " out draw"
   - Simultaneos Draw Texturing "in draw"

   } textured yarn

3. High Speed Spinning 3200-3500 m/min } POY partial oriented yarn → Draw Texturing S.R. = 1,6-1,7 200-700 m/min; Falstwist Texturing - spindle - friction } textured yarn

4. Spinn-Drawing } FOY full "flat yarn" oriented yarn

5. Spinn-Draw Texturing } textured yarn "bulk continous filament" BCF yarn
   - for carpets and furnishing
   - for PA6, PA66 : PP

## SPINNING PHASES

| | STAPLE FIBRES | | FILAMENT |
|---|---|---|---|
| 1. | chips | *no* in case of melt-spinning | chips |
| 2. | drying | | drying |
| 3. | melting | | melting |
| 4. | spinning | | spinning |
| 5. | air cooling | | air cooling |
| 6. | finish application | | finish application |
| 7. | depositing in cans | | winding |
| 8. | finishing process | | finishing process |

Thermosetting

| | |
|---|---|
| " tension-setting" | C- type |
| " shrink-setting" | W- type |

calender 8, 10, 12 roller

| | |
|---|---|
| - Higher temp. | tenacity increase,<br>elongation drop<br>shrinkage drop at boiling<br>elasticity increase<br>crimp stability and crimps<br>degree decrease |
| - "shrink-setting" | tenacity decrease<br>elongations increase<br>shrinkage increase<br>elasticity decrease<br>crimp stability and crimps<br>degree increase |

THE DIFFERENT POLYESTER BLENDING PARTNERS
IN COMPARISON TO THE CORRESPONDING
NATURAL FIBRES

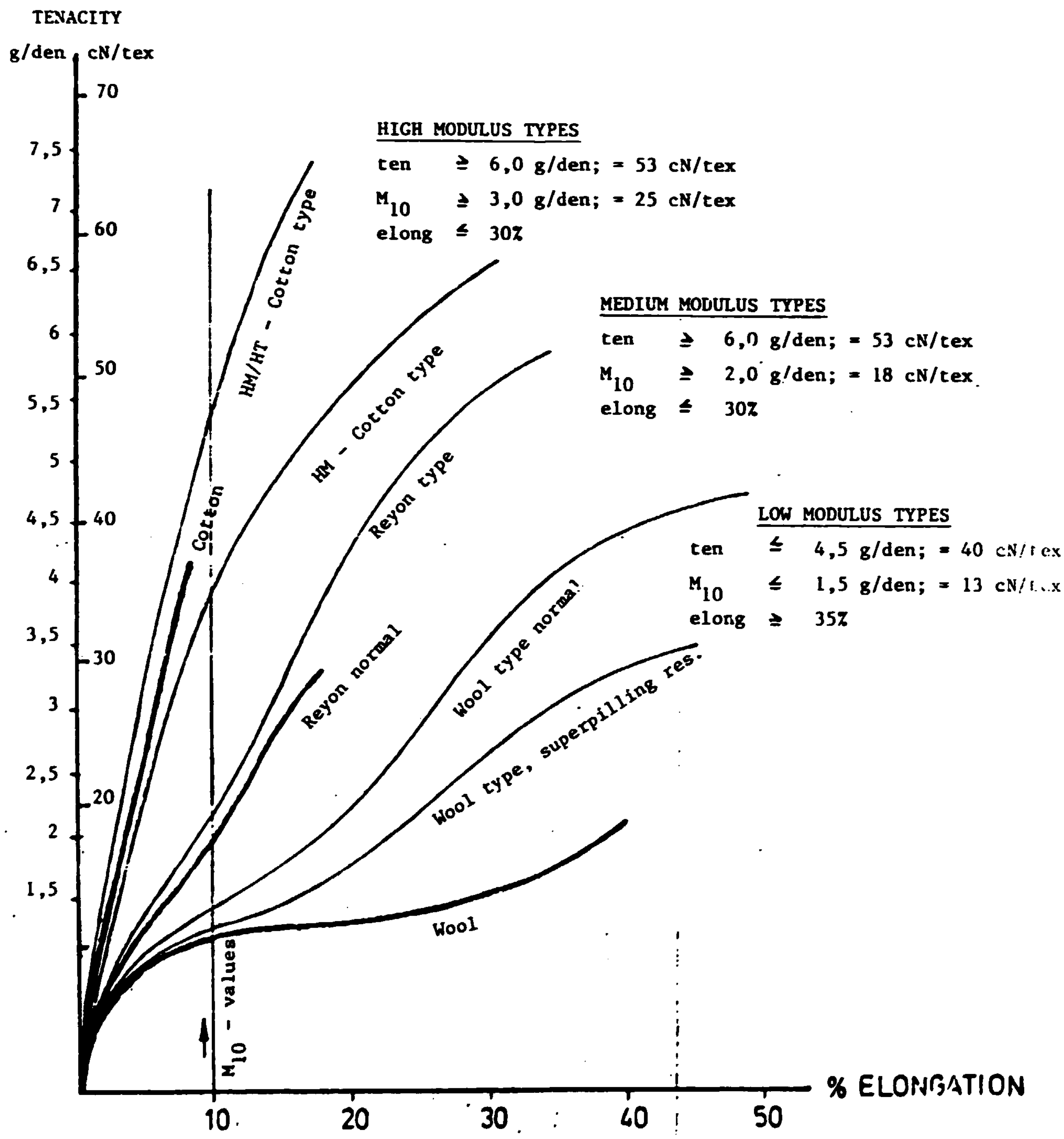



Fig.

| Type | Tenacity cN/Tex | Elongation at break % | Shrinkage in hot air 200°C, 15 mn. % | End use |
|---|---|---|---|---|
| 120 | > 55 | 17 - 27 | 10 - 13 | all fabrics in the cotton sector, coat, shirt, dress, bed and table linen ..... |
| 130 | > 60 | 17 - 27 | 9 - 12 | sewing threads |
| 131 | > 58 | 17 - 27 | 2,5-4,5 | sewing threads |
| 140 | > 55 | 17 - 27 | 4 - 6 | low-shrinkage fibre with the same properties and uses as type 120 |
| 220 | > 43 | 25 - 55 | 4 - 9 | standard type for wool sector : suit, dress, costume, trouser, shirt... |
| 350 | > 26 | 25 - 54 | 4 - 8 | a low-pilling fibre for knitting and weaving |
| 812 CF | > 37 | 40 - 50 | 6,5-12 | carpet fibre which can be dyed without carrier |
| 883 CF | > 30 | 40 - 60 | 6 - 8 | antistatic and antisoil treated fibres for carpets d = 1,29 $/cm^3$ |
| 206 | > 33 | 35 - 60 | 4 - 6 | siliconized hollow-fibres for filling |
| 250 | > 35 | 72 - 82 | 60 - 66* | special fibre for non-woven |
| 290 | > 38 | 25 - 60 | 4 - 10 | standard type for non-woven-product and fibres for fillings |
| 292 | > 26 | 45 - 55 | 0 - 2 | standard type with high crimp level for upholstery - non-woven |

CF - can be dyed at the boil without carrier

* - shrinkage at the boil

Producer : HOECHST, D-6230 FRANKFURT AM MAIN 80, WEST GERMANY

Trade-mark : TREVIRA

| Type | Tenacity cN/Tex | Elongation at break % | Shrinkage in $H_2O$ 95°C,15 min % | Shrinkage in hot air 200°C,15min % | End Use |
|---|---|---|---|---|---|
| B<br>HTB | 50 - 60<br>50 - 63 | 20 - 30<br>15 - 25 | ~1<br>~1 | 6 - 9<br>5 - 7 | Men's and ladie's wear<br>Raincoats and leisure wear<br>Furnishings<br>Embroideries |
| N | 58 - 68 | 15 - 25 | ~1 | 6 - 8 | Sewing threads<br>Technical fabrics |
| T | 52 - 62 | 25 - 35 | 2 - 4 | 9 - 11 | Ribbons |
| W | 40 - 50<br>34 - 45 | 45 - 60<br>50 - 70 | 1 - 3 | 6 - 10 | Outerwear<br>Furnishings<br>Floor coverings |
| AP | 36 - 45 | 40 - 55 | 1 - 2 | 6 - 9 | Outerwear<br>Furnishing |
| MAP | 28 - 35 | 40 - 60 | 1 - 2 | 5 - 8 | Outerwear |
| F3 | 25 - 35 | 25 - 35 | ~1 | 1 - 3 | Waddings and<br>inter-linings filters |
| HS | 34 | 75 - 95 | 45 - 55 | - | Synthetic leather<br>Filter<br>Technical non-wovens |

Producer : GRILON SA, CH-7013 DOMAT/EMS, SWITZERLAND
Trade-mark : GRILENE

## FILAMENT SPINNING

| Mark | Means | Spinning speed m/min. | Drawing % |
|---|---|---|---|
| LOY | low oriented yarn | 800-1800 | 290-440 |
| MOY | medium oriented yarn | 1800-2500 | 210-290 |
| POY | partially preoriented yarn | 2800-4000 | 150-210 |
| HOY | high oriented yarn | 4000-6000 | 40-60 |
| FOY | full oriented yarn | > 6000 | 20-30 |
| DTY | draw textured yarn | | |
| ATY | air textured yarn<br>( Du Pont trade-mark "TASLAN") | | |
| BCF | bulk continous filament<br>(Spinn - Draw - Texturing) | - for PA6, PA66 and PP<br>- end use for carpet and upholstery | |

| Spinning speed m/min. | Capacity per spinneret position g/min. | Increase % |
|---|---|---|
| 1200 | 73 | |
| 2500 | 95 | 30 |
| 3500 | 101 | 6 |
| 4500 | 104 | 3 |

## HIGH TENACITY FILAMENT

so called "filament for industrial use " or "technical filament"

| | textile filament | technical filament |
|---|---|---|
| tenacity CN/tex | 30 - 50 | 66 - 85 |

necessary:

1. high molecular mass ($\eta$) = 0,76 - 0,94
   high molecular mass is achieved by so called "postcondensation".

   a) solid condensation — T = 215 - 230 °C
      P = 0,4 - 0,6 Torr
      polymer chips — t = 10 - $20^h$

   b) melt condensation — T = 270 - 290 °C
      P = 0,4 - 0,6 Torr
      polymer melt — t = 30 - 60 min

2. high drawing degree — 4 - 6,5 X

3. special termosetting technology

END USE: SEWING THREAD, BAND CONVEYER AND RIBBON, FIRE PIPE, COATED TEXTILE, SECURITY BELT, TENT, COVER, NET, SIEVS, TYRE CORD ETC.

SOME PROPERTIES OF HIGH TENACITY FILAMENT

| TREVIRA TYPE | Tenacity CN/tex | Elongation % | Shrinkage $H_2O$, 100°C, 30 min | Shrinkage air, 10 min | |
|---|---|---|---|---|---|
| | | | | 160°C | 200°C |
| 730 N 1100 dtex/200/0 | 72 | 11,9 | 7.0 | 15,0 | 22,0 |
| 710 A 1100 dtex/200/0 | 72 | 14,0 | 0,5 | 1,4 | 5,0 |
| 715 GPA 1100 dtex/200/710 | 73 | 13,8 | 1,4 | 3,5 | 8,0 |
| 732 NN* 74 dtex/24/520** | 66 | 10,5 | 7,0 | 13,0 | 19,0 |
| 712 NA* 74 dtex/24/510 | 68 | 16,5 | 0,9 | 2,5 | 8,4 |

* for sewing thread

** fineness program : 74 dtex/24, 138 dtex/32, 150 dtex/48, 226 dtex/70, 300 dtex/90 etc.

WHAT PROPERTIES SHOULD FINISH POSSES ?

1. Lubricity
2. Anti-static control
3. Cohesion F/F and F/M - balanced
4. Oxidation resistance
5. Washability
6. Controlled viscosity range
7. Non-allergenic and Non-toxic
8. Odor resistance
9. Product stability
10. Corrosion
11. Non-volatibility
12. Color
13. Emulisfiability
14. Storagebility (resistance to frost and tropical conditions).
15. Solubility (so-called "handling").
16. Sprayability etc.

## DEFINITIONS

| | |
|---|---|
| Spin finish | used solely in the spinning process and during the classic fibre manufacture washed out again after the processes are completed. |
| Draw-finish | used solely in the drawing process and during the classic fibre manufacture washed out again after the processes are completed. |
| Final finish | applied in further textile processing at the end of the fibre line in front of the crimper. |
| Spin-draw final finish or Spin-draw/finish or Uni finish | used in the spinning process but also in the drawing procedure and as a final finish. This process represents a modern form of finish application. |

## Conventional Spin-Finish/Final-Finish Application Technology

### Advantages:

- Allowing the application of individual finish in each processing stage
- Final finish can be deposited after the drawing process so that the substances can be selected at discretion for the benefit of textile processing

### Disadvantages:

- Valuable material must be removed by washing
- High costs
- Heavy environmental pollution
- High water consumption
- Poor removal by washing and negative influence on subsequent processes by residues
- Rather troublesome and labour-intensive procedure because of the necessity to prepare many different emulsions
- Extensive inventory because of a plurality of products based
- Difficult analysis because of too many components contained in the end product
  Material cannot be recycled.

## Advanced Spin/Final-Finish Application Technology

### Advantages:

- Practically no loss in drawing range
- No removal by washing
- Low water consumption
- No environmental pollution
- low costs
- Very simple procedure (requiring only dilution of concentration)
- Subsequent processes will not be affected
- Inventory limited only to one product group
- Where application of only one component is involved, the liquid collected under the squeezing roller of the crimper can be recycled

### Disadvantages:

- It will be necessary to make certain compromises for which a solution can be found
- The technological procedure must be accurately adapted to the requirements of the finishes applied.

Comparisons between advantages and disadvantages of conventional spin-finish/final-finish application technology and advanced spin/final-finish application.

## THE ROLE OF THE FINISH

| | |
|---|---|
| Spinning | - no adhesion on the draw-off godets nor any tendency for wrapping .<br>- thread cohesion must be perfect to facilitate depositing of the tows.<br>- normaly antistatic behaviour is also necessary. |
| Drawing | - filament to metal friction must not be too strong since this would lead to friction damage (capillary breaks).<br>- filament to filament friction must also be maintained at a low level. |
| Tension-Setting | - high thermal stability<br>- low evaporitivity.<br>- complete absence of deposits. |
| Crimping | To obtain satisfactory crimping<br>- filament to filament friction must be as low as possible to prevent overheating.<br>- no deposits on crimping device.<br>- perfect crimper - roller - surface - rough crimper surface will inevitably result in overheating, damaged filaments and variations in crimp.<br>- thermal stability. |
| Drying | - low evaporativity . |

| | |
|---|---|
| Cutting | - good opening performance. |
| Scuttcher | - good opening performance and the laps must not peel off (filament-to-filament cohesion). |
| Card | - good web cohesion.<br>- absence of any tendency to wrapping.<br>- satisfactory antistatic behaviour. |
| Intersecting frame | - good tow cohesion.<br>- satisfactory antistatic behaviour.<br>- avoidance of fibre partner being thrown out.<br>- no tendency to form deposits. |
| Ring Spinning Machine | - no tendency to wrap formation.<br>- no high filament to metal adhesion.<br>- no formation of dust or deposits however<br>- good filament to filament friction (to ensure sufficent yarn tenacity).<br>- good antistatic behaviour. |

Some of this requirements are contradicting each other fiercely e.g. on the one hand filament-to-filament (F/F) cohesion during drawing and good opening performance on the cutter and on the scutcher; on the other hand good thread cohesion during spinning and plying plus web cohesion on the card no peeling off of wraps on the scutcher, good tow cohesion on the fibre line and a sufficiently high F/F cohesion (to obtain a satisfactory yarn tenacity) on the ring spinning machine. There is a contradiction between high F/F cohesion and good opening performance.

## INFLUENCE OF FRICTIONS CONDITIONS

Frictions conditions are also decisively involved in the very complex drawing procedure. Three essential requirements must be met:

a) In the tow, cohesion between the induvidual filaments must not be too intense. An extremely strong filament-to-filament cohesion hampers not only the filament's tendency to become oriented but also the drawing operation itself. It is obvious that due to the slight inhomogenity ordinarily present in the filaments all filaments in the tow can never be drawn at once at the very same point. The drawing operation can only begin when all single filaments are running completely parellel longitudiually as only from this point on can they be subjected to the full drawing force. Therefore the filament-to-filament cohesion produced by the finishes applied should be as low as possible.

b) Capillary breaks in the drawing area are another factor heavily dependent on friction conditions, especially on filament-to-metal friction and therefore on spin-finish and draw-finish application technology. Numerous productions tests have furnished proof that capillaries are especially sensitive to both frictions and temperature particulary in the transition or bottle-neck zone when passing from the undrawn to the drawn state. Thus most of the capillary breaks caused by filament-to-metal friction occur in this area. Moreover ( and primarily in this area ) cappillaries tend to stich together as a result of overheating.

c) This is in contradiction to the requirement that the material have sufficient grip on the rolls so that it passes over them if possible without shidding or slipping. Otherwise relative motion can occur within the tow and towards the roller surface. Also any change in tension resulting from changes in draw ratios will affect the drawing area by shifting the drawing point. This phenomenon just as filament-filament cohesion likewise increases capillary breaks and filament damage.

Based on the aforementioned facts it can be seen how extremly important is the right finish-choice. Right finish means not only smooth coarse in the production fibre line but also problemless fibres processing to yarns or textile fabrics. Owing to varying conditions in the spinnings mills e.g. type and adjustment of machines, spinning process, climate and the various types of fibre (fineness, staple length, crimp, cross-section) the fibre-producers task is more difficult. Therefore the manufacturer customer-service must have good skilled staff able to have a look not only in the fibre production but also to follow fibres further processing. Because every producer of finish, which is commonly the composition of several components, usually brings on the market besides ready-made finishes also individual components to impact on fibre smoothness, fibre to fibre cohesion, fibre to metal friction,anti-static behaviour etc. Having informations from the fibre production and from the further processing, good skilled customer-service staff is ready to advice additional use of any components to facilitate fibres processing.

As summary we can underline that only but only long-range, close and permanent cooperation between fibres producer and fibres consumers will give necessary and succesful results.

It has to be pointed out that the application of an inappropriate finish may modify the fibre to such as extent that it stops running on the fibre line or during further processing in textile mills.

## TRENDS ON STAPLE FIBRE FIELD

- increasing tne capacity on one line
  a) by total count
  b) by spinning speed and drawing speed

- specialities
  a) high tenacity or high modulus cotton type
  b) high tenacity with low shrinkage for special technical use
  c) anti-pilling and super-anti pilling wollen type; chemical modified polymer
  d) high-shrinkage fibres for non-woven and synthetic leather; chemical modified polymer
  e) carrier-free fibres, which can be d''ed at the boil without carrier; and chemical modified polymer
  f) siliconized hollow-fibres for filling
  g) flame retardent fibres; additieves
  i) changing the cross-section to get special effects like appereance, touch, bulkiness, etc.
  j) bicomponent fibres with three dimensional crimps
  h) antistatic and antisoil treated fibres for carpets etc.

# TRENDS ON FILAMENT FIELD

1. Production costs decreasing

   a) Compact spinning plant

   Investement for 8t/day POY-plant 167 dtex

| | conventional | compact* |
|---|---|---|
| building | 11% | 41% |
| climate | 4% | 50% |
| equipment | 52,3% | 100% |
| engineering + errection | 22,7% | 85% |
| Total | 100% | 88,5% |

   *values for conventional are tooken as 100%

   b) combining of many production phases

   - spinn-drawing FOY flat yarn
   - spinn-draw-texturing textured yarn

   c) new texturing process

   - Ringtex - system (rings) Barmag, W. Germany
   - Nip - system (belts) Murata, Japan

2. Modification for
   - bulkiness increasing
   - improved appearance
   - improved touch - e.g. silky-like touch
   - special effects e.g. spun-like yarn

## FINENESS DECREASING OF SINGLE FILAMENT

| fineness range | mark |
|---|---|
| 7 dtex | coarse fibres |
| 2,4 - 7,0 dtex | midle fine fibres |
| 1,0 - 2,4 dtex | fine fibres |
| 0,1 - 1,0 dtex | finest fibres |
| 0,1 dtex | super fine fibres |

- first step was increasing the nozzle-number on spinning plate ( spinneret ).
- but with classical spinning the limit is about 1,0 -1,5 dtex for single filament.

to achieve the lower fineness there are three ways:

a) alkali treatment (the weight reduction is usually 10 - 35 % ) .

b) special disposition of nozzle on spinneret and air-blowing (super-drawing).

c) matrix-spinning (bicomponent-fibre)
76 dtex/t 15 76 dtex/ 80 etc.

Aforementioned is achieved with

- fineness decreasing of single (or individual) filament.
- cross-section variaty
- bicomponents spinning
- alkali treatment
- simultanious spinning of various single fibre.
- simultanious combining of conventional false twist and air-jet texturing.