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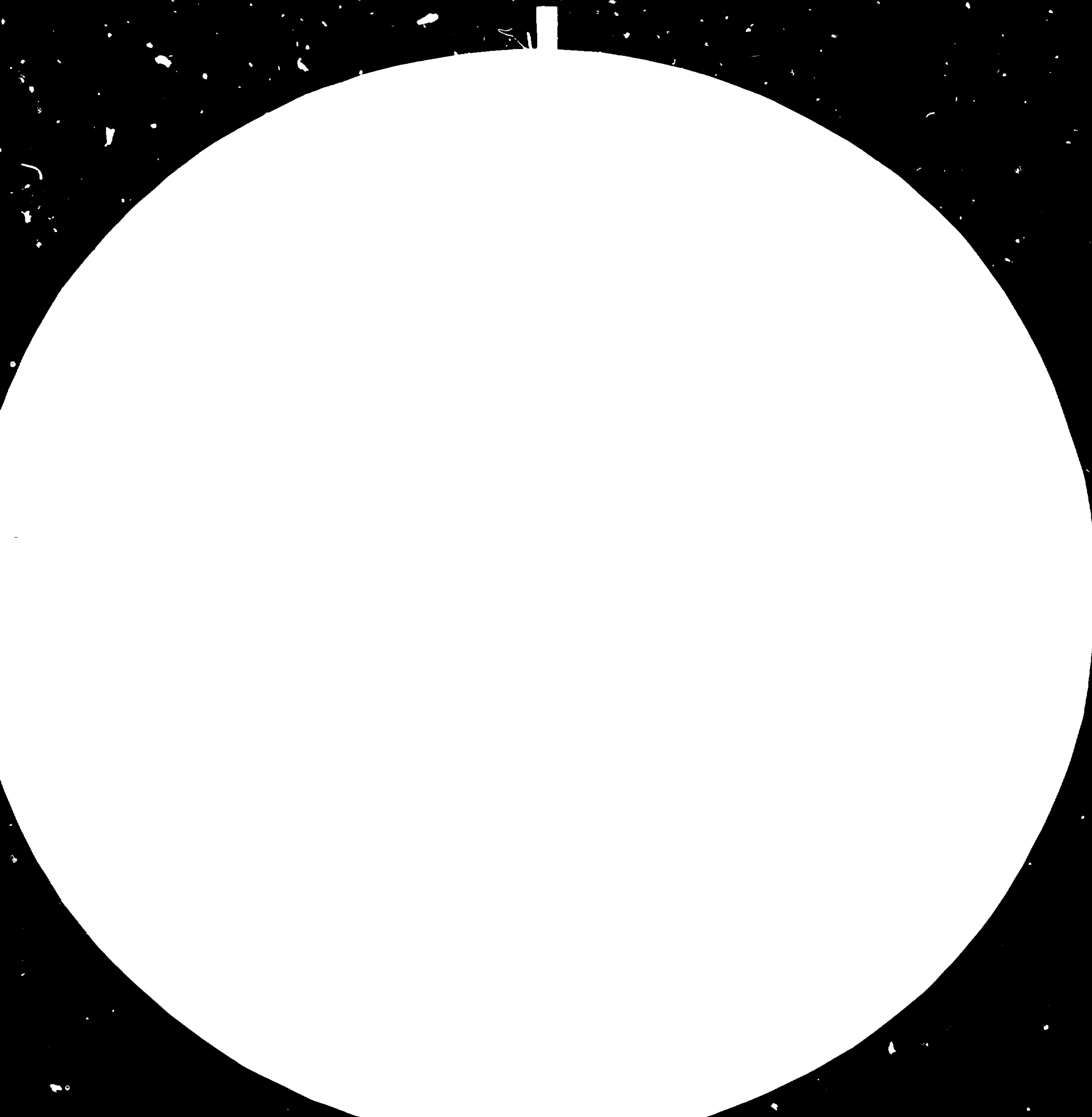

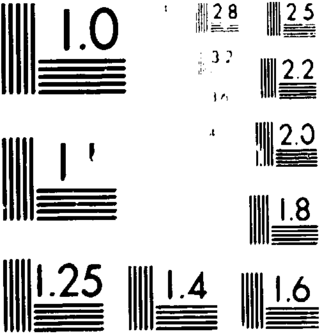

MICROCOPY RESOLUTION TEST CHART

09710 (F)

Pretreatment of Synthetic Fibres and Blends
for Dyeing and Printing

compiled by Dr. Leopold Machherndl

The economically most important synthetics are the polymers

-nylon 6 and 6.6. (mainly as filaments)
-polyester (as staple fibres and filaments) and
-polyacrylonitrile (almost always staple fibres)

Woven fabrics consisting solely of synthetic fibres or non-crimped filament yarns have, with the exception of a few special cloth, not achieved any importance in garment manufacture apart from the acrylic fibres, which occupy a special position among synthetic fibres on account of their wool-like handle.

The use of 100% synthetic fibres in textile materials has increased very considerably since the arrival of texturized yarns consisting of continuous filaments, and the growing importance of knitgoods. The use of open weave has allowed the production of lighter, air-permabble fabrics in which the physiological problems associated with the use of synthetic fibres in clothing have fallen into the background.

I. Pretreatment of Polyester Fibres and Blends

Polyester fibres with the composition polyethylene glycol terephthalate were introduced commercially during the forties after large-scale trials. The reason that these fibres have since enjoyed such widespread use is attributable to the large number of excellent properties they possess. The main ones are:

very good crease recovery and dimensional stability
very good bulking characteristics
good tensile strength and abrasion resistance,
good weathering and sun-light fastness properties,
good resistance towards acids, reducing and oxidizing agents,
and towards the majority of organic solvents, and
very good resistance towards insects and micro-organisms.

Polyester textile materials are light, dry rapidly, are easy to look after and their physiological characteristics are good. A particularly important processing variant is provided by the texturized polyester fibres.

Polyester fibres are marketed as continuous filament and staple fibres, and may be submitted for dyeing in the form of tow, flock, slubbing, yarn, woven or knitted material. Frequently, polyester fibres are processed together with cotton, spun rayon or wool. Apart from natural or regenerated fibres, polyester fibres are also employed as mixtures with other synthetic fibres, such as acrylic fibres.

As a rule, polyester fibres of different types and origin, or which have undergone different pretreatments, are normally not easy to process together unless, of course, a specific effect is to be achieved. For instance, it should be noted that even where the same type of fibre is involved, undyed yarns can only be woven together with dyed yarns when the former have been given a similar opportunity to shrink. This could be done, for example, by treating them in a blank dyebath. The selection of suitable dyes can, to a certain extent, overcome variations in the dyeing behaviour of fibres brought about by differences in manufacture or in thermal pretreatment.

The usual processing stages involved in the pretreatment of polyester fibres have been arranged systematically here. Normally, however, not all will be used and the order given here may not necessarily be maintained.
The pretreatment procedure employed will depend on the stage to which the fibre has been processed, the ultimate purpose of the material, and the properties expected of it.

Pretreatment of Polyester Fibres

Precleansing
Intermediate drying (if it is to be heat-set)
Heat treatment (presetting, preshrinking)
Alkaline treatment (only in special cases)
Bleaching and/or optical brightening (with white goods instead of dyeing)

Precleansing

Polyester fibres may be contaminated with foreign substances and stains of various kinds at any stage of processing and these include spinning oils or sizes, oily and graphite-containing machine rubbings, identification dyes or soil acquired during storage or transport. Since these contaminants can interfere in dyeing or other finishing processes, they must be removed from the fibre in good time.

If any water-soluble substances and contaminants are present that do not bring about any interfering reactions, a prescour may well not be necessary if a subsequent dyeing in an aqueous liquor can simultaneously serve to cleanse the material. However, the material is usually precleansed in a special liquor of Kieralon B Highly Conc, or Laventin OL and soda ash. Treat for 20-30 minutes at 70-80° C.

The material is then rinsed and the last rinsing bath is weakly acidified with acetic acid in order to remove residual alkali. If necessary, higher temperatures can be employed with these products.

Stubborn oil-containing dirt can be removed by using the following chemicals:
Nekanil LN, soda ash or ammonia 25% (pH approx. 9).
Treat for 20-30 minutes at about 45° C.
This is followed by rinsing and acidification.

Machine oil, e.g. loom-oil, can be removed much more readily if it initially contains Emulphor P.

Localized heavy stains and impurities can be removed by careful spotting with a concentrated solution of Nekanil LN or even Laventin OL, this being followed by washing.

Heat-Setting of Polyester Fibres

Only by heat-setting do polyester fibres acquire the dimensional stability, crease-resistance and resilience desired in use. Heat-setting is usually indispensable for ensuring satisfactory behaviour of the material during other finishing processes and is itself, therefore, one of the most important finishing processes employed with materials containing polyester fibres or their mixtures with other fibres.

Stresses are set up within the fibres during their manufacture, e.g., during the spinning process and subsequent stretching, owing to the re-formation and re-orientation of the crystalline regions. In addition, further stresses are introduced as a result of the new shape imparted to the fibre during subsequent processing such as yarn spinning, weaving or knitting, and these attempt to assert themselves when the opportunity arises. These latent stresses lead to shrinkage during subsequent wet and dry heat treatment, e.g., during washing, dyeing, drying, ironing or pleating. Piece goods which have not been heat-set also tend to form folds and creases, and possess a poor handle.

If sufficient heat energy is introduced into such a fibre or group of fibres so that some intermolecular linkages are broken and re-formed, stresses of the type described can be relieved. Usually, the material is in a tension-free state during the heat treatment so that the groups of fibres can shrink. After heat treatment has been completed, the newly acquired state should be "frozen-in" as quickly as possible so that it can be maintained indefinitely. Properly set polyester fibres possess very little residual tendency to shrink.

Mainly woven or knitted piece goods are heat-set, but single or double yarns are also treated in this way. The latter are heat-set or steamed to fix the twist. Yarns which have a tendency to shrink are, if necessary, pre-shrunk in a hot liquor or by steaming before being dyed in the form of crosswound packages.

Special effects can be obtained by heat-setting under special conditions, as for instance, in the manufacture of high bulk yarns, texturized yarns, safety belts and sewing threads. Polyester fibre-containing woven or knitted fabrics are mostly heat-set on a pin-stenter. Hot air is usually employed and is directed from above and below by jets onto the material. A controlled lengthwise and widthwise shrinkage is possible on this machine; the width of the frame and the overfeed can be adapted to the shrinkage to be expected. To ensure a good flow of hot air between the selvedge and the pin chain, and to avoid an impression of the pin-bed on the edge of the material, it is recommended that use be made of hook-shaped pins or pins with a thickened base or the like. "Quenching" of the material is effected in a cooling zone by blowing on cold air.

Setting of the material can be achieved without controlled widthwise shrinkage by passing it through a heated chamber of the hot-flue type.
The material can also be treated on a roller setting machine without temples. However, weftwise shrinkage is somewhat diminished by fluting the rollers. The fabric is led over heated metal cylinders (contact heat-setting) in such a way that alternating sides are subjected to heating. The side not immediately in contact with the cylinder can be supplementarily heated with hot air or a hot inert gas.

Apart from those already mentioned, there are other methods of setting a material, but these have so far not been widely used. It should be mentioned that super-heated steam has recently become increasingly popular as a heat-transfer medium.

The heat-setting of polyester woven or knitted fabrics has the effect of

(a) imparting better shape and dimensional stability, i.e., shrink resistance to both warp and weft or stability of loops;
(b) imparting a better resilience;
(c) modifying the handle;
(d) modifying the dyeing properties; and
(e) reducing the tendency to pilling

The material becomes stiffer with increase in setting temperature and time but this effect can be removed by a subsequent wet treatment.

Since all the heat-setting effects mentioned are modified by slight differences in treatment, it is essential to maintain uniformity in the heat-setting process. Polyester fibres are set within a few seconds at around 200^{0} C, but it must be remembered that some time is required to bring the materials to the setting temperature. Damp material dries at different rates at different places so that it would be unevenly set under high temperature conditions. Efforts should therefore be made to ensure that a material is dry before dyeing subjected to heat-setting.

Woven and knitted fabrics which are to be coated, laminated or used as interlinings must be pre-set and pre-shrunk with particular care so that their shape remains unaltered.

The shrinkage which occurs during wet finishing and heat-setting must be allowed for in calculating the width of the material on the loom or knitting machine. Working under excessive tension to prevent shrinkage, or a subsequent stretching of the material in order to achieve a prescribed width, can only be done at the expense of quality.

<u>The Point at which the Material should be Heat-Set</u>

In principle; polyester material can be heat-set either before or after dyeing. With the Thermosol dyeing process, the fibre is heat-set at the same time that the dye is fixed. In some cases it may well be necessary to heat-set a given article more than once in order to ensure a correct finish or a desired effect.

<u>Presetting</u>

If heat-setting precedes dyeing, the material is first scoured although this necessitates intermediate drying. Though the heat-setting of unscoured material is more economic, there is the danger that impurities and spinning preparations will be "burnt in".

It has already been mentioned that the dyeing properties of polyester fibres change after a heat treatment. Polyester fibres which have been heat-set with hot air at 160-180^0 C are dyed noticeably weaker by many disperse dyes than are not-set fibres or those which have been set at an even higher temperature. If the article permits, it is advisable for presetting to be carried out at a temperature of at least 190^0 C in order to obtain a good colour yield.

It must be pointed out that fluctuations in pre-setting can lead to unlevel dyeing. The tendency to reveal differences in setting is strongest when the subsequent dyeing is carried out at the boil in the presence of a dyeing accelerator. Fluctuations in heat-setting are not so marked when the HT process is used, and are least apparent after the Thermosol process. Usually, however, it is possible to suppress the effects of fluctuations in setting by a suitable selection of dyes.

Polyester fabrics are normally preset if it is intended to subject them to a wet treatment at an elevated temperature in rope form (winch) or in batch form (in a beam dyeing machine). While finishing the material in rope form gives rise to the danger of considerable crease and fold formation, the processing of a non-set material on a beam often produces a moire effect on account of shrinkage in the hot liquor, and this also results in a very much diminished liquor circulation.

If dyeing is to be carried out on the jigger, it is not absolutely essential to pre-set the material but is is advisable, since it eliminates any tensions within it that could lead to faults during processing and to a non-uniform appearance of the material.

Heat-setting of the material before dyeing actually has the advantage that no consideration need be given to thermal stability when selecting the dyes. There are, however, exceptions in those cases where garments have subsequently to be subjected to intensive heat treatment, e.g., pleating or resin finishing.

Caustic Treatment

If it is desired that the typical "synthetic" character of a polyester filament fabric should be modified when used, say, for blouses and the like, the material can be treated in a boiling aqueous alkaline liquor.

This has the following effects:

The handle of the material becomes softer and silk-like;
The fibre is delustred; and
The resilience is increased.

The caustic treatment leads to a slight roughening of the surface, this being caused by the superficial saponification of the fibre substance. There is a loss in weight and an increase in fineness of the fibre due to a scaling off of layers, the action being proportional to the alkali concentration, treatment time and temperature. Nevertheless, the strength of the fibre remains unaffected under the conditions of the alkaline treatment.

The fibres treated in this way dye more rapidly and deeply than untreated fibres, so that great care must be taken when giving the alkaline treatment and during subsequent dyeing.

Depending on the effect desired, the polyester material is treated with a solution containing solid caustic soda and Leophen LG, for 20-60 minutes at the boil. The goods must then be rinsed thoroughly to remove all alkali, and the bath is finally adjusted to pH 5-6 with acetic or formic acid.

The alkaline treatment can be carried out in closed winches, closed jiggers or in a star frame dyeing machine. To make the process economic, it is best, where possible, to employ standing baths. An optimum finish effect is obtained with the removal of approximately 5-8% polyester fibre substance.

The alkaline treatment is normally given after heat-setting and before dyeing. In the exceptional case of dyed goods being so treated, a test must first be made of the fastness of the dye to an alkaline liquor.

Bleaching

Usually, polyester fibres possess very little inherent colour when supplied. If, however, the degree of whiteness is unsufficient, the fibre can be chemically bleached or optically brightened. Where the degree of whiteness required is very high, both treatments can be applied.

Only sodium chlorite is suitable for bleaching polyester fibre, other bleaching agents not being sufficiently effective.

Recipe:	1 - 2	g/1 sodium chlorite 80%
	0,8- 1,5	g/1 Chlorite Stabilizer BASF
	1 - 2	cc/1 formic acid 85% (pH 3 - 3,5)

The goods are entered at 40 - 50° C into the liquor set with the above ingredients, the temperature then being raised to the boil within 20 - 30 minutes. Bleaching proceeds at the boil for 30 - 45 minutes. Warm and cold rinses are then given. The well-known precautions that apply to the use of sodium chlorite (chlorite-resistant machinery, good ventilation and the like) should be borne in mind.

Optical Brightening

In some cases, polyester fibres are already brightened during the fibre spinning process, e.g., as with some cotton-trade types. Polyester fibres can also be brightened during finishing by using the light-fast products.

Palanil Brilliant White G Liquid and
Palanil Brilliant White R Liquid.

Both brighteners behave as disperse dyes, and they can be applied either by exhaustion of Thermosol process.

When applied by the exhaust method, as with dyeing, either the high temperature process, or the carrier process at the boil or a somewhat higher temperature can be employed.

In order to obtain particularly brilliant dyeings, either of the optical brightening agents can be applied together with disperse dyes from one bath. Palanil Brilliant White G should be used for greenish shades, whereas Palanil Brilliant White R is preferable for red shades.

We use 1. The High Temperature Process and
2. The Carrier Process

After the Carrier Process hot and cold rinses are given to remove carrier.

3. Polyester fibres can be optically brightened at the boil without a carrier when Ultraphor HA is used.

We need Ultraphor HA and formic acid 85% (pH 3-4).
Treat for approx. 20 minutes at the boil and then rinse.
Ultraphor HA can also be added to the chlorite bleaching liquor.

<u>Special Procedures for Fibres in Various Stages of Processing</u>

The precleansing or loose stock, slubbing or tow is only necessary when the material is very much soiled or if a spinning oil or the like is present which is difficult to remove and might interfere with dyeing.

Fabrics which contain starch size are desized with enzymes. Water-soluble sizes are removed by scouring.

For precleansing we use the same recipes as given before.

If scouring is carried out in too short a liquor, e.g., in a jigger, the amounts of auxiliary and chemicals given there must be doubled. Precleansing prevents impurities being burnt in during subsequent heat-setting. The scouring of non-set material must, however, be done in such a way that no folds or creases are produced since these are very difficult to remove again. For this reason, fabrics are, as far as possible, washed in open width, that is, in a jigger or in an open-width scouring machine. Pieces should only washed in rope form, that is, on a winch or rope-scouring machine, when they have little tendency to crease. In this event, it is preferable to wash the material in tubular form with products which possess a very good cleansing action at low temperatures, e.g., with Hekanil LN.

If dyeing is carried out on a winch or beam-dyeing machine, the pieces should be preset to ensure dimensional stability. This is also advantageous when dyeing in a jigger. Piece goods comprising polyester fibres only are preset with hot air on a stenter for 20 - 40 seconds over the range 180 - 220° C, depending on the type, density and weight of the material. Heat-setting should be carried out under tension-free conditions; the resulting lengthwise and breadthwise shrinkage can amount to as much as 10%.

If the material is so stiffened by heat-setting that it would interfere with dyeing , an intermediate scour is given, say, with 0,5 g/l Kieralon B Highly Conc. and 1 g/l soda ash for 30 minutes at 70-100° C. After this, the goods are rinsed and slightly acidified with acetic acid. Often enough, however, the stiffness is removed to a sufficient extent during the dyeing process in any case.

Curtaining Materials and Drapes

The most important requirements expected of curtaining materials are:

1. High light fastness of both fibre and dyeing,
2. Good laundering and dry cleaning fastness of the dyeing, and
3. A high degree of dimensional stability.

Because of their inherent characteristics, polyester fibres have secured for themselves a pre-eminent position in curtaining, and they are also being increasingly used for heavy curtainings and drapes.

Curtaining materials and drapes are best treated in open-width form. The more important machinery manufacturers include wide jiggers, padding machines, stenters and other equipment specially designed for the finishing of curtaining materials in their production programmes.

Normally the material is scoured in a jigger or open-width machine under a minimum of tension with Kieralon B Highly Conc. or Laventin OL and soda ash. Treat for 1 hour at 80° C.

Where the material has been very much contaminated with oil spots, graphite or metal rubbings, especially in the case of knitted curtaining, an acid scour is often preferable.

Sometimes lead rubbings are found on curtaining material.
A treatment with hydrochloric acid conc. and Nekanil W Extra for 30 minutes at 60° C is recommended.
Iron impurities can be removed by use of hydrochloric acid conc. oxalic acid and Nekanil W Extra or Nekanil C Highly Conc.
Treat for 30 minutes at 60° C.

The material must be very carefully rinsed after this treatment in order to ensure complete removal of oxalic acid.
With curtainings, heat-setting is combined, as far as possible, with afterfinishing. Setting is done before dyeing or bleaching only when it is necessary to ensure satisfactory running of the material.

Bleaching and/or optical brightening will be done as described before.

Texturized Polyester Fibres (Yarns and Knitted Fabrics)

It was soon found that pretreatment of polyester fibres is a very important part of finishing, and that it has a decisive influence on the properties of the ready goods. Pretreatment mainly consists in developing the texturizing effect (by means of pre-scouring to simultaneously remove dirt and sizes, processing lubricants, etc.), and in drying and setting. The crimp which had been originally present in the yarn before processing and which had been flattened out by the tensile stress to which the yarn was subjected in the machines, has a tendency to develop again. But this tendency is temporarily blocked because the tensile forces in the yarn will not be sufficient to restore the crimp quickly and fully. This internal friction is only removed at an elevated temperature under the action of steam or water, and it is only then that the crimp can develop. Restoration of the crimp is promoted by mechanical action, e.g. by moving the goods in the washing range or in the drum drier (tumbler). The working method for developing the crimp, and the machines required, depend in the type of the goods, the degree of crimp contraction, and the required quality of the goods.

In many cases the type of dyeing equipment used will also exercise an influence. The tabulated survey shows how the different kinds of goods can be pretreated before they are dyed.

	Knitted fabrics Tubular knitted goods in tube form	 cut-open width	Warp-knitted goods and Raschel goods	Partly and fully fashioned articles	Woven goods
Crimp development and preliminary scouring	Tumbler (only crimp development) Scouring with solvents	Open-width washing machine	Open-width washing machine Winch beck	Preliminary steaming Tumbler Paddle-dyeing machine Scouring with solvents	Open-width washing machine Winch beck Star frame
	Winch beck				
Drying	Tube drier	Stenter	Stenter Suction drum drier Short-loop drier Conveyor drier	Tumbler	Stenter Suction drum drier Short-loop drier Conveyor drier
	Suction drum drier Short-loop drier Conveyor drier				
Setting	(Setting calender)	Stenter Autoclave	Stenter	Autoclave	Stenter
		HT beam-dyeing apparatus			

Pretreatment and Semi-Continuous Dyeing Processes for Polyester Fibres and their Blends

The most important of these processes for polyester fibre and polyester fibre blended woven and knitted fabrics is the

Thermosol Process.

The result of a Thermosol dyeing depends to a large extent on the care with which pretreatment has been carried out, and any errors here may become evident in the finished material The goods must be treated in the same manner and to the same extent over the whole surface, so that the dye can be applied uniformly during padding and drying, and then penetrate evenly into the interior of the fibre during the Thermosol process.

Because of the pronounced water-repellent nature of polyester fibres, particular care must be taken to ensure that the material wets out equally overall. Any difference in wettability causes uneven uptake of the dye during padding, and hence a skittery and unlevel dyeing. The surface of the fabric must be smooth and free of soiling. Thick knots and projecting ends of fibres must be carefully removed, since they are pressed in during padding and cause localised paler dyeings. Materials which contain a large number of burls or knops are not suitable for Thermosol dyeing.

Soiled patches are cleansed by prescouring with a suitable auxiliary such as Kieralon B or Laventin OL. Further details can be found in a description of the procedure for the individual types of material. Care should be taken on spotting with solvent-containing products; apart from the possibility of leaving a halo around the spotted area, the places treated with solvent may have their affinity for the dye modified. Furthermore, the spots must not be strongly rubbed otherwise rough patches may be produced on the material.

Polyester (mixture) materials do not normally need to preset if the Thermosol process is to be carried out in a stenter, since the material is actually set during the process, appropriate adjustments to the machine and feed of the material being made. Presetting is employed only when tensions are present in the material which might upset the regular progress of the material through the machine, or if irregular lengthwise and breadthwise shrinkage is to be avoided, since such could occur during the Thermosol process in the heating chamber or on the heated cylinders

When polyester (mixture) fabrics are to be dyed by the Thermosol process, singeing is carried out as a pretreatment. The resulting melted ends of the fibres do not dye to a different shade in the Thermosol process as indeed they would do from an aqueous liquor. The most economic procedure is to singe the loom-state material. However, it is sometimes preferable to desize and scour before singeing, since the fibre ends are more exposed and the burning in of impurities is avoided. Singeing must be uniform over the whole width of the material (staggered arrangement of the burners). Non-uniform singeing of the material leads to similar differences in affinity of the polyester fibre for the dye to those caused by non-uniform setting. It is advantageous to make two passages at a high speed with a small flame.

II. Pretreatment of Polyamide Goods

Causes of faults in the Pretreatment

Differences in the swelling of the goods caused by uneven moistening or local drying of wet goods often result in unevenness of shade in dyeing with fast dyes or padding with dye liquors. A presetting treatment prior to dyeing largely prevents such irregularities provided that the setting is uniform. Otherwise this will again result in uneven dyeings particularly when fast dyes are used.

Washing

To obtain good results in subsequent processing, it is usually advisable to remove all spin finishes, lubricating agents, oil and contamination from the goods. The wash water should be free from iron and cooper or contamination is liable to precipitate on the goods and from stains.

Basic recipe 1

		liquor 10:1	40:1
Kieralon B or OL	g/l	3-4	2
Soda ash	g/l	2	1-2

approx. 30 minutes at 70-95° C

or

Basic recipe 2

Nekanil 910	g/l	0,5	0,25
Ammonia 25%	ml/l	1,0	0,5

approx. 30 minutes at 60-80° C

or

Basic recipe 3

Nekanil LN or Nekanil 907	g/l	0,5	0,25
Ammonia 25%	ml/l	1,0	0,5

approx. 30 minutes at 35-40° C

For goods contaminated with metal filings (sinker streaks),

0,5-1 g/l Laventin W or Kieralon OL
1-2 g/l Trilon B Powder
pH 4-4,5 (with acetic acid)
30-45 minutes at 50° C

or an other recipe with oxalic acid is used.

A good rinse is essential as residues of oxalic acid in the fibre are liable to impair the lightfastness of the dyed shade.

Setting

Polyamide goods can be stabilized by three methods of setting, i.e., with hot air on a stenter, with superheated steam in the ager or with hot water in a high-temperature circulating liquor machine or autoclave. After the heat treatment, the material is given a shock cooling treatment

Normally, piece goods are set in stenters or in piece beam dyeing machines, also in the autoclave or in a vacuum steamer; yarns in high-temperature scouring or dyeing machines or in vacuum steamers; stockings, socks, briefs, tights etc. on aluminium boards in pressure steamers.

Setting of Piece Goods with Hot Air in Stenters

Nylon 6 goods are set	for 15-20 seconds at 190-195° C,
Nylon 66 goods	for 15-20 seconds ate220-230° C,
Nylon 11 goods	for 15-20 seconds at temperatures around 190° C.

The degreesof setting depends mainly on the temperature and to a lesser extent on the time of treatment at this temperature. Therefore, the goods need not be set for a certain length of time at the required setting temperature. The duration depends mainly on the time that is required to obtain the desired setting temperature at each point of the goods. Depending on the results to be achieved, the goods are set with hot air or superheated steam (without pressure) as follows:

	Nylon 6 goods	Nylon 66 goods
Good crease angle	approx. 190° C	approx. 230° C
Minimum residual shrinkage	approx. 200° C	approx. 200° C (untreated goods) approx. 190° C (scoured goods)
Good degree of white	approx. 190° C	approx. 190° C

When superheated steam containing approx. 90% water vapour is used for setting, the time required for heating the goods is only about 3/4 that necessary in setting with hot air. If the goods remain in the setting zone longer than necessary, the effect usually deteriorates.

Setting of Piece Goods with Heated Rollers

In view of the rapid heat-up of the goods, this method is very economical. It is, however, difficult to regulate the setting shrinkage length- and widthwise.

It is possible to use this setting equipment for the final setting of goods that have already been preset in the stenter. Occasionally, fabrics which have already been set in stenters are aftertreated on setting calenders to stabilize the selvedges.

The usual setting conditions are as follows:

Nylon 6 goods	8-15 seconds at 190-192° C
Nylon 66 goods	8-15 seconds at 205-215° C

Steam Setting in Vacuum Steamers

After exhausting the air, nylon 6, nylon 66 and nylon 11 are steamed for 10-30 minutes at 1,8 - 2 atü at a temperature of 130-132° C.

To ensure uniform setting temperatures also within large fabric batches, it is advisable to let off steam after 2-3 minutes of steaming at 132° C, then evacuate and subsequently steam again for several minutes at 132° C. It is also advisable to repeat this procedure several times.

After steaming, the fabric is cooled in vacuum.

In steam setting fabrics, however, moiré formation is liable to occur.

Steam Setting of Stockings in the Pressure Steamer

Stockings of nylon 6, nylon 66 continuous filament fibres are set with saturated steam for about 2 minutes at 120-125° C on aluminium boards either before or after dyeing depending on whether the preboarding or the postboarding process is used.

Nylon 6, nylon 66 and nylon 11 stockings, socks, tights, etc., made of batch-wise manufactured Helanca yarn are heat-set in a pressure steamer with saturated steam for 2 minutes at 135° C, articles made of continuously produced Helanca yarn (false-twist) at 105° C. It is advisable to stabilize such knitgoods of stretch yarns before washing, dyeing and finishing.

Nylon 6, nylon 66 and nylon 11 piece goods are hydro-set in water at 128-130° C in an autoclave or in a high-temperature circulating liquor machine. The hot liquor is allowed to circulate through the goods for 45 minutes but it is also possible to use a stationary liquor.

Polyamide yarns cannot only be set with saturated steam in yarn steamers but also in the form of wound packages in high-temperature washing machines or high temperature dyeing machines. If rigid tubes are used, however, it must be remembered that the inner layers of yarns cannot shrink as freely as the outer layers. This causes differences in tension within the material which become noticeable in dyeing later on.

For this reason, it would be better to use tubes which allow the inner layers of yarn to shrink by giving way to increased pressure. Perforated paper tubes are suitable for this application but these can only be used once.

The various methods of heat-setting have their characteristic effect on the material. Goods that have been set with hot air exhibit a relatively thin handle, while those that have been set with hot water exhibit a full and soft handle. The handle of steam-set goods lies between these two.

Bleaching of Polyamide Fibres

Reduction Bleach

3-4 g/l   Blankit IN
45-60 minutes at 70-80° C or
2-8 g/l   Blankit D
0,5 g/l   Kieralon OL
pH 2,6-2,8 (with formic acid)
60 minutes at 75° C
or 45 minutes at 80° C;
liquor ratio 10:1-40:1.

Blankit IN is a combination of sodium dithionite and an additive to stabilize the bleach bath. Blankit D is a specially activated reducing agent.

It is also possible to use Deflavit ZA for bleaching. This product is used in acid medium.

One-Bath Washing, Bleaching and Optical Brightening

Blankit I AWN is suitable for this combined treatment. This product is a mixture of Blankit I AN and a detergent. Blankit I AWN and Blankit IN is used. Treat 40-60 minutes at 70-80° C; (liquor ratio approx. 30:1).

Oxidation Bleach

It has been found that the acid oxidation bleach with hydrogen peroxide and Prestogen W, which was originally developed for wool, can also be used for polyamide fibres. This process gives a satisfactory bleaching effect with minimum tendering of the fibre. Conventional alkaline bleaching always results in some degree of fibre tendering when used on polyamide fibres.

The Prestogen W bleach can be carried out in long liquor and by the pad/steam or the pad/bath process.

It is also possible to bleach with sodium chlorite. It is necessary, however, to take precautionary measures against corrosion and cleavage of chlorine dioxide.

Ultraphor WT, Ultraphor BP and Palanil Brilliant White R Liquid can be used for optical brightening of polyamide. Although the white obtained with the Palanil Brilliant White type has very good light-fastness (rating 4-5), it does not always meet the requirements.

III. Pretreatment of Acrylic Fibres

General Working Method

Pre-cleansing the Fibrous Material

Acrylic fibres often contain, in addition to spinning and lubricating agents, contamination and oil. This contamination is liable to impair the levelness of shade dyed on the fibrous material. For this reason, it is usually advisable to precleanse the material before dyeing. This preliminary wash can be carried out in acid and also in weakly alkaline baths when the material is heavily contaminated. Following an alkaline bath, the fabric material should be rinsed, if necessary, with addition of acetic acid until it is free from alkali.

When the material has been contaminated with fat or oil, the cleansing effect can be increased by adding to the alkaline wash liquor Kieralon OL.

Nekanil LN, diluted 5-10 times has been found particularly suitable for the removal of local oil stains.

Bleaching and Optical Brightening

Acrylic fibres which are to be used for white goods or goods dyed in brilliant shades must have a high degree of white. Depending on the type of fibre, however, they exhibite a certain amount of yellowing which often requires a chemical bleach or even a combination bleach using an optical brightener.

Ultraphor PAN (cationic) and Ultraphor NA (non-ionic) are two optical brighteners which are resistant to chlorite. It is therefore possible to bleach and optically brighten acrylic fibres in one bath.

Chlorite Stabilizer BASF facilitates not only a controlled chlorine dioxide development but also exhibits good wetting and detergent properties. It is therefore often unnecessary to precleanse the fibrous material before bleaching and optical brightening. In addition, Chlorite Stabilizer BASF offers a certain amount of corrosion protection to stainless steel which comes in contact with the bleaching liquor.

Unevenness in the optical brightening which has been caused by improper procedure, such as by heating the bath too rapidly, can be improved by the following method:

We treat the material with Blankit IN and Kieralon B Highly Conc. for 30 minutes at the boil. After a short intermediate rinse we bleach with sodium chlorite 80%, Chlorite Stabilizer BASF and formic acid (pH 3-3,5) by heating the liquor within approximately 30 minutes to the boil and treating for a further 30 minutes at this temperature.

The optical brightening effect deteriorates somewhat during this process. If the effect should no longer be adequate the material can be treated in a fresh bath again with small amounts of sodium chlorite and optical brightener.

If an optical brightening treatment is unnecessary, a normal bleach is carried out with sodium chlorite 80%, Chlorite Stabilizer BASF and formic acid (pH 3-3,5)
Treat for approximately 30 minutes at the boil.

After bleaching, the treating bath should be cooled slowly as otherwise the handle is liable to be impaired.

Fabrics and knitgoods of acrylic fibres which have been contaminated or contain spin finishes or lubricating agents that are liable to cause trouble in dyeing should always be precleansed. Winch becks, hank washing machines and full width washers are suitable. A full width washer offers the advantage that the goods are processed in a flat form which excludes almost completely the possibility of crease formation.

Presetting

Fabric of acrylic fibres are often set before dyeing. The setting effect obtained however, differs markedly from that desired in setting polyester, polyamide and triacetate fibres.

While with fabrics of these fibres it is possible to obtain a permanent setting effect which imparts good shape retention to the finished product, the setting effect obtained on acrylic fibres is almost completely lost under dyeing conditions. This is caused by the fact that the acrylic fibre is plasticized as soon as the glass transition temperature is exceeded.

Despite this, fabrics of acrylic fibres are often "set". This is because certain fabric qualities which tend to form running creases or even breakage in which dyeing can be improved in this respect by a "presetting" operation. On the other hand, the purpose of presetting is also to ensure that the goods are shrunk completely. This is particularly important when the fabric is to be dyed on a piece beam in which case widthwise or lengthwise change during dyeing is lieable to cause trouble. A change in the dhape under dyeing conditions is usually caused by inner tension in the fabric resulting from weaving which is relaxed during dyeing. Any changes in this respect during dyeing can be prevented by "presetting" the goods in a tensionless state and thus relaxing the latent stresses within the material before the latter is dyed.

Generally speaking, stenters are used for presetting. The fabric should travel in such a manner that it can shrink freely. On leaving the stenter, no tension warp or weftwise should be exerted on the fabric and it should hang freely. To ensure this it is necessary to adjust the overfeed and the width should be adjusted to suit the special shrinkage behaviour of the fabric being treated. The temperature of the stenter is usually 170-190^{0} C and the treating time 15-60 seconds.