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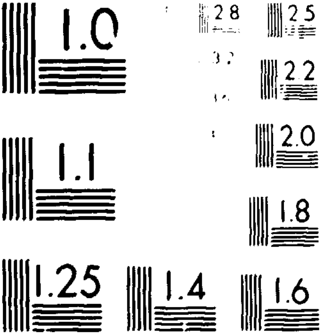
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Man-Made fibers for Technical purposes

by

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ENCLOSURE 1

Difference of physical data
of TEXTILE and INDUSTRIAL fibers

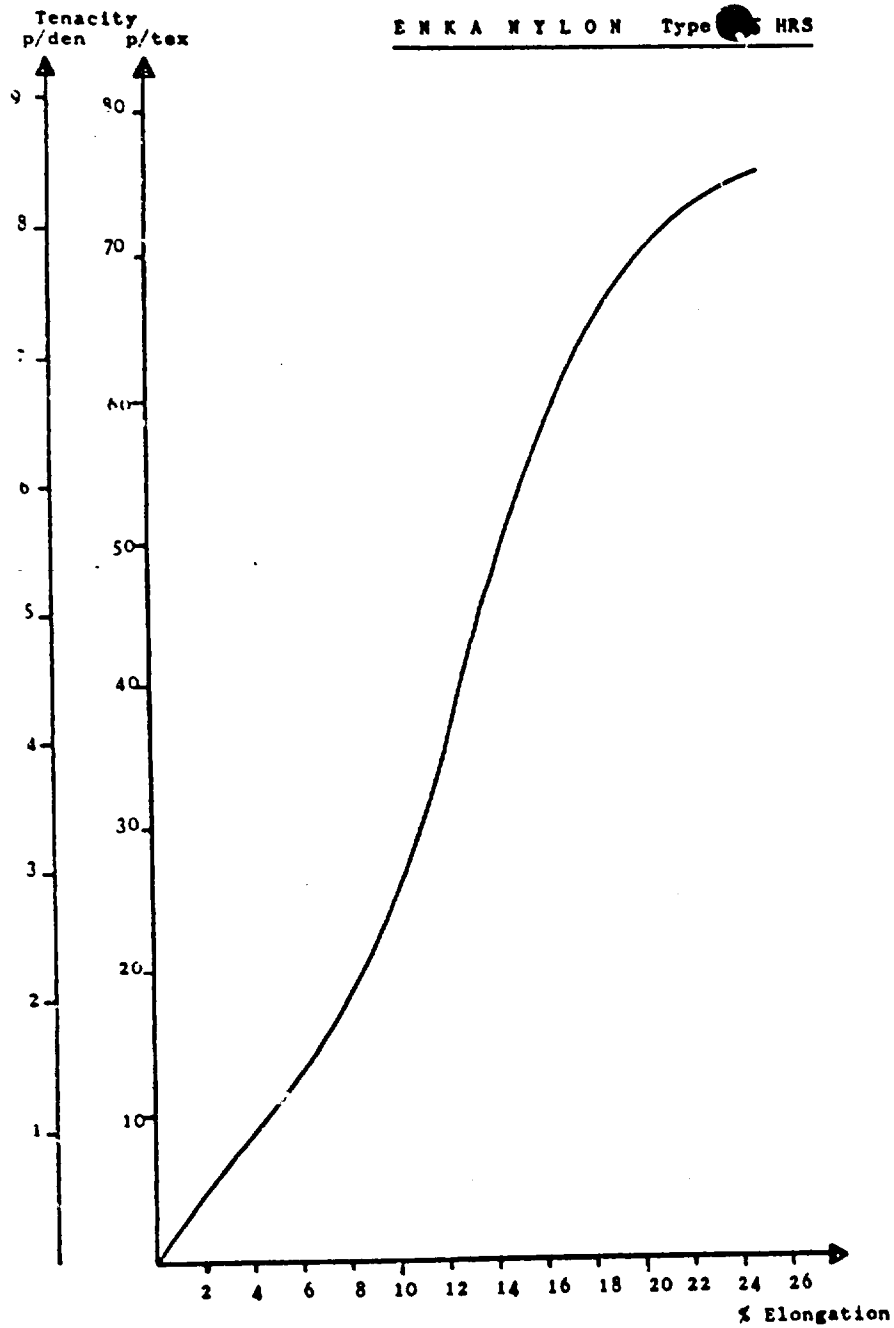
	REYON	POLYAMIDE textile +) PA 66	POLYAMIDE textile +) PA 6	POLYAMIDE indust. ++) PA 66	POLYESTER textile +)	POLYESTER indust. ++)	STEEL	GLASS
Tenacity dry mN/dtex	70	44	37	72	42	74	31	38-107
Elongation at break % (dry)	4,7	35	36-37	25	23-24	19	18	2,5-4,0
Shrinkage % Water	0,7	8-12	8-12	-	8	-	-	-
Hot Air 15'190° C	-	-	-	1,2	-	1,7	-	-
Specific Weight q/m3	1,52	1,14	1,14	1,14	1,38	1,38	7,85	2,48-2,54
Melting Point °C	175-205	255-260	215-220	255-260	250-256	250-256	-	-

+) depending on count of yarn

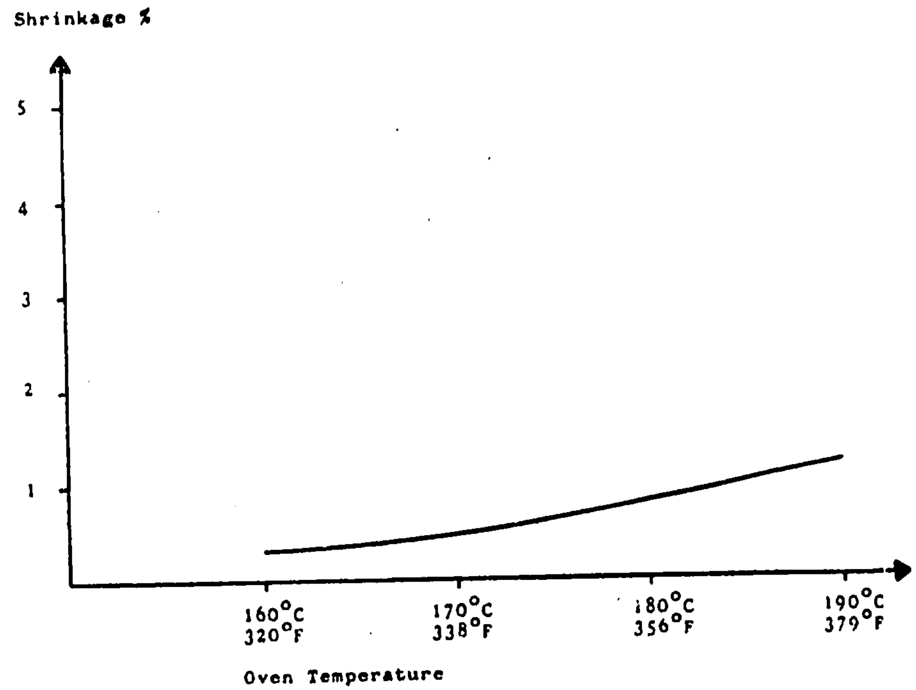
++) data taken form ENKA NYLON HRS 940 dtex (heat and light resistant, stabilized) and DIOLEN Superfest 174 S (stabilized) 1100 dtex

ENCLOSURE 1 A

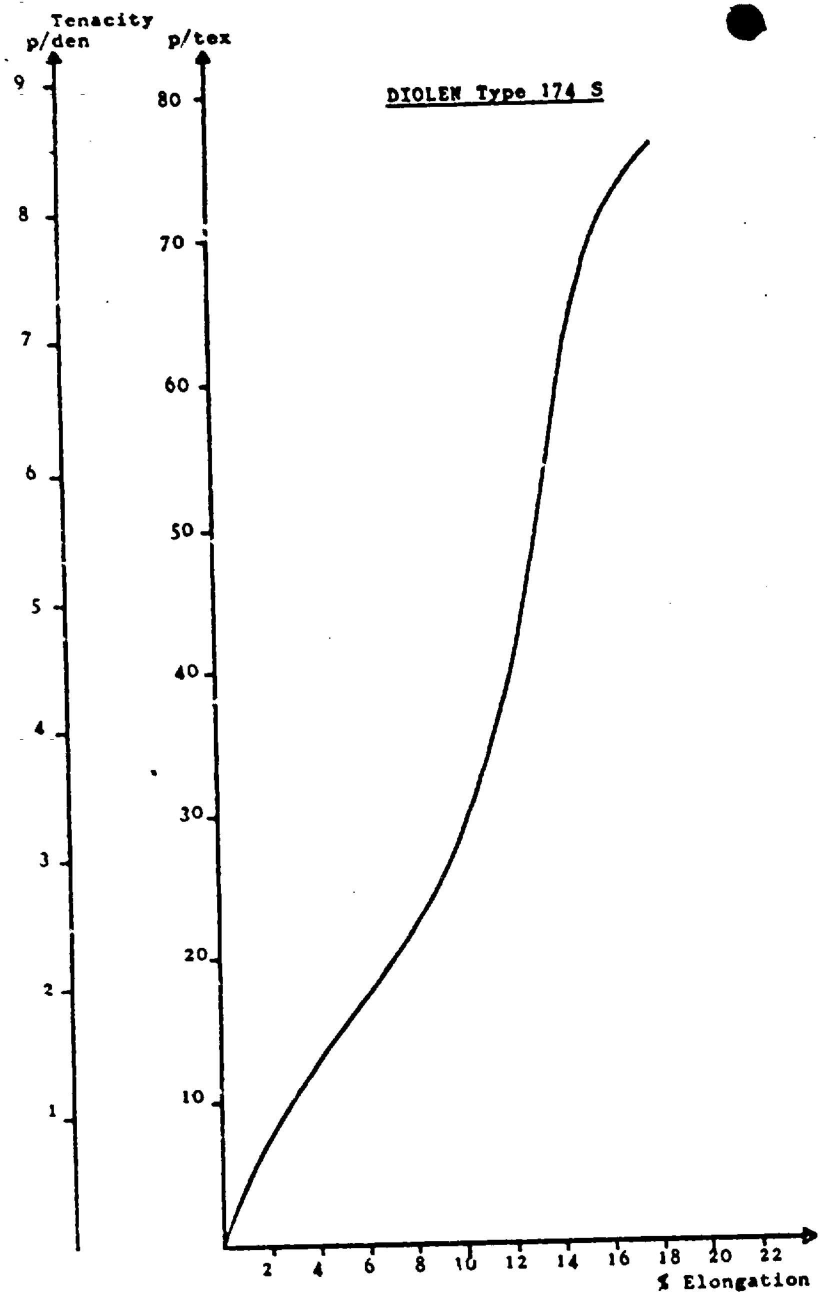
E N K A N Y L O N Type [illegible] HRS

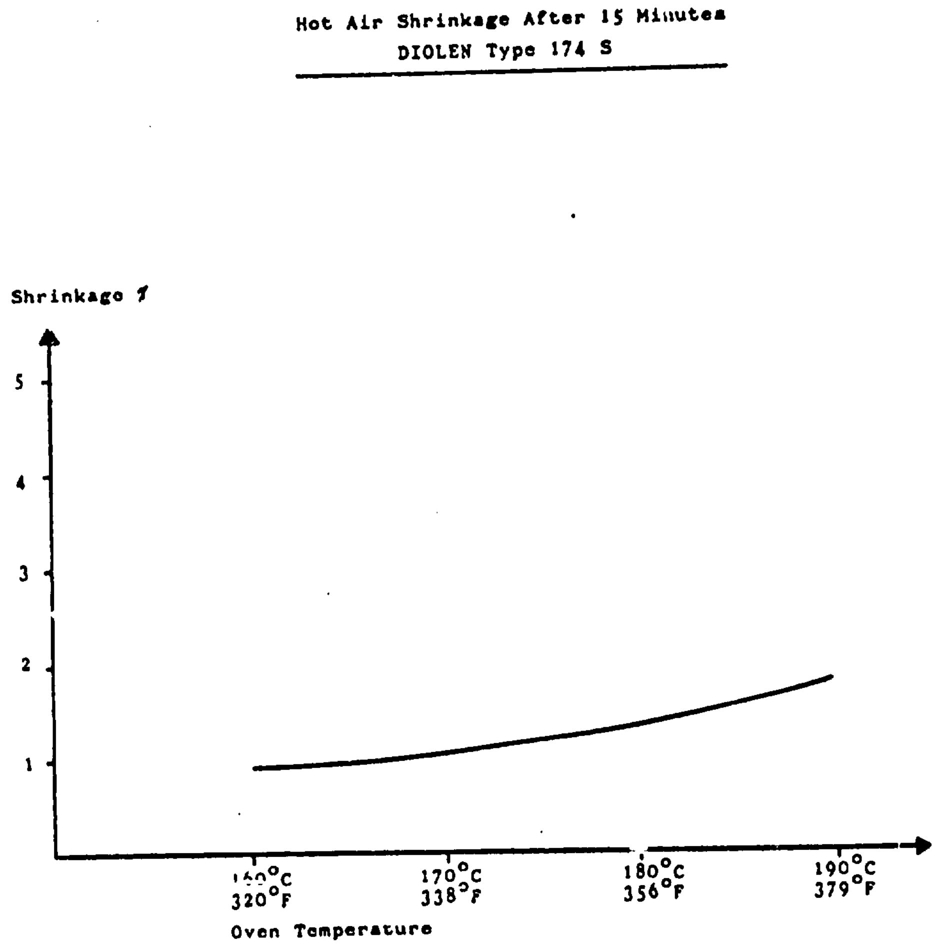


Hot Air Shrinkage After 15 Minutes
ENKA NYLON Type 155 HRS



ENCLOSURE 1 B





ENCLOSURE 2

TECHNICAL YARNS

Rayon	:	EHM® (Extra High Modulus)
		CORDENKA®
Polyamide	:	polyamide 6 ENKALON®
		polyamide 66 ENKA NYLON®
Polyester	:	DIOLEN® type 164 S (pretreated)
		DIOLEN® type 174 S (not pretreated)
		DIOLEN® type 760 (pretreated)
Steel	:	FERENKA®

ENCLOSURE 3

Trade Name	Material	Type	Main Application
Cordenka	viscose	EHM	Hoses.
Cordenka	viscose	RT 610	Flocking and ribbons
Enkalon	polyamide 6	101 HRN	Ropes.
Enkalon	polyamide 6	140 HR	Seat belts (spun-dyed charcoal).
Enkalon	polyamide 6	148 HR	Twines, nets, ropes and webbing.
Enkalon	polyamide 6	149 HR	Seat belts (spun-dyed black).
Enkalon	polyamide 6	420	Conveyor belts.
Enkalon	polyamide 6	429 HR	Twines, nets, camouflage nets, sewing yarns and filter cloth.
Enkalon	polyamide 6	431 HR	Seat belts (spun-dyed black).
Enkalon	polyamide 6	432 HRS	Base cloth for thermoplastic-, rubber-coating and laminating.
Enkalon	polyamide 6	500	Twines, nets.
Enkalon	polyamide 6	510	Twines, nets and ropes.
Enkalon	polyamide 6	520	Twines, nets, ropes and seat belts.
Enka Nylon	polyamide 66	130 HR	Safety lines, camouflage nets, seat belts, belting, conveyor belts.
Enka Nylon	polyamide 66	155 HRS	Base cloth for thermoplastic-, rubber-coating and laminating.
Diolen	polyester	52	Sail-cloth, filter cloth, paperfelt, ribbons.
Diolen	polyester	53 S	Sewing thread, core yarn.
Diolen	polyester	54 S	Base cloth for coating, ribbons.
Diolen	polyester	56	Seat belts
Diolen	polyester	164 S	Filter cloth, V-belts, hoses, conveyor belts, dryer felts.
Diolen	polyester	173 S	Carpet backing for tufted carpets (spun-dyed grey).
Diolen	polyester	174 S	Base cloth for thermoplastic-, rubber-coating and laminating (tarpaulins, inflatable halls, containers, silos), hoses.
Diolen	polyester	760	V-belts.
Diolen	polyester	850	Fire-hoses, conveyor belts, seat belts.

Man-Made fibers for technical purposes

During the last weeks you have been given a number of lectures on Man-Made fibers. Most of the papers dealt with fibers for textile end-uses, which we call textile because of their use for clothing, home furnishing and so forth.

It is obvious that textile materials for technical purposes need certain qualities which can only be attained by using yarn of special properties.

Mainly filament yarn is used and that is why this paper is in the

ENCL 1 first line dealing with these yarns. What is the difference between "textile" and "technical" - or Industrial fibers?

- The yarn count: textile: up to 330 dtex
  technical: from 235 dtex up
- Physical data (see enclosure 1)
- special preparation or pretreatment (to give better adhesion - for example)

ENCL 1A Because the articles made from industrial fibers cover a wide range

1B of articles a great number of yarns are made each with specific

ENCL 2+3 properties (enclosure 2 + 3).

Enclosure 3 shows a list of the various products of ENKA GLANZSTOFF and the proposed end-uses.

I will cover the articles during the course of my paper.

To complete the list of fibers used for industrial purposes sum up as follows:

Reyon	(R)
Polyamide 6 + 66	(PA)
Polyester	(PES)
Acrylic	(PAC)
Polypropylene	(PP)
Polyvinylchloride	(PVC)
Aramide	
Glass	
Steel	

Industrial yarns are produced as

Staple fiber
filament yarn
monofile yarn

Special profiles are hardly ever used. The "round" type, glossy in raw-white or black is what is needed by the industry dealing with these fibers.

Starting off with the raw material as it leaves the spinning section of a fiber plant we follow its way out to be made up into cylindrical bobbins, cops for untwisted and cones for twisted yarn, sectional beams for Raschel machines (bags, sacks), warps for all kinds of weaving.

We now reach the stage of production which takes place at a customer's plant, that means the first manufacturer outside a Man-Made fiber plant.

1) Nets and sacks are produced on Raschel-machines mostly in form of split-weaving PP. PA is used to sew the sacks.

2) Fishnets and other nets for loading goods at harbours are made on special net-machines.

3) Ropes and twines, fishing lines and heavy duty sewing threads are twisted.

4) Narrow webbing: Small bands and ribbons but also safety belts, belts for loading goods etc. are woven on small looms at high speed.

5) Non-wovens: This special field was covered by a separate paper. (End-product: paper felt)

6) Sheathed yarns of PES core with PA or other coating are woven to screens for the paper industry.

7) Broad weaving covers almost all the fields of articles:

According to consumption we could list the most important outlets as follows:

1) Rubber industry
2) Transport, storage and auxiliary means
3) Building and roofing
4) Sport
5) Miscellaneous
6) Safety

1) Rubber industry

a) Tyres: Tyres are manufactured during the last 40 years according to the same construction using High tenacity Reyon for their carcasses. Nylon-cord brings similar advantages to tyres as the change from cotton to HT-Reyon brought years ago.

Nylon surpasses Reyon as follows:

by 100 % in fatigue
" 65 % in heat resistance
" 40 % in tear strength

Dipped Cord fabric is cut in bias at
30° angle for speed tyres and
40° angle for standard tyres
manufactured to conventional (diagonal) tyres.

Radial tyres consist of one or two layers of cord fabric (HT-Reyon or Nylon) cut at 90° angle. Above the carcass that runs from one hump to the other the "belt" of several layers of steel or HT-Reyon will be vulcanized.
The humps consist of steel covered by Reyon to protect them from abrasion. Some of the bigger truck-tyres have two humps.

Comparison of Nylon and HT-Reyon

For practical use Nylon means a longer life for the tyre. The carcass will not get tired as a reyon-cord base will. Of course there is a certain difference in price of carcass material. That is why Nylon is used preferably for tyres used on high speed cars or in truck-tyres such reducing the number of layers.

The only disadvantage of Nylon carcass-tyres is "flat-spotting", i.e. a flat spot on the point where the hot tyre rests and cools off. The flat spot will disappear as soon as the tyre is getting warmer when used again.

Let us leave this classical field of technical Man-Made fibers in rubber industry which takes up the greatest part of technical fibers.

b) Conveyor belts are used for continuos transport of bulk goods on dredgers, excavation and other machines.

What is required of a conveyor belt?

- Absorption of the tensional forces introduced by the drive pulley and needed to overcome drag and belt slope.
- Good dynamic properties - i.e. good resistance to bending.
- Good energy absorption and resistance to shockloads and impact of material to be carried.
- Lengthwise dimensional stability.
- Intensibility and resistance to atmospheric conditions of surface and underground.

Most of the conveyor belts contain a carcass of textile fabrics (ducks). Lengthwise strength is their most important factor. Formerly used cotton belts were limited in strength due to duck strength, but since Man-Made fibers were introduced in conveyor belting the situation changed completly. The trend to synthetic belting is clearly seen

- in more favourable Weight/Strength ratio
- Intensibility to climatic conditions
- Resistance to rotting and mildew
- and last not least in cutting down costs per square meter and maintaining fabric strength at the same time.

This resulted in a great demand of EP fabrics (PES in warp PA in weft) expecially in times of raw material shortage and rising prices of ores etc. Even small mines - suspended for years - opened up and demand EP-fabrics instead of the meanwhile rotten cotton belts.

Production of conveyor belt:

Similar to tyre manufacturing, yarns or ducks are dipped to give better adhesional qualities. 2 to 6 layers of dipped ducks are vulcanized with rubber (natural or synthetic) as polymers to give certain qualities of conveyor belts. You can see the thick top ply of rubber (carrying surface).

Conveyor belts are made "endless" on the conveying machine - that means on the site where the belt will be in operation.

2 methods of joining the belts:

by hooks - for light weight bands
by splicing - for multi-ply-belts

Man Made fiber producers as ENKA GLANZSTOFF supply its customers with all information needed to supply the belt users with an efficient and economic conveyor belt produced by the most modern techniques.

c) V-Belts and reinforced hoses take advantage of the highly dimensional stability of PES which is most commonly used.

d) <u>Miscellaneous articles of the rubber industry</u>

Container-Transport:

- to keep goods from falling "Bellows" are used.
- Insulation winding of transcontinental wires.
- reinforced hose
- containers
- membranes
- tubular fabric for batteries
- sheet-rubber for printing trade
- bandages for vulcanization

e) <u>Rescue, sport and leisure</u>

- Rubber dinghies
- Life rafts
- Life vests
- Clothing for sportsmen

Special protective clothing has been recently developed in the F.R. of Germany against water, fire, heat, extreme low temperatures and chemicals.

Rescue on high sea:

The Insulation protects from drowning as well as from under-cooling the person floating in open water.

Before we go into the wide field of applications of Polyvinyl-coated fabrics let me give you an idea how tarpaulin material is made.

Substrates are mostly woven fabrics. They differ in the weave of the fabric and in the yarn count used.

As broad fabrics take a very dominant place I would like to spend a few words on this matter. Weaving is one of the oldest handicrafts of this world and was perfected over the last century in an astonishing way. This is best shown by a few slides.

Automatic looms with automatic pirn change need shuttles like the big one you see here and is compared with a weaving machine's projectile which draws yarn off a bobbin directly, thereby skipping the winding process. Working width up to 213 inches.

A similar process is performed in a gripper machine where yarn is also drawn direct off the bobbin.

The advantages of this modern machinery are on hand. A fabric can be woven up to 213 inches (for carpet-backing) or be separated by a hot welding wire into 3 pieces each as wide as a fabric woven on a single-broad loom. Further advantage is a high number of revolutions (170) which results in a phantastic output at highest possible efficiency. Similar in output are gripper and water-jet machines.

Now, having followed up production to a woven fabric we will see what can be done with it.

What are the applications?
The classical fields of the rubber articles, woven articles and nets are known to everyone. More recent developments have opened up a wide field of application in the technical fields. Storage problems, building-sector and production of composite materials in combination with plastics of all kind.

Suitable yarns are:

Polyester fine dtex 280, 550

" heavy dtex 1100, 1670 and 2200

Polyamide 66 Nylon dtex 940 and 1880

" 6 Perlon dtex 235 and 470

Differences of these materials become evident when we look at their

Enclosure 2 hot air shrinkage data.

Enclosure 3

The following table shows the shrinkage behaviour at different temperatures. As coating pastes are jellied and dried at 190°C, yarns with lowest possible shrinkage are predestinated for coating.

DIOLEN at 1,7 % and
ENKA NYLON at 1,2 % hot air shrinkage measured at 190°C and after 15 minutes are the world's most sophisticated yarn types for these enduses.

Construction of fabric is worked out according to desired tensile strength which is measured in kp or Newton/per 5 cm width of test piece. Setting is chosen in accordance with yarn count and is measured in threads/10 cm.

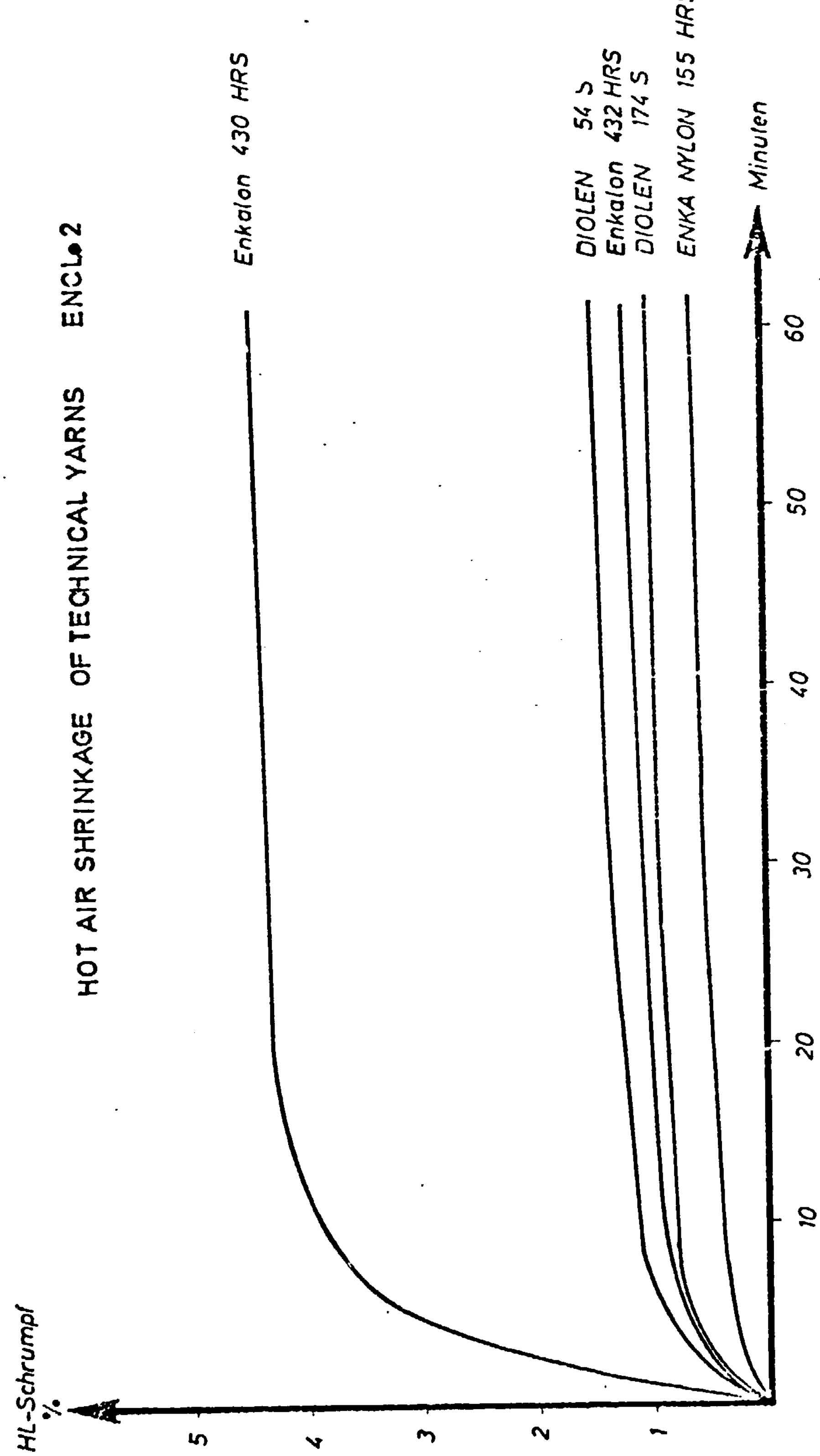
Advantages of yarns, especially made for coating with properties like lower shrinkage, high tensile strength, fastness to light etc. are on hand:

Weaver:
- excellent weaving properties
- higher weaving efficiency
- no sizing, no scouring

Coater:
- substrates without broken filaments cause no difficulties during coating
- no heatsetting
- no loss of squareyards due to shrinkage
- no puckering

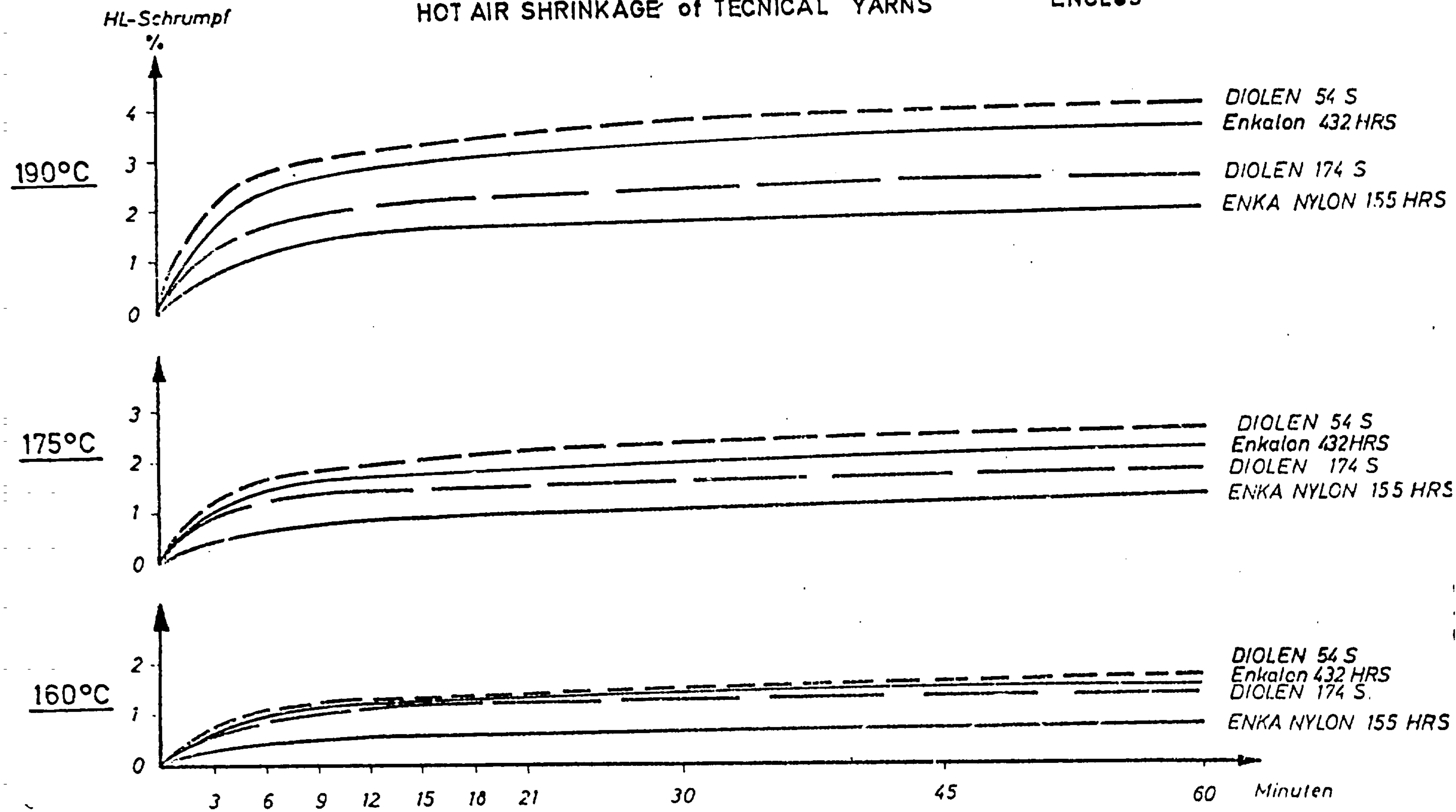
Enclosure 4

HOT AIR SHRINKAGE OF TECHNICAL YARNS ENCL. 2



145°C

HOT AIR SHRINKAGE of TECNICAL YARNS ENCL. 3



ENCLOSURE 4

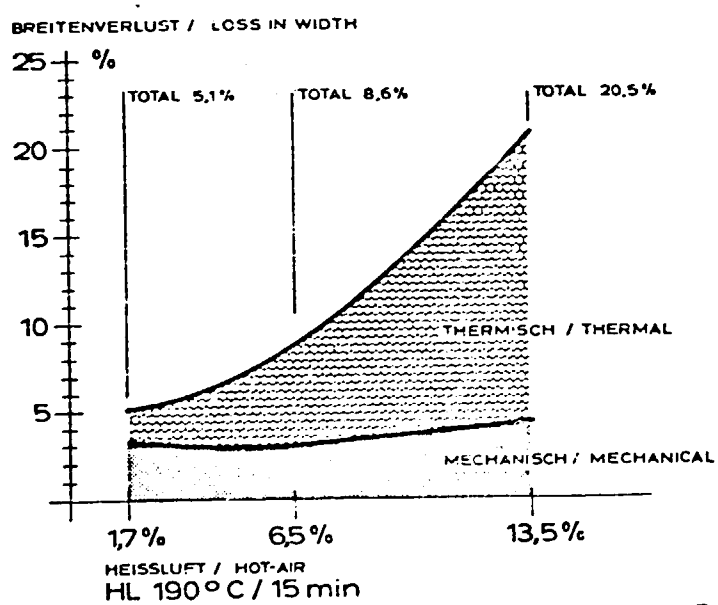
HEISSLUFTSCHRUMPF

EINFLUSS AUF DEN BREITENVERLUST DES GEWEBES

HOT-AIR SHRINKAGE

INFLUENCE ON LOSS IN FABRIC WIDTH

GEWEBE 8.7/9.0 FÄDEN/cm
FABRIC 8.7/9.0 ENDS/cm



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Coating:

a) Vinyl-pastes differ in formulation in dependance upon the end-use of the coated fabric.

Examples: Resistance to oils or certain chemicals is desired in a silo or container storing or transporting fruit juices, chemicals etc.

Airsupported structures must show more resistance to flammability and resistance to weathering.

For that reason the main components of a vinyl paste used for coating will contain stabilizers as well as uv-absorbing agents besides PVC and plastizisers.

Sufficiant adhesion of Vinyl-coating to substrate is obtained by an appropiate portion of isocyanates, being added to the basic layers.

b) Coating machinery:

Most commonly spreading machines are used. They consist of

spreading unit
jellying oven
stenter frame
embossing or smoothing calander
cooling system

Being the most important part of the machine, the spreading unit should be explained in detail.

In this unit the paste is spread on the substrate by means of the doctor-blade. 3 different kinds are known:

Air doctor blade
doctor blade over rubber blanket
doctor blade over roller

Using the air doctor blade the substrate to be coated is drawn over two rollers and between these rollers the blade is situated, the fabric being not supported under the knife. This system is used for the first coating layers. The thickness of the paste is regulated with the speed the substrate is drawn which means the faster the working speed the thinner the coating and by the distance between fabric and knife.

Rubber blanket and roller methods are used for the last layer. The doctor blade is thereby placed above a continuous rubber blanket or a roller.

To jelly the vinyl pastes usually jellying ovens are used. Hot air is blown either vertical or slantwise onto the fabric. Temperatures from 140°C for pre-jellying of the frist layer and 200°C for complete jellying of the whole component are needed.

Tarpaulins weighing from 450 to 500 gramm/sqm usually are coated in 3 - 4 passages that means 2 on the top and 1 - 2 on the reverse side. Spreading units are set up in tandem at some production lines. The first coat is quickly dried in a short oven or infrared field. That way a tandem-machine is able to finish one side of a tarpaulin in one passage.

In order to prevent dust particles from penetrating into the PVC-coating the upper side is provided with an additional soil resistant film of acrylic raisin.

Making up of coated fabrics:

Principially three different methods are known: Sewing
Glewing
Welding

Sewing is widely used for all purposes. Depending on the thickness of the tarpaulin or other coated fabric 2 to 4 seams are applied to aim at the same strength in the seams as in fabric itself. The disadvantage is perforation of the coating which affords making the piece watertight afterwards.

Welding can be done by Hotair - or High frequency method or hot plate. Hot-air method can be done continually, whereas the HF-method has a completly different procedure based on discontinual working method.

Hotair: Coating is heated and pressed together according to the system and this way the coats of the pieces to be connected are welded.

The criterion is adhesion: For tests welded seams are torn at reproducing practice in laboratories. Lab-tests give adhesion values in Kp. or Newton according to standards. Some 18 standards exist to test tarpaulin materials.

Enclosure 5

Comparison of results of commercially available tarpaulin types is shown in the following table. Direct comparison with traditional cotton tarpaulin shows the advantages of Polyester (DIOLEN) and Nylon.

Accepted are poorer water vapour and air permeability of synthetic fabrics but the overwhelming properties of tarpaulins made of Man-Made fibers leave no doubt that the future is theirs.

Enclosure 5

Comparative survey of the most important technological data

4. Comparison cotton tarpaulin with PVC - coated ENKA Nylon 155HRS and DIOLEN 174 S

	cotton tarpaulin	PVC-coated ENKA Nylon 155 HRS	PVC-coated DIOLEN 174 S	methods of test
thickness				DIN 53353
square weight				DIN 53352
tensile strength				DIN-53354
elongation at break				DIN 53354
tear strength				DIN 5335[illegible] BS3424
coating adhesion (HF), making up				VBK 1/69/14
resistance to flame				DIN 53906
resistance to flex cracking				DIN 53359
resistance to cold				VBK 1/69/5
dimensional stability				VBK 1/69/7
stiffness				EG-Taber Stiffness
resistance to soiling				VW-TL 566
air permeability				DIN 53887
water vapour permeability				JUP 15
water absorptive capacity				EG, VBK 1/69/7
resistance to water penetration				DIN 53886
bursting strength				DIN 53861

declaration of symbols: same range basis [empty box] better [hatched box] much better [bold box]

Now, to come back to the above mentioned summary we can tackle chapter 2.

2) Transport: Putting more and more trucks on the road meant a tremendous demand of tarpaulin. Taking Europe as an example: all countries - besides Great Britain and Spain - have more or less completely switched to synthetic fiber tarps. (The two mentioned countries still cling to cotton tarps for various reasons.) Good dimensional stability of Polyester gave these tarpaulins a firm place in addition to PA.

Storage: Roofs for railroad waggons

- Covers of all kind for goods
- Gas balloons
- Sacks and sewing thread for sacks
- Silos for forage, chemicals, food
- Containers for water (fire brigades in remote areas)
- Fiber-armed foils and papers

Auxiliary means:

- Aprons for Hoover-crafts
- Light conveyor belts
- Tubes to blow fresh air into mine-tunnels
- Fixing belts
- Air mail bags
- Loading nets used in harbours
- Parachutes
- Ropes to keep overshooting planes from falling off aircraft-carriers
- Felts and filters for paper industry

Fishing industry

- Nets of all kind
- Tows
- Protective clothing
- Covers and tarpaulins
- Seines, lines

Most of the material used is Polyamide (66 %), Polyethylene (30 %), the rest is Polyester and Polypropylene. Fishing industries estimate an annual growthrate of 2 %. They used some 70.000 tons of fishnet etc. of synthetic fibers in 1970.

Application of coated fabrics

3) Building and roofing:

- Air-supported structures (storage, sport etc.)
- Air cushions (like the German City of Marl placed above a shopping center)
- Tension structures and
- Tents for exhibitions, sport.

The main advantages of air-supported structures are:

- built quickly and cheaply and adaptable to intended use
- often temporarily used then dismantled and removed easily towards the next site
- alternations (adding further constructions to the existing ones) as well as repairing is easy.

Over 500 structures each in West Germany and Scandinavia show that experimental stage has long left early stages. Areas covered range from 300 to 1500 sq m. Some structures in Japan cover 5000 - 9000 sq m and one in France even has 10.000 sq m covered.

Air-supported structures serve as

storage rooms
Ice-hockey-hall (Finland)
exhibition centers
warehouses and
construction shelters for building in wintertime
emergency hospitals.

Structures are prefabricated and erected on a site, where foundations have been prepared. The skin is anchored to the ground by means of screw, peg-type or concrete anchors.

This is followed by setting up personal and lorry-entrances.
The cold (and hot)-air blower is installed.
An extra blower (mostly VW-motor) is set up.
The blowing-up starts and the work is finished - the slight over-pressure in the structure amounts to 20 to 30 mm water column. It is produced by a blower with a power of 0,55 to 7,5 Kw according to the size of the structure.

Of course, many standards must be observed - similar to tarpaulins - and in addition there are restrictions as:

- Number of persons admitted to the hall and to intended use.
- The number of escape systems is standardized according to dimensions.
- Weight and strength of envelope material (strength ranges between 300 and 600 Kg/5 cm depending on size of hall).
- Emergency generators for structures housing more than 30 persons.
- Flame resistance of the envelope.
- Electric light and power units.

Having obeyed all mentioned standards it proves that air-supported structures offer adequate safety, provided operation instructions are observed. Service life of a hall will last 10 to 15 years and - in comparison to rigid constructions - one can say that construction of an air-supported hall and service over that period will come to only approx 50 % of the cost of a rigid hall.

Maintenance:

Air blowers installed will consume 0,5 to 7,5 Kw per hour depending of size of hall. Air blower must be automatically coupled to an emergency blower which is independent from the power net. Heating is done by special units. A minimum of 12°C is needed under the top of the construction in order to melt snow and thus prevent the hall from excess of loading.

Air-supported structures being made of translucent coated fabrics give adequate good light inside the hall since light transmission goes up to 50 %. This is of importance when TV-shows are transmitted life out of a sports-hall like it has been done during the Olympic Games in Munich.

4) Sport

Leisuretime - more time - a growing industry of sports articles and building of sports-areas added a great number of end-uses to the list of articles.

Air-mattresses
rubber dinghies
sails
tows for boats
covers for boats
nets for fishing
nets for tenniscourts
protective clothing for yachtsmen
ropes for mountaineers
camping articles (tents, waterbags, ropes)
pools
covers for pools

5) Miscellaneous

household-use

- carpet backing is perhaps the biggest consumption field expressed in tons of use of Man-Made fibers. Polypropylene covers nearly 100 % of the market
- awnings
- shopping bags
- industrial sewing thread

just to name a few items.

Special fibers:

Vorious fibers are on the market to cover the field of end-uses where high melting points are urgently needed.

Examples: Firemen's clothing
Suits for racing car drivers
Protective clothing for steel workers etc.

Safety in Cars:

6) Safety belts, you will agree are among the best inventions since people think of security in cars. For some years they belong by law to the standard outfit in many countries. In Austria safety belts must be used by the persons sitting on the front seats of a car.

In practise it has proved that an unsecured person catapulted out of a car after a crash will be killed by a chance of 30 to 1.

Statistics show that the likelihood of being killed or injured severly is double if not protected by belts.

How effective safety belts will be in every day's use is simulated under realistic conditions:

a) - A test dummy is stripped to a test-sledge by means of the belting system to be tested.
   - The sledge is accelerated and then stopped apruptly simulating an accident.
   - The dummy will such be forced into the belts which are stretched or torn according to the force arising of the transmission of kinetic energy from body to parts of the sledge (car) or belts respectively.

b) Tests of webbing in laboratories (elongation, stiffness, rubbing-fastness, tensile strength, staining, colour fastness, resistance to degradation)

c) Comparison with results of other test methods.

The construction of safety belts largely depends on existing standards of the various countries. The use of Nylon (higher elongation) or Polyester (stiffer) depends on these standards as well as regulations such as speed limits or other standards regarding safety in automobiles.

Airbag:

Apart from safety belts a "passive" system has been looked for. It was found in the "airbag". The moment a car comes to a crash-like stop a bag is rapidly inflated by air in order to take up the bounce of the body flung into it.

The fabric from which an airbag is manufactured must stand the following tests:

highest tenacity at minimum of thickness
insensibility to temperatures (minus 40°C to + 100°C)
highest bursting strength when rapidly blown up
fastness to rotting and climatic conditions

Looking for a material with desired properties leads to Polyamide. It is a question whether the fabric should be used coated or not. It mainly depends on the air permeability. On the other hand there is no proof yet on the decay of Polyurethan or other coatings over the period of 5 or 10 years. For various reasons the development of airbags has not come to a point fully satisfying authorities.

Aramide:

Enclosure 6

It is not known yet which possibilities these fibers will have in coating, lami ing or other fields. Aramides certainly will have great chances in future. They will be located in textile constructions.

Due to the low stretch and high tenacity it might be suitable to construct airborne structures 3 to 4 times the size of those based on Polyester filament.

Of course Aramides will not substitute the current Industrial fibers of Polyamide or Polyester, they will most certainly open a new field of end-uses.

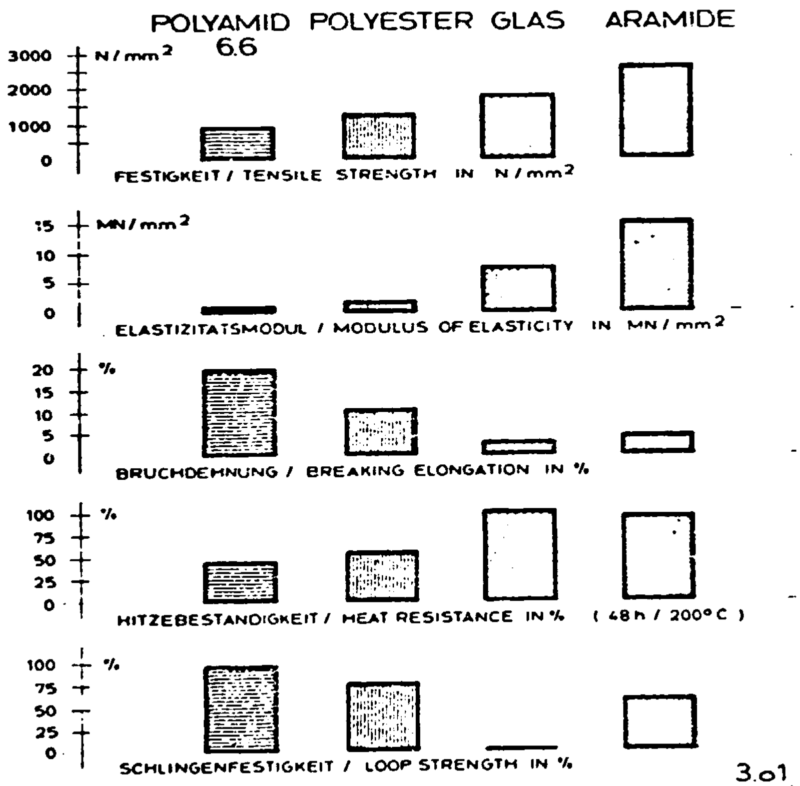
Aromatic Polyamides differ from Polyamide 66 (Nylon) especially in:

- Tenacity related to cross-section Aramide is 2 to 3 times stronger than Nylon 6.6
- Modulus of elasticity is substantially higher
- Elongation at break is clearly lower at about 3,5 %
- Heat resistance is about the same as glass
- Loop Strength is approximately the same as Polyester and about 2/3 of Polyamide.

ENCLOSURE 6

VERGLEICH
AROMATISCHE POLYAMIDE ZU ANDEREN TECHNISCHEN GARNEN

COMPARISON
AROMATIC POLYAMIDES WITH OTHER INDUSTRIAL YARNS



3.01

Industrial Fibers of Enka Glanzstoff

Enka Glanzstoff AG
Akzo group member

SHORT DESCRIPTION OF THE TEST METHODS FOR TECHNICAL YARNS
types 101 HRN, 140 HR, 148 HR, 149 HR, 429 HR, 431 HR, 432 HRS, 130 HR, 155 HRS, 52, 54 S, 56 164 S, 173 S 174 S and 760.

1. **Linear Density (dtex)**
   Of each bobbin a skein of 10 metres length is cut and weighed on a Sauter balance „Toppan" (For type 101 HRN 1 m length.).

2. **Tensile properties**
   The tensile tests are carried out on a Vollautomat Zwick Z 13 H.
   Gauge length 50 cm, pretension about 10 grams.
   The testing speed is chosen in such a way that the break time is 20±2 seconds.
   5 Determinations of each bobbin are carried out.

3. **Shrinkage at elevated temperature**

   a. **In hot air, 4 min. at 160° C**
   Firstly the yarns are conditioned tensionfree. Thereafter one end of the sample is secured in the fixed upper clamp of the apparatus and the other end is loaded with 0,45 g/tex in such a manner that there is no change in tw... The sample length is 50 cm.
   Next the sample is heated in hot air of 160° C for 4 minutes. Directly after these 4 minutes the sample length is measured in the hot condition; always under a tension of 0,45 g/tex (1).
   Normally 3 specimens of each bobbin are tested.
   The shrinkage is calculated from $\frac{50 - 1}{50}$ 100%.

   b. **In boiling water (30 min. at 100° C)**

   Without pretension skeins are made.

   dtex < 522 = 30 m
   dtex 523 - 1067 = 10 m
   dtex > 1068 = 5 m

   The skein is conditioned for 1 hour and thereafter the length (a) of the skein is measured under a pretension of 0,5 gr/tex (For type 101 HRN 0,1 gr/tex).
   The skein is boiled for 1 hour in water of 100° C, spindryed and conditioned for 2 hours.
   The length (b) of the skein is measured again under a pretension of 0,5 gr/tex.

   The shrinkage is calculated from $\frac{a - b}{a}$ .100%

c. **Shrinkage at elevated temperature 15 min. at 190° C**

A yarn length of about 150 cm is taken from the bobbin and two normal knots are made on a 100 cm distance from each other. Next the sample is conditioned tension-free.

The exact length (a) is measured between the knots in mm under a tension of about 0,1 gr/tex.

Thereafter the sample is heated in hot air of 190° C for 15 minutes. After these 15 minutes the sample is conditioned at least 2 hours, and the length (b) is measured again under a tension of 0,1 gr/tex.

The shrinkage is calculated from $\frac{a - b}{a} \cdot 100\%$.

Normally 1 specimen of each bobbin is tested.

Generally 10 bobbins are tested.

4. **Shrinkage force at elevated temperature**

Firstly the yarns are conditioned, tensionfree on a skein.

Thereafter a sample length of 50 cm is placed between the grips of the tester, under a tension of 0,45 g/tex. The distance between the grips is fixed.

Next the sample is heated in hot air of 160° C for 4 min. The force exerted in the specimen directly after the 4 min. is measured.

3 Samples are tested from each bobbin.