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KNIT FABRICS POSSESSING IMPROVED DURABLE-PRESS AND COMFORT PROPERTIES

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ABSTRACT OF THE DISCLOSURE

A durable press textile having improved shape retention, comfort and wear characteristics which comprises a knitted fabric having a face consisting at least essentially of non-cellulosic yarn (which is free from durable press finish) and a back consisting at least in part of cellulosic yarn, the back having a durable press reactant finish thereon. The product may be made by knitting a single, double or warp knit fabric, presensitizing the cellulosic back by application thereto of a durable press resin, pressing and curing.

The present invention is concerned with knit fabrics which demonstrate improved durable-press, wear and comfort properties. The invention is of particular importance in connection with knit fabrics (single knit, double knit or warp knit) containing or consisting of polyester face yarn, although the invention also contemplates the use of other synthetic thermoplastic yarns, e.g. nylon, acrylics, cellulose triacetate, etc., and/or wool, in lieu of, or in addition to, polyester as the face yarn.

As background to the invention, it is noted that conventional knit fabrics, for example, knits composed entirely or essentially of polyester, suffer from several disadvantages. One problem is that 100% polyester knits cannot consistently be given a durable press or pleat, at least in the absence of special processing techniques. Apparently this is due, at least to some extent, to yarn movement in the knit structure, the movement causing pleats or creases to become rounded during wear. Whatever the explanation, however, the difficulty of consistently imparting a durable press to polyester knits is well-recognized and has been a limiting factor in the nature of the use of such products.

Another problem with conventional polyester knits is their lack of comfort to the wearer. This is due to such factors as feel, static pickup, low moisture absorption, and the like. These property disadvantages can be minimized or overcome by the application of certain finishes but, generally speaking, these finishes create other problems such as stiffness or tackiness. Similar problems are encountered in the case of conventional knits made with other synthetics, e.g. nylon.

Cotton and like cellulosics are well known for their comfort properties but, when a durable press finish is applied thereto, other advantageous properties, particularly abrasion resistance, are undesirably affected.

The principal object of the present invention is to provide durable press knit textiles, e.g. double or single knits or warp knits, which are free from the disadvantages noted above. A specific object of the invention is to provide knit fabrics containing polyester and cellulosic yarns which have better durable press, comfort and wear properties than otherwise possible using conventional techniques and/or knit constructions. Other objects will also be apparent from the following detailed description of the invention.

Broadly stated, the objects of the invention are realized by providing a knit fabric having a face consisting at least essentially of non-cellulosic yarn and a back consisting at least in part of cellulosic yarn, the back having

a durable press reactant finish thereon. Such product may be prepared by knitting a fabric, for example, a double knit fabric, having a face composed exclusively of polyester filament yarns and a back consisting at least in part of cellulosic yarn, e.g. filament rayon, presensitizing the cellulosic back by the application thereto of a durable press resin, preparing a garment from the thus treated fabric, pressing and curing.

A wide variety of knit constructions can be made according to the invention providing the face and back are predominantly made of different fibers as described above. Appropriate apparatus for preparing such knit constructions are well known and includes such conventional types of single, double and warp knitting apparatus as, for example, Raschel or tricot machines. Typical apparel constructions include, in the case of double knits, the so-called Milano Rib and Ponti de Roma. The first of these (Milano Rib) requires three yarn feeds, identifiable as the cylinder (or face), rib (face and back) and dial (or back) feeds, while the Ponti de Roma requires four feeds, two being identifiable as interlocking, another as the dial or back feed and the fourth as the cylinder or face feed.

As indicated the face of the present fabric is preferably polyester, most advantageously polyester multifilament (e.g. 100/20 or 150/34 polyester filament yarn). Spun yarns may also be used but best results, particularly in respect of pilling resistance, are obtained if filament yarn is used for the face. Other synthetic thermoplastic yarns or wool as noted above may also be used in lieu of the polyester or blended therewith. Preferably, however, at least 50% by weight of the face is polyester filament yarn. The face may also include a minor amount of cellulosic filament or, in certain cases, spun yarn but preferably the cellulosic content in the face does not exceed 35% by weight of the total face yarn.

As for the back yarn, considerable variation is possible provided the back includes at least some cellulosic yarn (e.g. 20% or more by weight based on the total weight of back yarn. Filament rayon is preferred as the cellulosic yarn component for the back of the fabric. A typical example thereof suitable for use herein is 100/40/25 filament rayon, although obviously other rayon filament yarns may be used. The rayon yarn may be regular rayon, high wet modulus rayon or blends of these, with each other or with other synthetic fibers. Other possibilities for the back include, for example, spun yarns comprising polyester and cotton or polyester and rayon, or plied polyester/rayon filament yarn. When maximum strength is desired, it is preferred to use polyester filament for the back in conjunction with the cellulosic component. In such cases, the cellulosic component, e.g. rayon filament is wrapped around a polyester filament core or the two yarns may be plied together.

Best overall results seem to be obtained when the back of the fabric does not have too high a cellulosic content (e.g. not in excess of 60–75% by weight). The back may be completely cellulosic in cases where the fabric is not subjected to considerable strain or tension in use although normally, as indicated, it is preferred to use a combination of cellulosic and non-cellulosic yarn, especially polyester yarn, for the back.

Any of the conventional durable press resins, and curing catalysts therefor, may be used for present purposes. Typically the resin may be a water-soluble precondensate of formaldehyde with such amino compounds as urea, thiourea, cyclic ethylene ureas (e.g. dimethylol cyclic ethylene urea or dimethylol dihydroxy cyclic ethylene urea), melamine, ethyl carbamate, urons, triazones and triazines or mixtures thereof. Blocked isocyanates may also be effectively used. Suitable curing catalysts include, without being limited thereto, magnesium chlo-

ride or nitrate or zinc chloride or nitrate; various amine hydrochlorides such as 2-amino-2-methyl-1-propanol hydrochloride, or triethanol-amine hydrochloride; and ammonium salts such as ammonium chloride, tartrate, citrate, formate, oxalate, nitrate or ammonium ethyl phosphate or ammonium dihydrogen phosphate or the like. These catalysts may be combined, e.g. zinc nitrate and ammonium chloride may be used together, and/or catalyst modifiers may be included as necessary to achieve desired effects, e.g. to increase or decrease catalyst activity.

Typically, the finish of the invention will comprise, on a weight basis, from 5–35% durable press resin (usually 10–25%); 0.1–7% catalyst; and 0 to 5% (usually 0.2–2%) surfactant, balance water with the optional addition (e.g. 0–10%) of other conventional durable press components such as extenders, softeners or the like.

The finish is applied to the fabric back in any convenient fashion, e.g. by dipping or spraying but preferably by padding. It generally does not matter that finish is also applied to the face although in some cases it may be preferable to essentially limit application of the finish to the back by using a kiss roll. As noted above, however, this is usually not essential, particularly when the face is predominantly polyester or like hydrophobic material since the finish will stay on the surface of such yarns rather than impregnating the same and is not detrimental to the properties of the fabric.

The amount of the finish applied to the fabric can be widely varied and is dependent on such factors as the nature and construction of the fabric, its intended use, etc. Usually, however, wet pickup will fall in the range of 30–75% by weight of the fabric. The thus treated fabric is then dried, usually at 190–200° F. for 1–5 minutes, to a moisture content in the order of 5–10% by weight.

The dried fabric is then cut into the desired shape, sewn into a garment or other article, pressed on a hot head press or the equivalent and cured. Conventional pressing and curing conditions may be used, e.g. pressing on the hot head press may involve application of heat at 300–325° F. for 5–15 seconds and curing may be accomplished by oven baking or heating at 300–350° F. for 5–15 minutes. As an alternative, pressing and curing may be carried out simultaneously on a hot head press or the like.

The invention is illustrated, but not limited, by the following examples wherein percentages are by weight unless otherwise indicated.

EXAMPLE 1

A Milano Rib double knit construction was prepared using 100/20 filament polyester yarn for the face and 100/40/25 filament rayon and the filament polyester yarn together for the back as follows:

Feed #1—Cylinder (face)—polyester
Feed #2—1 x 1 Rib (face & back)—polyester
Feed #3—Dial (back)—1 end polyester, 1 end rayon

The resulting fabric was then scoured with perchloroethylene, ironed to remove wrinkles, heat set (at 400° F. for 30 seconds) on a pin frame and then padded with an aqueous durable press resin solution having the following composition:

25% dimethylol dihydroxy ethylene urea (45% aqueous solution)
5% zinc nitrate (50% aqueous solution)
2% Emmersoft 7777 (triglyceride type softener from Emery Industries)
0.1% non-ionic wetting agent (nonyl phenol ethylene oxide adduct)
Wet pickup amounted to about 60%.

The fabric was dried on a pin frame at 200° F. for 3 minutes and then constructed into pant leg bottoms, pressed on a hot head press at 325° F. for 5 seconds steam, 5 seconds bake and 5 seconds vacuum followed by baking in an oven at 330° F. for 15 minutes.

The thus pressed and cured pant leg bottoms were then washed five times at 105° F. (in a Sears Kenmore 600 washer), on a wash-and-wear cycle using warm water and tumble dried. The leg bottoms exhibited excellent shape and pleat retention even after the repeated washings.

EXAMPLE 2

Example 1 was repeated using the same polyester and rayon yarns in the following constructions:

Ponti de Roma

Construction #1
Feed #1—Interlock—polyester
Feed #2—Interlock—polyester
Feed #3—Dial (back)—rayon
Feed #4—Cylinder (face)—polyester

Construction #2
Feed #1—Interlock—polyester
Feed #2—Interlock—rayon
Feed #3—Dial—polyester
Feed #4—Cylinder—rayon

Milano Rib

Construction #3
Feed #1—Cylinder (face)—polyester
Feed #2—1 x 1 Rib (face & back)—polyester
Feed #3—Dial (back)—polyester

Construction #4
Feed #1—Cylinder—polyester
Feed #2—1 x 1 Rib—polyester
Feed #3—Dial—1 end polyester, 1 end rayon

Construction #5
Feed #1—Cylinder—polyester
Feed #2—1 x 1 Rib—polyester
Feed #3—Dial—rayon—2 ends

All of the above constructions were processed as in Example 1 except that, in construction #3, the resin treatment was omitted. Constructions 2 and 3 were used for comparison purposes while constructions 1, 4 and 5 are representative of the invention.

Each construction was subjected to the following physical tests with the results indicated:

PHYSICAL TEST RESULTS

Resin treated (except # 3, i.e. 100% polyester)

	Constructions				
	1	2	3	4	5
Accelerotor abrasion loss, g.:					
Face	14.9	35.4	0.1	0.2	3.2
Back	16.3	35.3	0.1	0.1	13.0
Mullen bursting test (lbs.)	58	33	130	125	56
Crease angles (warp & fill), °:					
Dry	341	262	301	309	331
Wet	325	225	281	315	319
Crease retention	5	5	2	5	5

DISCUSSION OF RESULTS

(A) General

Construction #4 gave the best balance of physical properties with constructions 1 and 5 next best.

(B) Accelerotor abrasion loss

The more protected the filament rayon was in the constructions the better the abrasion resistance. Construction #4 was particularly good in this respect.

(C) Mullen bursting test

Construction #4 was particularly good in this respect because the filament rayon was plied together with the polyester filament, thus giving added strength.

(D) Crease angles

Crease angles were excellent for all the constructions except #2.

(E) Crease retention

Crease retention, based on estimated values of from 1–5, was excellent (5) for all the constructions except #4 (the 100% polyester construction).

The constructions with cellulosic yarns in the back, i.e. constructions 1, 4 and 5, also showed much greater absorbency rates than the others. For instance, the rate at which a drop of water is absorbed by constructions 1, 4 and 5 may be of the order of 2–4 times the absorbency of construction 3, thus providing much greater comfort in wear.

EXAMPLE 3

The following Milano Rib constructions were prepared as indicated and then processed in the manner of Example 1 except that in this case the fabrics were scoured and cross-dyed after heat setting but before resin application:

	Construction		
	1	2	3
	Face cylinder only	Face and back 1 x 1 rib	Back dial only
A	100/20 polyester filament.	100/20 polyester filament	1 end 100/20 polyester filament (core); 1 end 100/40/25 rayon.
B	do	do	1 end 100/20 polyester filament (core); 1 end 35/1 50 polyester/50 cotton spun yarn.
C	do	do	28/1 50/50 polyester/cotton spun yarn.
D	do	100/20 polyester filament—2 ends	1 end 100/20 polyester filament (core); 1 end 400/40/25 rayon.
E	do	1 end 100/20 polyester filament (core); 1 end 100/40/25 rayon	100/20 polyester filament.
F	28/1 50/50 polyester/rayon spun yarn.	100/20 polyester filament	28/1 50/50 polyester/cotton spun yarn.
G	35/1 50/50 polyester/cotton spun yarn.	35/1 50/50 polyester/cotton spun yarn	35/1 50/50 polyester/cotton spun yarn.
H	28/1 50/50 polyester/rayon spun yarn.	28/1 50/50 polyester/rayon spun yarn	28/1 50/50 polyester/rayon spun yarn.
I	100/20 polyester filament.	100/20 polyester filament	100/20 polyester filament.
J	24/1 50/50 Dacron/cotton spun.	24/1 50/50 Dacron/cotton spun	24/1.50/50 50/50 Dacron/cotton spun.
K	do	100/20 polyester filament	24/1 50/50 Dacron/cotton spun.
L	31/1 50/50 Dacron/cotton spun.	31/1 50/50 Dacron/cotton spun	31/1 50/50 Dacron/cotton spun.
M	do	100/20 polyester filament	Do.

The above constructions were tested for various physical properties as shown below with the results indicated:

	Construction												
	A	B	C	D	E	F	G	H	I	J	K	L	M
Brusting strength (Mullen tester), lbs	129	114	141	97	135	117	92	72	95	120	109	80	91
Crease resistance Monsanto tester, °:													
Dry:													
Wales	141	146	147	150	149	150	137	128	129	133	144	127	133
Courses	165	137	133	115	129	168	161	152	148	140	144	154	154
Wet:													
Wales	138	147	159	156	146	146	133	114	112	115	136	115	130
Courses	153	118	117	94	105	153	143	131	122	124	133	130	146
Shrinkage (1 laundering at 105° F., tumble dried), percent:													
Wales	1.0	0.5	1.5	0.5	0.5	1.0	0.5	2.5	0.5	0.5	0.5	2.0	2.0
Courses	0.5	1.5	2.0	2.5	1.0	0.5	2.0	2.0	1.5	1.5	1.5	1.5	1.5
Surface appearance (1 laundering at 105° F., tumble dried): No touch up	5	5	5	5	5	5	5	5	5	5	5	5	5
Resistance to pilling: Random tumble method	5	5	5	5	5	1	1	1	5	1	1	1	1
Resistance to differential wear:													
Back	5	5	5	1	5	1	1	1	5	1	1	1	1
Face	5	5	5	5	5	1	1	1	5	1	1	1	1

DISCUSSION OF RESULTS

(A) Handle

All the samples consisting primarily of the spun yarns were extremely soft. The samples containing primarily filament yarns had a crisper handle. The softness was directly proportioned to the amount of spun yarns.

(B) Bursting strength (Mullen tester)

All the samples appeared to have adequate strength.

(C) Crease resistance—Monsanto tester

The samples containing primarily filament yarns exhibited higher crease angles.

(D) Shrinkage

The highest shrinkage of any of the samples was 2.5% with the average being between one and two percent.

(E) Surface appearance

All the samples exhibited a 5 (excellent) rating.

(F) Resistance to pilling

The samples show that a preponderance of spun yarns on the face of the fabric generally results in an increase in the tendency to pill. The tendency to pill, therefore, is directly proportional to the amount of spun yarn in the face of the product (compare values of 1 indicating poor resistance to pilling for constructions F, G and H to value of 5, representing no pilling for other constructions).

(G) Resistance to differential wear

All the samples containing primarily spun yarns (constructions G, H, I, J, K, L and M) were rated 1 (poor) both on the face and back. The samples with the face yarns all filament polyester (constructions A–D) exhibited class 5 (excellent) rating on the face.

The above results indicate that constructions A–D, containing all polyester filament face yarns with rayon or other cellulosic in the back of the fabric, give the best balance of properties when processed according to the invention. These fabrics also showed outstanding antistatic properties.

By cross-dyeing fabrics as described in Example 3 it is possible to obtain a wide variety of pattern or random color effects on the face and the back of the fabric based on the different dyeing characteristics of the yarns involved and the knitting pattern selected.

While the foregoing examples illustrate the invention as applied to double knit constructions, corresponding results can be obtained with single knit (jersey) and warp knit constructions, e.g. tricot or Raschel knits, wherein the back is at least partly cellulosic and the face is mainly

polyester or other synthetic or non-cellulosic yarn. Useful yarn combinations for such constructions include filament rayon either wrapped around a polyester core or plied with polyester for the back and for the face, polyester filament yarn or spun yarn, as such or blended with, for example, wool or other staple, preferably non-cellulosic. When filament rayon is used in the back of warp knit fabrics in particular, it is preferable to wrap or ply the yarn with another yarn (e.g. polyester filament) or use a spun blend (such as polyester/rayon) to minimize strain on the rayon back. Representative warp knit fabrics according to the invention include, for example, warp knit jersey containing 150/34 textured polyester filament in the face and 150/25/40 rayon filament in the back or 22/1 spun polyester in the face and 20/1 polyester-rayon spun yarn for the back. A particularly useful single knit jersey construction for processing according to the invention comprises a 100/20 polyester jersey feed as the face and, as the lay-in feed or back, an end of 100/40 rayon wrapped around an end of 100/20 polyester yarn as the core. It will be recognized, however, that these combinations are only given for purposes of illustration and a wide variety of other yarn combinations and fabric constructions may be utilized provided the resin-treated back includes some cellulosic yarn and the face is essentially non-cellulosic as described above.

The invention as applied to warp knit and single knit constructions is exemplified in more detail by the following additional examples:

EXAMPLE 4

A single knit jersey construction was prepared on a 20" 28-cut unit. The construction include a La Coste stitch for the jersey feeds in combination with lay-in feeds. The jersey feeds were composed of 100/20 polyester filament yarn while the lay-in feeds comprised 1 end of 100/40 rayon and 1 end of 100/20 polyester (core), i.e. the rayon was wrapped around the polyester core.

The resulting jersey construction was then dry-cleaned, heat-set at 400 F. for 30 seconds on a pin frame, scoured and cross-dyed, and then padded with aqueous durable press resin solution, dried, made into pant leg bottoms, pressed and cured, all as in Example 1. The thus pressed and cured leg bottoms were then washed as in Example 1 and evaluated as before with the following results:

Mullen burst, lbs.	139
Crease resistance, ° :	
Dry—Wales	171
—Courses	140
Wet—Wales	172
—Courses	132
Shrinkage test after 1 la. 105° F.T.D.:	
Wales	(Not measured)
Courses	
Wash and wear appearance, 1 la. 105° F. T.D.	4
Random tumble pilling	5
Resistance to differential wear:	
Face	5
Back	5
Pleat retention:	
After 5 launderings (105° F.), tumble dried	4.0

As will be evident, the above jersey knit product demonstrated an outstanding balance of durable-press, resistance to differential wear, strength, high wet and dry crease resistance, and resistance to pilling. Additionally, the product had excellent hand and comfort properties.

EXAMPLE 5

A textured polyester/rayon jersey fabric was made by warp knitting (tricot) using 150/34 textured polyester filament yarn for the face and 150/2.5/40 dull filament rayon for the back. The fabric was processed and tested as in Example 3 with the following results:

Bursting strength, lbs.	95
Crease resistance, ° :	
Dry—Wales	110
—Courses	127
Wet—Wales	71
—Courses	149
Surface appearance	5
Resistance to pilling	5
Resistance to differential wear:	
Back	5
Face	5
Shrinkage, percent:	
—Wales	2.5
—Courses	4.5
Crease retention	4.0

The handle and appearance of the fabric were excellent and not impaired by the resin treatment. Strength was satisfactory but could be increased if desired by wrapping the rayon back yarn around polyester filament yarn so that load on the fabric would be transferred to the polyester yarn.

The normal procedure for dyeing warp knits containing textured polyester yarn is to heat-set after dyeing to bulk the textured polyester but the fabric of Example 5 was uniformly and otherwise satisfactorily dyed by following the sequence of steps outlined in Example 3 including scouring and heat-setting before dyeing.

It will be recognized that various modifications may be made in the invention described herein. Hence, the scope of the invention is defined in the following claims wherein:

I claim:

1. A pressed and cured textile having improved shape retention and wear characteristics which comprises a knitted fabric having a face consisting at least essentially of polyester filament yarn and a back consisting essentially of filament rayon yarn wrapped or plied with a polyester filament yarn, the amount of rayon yarn in the back comprising from 20–75% by weight of the yarn in the back, the back having a cured thermosetting durable press resin finish thereon.

2. A textile according to claim **1** in the form of a garment which has been pressed and cured.

3. A textile according to claim **1** comprising a double knit fabric.

4. A textile according to claim **1** comprising a warp knit fabric.

5. A textile according to claim **1** comprising a single knit fabric.

6. A textile according to claim **1** which includes not more than 35% by weight cellulosic yarn in the face.

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