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PROCESS FOR IMPROVING THE ELASTICITY OF WOVEN TEXTILES

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ABSTRACT OF THE DISCLOSURE

The present invention relates to a method of improving the elasticity of woven textiles by a combination of (1) weaving to obtain a fixed yarn density, (2) scouring and heat setting to secure a fixed degree of shrinkage while the fabric is under a pre-determined tension of 20 to 80 kg./m., and then (3) shrinking the fabric in its warp direction by a controlled amount.

SUMMARY OF THE INVENTION

The present invention relates to a process for imparting improved elasticity to woven textile fabric in its weft direction by effecting tension in its warp direction. Woven textile fabrics prepared by the process of the present invention possess high elasticity, which is durable even after being washed many times. By the term "the fabric having high elasticity" we mean that the fabric has high stretchability and high elastic recovery rate.

The present invention provides a process for improving the elasticity of a woven textile fabric composed of thermoplastic yarns at least in its weft direction, which process comprises (a) weaving a fabric in such a manner that the density of the warp yarns is 30 to 80% of that of its warp yarns of the finished fabric, (b) scouring and heat-setting said fabric so as to shrink the fabric by from 20 to 40% in its weft direction, said fabric being scoured and heat-set under a tension of from 20 to 80 kg./m. so as to bend the weft yarns strongly, (c) and then shrinking said fabric by from 0.5 to 5% in its warp direction.

It is possible to obtain a high elasticity and good elastic recovery rate in the weft direction according to the present invention in which the fabric is first stretched in its warp direction so as to bend the weft yarns strongly in a sectional direction and to shrink the fabric in its weft direction and in which the fabric is then fixed in its altered form, and afterwards is shrunk in its warp direction contraversely. The fabrics obtained according to the present invention have an excellent elasticity and high elastic recovery rate, and furthermore their elasticity and elastic recovery rate after repetition of washing many times are almost unchanged in comparison with those before washing. The fabrics treated by the process according to the present invention have therefore a good stability.

Textile yarns having a thermoplastic nature, which may be used for the present invention, include thermoplastic textile yarns composed of filaments or staple fibers, and further include certain thermoplastic yarns blended with natural or regenerated fibers as well as those composed of two or more thermoplastic fibers. The aforesaid blended yarns are identical with the so called blended spun yarns.

In weaving woven textile fabrics by using these thermoplastic yarns, these yarns should be used at least in the weft direction of the fabric. Non-thermoplastic yarns such as natural or regenerated yarns may be used as warp yarns. In weaving woven textile fabrics, which may be used

for common purposes, in conventional manner, the density of the warp yarns usually reaches 80 to 100% of that of the warp yarns of the finished fabric. On the contrary, the density of the warp yarns reaches to 30 to 80% (preferably 60–80%) of that of the warp yarns of the finished fabric according to the present invention. The aforesaid density value is important for improving the elasticity of the final products according to the present invention, since the weft yarns must be bent strongly by stretching the fabric in its warp direction.

It is possible to use such apparatus as pad-steamer, open-soaper, etc. capable of treating the fabric in its spread state in the scouring operation, wherein the fabric is stretched under tension of 20–80 kg./m. in its warp direction so as to bend strongly the weft yarns, which are crossing sectionally with the warp yarns. As a result, the woven textile fabric is shrunk in its weft direction. At the same time of this operation, the rate of the feed-in mangle to the feed-out mangle is determined to be 1:1.0–1.3 (preferably 1:1.01–1.05) and the rate of shrinkage of the fabric itself in hot water can also be taken into account. Thus it is possible to give to the fabric a tension amounting to about 1.5–5 times as large as that, which may be given to woven textile fabrics by conventional treatment. By this treatment the fabric is shrunk by 10–25% in its weft direction. Although the weft yarns are bent strongly around the upper and under surfaces of the warp yarns, they can not yet be fixed in their bent forms, since this treatment is carried out at about 50–100° C. It is, therefore, necessary to fix the fabric in its altered state in the coming heat setting step.

The fabric is heat-set by using an apparatus such as the roller-type heat-setting machine capable of stretching the fabric in its warp direction without any restriction in its weft direction. The fabric is heat-set under a tension of 20–80 kg./m. in its warp direction. It is also possible to heat-set the fabric at the same time as the dyeing or resin-treatment. For example, the thermosol-dyeing or the baking of the resin may be carried out by using a roller-type machine. As described above, the fabric is stretched by heat-setting, in its warp direction and is set at a high temperature. Thus it is possible to shrink the fabric by 20–40% in its weft direction and to heat-set sufficiently the weft yarns in their bent state.

As described below, according to the present invention, the fabric is, scoured and heat-set under a tension of 20–80 kg./m. The scouring and heat-setting treatments should be carried out in this order for the purpose of obtaining the weft yarns being bent strongly, because such a strongly bent state cannot be obtained when the fabric is scoured after heat-setting treatment. In scouring, the scouring aqueous solution may act to the fabric as lubricant and furthermore the elevated temperature effected in the heat-setting treatment may plasticize the fabric whereby it is possible to bend the weft yarns of the fabric strongly.

By the application of the plasticization only, the weft yarns cannot be bent strongly without injuring the feeling and appearance of the resulting finished fabric.

By the scouring and heat-set treatments, the fabric is shrunk by 20–40% in its weft direction, and is fixed positively in its altered state. As the fabric is stretched strongly in its warp direction in these steps and consequently the warp yarns take almost linear forms, it is necessary to shrink the warp yarns in the final shrinking step. This step is carried out by the use of an apparatus capable of giving to the fabric no tension in its warp direction, such as e.g. the short loop drier, in which the fabric can be dried under such conditions that could shrink the fabric so as to give it a shrinkage of 0.5–5%. Alternatively, the fabric can be shrunk under compulsion to give a shrink-

age of 0.5–5% by using an apparatus such as e.g. the rubber-type compactor. It is also possible to shrink the fabric after subjecting it to the free shrinkage. By these final shrinking treatments, it is possible to remove distortions of the fabric, the elastic recovery rate of the fabric in its weft direction can also be highly improved, and the elasticity of the fabric can be stabilized, i.e. the elastic recovery rate and elastic stretchability after washing of the fabric can be made to be unchanged in comparison to those before washing. Accordingly, it is possible to obtain woven textile fabrics having a highly improved elasticity.

According to another feature of the present invention, it is possible to insert various treatments, which are conventionally carried out in the finishing step. For example, the dyeing or resin-treatment can be carried out at the same time or after the heat-setting, in which it is preferred to give to the fabric a tension of 20–80 kg./m. in its warp direction.

In the following examples, the results were determined as follows:

Woven textile fabrics having a similar dimension of 20 cm. (in the warp direction) x 5 cm. (in the weft direction) were used as samples. The stretchability (percent) was determined by burdening a sample with a load of 2 kg' in its warp direction and comparing the elongation with the initial length of 20 cm. The elastic recovery rate (percent) was determined by burdening a sample with a suitable load so as to give an elongation of 20% in its warp direction, keeping it in elongated state for 3 minutes, removing the load from the fabric, leaving it 1 minute in free state and measuring it in its recovered length, which was compared with the initial elongated length (20 x 20/100 cm.) to obtain the elastic recovery rate.

EXAMPLE 1

A tropical woven textile fabric was prepared from a blended spun yarn composed of 65% copolymerized polyether ester fiber, which contained 85 mol percent of ethylene terephthalate unit and 15 mol percent of ethylene oxybenzoate unit and 35% viscose rayon fiber under the following weaving conditions:

	Cotton count	Density of the fabric (thread/inch)
Warp	30/2	45
Weft	30/2	45

The fabric obtained was desized and scoured in an open soaper. The scouring was performed while the fabric was under a tension of 30 kg./m. in its warp direction at 80–90° C. so as to shrink the fabric by 17–18% in its weft direction. The fabric was padded with a dispersed dye, dried at 100° C. for 3 minutes, and was then thermofixed at 170° C. for 2 minutes under a tension of 30 kg./m. in its warp direction. After this, the fabric was subjected to continuous reduction cleaning in a soaper having seven baths, and was dried in a cylindrical drier so as to give a shrinkage by 2% in its warp direction and by 25% in its weft direction. After being subjected to the shearing and singeing treatments, the fabric was given a resin-treatment using a resin having the following compositions, and which is typical for such treatments:

Composition of the resin (percent by weight)

Sumitex Resin 800 K (trade name of the cellulose reactive resin available from Sumitomo Kagaku Kogyo K.K., Japan)—10%. Sumitex Resin M–3 (trade name of the melamine resin available from Sumitomo Kagaku Kogyo K.K., Japan)—0.3, Norna silicone softener (trade name of the silicon softening agent available from Nippon Reichhold K.K., Japan)—1.5%. Sybinol Pn–3500 trade name of the polyethylene softening agent available from Saiden Kagaku Kogyo K.K., Japan)—1%. Zinc nitrate—5%.

The fabric treated with the resin was dried at 100° C. for 3 minutes under a tension of 20–80 kg./m. in its warp direction, and was baked at 145° C. for 4 minutes under the same tension. After being soaped in an open soaper, the fabric was dried under no tension in its warp direction by using a short loop drier so as to remove distortions caused by the preceding treatments.

The fabric was steamed with a semi-decatizer at 120° C. for 30 minutes, cooled for 5 minutes, and subjected to a shrinkage of 1.5% in its warp direction under compulsion by using a conventional Sanforizing machine to remove distortions completely. The densities of the finished fabric were 56 threads/inch (warp) and 46 threads/inch (weft) respectively. The improved elasticity of the fabric obtained is apparent from the following table:

	Before final shrinking, percent	Finished fabric: Before washing, percent	Finished fabric: After washing 5 times, percent
Elongation	23	26	27
Elastic recovery rate	91.0	92.5	92.3

EXAMPLE 2

A tropical woven textile fabric was prepared from a 100% copolymerized polyether ester yarn having a similar composition to that described in Example 1 under the following weaving conditions:

	Cotton count	Density of the fabric (thread/inch)
Warp	30/2	45
Weft	30/2	57

After singeing, the fabric was desized and scoured. The scouring was carried out at 90° C. under a tension of 25 kg./m. in its warp direction in an open soaper, and the fabric was dried in a cylindrical drier. The dried fabric was padded with a dispersed dye and dried at 100° C. for 3 minutes. The fabric was then heat-set at 170° C. for 90 minutes under a tension of 30 kg./m. in its warp direction, so as to give a shrinkage of 26% in its weft direction, and subjected to reduction cleaning, which was carried out by padding a reducing washing agent to the fabric, washing the fabric in an open soaper and drying it on a cylinder drier.

The fabric was padded with a softening agent and was dried on a short loop drier so as to give a free shrinkage of 1%. The densities of the fabric were 56 threads/inch warp and 48 threads/inch (weft) respectively.

The fabric obtained had an improved elasticity, which is apparent from the following table:

	Finished fabric: Before washing, percent	Finished fabric: After washing 5 times, percent
Stretchability	26	26.5
Elastic recovery rate	94	94

In the above mentioned table, the results were obtained under similar conditions to those described in Example 1.

EXAMPLE 3

A tropical woven textile fabric was prepared from a blended spun yarn composed of 50% polyethylene terephthalate fiber and 50% nylon 6 fiber under the following weaving conditions:

	Cotton count	Density of the fabric (thread/inch)
Warp	30,2	45
Weft	30/2	47

After singeing, the fabric was desized and scoured. The scouring was carried out at 90° C. under a tension of 25 kg./m. in its warp direction in an open soaper and the fabric was dried in a cylindrical dryer. The dried fabric was padded with a dispersed dye, and dried at 100° C. for 3 minutes. The dried fabric was heat-set at 180° C. for 90 seconds under a tension of 30 kg./m. in its warp direction so as to give a shrinkage of 25% in its weft direction and was subjected to reduction cleaning, which was carried out in a similar manner to that described in Example 2. The fabric was washed in a open soaper and dried so as to give a free shrinkage of 0.5%. The densities of the finished fabric was 56 threads/inch (warp) and 48 threads/inch (weft) respectively. The resulting fabric had an improved elasticity as shown in the following table, wherein the result was obtained under similar conditions to those described in Example 1:

	Finished fabric	
	Before washing, percent	After washing 5 times, percent
Stretchability	24	25
Elastic recovery rate	91	90

EXAMPLE 4

A tropical woven textile fabric was prepared from a blended yarn composed of 65% nylon 6 fiber and 35% viscose rayon under the following weaving conditions:

	Cotton count	Density of the fabric (thread/inch)
Warp	30/2	38
Weft	30/2	46

The fabric was desized and scoured. The scouring was carried out at 90° C. under a tension of 30 kg./m., and the fabric was dried in a cylindrical dryer. The dried fabric was padded with a dispersed dye and vat dye, and was then dried at 100° C. for 3 minutes. The dried fabric was heat-set at 160° C. for 90 seconds under a tension of 30 kg./m. in its warp direction so as to give a shrinkage of 25% in its weft direction.

The fabric was subsequently padded with a reducing agent, was steamed to develop the vat dye, and was dried in a cylindrical drier. After singeing, the fabric was washed in an open soaper, and dried in a roller-type drier, and a resin was applied to the dried fabric. The resinated fabric was baked at 145° C. for 45 minutes under a tension of 20 kg./m. in its warp direction in a roller-type baking machine. The fabric was washed in an open soaper and was then dried in a short loop drier so as to give a free shrinkage of 2%. The densities of the fabric were 50 threads/inch (warp) and 46 threads/inch (weft) respectively. The fabric obtained had an improved elasticity as shown in the following table, in which the results were obtained under similar conditions to those described in Example 1:

	Finished fabric	
	Before washing, percent	After washing 5 times, percent
Stretchability	22	23
Elastic recovery rate	91	90

EXAMPLE 5

A tropical woven textile fabric was prepared from a blended yarn composed of 65% copolymerized polyether ester fiber, which contained 85 mol percent of ethylene terephthalate unit and 15 mol percent of ethylene oxybenzoate unit and 35% oilynosic fiber under the following weaving conditions:

	Cotton count	Density of the fabric (thread/inch)
Warp	30/2	45
Weft	30/2	47

The fabric was desized and scoured at 70° C. under a tension of 40 kg./m. in an open soaper, and was dried in a cylindrical drier. The dried fabric was padded with a dispersed dye and vat dye, was heat-set at 170° C. for 120 seconds under a tension of 40 kg./m. in its warp direction in a roller-type baking machine, padded with a reducing agent, and was steamed to develop the dyes. The shrinkage value of the fabric was 26% in its weft direction.

After singeing, the fabric was washed in a soaper, dried in a cylindrical dryer, and was subjected to a resin-treatment; the resin was baked at 145° C. for 4 minutes under a tension of 20 kg./m. in its warp direction. The fabric was dried so as to give a free shrinkage of 0.5%. The densities of the finished fabric were 57 threads/inch (warp) and 48 threads/inch (weft) respectively. The resulting fabric had an improved elasticity as shown in the following table, in which the results were obtained under similar conditions to those described in Example 1:

	Finished fabric	
	Before washing, percent	After washing 5 times, percent
Stretchability	24	24
Elastic recovery rate	90	90

EXAMPLE 6

A tropical woven textile fabric was prepared from a blended spun yarn composed of 50% polymerized polyether ester fiber, which contained 85 mol percent ethylene terephthalate unit and 15 mol percent ethylene oxybenzoate unit, and 50% acrylonitrile fiber under the following weaving conditions:

	Cotton count	Density of the fabric (thread/inch)
Warp	30/2	45
Weft	30/2	45

The fabric was desized and scoured. The scouring was carried out at 90° C. under a tension of 30 kg./m. in its warp direction in a soaper. The fabric was dried in a roller-type drier. The dried fabric was heat-set at 150° C. for 90 seconds under a tension of 30 kg./m. in its warp direction so as to give a shrinkage of 24% in its weft direction, was subjected to beam padding under a tension of 20 kg./m. in its warp direction, and was subjected to beam-dyeing. After singeing, the fabric was washed in a soaper, was dried in a roller-type drier, was padded with a softening agent, and was dried in a short loop drier so as to give a free shrinkage of 1%. The densities of the fabric were 56 threads/inch (warp) and 46 threads/inch (weft) respectively. The resulting fabric had an improved elasticity as shown in the following table, in which the results were obtained under similar conditions to those described in Example 1:

	Finished fabric	
	Before washing, percent	After washing 5 times, percent
Stretchability	23	24
Elastic recovery rate	92	91

EXAMPLE 7

A tropical woven textile fabric was prepared from spun yarn composed of 65% copolymerized polyether ester

fiber, which contained 85 mol percent of ethylene terephthalate unit and 15 mol percent of ethylene oxybenzoate unit in the weft yarns, and spun yarn of viscose rayon in the warp yarns. Weaving conditions are as follows:

	Cotton count	Density of the fabric (thread/inch)
Warp	30/2	44
Weft	30/2	46

The fabric obtained was desized and scoured in an open soaper. The scouring was performed while the fabric was under a tension of 30 kg./m. in its warp direction at 80–90° C. so as to shrink the fabric by 17–18% in its weft direction. The fabric was padded with a dispersed dye, dried at 100° C. for 3 minutes, and was then thermofixed at 170° C. for 2 minutes under a tension of 30 kg./m. in its warp direction. The shrinkage of the fabric in the weft direction was 25%. Then the fabric was subjected to reduction clearing and dried in a short loop drier so as to give free shrinkage of 1.5%. The density of the finished fabric was 55 threads/inch and 47 threads/inch. The elasticity of the finished fabric is apparent from the following table, wherein the results were obtained under similar conditions to those described in Example 1:

	Finished fabric	
	Before washing, percent	After washing 5 times, percent
Stretchability	25	26
Elastic recovery rate	91	90

What we claim is:

1. A process for improving the elasticity of a woven textile fabric composed of thermoplastic yarns at least in its weft direction, which process comprises:
(a) weaving a fabric in such a manner that the density of the warp yarns is 30 to 80% of that of its warp yarns of the finished fabric,
(b) scouring and thereafter heat-setting said fabric so as to shrink the fabric by from 20 to 40% in its weft direction, said fabric being scoured and heat-set under a tension of from 20 to 80 kg./m. in its warp direction so as to bend the weft yarns strongly,
(c) and then shrinking said fabric by from 0.5 to 5% its warp direction.

2. A process as claimed in claim 1, wherein the thermoplastic yarn comprises at least 60% of the thermoplastic fibers at least in the weft direction.

3. A process as claimed in claim 1 wherein the density of the warp yarns of the fabric before treatment is 60 to 80% of that of the warp yarn of the finished fabric.

4. A process as claimed in claim 1 wherein the fabric is shrunk in its warp direction by drying it under conditions of no tension.

5. A process as claimed in claim 1 wherein the fabric is shrunk in its warp direction under compulsion.

6. A process as claimed in claim 1 wherein the fabric is dyed at the same time as the heat-setting step.

7. A process as claimed in claim 1 wherein the fabric is subjected to a resin treatment simultaneously with the heat-setting step.

8. A process for improving the elasticity of a woven textile fabric composed of thermoplastic fibers comprising at least 60% of the thermoplastic fibers, at least in its weft direction, which comprises: (a) weaving a fabric in such a manner that the density of the warp yarn is 60 to 80% of that of the warp yarn of the finished fabric, (b) scouring and thereafter heat-setting said fabric so as to shrink the fabric by from 20 to 40% in its weft direction, said fabric being scoured and heat-set under a tension of from 20 to 80 kg./m. in its warp direction so as to bend the weft yarns strongly, (c) and then shrinking said fabric by from 0.5 to 5% its warp direction.

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