Title: PROCESS FOR GARMENT DYEING OF AN ARTICLE COMPRISING A MICROFIBROUS NON WOVEN FABRIC

Abstract: A process for garment dyeing of an article comprising a microfibrous non woven fabric, wherein the raw microfibrous non woven fabric is pre-treated with an aqueous solution containing dyeing auxiliaries and devoid of dyes, at a temperature of from 100°C to 140°C. After washing of the raw fabric and manufacture of the article, the latter is subjected to a dyeing step at a temperature of from 100°C to 140°C, and then the non fixed dye is removed by means of at least one stripping step. This process produces articles having the aesthetic properties and "feel" typical of microfiber non woven fabrics, and at the same time a high color fastness to both dry or wet cleaning and under prolonged exposure to the action of light and/or sweat.
"PROCESS FOR GARMENT DYEING OF AN ARTICLE COMPRISING A MICROFIBROUS NON WOVEN FABRIC"

DESCRIPTION
The present invention relates to a process for garment dyeing of an article comprising a microfibrous non woven fabric.

Microfibrous non woven fabrics, made from synthetic polymer microfibers, generally polyester or polyamide combined with a polyurethane matrix, are well known in the art. Such fabrics have the appearance of natural leather and are often even superior to it as regards some characteristics, such as feel, lightness, and fastness to light and atmospheric pollutants (in particular nitrogen oxides). Such microfibrous non woven fabrics are thus of particularly fine quality and are widely used in the clothing and interior design industries, and for the interior upholstery of cars, boats and other means of transport.

For applications in the interior design and upholstery sectors, microfibrous non woven fabric can be coupled, if necessary, with suitable substrates, such as canvas, knitted fabric or expanded plastic material, in order to impart the required mechanical strength and rigidity to the product. In this regard, see for example patents GB 2.235.651 and GB 2.235.652.

As regards the dyeing of such materials, this is generally carried out "in the piece", i.e., on the raw non woven fabric not yet manufactured into an article. In recent years, however, so-called "garment dyeing" processes have had wide application, in particular in the clothing and interior design sectors; these entail
manufacturing the article with raw, i.e. undyed, textile material, and of carrying out the dyeing process directly on the finished garment.

More in detail, the garment dyeing process entails directly immersing the finished garment, manufactured from raw or so-called "ready-to-dye" fabrics, i.e. fabrics subjected to preliminary purging (elimination of oil or sizing solutions), bleaching, heat setting or other treatments, in the dyeing bath, in special machines. This process was developed in particular for dyeing natural fibres such as wool and cotton, using, therefore, "open" dyeing machines, i.e. machines operating at atmospheric pressure and thus with a dyeing bath temperature lower than 100°C.

Though generally more costly than piece dyeing, the garment dyeing process gives two types of advantages:
- of a logistic nature, tied to the possibility of keeping undyed finished garments, which can be dyed a few at a time with the colours required, thus minimizing leftover stock of obsolete colours at the end of the season;
- of a "stylistic" nature, tied to the possibility of maximizing the colour variants and obtaining inhomogeneous or uneven dyeing effects (so-called "tie-dye" effect) and completing the dyeing and finishing cycle with treatments applied directly on the finished article (softening, stone washing, fading, etc.).

It is moreover possible to achieve cost savings in cases in which the dyeing process is particularly expensive and the fact that the manufacturing scraps are raw fabric rather than dyed fabric takes on importance.
Being based on machines that operate at atmospheric pressure, garment dyeing is not applicable to polyester-based fabrics, even though various attempts have been made, based on the use of carrier or swelling additives or the use of modified polyesters (dyeable at a low temperature and/or with cationic dyes). Only recently have "closed" bath dyeing machines, capable of dyeing at a pressure higher than atmospheric pressure and with a bath temperature of up to 140°C, i.e. operating in dyeing conditions suitable for dyeing polyester, appeared on the market.

The Applicant set itself the objective of realizing articles comprising a garment-dyed microfibrous non woven fabric, which exhibits aesthetic properties and a "feel" typical of microfiber non woven fabrics, and at the same time high colour fastness to dry cleaning or wet washing, and under prolonged exposure to light and/or sweat.

The Applicant has ascertained that directly subjecting an article comprising a microfibrous non woven fabric to a garment dyeing process with a bath temperature of over 100°C does not provide satisfactory results, in particular as regards the aesthetic properties, "feel" and colour fastness. In fact, after garment dyeing the article turns out to have an excessively rigid "feel", a flat (non-mottled) appearance, and shows an aesthetically inferior surface due to the evident presence of dirt and fluff. Moreover, the colour fastness is inadequate to satisfy the most common quality standards, in particular after repeated washing and contact with sweat.
The Applicant has now found that garment dyeing an article comprising a microfibrous non-woven fabric is capable of providing results meeting the above-described objectives if the microfibrous non-woven fabric is first subjected to a pre-treatment with an aqueous solution containing dyeing auxiliaries devoid of dyes, at a temperature of from 100°C to 140°C, subsequent washing in order to remove the dyeing auxiliaries, manufacture of the article to be dyed and then the dyeing process itself at a temperature of from 100°C to 140°C, to be followed by at least a "stripping" step in order to remove the dye not fixed into the material.

In a first aspect, the present invention thus relates to a process for garment dyeing of an article comprising a microfibrous non-woven fabric, which comprises:

- pre-treating the raw microfibrous non-woven fabric with an aqueous solution containing dyeing auxiliaries and devoid of dyes, at a temperature of from 100°C to 140°C;
- washing the so pre-treated microfibrous non-woven fabric to remove the dyeing auxiliaries;
- manufacturing the article by using the pre-treated microfibrous non-woven fabric;
- subjecting the so manufactured article to a dyeing step by means of a dyeing bath comprising at least one dye and dyeing auxiliaries, at a temperature of from 100°C to 140°C;
- removing the non fixed dye by means of at least a stripping step.

As regards the step of pre-treating the raw microfibrous non-woven fabric, this is preferably carried out by immersion in an aqueous solution containing dyeing
auxiliaries at a temperature of from 100°C to 140°C, preferably from 110°C to 130°C. The immersion time can vary within wide limits, and generally from 1 to 6 hours, more preferably from 3 to 5 hours with a maintenance time at the maximum temperature of from 30 to 90 minutes, more preferably from 45 to 75 min.

The pre-treatment step is generally carried out in a machine such as to impose stresses of a thermal-mechanical type on the raw material, in particular via agitation of the bath and contact of the piece with the nozzles normally present in jet dyeing machines. Preferably, the dyeing auxiliaries comprise an acid-base pair which acts as a buffer, preferably selected from among: a carboxylic acid/carboxylic salt mixture (e.g. an acetic acid/alkali metal acetate mixture, or a citric acid/alkali metal citrate mixture). Preferably, the dyeing auxiliaries further comprise at least one ionic or non-ionic surfactant, e.g. polyglycols or modified polyalcohols, fatty amine esters, naphthalene sulfonic acids, fatty acids or derivates thereof.

Preferably, the aqueous solution containing dyeing auxiliaries has a pH value ranging from 4.0 to 5.5, preferably from 4.4 to 5.0.

Preferably the dyeing auxiliaries are present in concentrations greater than 2 g/l relative to the volume of the dyeing bath.

The subsequent washing step has the purpose of removing the dyeing auxiliaries in a substantially complete manner, and can be carried out with water, in particular water at room temperature, for example by overflow rinsing.
Before the step of manufacturing the article, the non-woven fabric thus pre-treated is generally subjected to drying. As regards the step of manufacturing the article, this is carried out like the normal manufacture of an article of clothing, but with particular attention being paid to the tension with which the seams are sewn to prevent defects from occurring during the subsequent dyeing of the article thus realized, due either to a different shrinkage of the materials themselves and of the seams, with the formation of creases or folds, or poor penetration of the dye into the stitches, thus generating characteristic defects of inhomogeneous dyeing.

The dyeing step is generally carried out by immersing the manufactured article in a dyeing bath comprising at least one dye and dyeing auxiliaries, at a temperature of from 100°C to 140°C, preferably from 110°C to 130°C. As regards the dyeing auxiliaries, these can be selected from among the ones indicated above for the pre-treatment step. As regards the dyes, these can be selected from the class of disperse dyes, e.g. azoic dyes, anthraquinone dyes, aminoketone or quinophthalone dyes, or leuco dyes.

Preferably, the dyeing step is carried out in a garment dyeing machine having a closed bath, which makes it possible to dye at a pressure higher than the atmospheric pressure and with a bath temperature of up to 140°C, and at the same time to recirculate the dyeing solution and if necessary reinject it into the bath via a high-pressure jet.

The dyeing step is carried out with a bath ratio ranging
from 1:2 to 1:30, preferably from 1:4 and 1:20. Said step preferably envisages a maintenance time at the maximum temperature of from 30 to 90 min, preferably from 45 to 60 min.

During dyeing, the basket speed is generally set at at least 20 rpm.

The subsequent stripping step, mainly having the purpose of removing the non-fixed dye, is preferably carried out by treating the dyed article with a basic solution comprising at least one reducing agent. The latter can be selected between, for example, sodium hydrosulfite and sulfinic acid derivatives.

The basic solution preferably has a pH value greater than 8, more preferably greater than 10. Such pH values can be obtained by adding an inorganic base, in particular an alkali metal hydroxide, for example an aqueous solution of NaOH and/or KOH. The basic solution preferably includes at least one surfactant, preferably of the class of organic phosphorous compounds or mixtures of neutralized organic acids.

The stripping step is preferably carried out at a temperature of from 50°C to 100°C, more preferably from 70°C to 90°C.

The stripping step preferably has an overall duration of from 90 to 360 minutes, more preferably from 100 to 240 minutes, and can be subdivided if necessary into a plurality of sub-steps so as to obtain a better removal of the non-fixed dye. Between one sub-step and another, the basic solution is drained and replaced with fresh solution. It should be noted that in the stripping step, unlike the actual dyeing step, it is preferable not to
carry out recirculation of the solution with air injection (for example with high-pressure jets), since the solution itself would tend to become exhausted more quickly, and it is thus advantageous to replace it cyclically with fresh solution. In fact, the Applicant believes that injecting air into the stripping bath would have the effect of accelerating the process of degradation of the reducing agent, which would react prevalently with the air rather than with the excess dyes.

Once the stripping step is over, the dyed article is washed and dried according to known techniques. As regards the raw microfibrous non woven fabric, this can be produced according to techniques well known in the art, for example as described in patents EP 0 584 511, US 3 716 614, US 3 531 368 and EP 1 431 448, all in the Applicant's name. The process generally envisages a step of producing of a flock fibre formed from microfibers of polyester, in particular polyethylene terephthalate, having an extremely fine titre, generally from 0.01 to 0.4 deniers, preferably from 0.08 to 0.15 deniers, coated with a texturing sheath, generally formed from polystyrene, a styrene copolymer, a copolyester or a polyvinyl alcohol. The textured flock fibre generally has titre of from 1.4 to 10 deniers, preferably from 2.5 to 6 deniers, a length of from 30 to 150 mm, a stretching ratio of from 2/1 to 5/1 and curling of from 4 to 15 waves per centimetre. The textured flock fibre generally comprises from 30 to 90% of polyester by weight and 10 to 70% of texturing sheath by weight.
The flock fibre thus produced is then used to prepare, according to known techniques, a raw felt, which is then subjected to needle punching so as to obtain a needle-punched felt generally having a density of from 0.15 to 0.35 g/cm$^3$. The needle-punched felt is then immersed in an aqueous solution of polyvinyl alcohol and then, after drying, in a solvent capable of solubilizing the matrix in a substantially complete manner. The resulting product is subjected to drying so as to obtain the non woven microfiber fabric, which is impregnated, by immersion in a solution or dispersion, with an elastomeric matrix, preferably polyurethane. The polyurethane generally consists of soft segments and hard segments.

The soft segments generally have an average molecular weight ranging from 500 to 5000, preferably 600 to 2000, and can be selected from among, for example:

- polyethers, e.g. polytetramethylene glycol diol (PTMG), polyethylene glycol diol (PEG), polypropylene glycol diol (PPG);
- polyesters, e.g.: adipic acid polyesters, such as polyhexamethylene adipate diol (PHA), poly (3-methyl pentamethylene) adipate diol (PMPA), poly (neopentyl adipate) diol (PNA); polyesters obtained by opening cyclic molecules such as caprolactone (thus obtaining polycaprolactone diol, PCL);
- polycarbonates, such as, for example, poly (hexamethylene carbonate) diol (PHC), polypentamethylene carbonate (PPMC) poly (3-pentamethylene carbonate) diol (PMPC), polytetramethylene carbonate diol (PTMC) and copolymers
or mixtures thereof.
Polyether esters formed by copolymerization of the polyethers and polyesters indicated above, as well as polyesters-co-polycarbonates obtained by copolymerization of the polyesters and polycarbonates indicated above, can likewise be used as soft segments.

The hard segments are generally polymeric chains derived from the reaction of an aromatic diisocyanate, such as, for example, methylene-bis-(4-phenyl isocyanate) (MDI) or toluene-diisocyanate (TDI), or of an aliphatic or cycloaliphatic diisocyanate, with a diamine or a diol.

If diamines are used, a polyurethane-urea is obtained, whereas if diols are used, polyurethanes proper are obtained.

Diamines suited to the purpose can be selected, in particular, from among: aliphatic diamines, e.g. ethylenediamine (EDA), 1,3-cyclohexanediameine (1,3-CHDA), 1,4-cyclohexanediameine (1,4-CHDA), isophorone diamine (IPDA), 1,3-propylenediameine (1,3-PDA), 2-methylpentamethylene diamine (MPDM), 1,2-propylene diamine (1,2-PDA), or mixtures thereof; aromatic diamines, e.g. 3,3'-dichloro-4,4'-diaminodiphenylmethane, methylene-bis (4-phenylamine) MPA), 2,4-diamino-3,5-diethyltoluene, 2,4-diamino-3,5-di-(methylthio) toluene, or mixtures thereof. The aforesaid aliphatic or aromatic diamines can be added as such or developed in situ by reaction between the corresponding isocyanate and water. As regards the diols, these can be selected, for example, from among ethylene glycol, tetramethylene glycol, or mixtures thereof. Finally, the extension of the chain can also be
obtained by reacting the diisocyanate with a bicarboxylic acid, for example malonic acid, succinic acid, adipic acid, or mixtures thereof.

After the step of impregnation with the polyurethane elastomeric matrix, the impregnated material is usually squeezed, for example by being passed through at least a pair of rollers, and subsequently coagulated by immersion in water, generally at a temperature of from 20° to 50°C. A material in sheet form is thus obtained; it is generally immersed in hot water, for example at about 80°C, so as to extract the residual solvent and polyvinyl alcohol. Alternatively, coagulation may be achieved by steam, or in an acidic solution or in a hot air oven.

The material in sheets is then dried and cut along its thickness so as to obtain sheets about 0.6-1.5 mm thick. The sheets are then subjected to buffing in order to raise the microfiber on the surface and thereby obtain the typical "suede" effect of nap.

The present invention will now be further illustrated with some examples of embodiments, which are provided solely for illustrative purposes without limiting the scope of the invention.

EXAMPLE 1.

A raw Alcantara® non-woven microfiber fabric with a thickness of 0.8 mm, width of 145 cm and unit weight of 228 g/m² was pre-treated in a Hisaka "Jet" NX type high pressure dyeing machine, with an aqueous solution containing the following dyeing auxiliaries, but devoid of dyes:

\[
\text{CH}_3\text{COOH} \quad 0.70 \text{ g/l}
\]
CH₃COONa 0.65 g/1
Polyglycol ether 4.00 g/1
The solution had a pH value of 4.5-5.0.
The pre-treatment was carried out for 60 min at 120°C.
The non-woven fabric thus pre-treated was then washed and dried and then used to manufacture men's trousers (five-pocket model).
Said articles were then subjected to a dyeing process in a jet dyeing machine (TONELLO Gi 160 LSPEJ), using the following dye composition:

- Disperse Red 179 1.490%
- Disperse Orange 45 1.670%
- Disperse Orange 29 liq 80% 4.140%
- Disperse Blu 165:2 2.930%

where the percentages of dyes are percentages by weight relative to the weight of the material to be dyed. The rotation speed of the basket was set at 40 rpm.
The dyeing bath contained the same auxiliaries as used for the pre-treatment in the same concentrations. The dyeing was carried out for 45 min at 120°C, always maintaining the recirculation system active, which system constantly withdrew an aliquot of the dyeing bath and reinjected it therein by means of a high pressure jet.

After the exhausted dyeing bath was drained, the articles were subjected to a stripping step subdivided into three sub-steps, the first carried out at 80°C for 30 min and the second at 70°C for 30 min, followed by a step of washing in water at 70°C for 20 min. At the end of each step, the stripping bath was drained and replaced with a fresh bath. The composition of the
stripping bath was the following:

Organic Phosphorous Compound
(Securon® 5 4 0) 1.5 g/l
NaOH aq. sol. 50% 15% by weight

where the percentages by weight are relative to the weight of the dyed material.

During the stripping step, the recirculation system of the dyeing machine, with air injection by means of a high pressure jet, was deactivated.

The dyed articles thus obtained conformed to the quality standards of Alcantara®, exhibiting a soft feel, an appearance in line with the standard visual references, and a surface devoid of dirt and fluff. Penetration of the dye into the seams was satisfactory.

The dyed articles were subjected to evaluations of colour fastness under various conditions. The results are shown in Table 1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Reference</th>
<th>Lower limit of specification</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour fastness to dry cleaning</td>
<td>change in shade</td>
<td>AATCC - 132</td>
<td>Grey scale ISO 105 A02</td>
<td>4.0</td>
</tr>
<tr>
<td>Colour fastness to washing in water</td>
<td>change in shade</td>
<td>UNI EN ISO 105 C06</td>
<td>Grey scale ISO 105 A02</td>
<td>4.0</td>
</tr>
<tr>
<td>Colour fastness to washing in water</td>
<td>colour discharge</td>
<td>UNI EN ISO 105 C06</td>
<td>White scale ISO 105 A03</td>
<td>3.0</td>
</tr>
<tr>
<td>Colour fastness to washing in water</td>
<td>colour discharge</td>
<td>UNI EN ISO 105 C06</td>
<td>White scale ISO 105 A03</td>
<td>3.0</td>
</tr>
<tr>
<td>Colour fastness to rubbing</td>
<td>dry UNI EN ISO 105</td>
<td>Grey scale UNI EN ISO 105 A02</td>
<td>4.0</td>
<td>4/5</td>
</tr>
<tr>
<td>----------------------------</td>
<td>--------------------</td>
<td>-------------------------------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Colour fastness to sweat</td>
<td>acid UNI EN ISO 105</td>
<td>Grey scale UNI EN ISO 105 A02</td>
<td>4.5</td>
<td>4.5</td>
</tr>
<tr>
<td>Colour fastness to light (80 hours)</td>
<td>AATCC - 16A</td>
<td>White scale UNI EN ISO 105 A03</td>
<td>3.0</td>
<td>4</td>
</tr>
</tbody>
</table>

The results set forth above show a high colour fastness in accordance with the reference standards.

**Example 2** (comparative).

Example 1 was repeated under the same conditions using the same materials, except for the fact that the non-woven fabric raw was not subjected to the pre-treatment with the dyeing auxiliaries. After the dyeing process, the dyed article had an excessively rigid feel and a flat (non-mottled) appearance, in addition to an evident presence of dirt and fluff on the surface.

**Example 3.**

A raw Alcantara® non-woven microfiber fabric with a thickness of 0.82 mm, width of 146 cm and unit weight of 235 g/m² was pre-treated as per Example 1 and then used to manufacture men's trousers (five pockets), which were garment dyed in a FLAINOX ARC-H7 dyeing machine (which is not equipped with jet recirculation systems) according to the same procedure as in Example 1, using the following formulations:
- Dyeing auxiliaries:
  \[
  \begin{align*}
  \text{CH}_3\text{COOH} & \quad 0.70 \text{ g/l} \\
  \text{CH}_3\text{COONa} & \quad 0.65 \text{ g/l} \\
  \text{Polyglycol ether} & \quad 4.00 \text{ g/l}
  \end{align*}
  \]

- Dyeing bath:
  - Disperse Orange 29 liq. 25% 10.750%
  - Disperse Orange 32 liq 33% 14.230%
  - Disperse Blue 56 10.690%
  - Disperse Red 91 4.490%
  - Disperse Red 179 0.790%

- Stripping bath:
  - Organic Phosphorous Compound (Securon® 540) 1.5 g/l
  - NaOH aq. sol. 50% 10%
  - pure Na$_2$S$_2$O$_4$ 15%

where the concentrations of the dyes, soda solution and hydrosulphite are relative to the weight of the material to be dyed.

The dyed articles thus obtained conformed to the quality standards of Alcantara®, exhibiting a soft feel, an appearance in line with the standard visual references, and a surface devoid of dirt and fluff. Penetration of the dye into the seams was satisfactory.

The dyed articles were subjected to evaluations of colour fastness under various conditions. The results are shown in Table 2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Reference</th>
<th>Lower limit of</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colour fastness to dry cleaning</td>
<td>change in shade</td>
<td>UNI EN ISO 105 C06</td>
<td>Grey scale ISO 105 A02</td>
<td>4.0</td>
</tr>
<tr>
<td>Colour fastness to washing in water</td>
<td>change in shade</td>
<td>UNI EN ISO 105 A02</td>
<td>Grey scale ISO 105 A03</td>
<td>4.0</td>
</tr>
<tr>
<td>Colour fastness to rubbing</td>
<td>dry</td>
<td>UNI EN ISO 105 X12</td>
<td>Grey scale ISO 105 A03</td>
<td>4.0</td>
</tr>
<tr>
<td>Colour fastness to sweat</td>
<td>Acid</td>
<td>UNI EN ISO 105 E04</td>
<td>Grey scale ISO 105 A03</td>
<td>4.5</td>
</tr>
<tr>
<td>Colour fastness to light (80 hours)</td>
<td>AATCC - 16A</td>
<td>White scale ISO 105 A03</td>
<td>3.0</td>
<td>4/5</td>
</tr>
</tbody>
</table>

The results set forth above show a high colour fastness
in accordance with the reference standards.

**EXAMPLE 4**

A raw Alcantara® non woven microfiber fabric with a thickness of 0.8 mm, width of 145 cm and unit weight of 228 g/m², was pre-treated in a Jet dyeing machine under the same conditions as described in Example 1. Small lengths (up to 2.5 m) of the non woven fabric were then prepared for dyeing by being folded in "rope-like" fashion and compacted by insertion into elastic broad mesh nets knotted at the ends. This serves to hinder the diffusion of the dyeing bath in some areas of the samples so as to obtain a so-called "uneven" or "tie-dye" effect.

The samples thus obtained were garment dyed in a garment dyeing machine (FLAINOX ARC-H7), which is not equipped with jet recirculation systems, under the same conditions as described in Example 1 and using the following formulations:

- **Dyeing auxiliaries:**
  - \(\text{CH}_3\text{COOH}\) 0.70 g/l
  - \(\text{CH}_3\text{COONa}\) 0.65 g/l
  - Polyglycol ether 4.00 g/l

- **Dyeing bath:**
  - Disperse Red 91 4.000%
  - Disperse Red 60 2.200%
  - Disperse Blu 56 liq. 50% 0.100%

- **Stripping bath:**
  - Organic Phosphorous Compound (Securon® 540) 1.5 g/l
  - \(\text{NaOH}\) sol. aq. 50% 15%
  - pure \(\text{Na}_2\text{S}_2\text{O}_4\) 20%
where the concentrations of the dyes, soda solution and hydrosulphite are relative to the weight of the material to be dyed.

It should be noted that, after the dyeing step, the samples were extracted and the knots, nets and binds were removed so as to allow the stripping step to be carried out in a homogeneous and effective manner over all the material.

The dyed articles thus obtained, having evident "tie-dye" effects in the areas of compacting, conformed to the quality standards of Alcantara®, exhibiting a soft feel, an appearance in line with the standard visual references, and a surface devoid of dirt and fluff.

The dyed articles were subjected to evaluations of colour fastness under various conditions. The results are shown in Table 3.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Reference</th>
<th>Lower limit of specification</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour fastness to dry cleaning</td>
<td>change in shade</td>
<td>ISO 105 A02</td>
<td>4.0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>change in shade</td>
<td>ISO 105 A03</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>colour discharge</td>
<td>ISO 105 A02</td>
<td>4.0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>colour discharge</td>
<td>ISO 105 A03</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Colour fastness to washing in water</td>
<td>change in shade</td>
<td>ISO 105 A02</td>
<td>4.0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>change in shade</td>
<td>ISO 105 A03</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>colour discharge</td>
<td>ISO 105 A02</td>
<td>4.0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>colour discharge</td>
<td>ISO 105 A03</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Colour dry</td>
<td>UNI EN ISO 105 A02</td>
<td>Grey scale</td>
<td>4.0</td>
<td>5</td>
</tr>
<tr>
<td>dry</td>
<td>UNI EN ISO 105 A03</td>
<td>White scale</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Fastness to Rubbing</td>
<td>Wet X12</td>
<td>White Scale ISO 105 A03</td>
<td>3.0</td>
<td>4/5</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------</td>
<td>------------------------</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>Colour Fastness to Sweat</td>
<td>Acid UNI EN ISO 105 E04</td>
<td>Grey Scale ISO 105 A02</td>
<td>4.5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Basic ISO 105 E04</td>
<td>White Scale ISO 105 A03</td>
<td>4.5</td>
<td>5</td>
</tr>
<tr>
<td>Colour Fastness to Light (80 hours)</td>
<td>AATCC 16A</td>
<td>White Scale ISO 105 A03</td>
<td>3.0</td>
<td>4/5</td>
</tr>
</tbody>
</table>

The results set forth above show a high colour fastness in accordance with the reference standards.
CLAIMS

1. Process for garment dyeing of an article comprising a microfibrous non-woven fabric, which comprises:

- pre-treating the raw microfibrous non-woven fabric with an aqueous solution containing dyeing auxiliaries and devoid of dyes, at a temperature of from 100°C to 140°C;
- washing the so pre-treated microfibrous non-woven fabric to remove the dyeing auxiliaries;
- manufacturing the article by using the pre-treated microfibrous non-woven fabric—subjecting the so manufactured article to a dyeing step by means of a dyeing bath comprising at least one dye and dyeing auxiliaries, at a temperature of from 100°C to 140°C;
- removing the non-fixed dye by means of at least one stripping step.

2. Process according to claim 1, wherein during the step of pre-treating the duration of immersion in the aqueous solution is from 1 to 6 hours, preferably from 3 to 5 hours, with a maintenance time at the maximum temperature of from 30 to 90 min, preferably from 45 to 75 min.

3. Process according to any one of the preceding claims, wherein the dyeing auxiliaries are selected from: acid-base pairs acting as a buffer, ionic or non-ionic surfactants, and mixtures thereof.

4. Process according to any one of the preceding claims, wherein during the pre-treatment step the aqueous solution containing dyeing auxiliaries has a pH value ranging from 4.0 to 5.5, preferably from 4.4 to
5.0.

5. Process according to any one of the preceding claims, wherein during the step of dyeing at least one disperse dye is used, selected from: azoic dyes, anthraquinone dyes, aminoketone or quinophthalone dyes, leuco dyes.

6. Process according to any one of the preceding claims, wherein the step of dyeing is carried out in a garment dyeing machine having a closed bath.

7. Process according to any one of the preceding claims, wherein the step of dyeing is carried out with a bath ratio ranging from 1:2 to 1:30, preferably from 1:4 to 1:20.

8. Process according to any one of the preceding claims, wherein the step of stripping is carried out by treating the dyed article with a basic solution comprising at least one reducing agent.

9. Process according to claim 8, wherein said at least one reducing agent is selected from: sodium hydrosulfite and sulfinic acid derivatives.

10. Process according to claim 8 or 9, wherein the basic solution has a pH value greater than 8, preferably greater than 10.

11. Process according to any one of claims from 8 to 10, wherein the basic solution includes at least one surfactant.

12. Process according to any one of claims from 8 to 11, wherein the step of stripping is carried out at a temperature of from 50°C to 100°C, preferably from 70°C to 90°C.

13. Process according to any one of claims from 8
to 12, wherein during the step of stripping no recirculation of the basic solution, accompanied by air injection, is carried out.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. D06P1/00 D06P1/613
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D06P D06B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>WO 2005/080669 AI (CIBA SC HOLDING AG [CH]; OUZEL PHILIPPE [FR]; STRAHM ULRICH [CH]) 1 September 2005 (2005-09-01) page 14, line 9 - line 29</td>
<td>1-13</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"Z" document member of the same patent family

Date of the actual completion of the international search: 9 July 2012

Date of mailing of the international search report: 19/07/2012

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel.: (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer: Fiocco, Marco

Form PCT/ISA/210 (second sheet) (April 2005)
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>US 2004163189 Al 26-08-2004</td>
<td>CN 1535341 A</td>
<td>DE 10135941 Al</td>
</tr>
<tr>
<td></td>
<td>DE 1409788 Al</td>
<td>US 2004163189 Al</td>
</tr>
<tr>
<td></td>
<td>Wo 03012194 Al</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wo 03014464 Al</td>
<td></td>
</tr>
<tr>
<td>Wo 2005080669 Al 01-09-2005</td>
<td>BR PI0507904 A</td>
<td>CN 1918337 A</td>
</tr>
<tr>
<td></td>
<td>CN 1716285 Al</td>
<td>EP 1412578 Al</td>
</tr>
<tr>
<td></td>
<td>Wo 2005080669 Al</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US 2004194234 Al 07-10-2004</td>
<td>CN 1535342 A</td>
<td>DE 10135940 Al</td>
</tr>
<tr>
<td></td>
<td>DE 1412578 Al</td>
<td>EP 2004194234 Al</td>
</tr>
<tr>
<td></td>
<td>EP 03014464 Al</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wo 03012194 Al</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wo 03014464 Al</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JP 1192884 A 02-08-1989</td>
<td>JP 1192884 A</td>
<td>JP 1945889 C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>