COLOUR MEASUREMENT IN THE VARIOUS METHODS FOR THE ARTIFICIAL AGEING OF JEANS

ANTONELLA DEL SIGNORE (*)

Abstract

Through use of the CIELAB 1976 colour space system for measuring colour, the various techniques used in the artificial ageing of jeans were evaluated.

The results of the study show that all of the methods for artificially ageing jeans (sandblasting, sandpaper, brushing) produce the same effect (with the exception of those methods that use chemicals) and that effect varies depending on the intensity of the treatment that has been used to produce the finished product.

Riassunto

Mediante la misura univoca del colore, secondo lo spazio cromatico CIELAB, 1976, sono state valutate le diverse tecniche impiegate per l'invecchiamento artificiale dei jeans.

E' risultato che non esistono tecnologie per l'invecchia-mento artificiale degli indumenti (sabbiatura naturale, carteggio, spazzolatura, ecc.) che producono effetti diversi (fatta eccezione ovviamente per quelle che prevedono l'impiego di sostanze chimiche), ma esiste un unico effetto di invecchiamento valutabile in base all'intensità del trattamento che si effettua sul prodotto finito.

Keywords: Jeans, used bleached jeans, CIELAB

(*) Dipartimento di Metodi Quantitativi e Teoria Economica, Università "G. d'Annunzio", Chieti-Pescara, Viale Pindaro, 42 – 65127 Pescara. Phone: +39-085-4537505; Fax: +39-085-4537545; e-mail: signore@sci.unich.it

Introduction

Since the 1960s fashion has dictated the use of clothing that has a 'used' or 'worn' look when it is purchased[1]. This trend has been particularly strong in the clothing sector (trousers, jackets, shirts, etc.) which uses jeans material[2]. Articles of clothing are treated so that they look as if they have already been worn for a long time. As the trend developed it also became fashionable for articles of clothing to have particular areas that had a worn out look. The faded/aged look that had been applied to the whole garment was now applied to particular areas of the garment.

For many years, then, the jeans industry has been producing garments made of jeans material that has been softened and pre-shrunk through a first washing with fabric softener. These garments are called 'rinsed". In this first washing various substances are added to the water to change the colour and the appearance of the cloth. By adding chlorine to the first wash a lighter colour is obtained. The terms 'bleached' and 'super bleached' are used for the garments that have received this treatment which makes them almost white. 'Tie bleached', instead, is the term applied to garments where irregular colour patches are obtained by tying the garment before the wash.

In the 1990s industrial methods for obtaining this fashionable aged or worn out look came into being: washing with pumice stones alone (stone-washed) or with the addition of chlorine (stone-bleached) or other whitening substances (marbleizing or Klondyke).

These conventional technologies generate large quantities of polluted water as a by-product . The 'worn out look' can also be obtained by using enzymes which are less polluting but require greater care in their handling (3-5), or by ozone or a laser treatment (6-7).

To create a more authentic used look in certain areas of the jeans, sandpaper or chemical whitening products are employed. "Used-stone" and "used-bleached" jeans, then, began to be a produced using the above described processes.

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[1] Frequently Asked Questions about jeans are reported in U. Volli (1).

[2] Jeans – The word 'jeans' originates from an American mispronunciation of the word 'Genova' ('Genes' in French) which came into use to refer to the material of the trousers always worn by sailors from Genoa. A material that had the same characteristics was also produced in the city of Nimes and it was called 'serge de Nimes' which was later contracted into 'denim' (2). There are only slight differences between denim and jeans. Jeans material is a cotton cloth that has a warp and weft that have been dyed with the same colour. It is especially suited to making well cut trousers, , sports clothing, uniforms for doctors and nurses and the lining for shoes and boots. In denim the thread of the warp is blue while the thread of the weft is white or ecru and the material is more suited to making heavy work clothing. The two materials are very similar but not the same, even though nowadays the words 'jeans' and 'denim' are often used interchangeably.

Evolution of artificial ageing techniques

The aged look in jeans that has become desirable from a purely aesthetic point of view, is accomplished through artificial methods. Initially these methods were simple, consisting in repeated washes which were enhanced by the addition of various materials and substances (salt, bleach, stones, pumice, etc.) Eventually the clothing industry broke into this niche market with various patented methods for the artificial ageing. Aged or worn out garments that had received a variety of different treatments - both uniform (see Figure 1 – application for patent V191U00099 dated November 20, 1991) as well as non-uniform (See Figures 2a and 2b- European Patent application no. 86830303.3 dated October 22, 1986; United States Patent no. 4,740,213, April 26, 1988. Patent no. 1215001 dated January 31, 1990 – Min. ICA Ufficio Centrale Brevetti)[3].

[3] The description of patent no. 1215001 - soak granules of coarse, permeable material with a whitening agent. Carry out a dry cycle with the granules in order to age material. Separate the garments from the granules . The granules can be pumice, sand or other granules. The whitening/fading agents can be: bleach, hypochlorite, potassium permanganate or any other substance that has whitening power.

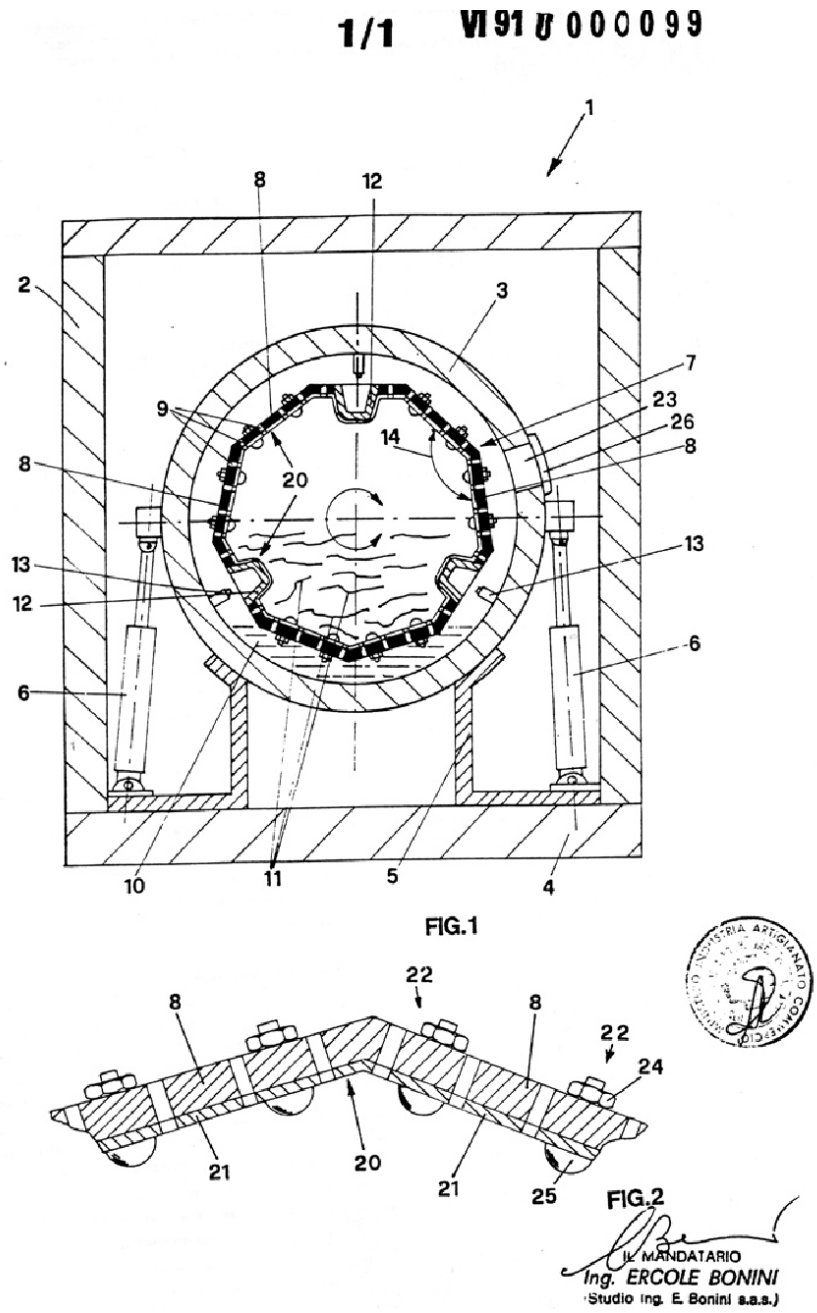

Fig. 1 - Washing machine with rotating drum for the uniform artificial ageing treatment of jeans material.

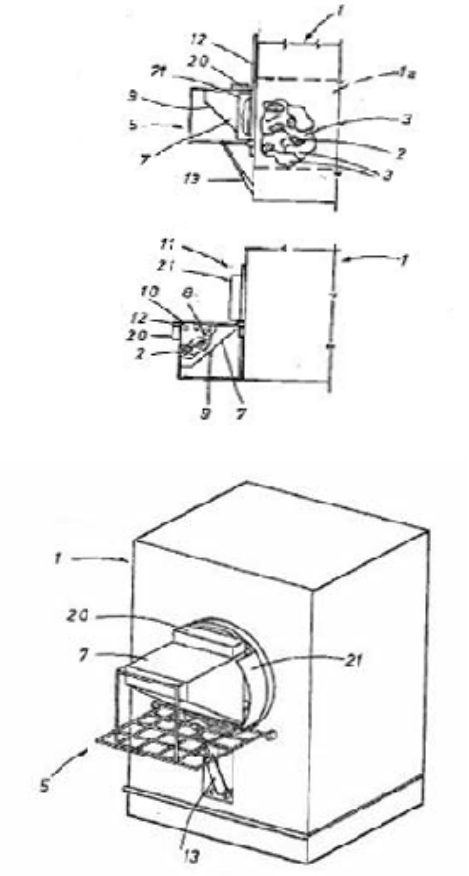

Fig. 2a and 2b – Method for producing a random faded effect on cloth or assembled garments and the end-product obtained by the implementation of such a method.

The process of dry fading represents an evolution in ageing methods. Garments are placed in a drum without water and the fading is not uniform but occurs only on those areas of the garment that come into contact with the granules. The areas of the garment that are not touched by the granules, for example the inside, along the seams, inside of the pockets, the underside of belt loops, etc. retain the original colour.

An improvement to this dry fading process is protected in patent n. 217233 issued on March 14, 1990 (Min. ICA, Ufficio Centrale Brevetti) which delineates a method for fading fabrics in a non-uniform way (see Figure 3).

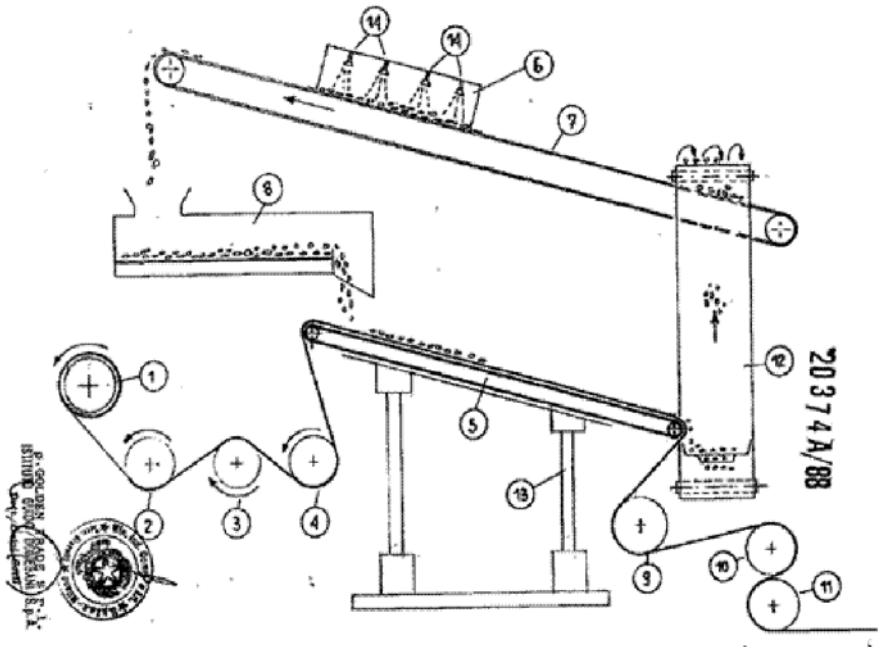

Fig. 3 – Procedure for non-uniform fading of fabric or assembled garments.

Uniform fading and ageing (or repeated washing/ ageing) are, in a certain sense, easier to do since the treatment is applied to the whole garment. Currently, however, the demand is greater for garments that have fading on those areas of the garment that are naturally subject to wear, that is, an ageing that resembles the look of a garment which really is old.

Practically speaking the treatment has to create a faded look by using abrasive agents on the fabric, reproducing the natural wear that garments undergo and creating the worn out, used look.

There are a variety of techniques that are employed to obtain this effect[4] and many of them have also been patented. These methods include an abrasion which is generally called "sanding" and is carried out on the surface of the garment:

4 Treatment of fabric with chemicals has also been used. This method however is now outdated and a careful examination of the fabric treated in this way will show that chemicals fail to create the appearance of the desired 'natural ageing'. For this reason this treatment will not be considered in the present study.

1. Using sandblaster, a manual sand sprayer
2. Using sandpaper
3. Using a abrasive rotating brush which scrapes the fabric (brusher)

1. The sandblasting method involves spraying a jet of sand on the area to be aged : the ageing occurs only on the surface of the areas that are subjected to the jet of sand. Since this method generally does not produce a result that effectively simulates long term wear of the garment, another method was developed to overcome this shortcoming and patent n. RM94 A 000685 –October 21, 1994 was issued for this new process. The patent covers a method in which a mannequin is dressed in the garment to be aged and numerous lines are sketched to create what is known as the "whiskers" effect (see Figure 4). This effect is obtained through three different stages of production which require the use of a machine equipped with special apparatus mannequin able to produce numerous lines in the area of the pockets, the saddle and the knees and once these lines are drawn the areas involved are also faded.

This method manages to reproduce the "whiskered" look near the pockets and on the legs of the jeans which would normally come about over time from a person wearing the jeans repeatedly bending to sit down. It also manages to simulate the faded, spotty or stained look of jeans that have really undergone long term wear. Sandblasting used to be the most widely used method, but it has been the object of harsh criticism because of reports from Turkey that it causes silicosis since workers in the garment industry work long hours in unhygienic working conditions without any serious respiratory protection (8-11).

Fig.4 – Production stages in the ageing of blue jeans that are sandblasted after being placed on a mannequin.

2. Abrasion with sand paper involves carrying out an energetic brushing on the specific areas where the desired fading is to be created (this also results in the sandblasted look) . This brushing can be done manually but this has the disadvantages of requiring a lengthy production time with the consequent high cost of labour and moreover it is not able to produce a uniform product that can be accurately and repeatedly reproduced because, of course, of the workers inability to apply of the process in exactly the same way to each garment.

3. Mechanized abrasion employs rotating brushes with abrasive bristles that have been developed to replace the sand techniques. With this method it is possible to follow the same stages of production, that require the same amount of time and are carried out at the same speed and under the same conditions of pressure on the garment on the mannequin - all of which results in a much greater uniformity of the end product that has been treated to have the sand blasted look. (patent no. 01253347 dated July 25, 1995, Min. ICA – Ufficio Italiano Brevetti e Marchi, U.S. Patent No. 5,395,281 dated March 6, 1995) (see Figure 5a).

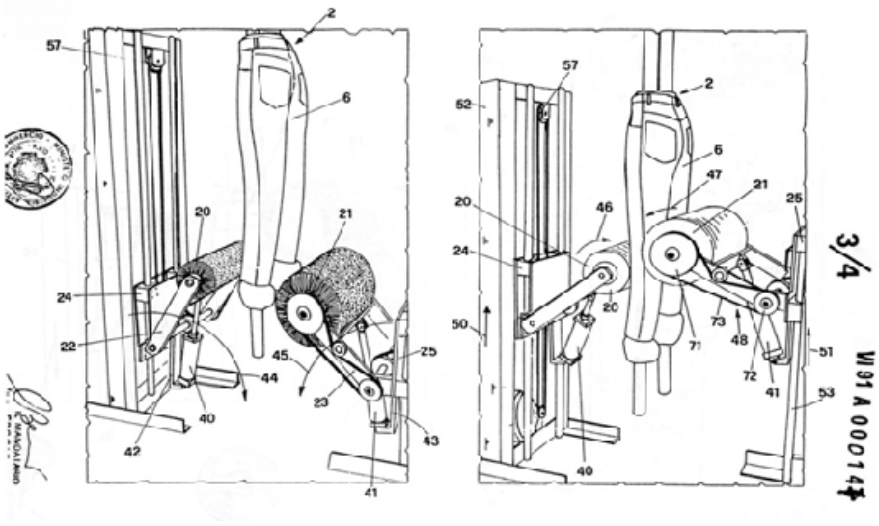

Fig. 5a – "Worn " look obtained through use of a mechanical brusher.

The creation of the so-called "whiskers" that form on the surface of jeans as a result of normal wear and that appear on those areas of the jeans that are subjected to greater wear through bending, is accomplished through 'bunching' the garment (see point 6 of Figure 5b)

At the end of this phase of production the garments treated have acquired the characteristics of ageing that are perfectly analogous to the results of real long term wear. The process gives the product an authentic and distinctive look.

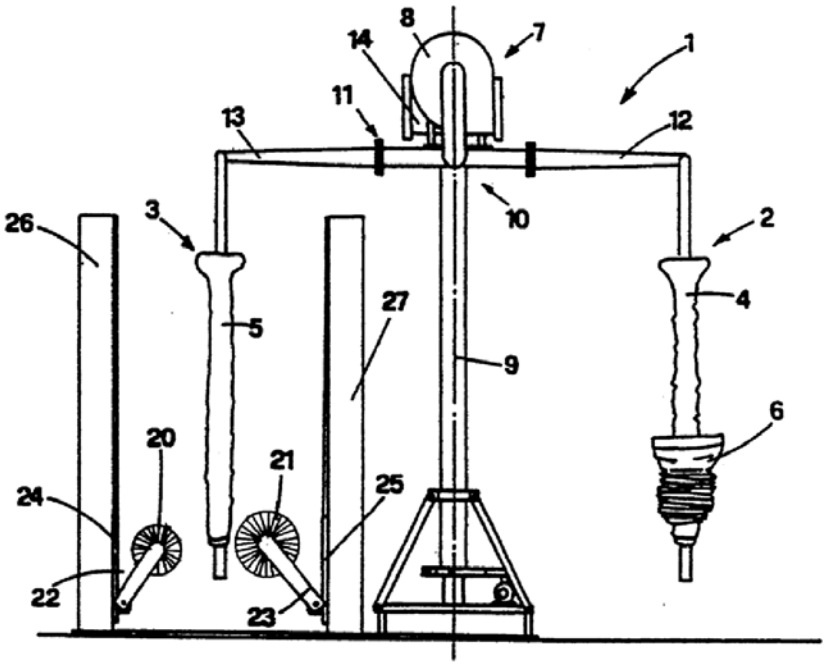

Fig. 5b – Machine for "bunching' the garment for the formation of 'whiskers' (point 6)

A determination of the effects of various procedures on the "quality" of ageing treatments for jeans

From a commercial point of view there is an evident interest in knowing about how the various mechanical treatments used on jeans effect the material treated: whether the methods produce different abrasions and fadings, whether the methods produce shininess or different tonalities – essentially, what different effects are actually produced as a consequence of using the various treatment methods.

Because of the commercial importance of artificial ageing of garments, a number of controversies have arisen regarding the effects produced by the various techniques of fading on garments of the same colour and fabric as well as on garments of different colours and fabrics.

In order to make an objective comparison of the results obtained by using the various techniques of fading, it is necessary to measure the surface colour after treatment. In fact, objective observation of the colour is not always in agreement with the data obtained from spectrophotometric measurement (12).

The unequivocal measurement of colour, as has long been widely acknowledged, calls for an exact indication of luminosity, tonality and saturation of the object under consideration. These three parameters taken together constitute the basic elements that give Man the visual sensation required to appreciate a colour and they are a sufficient means for an exact measurement of the differences in colour.

Colour was measured: (a) in different types of jeans (cloths of different colours and different consistencies); (b) on identical jeans (same cloth, same colour) that had undergone various abrasion treatments (see Table 1 where some characteristic data are reported).

The results of these measurements are described here in detail, and brief comments are offered from time to time; a more general and conclusive comment is then made, based on what can be deduced from the overall results obtained.

Material and Methods

Colour measurements were carried out with a Beckmann DU 70 spectrophotometer equipped with a integrating sphere to measure reflectance, connected to software for computerized colorimetry.

The chromatic space CIE 1976(L*,a*,b*) (abbreviated CIELAB) was used, and the differences in colour ΔE_{ab} (abbreviated ΔE CIELAB) were calculated following the recommendations of the CIE (see Colorimetry, Publication CIE 15 (E-1.3.1) 1971; Supplement No. 2 to CIE Publication 15 (E-1.3.1) 1971/(TC-1.3) 1978; Publication CIE 15.2-1986, 2nd edition, corrected reprint, 1996).

The following conditions for measuring were adopted: illuminant D_{65} and illuminant A were both used in as much as the former, as is known, corresponds to a generic day light (it can be considered a medium day light

since it corresponds neither to cloudy sky nor to bright sun light), while illuminant A corresponds to standard artificial light (incandescent light bulb that radiates an absolute temperature of 2,856 ° K)[5]. Illuminant A is closer to the conditions in which the chromatic appreciation of a fabric is carried out in the Standard Observatory: 2°; Δλ:5 nm.

Comparison of colours produced by the various methods of ageing

An initial determination of colours was followed by a comparison of jeans of four different brands (called T, CA, CR and K) that had been aged using three different methods (sandblasting, sand paper and brushing).

A comparison was also made between jeans of the same brand (TE) that were of two different colours; one was made from light coloured cloth, the other from dark coloured cloth; both colour types were treated with the three different ageing techniques.

The measurement of colour was carried out in the centre of the treated area, where possible differences are certainly more visible.

The internal part of the leg serves in the study to measure the part of the garment that has not undergone treatment.

The differences in colour are expressed in C.I.E.(Commision Internazionale de l'Éclairage) units of measurement = ΔE, which are recognized internationally. It is assumed that differences in colour that are under 2 units are visible only to a trained eye; the differences of from 4 to 5 units are perceptible but they do not stand out. When the difference is above 5 units, the objects can be said to have different colours.

In the specific case of jeans, the shaded, non-uniform colour characteristic of this type of garment makes the difference in colour even less apparent to the eye.

Comparison of different brands

CASE 1, similar material, in fact the legs show an identical coloration which results in the difference ΔE = 0.72:

T (sandblasting)

CA (sandpaper)

[5] The description of patent no. 1215001 - soak granules of coarse, permeable material with a whitening agent. Carry out a dry cycle with the granules in order to age material. Separate the garments from the granules . The granules can be pumice, sand or other granules. The whitening/fading agents can be: bleach, hypochlorite, potassium permanganate or any other substance that has whitening power.

Difference in colour:
- Front ΔE = 5.78
- Back ΔE = 7.72

These differences are the result of the fact that T is shinier and CA is more saturated.

CASE 2, different materials, in fact, the part of the leg where no abrasion has been applied shows an appreciable difference in coloration: ΔE = 10.70:
T (sandblasting)
CR (idem)
Difference in colour:
- front ΔE = 4.15
- back ΔE = 3.77

CR is shinier and slightly more saturated.

CASE 3, different materials, in fact, the part of the leg where no abrasion has been applied shows an appreciable difference in coloration: ΔE = 7.22:
T (sandblasting)
K (brushing machine)
Difference in colour:
- front ΔE = 2.46
- back ΔE = 2.34

The coloration is practically equal, the shininess is practically the same; the slight difference that is noticeable is due to the fact that the K model is slightly more saturated.

CASE 4, different materials, in fact, the part of the leg where no abrasion has been applied shows an appreciable difference in coloration: ΔE = 7.88:
CA (sandpaper)
K (brushing machine)
Difference in colour:
- front ΔE = 4.98
- back ΔE = 5.77

K is shinier but less saturated than CA.

CASE 5, different materials, in fact, the part of the leg where no abrasion has been applied shows an appreciable difference in coloration: ΔE = 11.35:

CA (sandpaper)
CR (sandblasting)
Difference in colour:
- front ΔE = 8.37
- back ΔE = 10.27

CR is shinier than CA.
CA is slightly more saturated than CR.

CASE 6, material that is almost identical, in fact the part of the legs where no abrasion has been applied show a similar coloration with ΔE = 3.63:
CR (sandblasting)
K (Tonello brushing machine)
Difference in colour:
- front ΔE = 3.81
- back ΔE = 4.61

There are only minimal differences: K is less shiny but slightly more saturated than CR.

Comparison between garments of the same brand (light coloured cloth and dark coloured cloth):

Light coloured cloth
Comparison of different parts of the jeans treated with sandblasting, sandpaper and brushing methods.

leg[6] :	sandpaper – brushing machine	= ΔE 0.95
	sandpaper – sandblasting	= ΔE 0.48
	brushing machine-sandblasting	= ΔE 0.66
front:	sandpaper-brushing machine	= ΔE 4.02
	sandpaper-sandblasting	= ΔE 6.03
	brushing machine- sandblasting	= ΔE 2.18
behind:	sandpaper-brushing machine	= ΔE 2.11
	sandpaper-sandblasting	= ΔE 5.28

Dark coloured cloth

Comparison of different parts of the jeans treated with sandblasting, sandpaper and brushing methods.

6 No treatment was carried out on the surface of the material.

leg:*	sandpaper-brushing machine	= ΔE 1.19
	sandpaper-sandblasting	= ΔE 0.40
	brushing machine-sandblasting	= ΔE 0.80
front:	sandpaper-brushing machine	= ΔE 3.51
	sandpaper-sandblasting	= ΔE 4.21
	brushing machine	= ΔE 1.99
behind:	sandpaper – brushing machine	= ΔE 0.37
	sandpaper – sandblasting	= ΔE 3.29
	brushing machine – sandblasting	= ΔE 5.27

Discussion of the results

Comparison of different brands

CASE 1: the same material treated with different methods gives a difference in coloration that is slightly superior to that of **CASE 2** where the material is different, but the treatment is the same.

CASE 3: different materials subjected to different treatment methods show a just barely perceivable difference in coloration (to the trained eye).

CASE 4: different materials, different treatments, appreciable difference in colour.

CASE 5: very different materials, different treatment methods: the difference in colour is high due to the big difference between the materials.

CASE 6: almost identical materials (small difference in colour), different treatments, coloration is slightly different.

The results, therefore, show that both in the case where different materials are used (CASE 3) as well as in the case where materials are similar (CASE 6) the various treatments used give results that are only barely perceivable.

A preliminary conclusion is that the final coloration does not depend on the type of treatment in itself (identical treatments give different colorations, different treatments give identical colorations) but rather on the intensity and the duration of treatment.

Comparison of brands

As regards the light coloured cloth, there are no obvious differences in coloration on the part of the garment that has not been treated.

On the front of the garment, differences are found between areas treated with sandpaper and those treated with a brushing machine; apparent differences are also present between areas treated with sandpaper and

those treated instead with sandblasting; no differences are found between areas treated by brushing machine and those treated with sandblasting.

In contrast, on the back part, differences are found between sandpaper and sandblasting and between brushing machine and sandblasting (slight difference) and no differences are found between sandpaper and brushing machine.

Therefore, the differences do not depend on the type of treatment used but rather on the intensity and duration of the treatment.

As regards the dark coloured cloth, there are no obvious differences in coloration on the part of the garment that has not been treated.

On the front of the garment, differences are found between areas treated with sandpaper and those treated with a brushing machine; differences are also found between those treated with sandpaper and those treated with sandblasting; no differences are found between areas treated with a brushing machine and those treated with sandblasting.

In contrast, the back of the garment shows differences between areas treated with sandpaper and those treated with sandblasting and between those treated with a brushing machine and those treated with sandblasting: no differences are found between areas treated with sandpaper and those treated with a brushing machine.

Therefore, the differences do not depend on the type of treatment used but rather on the intensity and duration of the treatment.

Moreover, a study of identical garments leads to a conclusion that is analogous with that reached in regard to garments of different brands: the final level of 'fading' does not depend on the treatment itself (identical treatments produce different colorations and different treatments produce identical colorations) but rather on the intensity and the duration of the treatment.

It can therefore be affirmed that the various methods used for the artificial ageing of jeans (sandblasting, sandpaper, brushing machine) do not produce different effects (with the exception of methods that employ chemical substances).

There is one single effect of artificial ageing that has a variety of measurable colorations which are due to the intensity of the treatment which the garment has undergone.

This result is of interest particularly because of the health problem presented by the occurrence of silicosis among workers who do sandblasting; it demonstrates that sandblasting produces no particular effect that cannot be produced by one of the other methods and therefore garment producers

could very well give up this method and use one of the others without the risk of losing customers for their products.

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