Patented Dec. 21, 1948 2,457,033

UNITED STATES PATENT OFFICE

2,457,033

TREATMENT OF WOOL TO IMPART SHRINKAGE RESISTANCE THERETO

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No Drawing. Application January 31, 1946, Serial No. 644,664

13 Claims. (Cl. 8—128)

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This invention relates to a treatment for imparting shrinkage resistance to wool and particularly to woolen fabrics and fabrics consisting partly of wool.

This application is a continuation-in-part of our co-pending application Serial No. 616,956, filed September 17, 1945, now abandoned.

A well-known disadvantageous characteristic of woolen goods is their shrinkage and felting when subjected to laundering. It is customary to clean woolen clothing in the form of suits and dresses by means of dry cleaning, and to wash woolen socks and underwear in lukewarm water with great care and dry them on hangers and forms in order to avoid shrinkage and loss of shape. Great monetary losses are incurred by the public as a result of shrunken woolen goods. Likewise, considerable difficulties and property losses have been sustained by the armed forces because woolen clothing, and particularly woolen socks issued to individuals became useless in a short time because of the impossibility of washing the woolen goods in such a manner as to avoid shrinkage; consequently, the clothing had to be sent to the salvage heap long before its useful life had become exhausted through normal wear and tear.

Numerous attempts have been made to treat wool in such a manner that its tendency to shrink and felt will be overcome, or at least substantially restricted. One of the earliest, and still one of the most economical processes is the treatment of the woolen goods with a solution of which the active agent is a hypochlorite or hypobromite. This process imparts good shrinkage resistance to wool, but has the disadvantage that, unless controlled with meticulous care, it results in grave damage to the wool fibers. Another consideration that has heretofore prevented wide acceptance of this process is the yellowish discoloration of the wool treated thereby; this discoloration is particularly troublesome when it results in streaks caused by a too rapid progress of the reaction due to insufficient control.

The major object of the present invention is an adaptation of the hypochlorite or hypobromite treatment of wool for the purpose of making the same substantially shrink resistant, without the disadvantages inherent in the prior art, namely, the disadvantages of wool fiber destruction and

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the disadvantage of streakiness of the treated goods.

Another object of the present invention is a process for imparting shrink resistance to woolen goods, which is not in need of careful control and meticulous supervision, but which can be carried out safely and efficiently even by relatively inexperienced operators.

A further object of the invention is the imparting of shrink resistance to woolen underwear in need of frequent washing, particularly socks.

A further object is the lengthening of the serviceable life of woolen clothing by eliminating loss of utility due to shrinkage, without lowering its strength below normal standards.

Still another object of our invention is a hypochlorite treatment for wool which facilitates subsequent dyeing in any shade containing yellow as its component, such as brown, green, khaki, olive drab, and similar shades.

Yet another object of our invention is a process of particular usefulness for imparting shrinkage to goods consisting partly of wool and partly of another textile, such as cotton; for instance, goods with a wool warp and cotton filling, or vice versa.

These and other objects and aspects of our invention will become more fully apparent in the following description.

We have discovered that shrink resistance imparting treatment applied to woolen goods by means of a hypohalite solution, that is of a hypochlorite or hypobromite solution, can be carried out with best results and a maximum degree of safety if the hydrogen ion concentration of the solution is so adjusted that its pH is between 7.5 and 9.0. A moderately basic hypochlorite solution renders the wool substantially shrink resistant, and does not result in more than negligible damage to the wool. Our observations have shown that if the treating solution has an alkalinity substantially exceeding pH 9.0, say pH 9.5, or higher, the structure of the wool fibers is not sufficiently modified to give it the desired amount of shrinkage resistance, while on the other hand, a hypochlorite solution having a pH of below 7.5, that is, a very slightly basic or an acid solution, results in excessive fast reaction, with accompanying considerable damage to the wool and streaky, uneven discoloration.

The only necessary control to be observed in our process is that of the hydrogen ion concentration of the hypochlorite solution. The desired concentration is readily accomplished by the addition of buffer salts to the solution, or by adding the hypochlorite solution to the buffer salt solution. The hydrogen ion concentration may be readily measured by conventional indicators.

Any hypochlorite or hypobromite, such as potassium hypochlorite, potassium hypobromite, sodium hypochlorite, sodium hypobromide, calcium hypochlorite, or calcium hypobromite, is suitable for the purpose. We prefer calcium hypochlorite for its ready availability and inexpensiveness in the form of HTH ("High-test Hypochlorite," a product made by Mathieson Alkali Works, Inc.) which contains 70% available chlorine.

A drawback of earlier treatments of woolen goods with a basic calcium hypochlorite bath to which a buffer salt was added, has been the formation of a precipitate by a combination of calcium ions with the negative ions of the buffer salt to a water soluble calcium salt. We observed that this precipitation, though harmless in the case of woolen underwear for the armed forces, where quality counts more than appearance, may be avoided by compounding the buffer salt in such a manner that one of its principal components is a salt capable of forming a water soluble calcium salt by reacting with the calcium ions of the calcium hypochlorite in solution; a buffer salt fulfilling this requirement is borax

$$(Na_2B_4O_7.10H_2O)$$

which forms with the calcium ions calcium borate, a compound being sufficiently water soluble to avoid precipitation. In order to depress the pH of the solution below 9.0, we have found it necessary to add to the borax another buffer salt, such as sodium bicarbonate, as with borax as the sole buffer salt the solution would have to be diluted excessively before it can be brought below the pH 9.0 mark.

Within the range of hydrogen ion concentrations from pH 7.5 to pH 9.0, we have found that markedly improved results are obtained above pH 8.0. The reduction of area shrinkage remains substantially constant through the range of pH 8.0 to pH 9.0, while the weakening of the wool fiber is decreased as the pH value of the solution increases. It follows theoretically, and is confirmed by our experiments, that the optimum range is between pH 8.5 and pH 9.0, where shrink resisting qualities of the treated wool are near the optimum, while damage to the fibers is restricted to a degree well within acceptable limits. As pointed out above, and as will be more fully shown in the table below, shrinkage loss by laundering rapidly increases, however, if the pH of the treating solution is permitted to exceed 9.0.

Woolen goods treated in accordance with our invention are preferably given a final treatment with a small amount of sodium bisulfite to dechlorinate the treated wool; the sodium bisulfite is preferably added to the bath during the last few minutes of the immersion of the wool. Such a treatment is conventional and forms no part of our invention.

The treatment of the wool in accordance with our process results in a slight yellowish discoloration. This can be easily compensated in all dye shades containing yellow as a component, e. g. yellow, brown, green, khaki, olive drab; in those shades, the amount of yellow dye which ordinarily would be applied is reduced or totally eliminated.

The following table summarizes our observations of the results of the treatment of identical samples of woolen fabric with calcium hypochlorite solutions adjusted to various degrees of alkalinity and acidity.

pH	Area Shrinkage During Laundering	Alkali Solubility	30% Index	Weight Loss During Treatment
	Per cent	*Per cent*		*Per cent*
Untreated	25	15	99	
11	11	12	90	1
10	17	13	94	2
9	10	14	95	1
8	6	15	93	1
7	−3	16	88	0
5	0	28	88	2
3	1	29	86	2
1	−2	23	79	4

This table shows clearly the marked increase in shrinkage loss after a treatment above pH 9, and the rapid increase in damage to the wool, as expressed in terms of alkali solubility and 30% index, at and below pH 7.

Alkali solubility in this table denotes the amount of wool on a percentage basis dissolved by 0.1N sodium hydroxide under standard conditions of time and temperature. The 30% index is a measure of fiber damage as interpreted from the stress-strain curves of individual wool fibers; a 30% index of from 95 to 100 means that there has been no substantial change in the stress-strain properties due to the treatment, while a value below 95 implies fiber modification, the damage increasing as the 30% index decreases.

The following detailed examples will illustrate the application of the method and the results obtained:

Example 1

100 pounds of woolen goods were wetted out in a solution of 3 pounds sodium bicarbonate and 3 pounds sodium tetraborate in 360 gallons of water. This provided a solution buffered at pH 8.5. Seven pounds of calcium hypochlorite (containing 70% available chlorine) dissolved in 21 gallons of water were added over a period of 20 minutes whereupon the batch was allowed to soak an additional 30 minutes until the chlorine had been substantially completely reacted. A reduction in shrinkage, area basis, of from 20% untreated) to 1% (treated) resulted.

Example 2

100 pounds of wool yarn in package form were wetted out in a solution of 3 pounds of sodium bicarbonate and 3 pounds sodium tetraborate in 72 gallons of water. This provided a solution buffered at pH 8.5. After a 10 minute soak, sufficient sodium hypochlorite was added to provide 7 pounds of available cholrine. The sodium hypochlorite was added evenly over a period of 20 minutes. A soaking time of 20 minutes was provided at the end of which substantially all of the chlorine had been reacted. Then 1 pound sodium bisulphite was added and an additional soaking time of 10 minutes allowed. This yarn was finished conventionally and knitted into sweater fabric. A reduction in shrinkage of the fabric, area basis, of from 58% (untreated) to 24% (treated) was achieved.

Example 3

100 pounds of goods containing 50% wool were wetted out in a solution containing 1½ pounds

sodium bicarbonate and 1½ pounds sodium tetraborate. This solution provided a control of pH at 8.7. After a 10 minute soak, 3½ pounds of calcium hypochlorite (containing 70% available chlorine), dissolved in 10 gallons of water were added evenly over a period of 10 minutes with provision of an additional 20 minutes soaking time. Then ¾ pound of sodium bisulphite was added and an additional soaking time of 10 minutes allowed. The thus treated material was then processed into finished goods in a conventional manner and tested for resistance to shrinkage. A reduction in shrinkage, area basis, of from 23% (untreated) to 4% (treated) was attained.

The area loss determination in the above examples was made after the samples were subjected to washing tests in a standard commercial laundry wheel, 24" in diameter x 20" long, running at 30 to 32 R. P. M. and reversing every 5 revolutions; enough water containing 0.2 sodium carbonate was used to keep the level 2" above the bottom of the inside cylinder; enough soap was added to give a running suds (that is, a suds coming halfway up the cylinder). Four pounds of the material were washed for two hours at 140° F., given two 5 minute rinses at 120° F., centrifuged, and dried at room temperature. Such a test is equivalent to 10 ordinary washings in mobile field laundries of the U. S. Army type.

Repeated tests on a large variety of woolen materials demonstrated conclusively that the optimum result of maximum resistance to shrinkage with minimum chemical damage is obtainable only within the specified range of pH and that within this range, better reaction control with uniformity of treatment are had as evidenced by uniform response to dyeing and complete absence of tendering.

While the foregoing examples illustrate specific applications of the principle of our invention, they are not to be taken as a limitation of the scope of our invention to the particular methods set forth therein. Modifications and additional examples will be readily apparent to the expert as the result of our disclosure. We thus intend to claim our invention broadly and to be limited only by the appended claims.

We claim:

1. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a hypochlorite solution and a buffer system comprising borax, said solution having a hydrogen ion concentration of between pH 8.0 and pH 9.0.

2. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a hypochlorite solution and a buffer system comprising borax, said solution having a hydrogen ion concentration of about pH 8.5.

3. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising a calcium hypohalite, said hypohalite being selected from the group consisting of calcium hypochlorite and calcium hypobromite, and a buffer salt system comprising borax, said solution having a hydrogen ion concentration of between pH 8.0 and pH 9.0.

4. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising a calcium hypohalite, said hypohalite being selected from the group consisting of calcium hypochlorite and calcium hypobromite, and a buffer salt system comprising borax, said solution having a hydrogen ion concentration of about pH 8.5.

5. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising a calcium hypohalite, said hypohalite being selected from the group consisting of calcium hypochlorite and calcium hypobromite, and plurality of buffer salts, one of said buffer salts being borax and another of said buffer salts being a bicarbonate, said buffered solution having a hydrogen ion concentration between pH 8.0 and pH 9.0.

6. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising a calcium hypohalite, said hypohalite being selected from the group consisting of calcium hypochlorite and calcium hypobromite, and a plurality of buffer salts, one of said buffer salts being borax and another of said buffer salts being a bicarbonate, said buffered solution having a hydrogen ion concentration of about pH 8.5.

7. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising calcium hypochlorite and a buffer salt system comprising a bicarbonate and borax, said solution having a hydrogen ion concentration of between pH 8.0 and pH 9.0.

8. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising calcium hypochlorite and a buffer salt system comprising a bicarbonate and borax, said solution having a hydrogen ion concentration of about pH 8.5.

9. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising calcium hypobromite and a buffer salt system, comprising a bicarbonate and borax, said solution having a hydrogen ion concentration of between pH 8.0 and pH 9.0.

10. A process for imparting shrinkage resistance to wool and fabrics comprising wool, said process comprising: treating said material with a solution comprising calcium hypobromite and a buffer salt system comprising a bicarbonate and borax, said solution having a hydrogen ion concentration of about pH 8.5.

11. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising calcium hypochlorite and a buffer salt system, comprising sodium bicarbonate and borax, said solution having a hydrogen ion concentration of between pH 8.0 and pH 9.0.

12. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising calcium hypochlorite and a buffer salt system, comprising sodium bicarbonate and borax in substantially equal proportions by weight, said solution having a hydrogen ion concentration of from about pH 8.5 to about pH 8.7.

13. A process for imparting shrinkage resistance to wool and to fabrics comprising wool, said process comprising: treating said material with a solution comprising sodium hypochlorite and a buffer salt system, comprising sodium bicar-

bonate and borax in substantially equal proportions by weight, said solution having a hydrogen ion concentration of about pH 8.5.

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