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[54] **DRY CLEANING COMPOSITION AND PROCESS**

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[51] **Int. Cl.** **D06l 1/00**

[58] **Field of Search** ..... 252/170, 171; 8/142; 134/34; 195/63, 68, 63 P

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[57] **ABSTRACT**

Improved removal of stains of animal or vegetable origin from fabrics by a dry cleaning process is obtained when the dry cleaning solvent contains small amounts of water and one or more enzymes. Proteolytic enzymes such as trypsin are of particular interest.

9 Claims, No Drawings

DRY CLEANING COMPOSITION AND PROCESS

BACKGROUND OF THE INVENTION

The present invention relates to a novel dry cleaning solvent composition and to an improved dry cleaning process whereby certain organic stains are effectively removed from fabrics by that solvent composition.

Clothes, draperies, and other such articles made of textile fabrics are usually cleaned by one of two methods, that is, by laundering with water and soap or other detergent or by dry cleaning with an organic solvent which may also contain a detergent. One or both of these methods usually cleans soiled cloth effectively although certain kinds of stains are very difficult to remove completely and may require strenuous scrubbing or treatment with strong chemicals, either of which may damage the structure or color of the cloth irreparably. Particularly resistant stains are those of animal or vegetable origin such as blood, food, and grass stains.

Enzyme — assisted desizing of fabrics is known. Amylase or a similar enzyme is used in water solution to attack the sizing which is usually starch. The process is sometimes used in the presence of a chlorinated solvent which aids in oil and wax removal, but the solvent is ordinarily used in limited proportions.

In recent years, enzymes, particularly proteolytic enzymes such as trypsin, have been added to laundry detergents to facilitate the removal of such stains from cloth by washing in water. As is well known, enzymes function in this kind of cleaning process by a kind of lytic action whereby the complex molecular structure of the organic material composing these stains is broken down or hydrolyzed by the enzyme and the resulting fragments are then more easily washed out of the cloth. However, even with an enzyme-fortified detergent, aqueous washing is sometimes only partially effective. Furthermore, some articles cannot be laundered and must be dry cleaned. Heretofore, it had been assumed that enzymes would not function effectively in the organic solvent environment of a dry cleaning process.

SUMMARY OF THE INVENTION

It has now been found that an organic dry cleaning solvent containing a minor proportion of water and a lytic amount of at least one enzyme not only maintains the enzyme component in an active state, but also allows the enzyme to function in a fully effective manner when used in an otherwise conventional dry cleaning process. Soiled fabrics, particularly those stained with matter of animal or vegetable origin as previously described, are more effectively cleaned with such a solvent composition than with known dry cleaning solvent compositions and in many cases, are better cleaned than by laundering with an enzyme-fortified detergent. Preferably, a detergent is also used in the dry cleaning process, either combined with the enzyme-containing solvent or in a separate solvent bath.

DETAILED DESCRIPTION

The quantity of water in the enzyme-containing solvent is not critical so long as there is a significant amount present. Ordinarily, a minimum amount of about 0.5 percent based on the weight of solvent is required. About 1–5 percent of water is preferred and 1–3 percent is most preferred. More water can be used,

the upper limit depending upon the dry cleaning process used and the type of fabric being cleaned.

The proportion of enzyme in the cleaning composition is preferably about 25–500 parts per million based on the weight of solvent with a proportion of 50–200 ppm being most preferred. More enzyme can of course be used by the improvement in results thereby obtained does not ordinarily justify the additional cost.

Enzymes suitable for use in the solvent composition can be substantially any amylase, esterase, or proteolytic enzyme with the latter type generally most useful. Amylases, which break down carbohydrates such as starch and sugar, include alpha and beta amylase, amyloglucosidase and invertase. Esterases attack fats and other such substances having ester linkages and some typical examples are the lipases, tannase, and pectinesterase. Most advantageous in a dry cleaning process are the proteolytic enzymes which attack organic stains such as those from blood, lymph, food, grass and the like which are resistant to conventional dry cleaning. These enzymes include pepsin, trypsin, papain, ficin, rennin, chymotrypsin, bromelin, and pancreatin.

Any dry cleaning solvent can be employed in the present invention, that is, either the hydrocarbon type or the halogenated hydrocarbon type of solvent. Examples of the first class include the aliphatic hydrocarbons such as stoddard solvent, naphtha and gasoline and the aromatic hydrocarbons such as benzene, toluene, and xylene. Halogenated hydrocarbon dry cleaning solvents include the common chlorinated aliphatic hydrocarbons such as carbon tetrachloride, ethylene dichloride, methylene chloride, methyl chlorofrom, dichloroethylene, trichloroethylene, and perchloroethylene. Also included in this class are analogous fluorinated compounds such as trichlorofluoromethane, 1,1,2-trichloro-1,2,2-trifluoroethane, and 1,1,2,2-tetrachloro-1,2-difluoroethane.

The dry cleaning solvent composition can be a mixture of solvent, water and enzyme of the nature and proportions described above or it can also include one or more dry cleaning additives such as detergents, fabric softeners, insecticides, and water and insect repellents. A detergent component of one or more of the commonly known detergents used in dry cleaning processes is desirably included in a process using the present invention, since, as previously disclosed, the enzyme additive acts by splitting the complex molecules in an organic stain into smaller molecular fragments which are then more easily removed from the soiled fabric by the action of a detergent. The detergent can be included in the solvent composition with the enzyme or, preferably, it is contained in a subsequent solvent bath used to finish the cleaning process. The quantity and nature of the detergent used, of course, will be determined in each case by the kinds of garments cleaned and the type of cleaning apparatus used.

The solvent composition may advantageously also contain a buffering agent since each enzyme has an optimum pH range where its activity is highest. For example, trypsin is most active at about pH 7.4–8.2 whereas pepsin shows best activity at about pH 1.5–3 and malt amylase is most effective at about pH 4.5–6.5. Similarly, particular enzymes have optimum temperature ranges where their activity is highest. Trypsin and pepsin, for example, are most effective at about 40° C. while malt amylase has an optimum temperature of about 65°–70° C. Therefore, the solvent composition is

buffered as needed and used at a preferred temperature, usually ambient temperature or somewhat above that level, for example, about 20°–70° C., according to the particular enzyme or enzymes which are present.

The dry cleaning process comprises contacting a fabric containing organic stains with a solvent-enzyme composition as defined above under the temperature and pH conditions suitable for the enzyme used as described as a first step, then contacting the treated fabric with at least one and preferably two or three baths of a conventional dry cleaning solvent-detergent composition as subsequent steps. The enzyme-solvent treating step constitutes, therefore, a preliminary step added to what is otherwise a conventional dry cleaning process.

EXAMPLE 1

Four inch square swatches of cotton and cotton-polyester blend fabrics were spotted with about 0.75 inch diameter spots of human blood. After these had dried, they were subjected to a three stage cleaning process in 400 ml. beakers using a magnetic stirring bar for agitation. The compositions of the three cleaning baths and duration of the cleaning stages were as follows, quantities being listed in weight percent:

	Stage 1	Stage 2	Stage 3
Time, minutes	30	10	5
Perchloroethylene	98	98	99
0.1 Phosphate buffer*	2	1	0
Detergent	0	1% Sanitone**	1% Sanitone**
Trypsin	100 ppm	0	0

* 0.157 g. KH_2PO_4 + 1.575 g. Na_2HPO_4 in 100 ml. H_2O, adjusted to pH 7.6.

** Sanitone is the trademark for a mixture of sulfonated mineral oils containing methoxychlor.

All swatches were satisfactorily cleaned by the above procedure with no visible spots remaining. When similar blood-spotted swatches were cleaned in the same way except for omission of trypsin from the first stage bath, only partial removal of the blood spots was obtained. Similarly, conventional laundering using a detergent plus trypsin failed to remove the dried blood spots completely.

EXAMPLES 2–7

In tests carried out as described above using bromelin, ficin, papain, pancreatin, pepsin, protease, and proteinase respectively as the enzyme components, blood-spotted swatches were also cleaned although these enzymes were somewhat less effective than trypsin under the conditions of the experiments.

EXAMPLE 8

A similar test was made on cloth stained by sucrose syrup using a perchloroethylene composition containing invertase as the enzyme component. The perchloroethylene composition contained 2 percent by weight of water and 100 ppm of enzyme but no buffer. Except for the absence of a buffer and the shortening of the total wash time to 10 minutes, the test was run as described in Example 1. The syrup stain was effectively removed from the cloth by this treatment.

EXAMPLE 9

A simulated industrial dry cleaning procedure using a four bath system was carried out with a mixture of three classes of soiled garments from a hospital. These garments, mostly of cotton or cotton-polyester blend fabrics, consisted of (1) 14 garments having fresh, localized stains of blood, food, ink, and shoe polish, (2) 7 garments similarly stained which had been prespotted and processed through conventional dry cleaning, and (3) 38 throw away garments added primarily to add bulk. Many of the latter class were burned in places or otherwise stained too badly to be recoverable.

These garments were cleaned in an industrial dry cleaning machine using four cleaning stages at about room temperature with solvent baths as described below.

	Stage 1	Stage 2	Stage 3	Stage 4
Time, minutes	40	5	5	3
Perchloro- Perchloro—ethylene	60 gal.	60 gal.	60 gal.	60 gal.
Buffer	150 ppm $NaHCO_3$			
Detergent	ca. 40 lb.[1]	1 lb.[2]	ca. 40 lb.[1]	1 lb.[2]
Water	4 gal.	1 gal.		
Trypsin	100 ppm			

[1]mixed nonylphenol adduct of 4 moles ethylene oxide and the sodium salt of its phosphate ester plus some sodium phosphate as described in U.S. 3,482,928.

[2]petroleum sulfonate

After the above cleaning process and a drying cycle at the end, the cleaned garments were sorted out according to class and those in each class were inspected to determine the effectiveness of the process. The garments were graded as acceptable when satisfactorily cleaned for reuse with essentially all spots and stains removed, as questionable when fairly well cleaned but with some stains still showing, and as unacceptable for further use. The results are listed below.

Summary of Stain Removal

	Acceptable	Questionable	Unacceptable
1. Fresh Stains	10	4	0
2. Old Stains	4	0	3
3. Throwaway	4	13	21
Total No.	18	17	24
% of Total	30.1	28.4	41.5

It is seen that most of the garments containing fresh or old stains were satisfactorily cleaned, none of the freshly stained garments was rated "unacceptable," and almost half of the throwaway garments were cleaned well enough for some further use. As nearly as could be determined, all of the fresh blood and food stains were completely removed as well as some of the old protein stains. Ink and shoe polish stains were not substantially affected but some other stains were visibly lightened. Normal recovery of similar mixed soiled garments by conventional dry cleaning is about 10–15 percent whereas the above process showed a 30–58 percent recovery, depending upon the number of garments rated "questionable" which were ultimately judged satisfactory for reuse.

Results similar to those shown in the above examples are obtained when the dry cleaning solvent employed is stoddard solvent, trichloroethylene, methyl chloroform, or other known dry cleaning solvent as previously indicated. Similarly, the enzyme component can be another proteolytic enzyme such as pepsin or papain or a mixture of proteolytic and other classes of enzymes such as pancreatin. For particular dry cleaning problems, where fat and carbohydrate stains predominate, esterase or amylase enzymes are preferably the primary enzyme components.

We claim:

1. A process for dry cleaning fabrics soiled by organic stains which comprises contacting said fabrics with an organic dry cleaning solvent containing about 0.5–5 percent by weight of water and a lytic amount of at least one enzyme selected from the group consisting of an amylase, an esterase, and a proteolytic enzyme for a time sufficient to obtain substantial lytic action by said enzyme on said stains.

2. The process of claim 1 wherein the solvent is a chlorinated lower aliphatic hydrocarbon.

3. The process of claim 2 wherein the enzyme in the solvent composition is a proteolytic enzyme.

4. The process of claim 3 wherein the enzyme is essentially trypsin.

5. The process of claim 1 wherein the enzyme component is present in a quantity of 25–500 parts per million based on the weight of solvent.

6. The process of claim 1 wherein the solvent also contains about 0.1–5 percent of detergent based on the weight of solvent.

7. The process of claim 2 wherein the chlorinated hydrocarbon is perchloroethylene.

8. The process of claim 4 wherein the aqueous phase is maintained at about pH 7.4–8.2 by the presence of a dissolved buffer.

9. A dry cleaning process wherein a fabric treated by the process of claim 1 is subsequently contacted with from one to three baths of a dry cleaning solvent-detergent composition containing no enzyme.

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