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WETTABLE MATERIAL

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The present invention relates to the treatment of cotton, wool, linen, silk or other fibres for the purpose of making such fibres, whether separate or organized for example as felts, threads or fabrics, wettable by water, or to increase their wettability, so that aggregations of said fibres, or fabrics made therefrom, have the property of absorbing water. The invention also relates to the product of such treatment.

10 The phenomenon of absorption of water by a fabric or an aggregation of fibres, which we have herein for convenience termed "capillary absorbency", involves the absorption and retention of water or water-like fluids between constituent
15 fibres. This in turn involves wetting of the external surfaces of the fibres.

Fibrous bodies which lack the property of capillary absorbency are characterized by low wettability of the surfaces of constituent fibres.
20 By this invention the property of capillary absorbency may be imparted to fibrous bodies by treating the surfaces of constituent fibres so as to make them readily wet by water.

While, as just stated, the treatment is applicable to many other fibres, for illustrative purposes it will be described in connection with its application to cotton.

The water-wettability of a substance may be defined in terms of its wetting angle,—that is,
30 the angle formed at the juncture of the water with the surface of the material. If this angle is less than 90 degrees, water will in general tend to spread over the surface; if this angle is greater than 90 degrees, water will tend to retreat from
35 the material and collect into drops on the surface.

Although the pure cellulose constituent of cotton fibres is freely wettable by water, as cotton occurs in nature the cellulose contains or is coated
40 with natural waxes, oils, pectins, etc. These materials, in the form in which they occur on natural fibres, are substantially non-wettable by water and their presence imparts to the raw cotton fibre as a whole the property of being substantially non-wettable by water. Similar or
45 other non-water wettable materials appear on raw wool, silk, etc.

These non-wettable constituents may be removed, for example from cotton fibre, or at least
50 reduced in amount to such an extent that they no longer have any perceptible influence upon wettability of the fibre, by conventional boiling and bleaching treatments, involving cooking with caustic alkali, soaps and other preparations.
55 The conventional boil and bleach result in a loss

in weight and also a loss in the strength of the raw material and a change in its character, the boiled and bleached material being less springy and more prone to mat down than the raw fibre. Another effect of the conventional boil and bleach is the creation of a harsh and frequently undesirable feel, due to the removal or substantial reduction in the natural waxes, oils, etc. which provide lubrication in the natural fibres.

We have discovered that cotton and other
10 fibres and materials may be made water wettable and absorbent, without removing the waxes, oils, etc., by a surface treatment of the fibre. The novel product resulting from our treatment is adapted to a wide variety of uses, including use
15 as an absorbent material in sanitary pads or surgical dressings, as a wiping cloth, etc. Among various other uses, our treatment may, for example, be advantageously applied to the fabric disclosed and claimed in the co-pending
20 application of H. A. Secrist, Ser. No. 60,220, filed January 22, 1936, now Patent No. 2,081,370, dated May 25, 1937.

Our treatment may be so carried out that, while the wettability of the fibres in the dry state
25 is greatly increased, their natural appearance and "feel" are not perceptibly changed. Due to the fact that the natural springiness of the fibre may be retained through our treatment, it is possible to make a more fluffy, absorbent material with larger capacity to hold water for a
30 given weight of fibre.

In such materials as sanitary pads, surgical dressings, wiping cloths, mops, etc., the utility of the product lies in its ability to absorb and
35 retain water and water-like fluids. In this absorption the water or water-like fluids are retained between the fibres, where they are held by capillary forces due to the relatively high water wettability of the surfaces of the fibres. The
40 greater the water wettability of the surfaces of the fibres, and the greater the total air space (within the limits of capillarity) between the fibres, the greater will be the capacity of the material for absorbing water and water-like materials.
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A further advantage of our novel product is that the natural springiness and softness of the material is retained, inasmuch as the natural lubricating materials, already referred to, are
50 not removed.

In accordance with our invention, non-wettable fibres may be made water wettable, and fibres of low wettability may have their wettability increased to a substantial extent, by applying over
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surfaces of the fibres a film or coating of a material which will form an interface between the natural non-wettable or difficultly wettable coating on the fibre, and water, and present a surface wettable by water.

In selecting the material for this film or coating, certain principles should be borne in mind. Whether a liquid will wet or spread over a solid surface to form a continuous film, or whether it will tend to collect into drops, is determined by the chemical nature of the liquid and solid involved. A liquid will spread if its work of surface cohesion is less, and will not spread if its work of surface cohesion is greater than, the work of surface adhesion with respect to the solid. In other words, if the attraction of the liquid for the solid is greater than the attraction of the liquid for itself, the liquid will spread over the solid. In this connection substances (or surfaces) are classified as polar or non-polar, water being one of the most polar of liquids and hydrocarbons such as paraffin, benzene and petroleum ether the least polar. It has been found that while the introduction of polar groups such as the sulphonic (HSO_3), amino (NH_2), carboxylate (COOH), hydroxy (OH) or chloride (Cl) into a non-polar liquid only increases the surface cohesion of such liquid by a small amount, the application of such groups over a solid surface increases the adhesion of the surface to water very markedly, and hence facilitates wetting and spreading of water over the surface so treated.

Because of this attraction for water, these groups also increase the solubility of non-polar compounds in water when they are substituted in the molecule of such compounds. If the coating substance is too soluble in water, it will tend to go into solution in the water, rather than adhering to the surface of the fibre and promoting wettability thereof. In this connection, while in certain instances and for certain uses it may be immaterial whether the water wettable coating is removed from the fibre when the product is wetted by water, through solution of the coating in such water, in many instances this is undesirable because repeated use of the material is required. When this property of repeated wettability is desired, one should select substances which not only have polar groups to permit wetting by water, but also resist going into solution in water and tend to remain attached to the surface of the fibre. Such substances may be sparingly soluble in water, or have at least a slightly greater affinity for the hydrophobic surface of the material to be treated than for water, or may form such closely-packed or coherent films that the wetting of the material or fibrous mass only slowly dissolves or removes the wettable film.

One means of accomplishing this objective of repeated wettability is to select a coating material which has a large hydrocarbon residue in the molecule, coupled with a highly polar solubilizing group, the net properties being determined by the relative effects of these two components. Substances, the molecule of which contains a chain of a considerable number of carbon atoms, say ten or more, at one end of the structure, and a polar group at the other end, are advantageous. Organic chain compounds, the molecules of which do not have side chains except at the end of the molecules, are preferred for many uses. Organic compounds having a ring structure of carbon atoms, and containing a hydrophilic group, may also be used, however.

Molecules of this sort are believed to tend to orient themselves, for instance on the surfaces of fibres to which they are applied, so that the hydrophobic end of the molecule is in contact with the hydrophobic content of the fibres, while the hydrophilic end remains free to present a wettable surface.

Among specific examples of coating materials suitable for use in our process, mention may be made of sulphated or sulphonated fatty alcohols, condensation products of fatty acids, substituted fatty acids, substituted alcohols, alkylated naphthalene sulphonic acids, sulphonated fatty oils, sulphonated fatty acids, and soaps.

Sulphonated compounds having a long chain of carbon atoms in the molecule have been found particularly well adapted to our purpose.

Many suitable substances for use as coating materials are found in the group of commercial wetting agents. It should be borne in mind, however, that since the object is so to treat solid surfaces that they will be wettable even after drying, rather than to decrease the surface cohesion of a liquid, not all wetting agents are suitable for our purpose, and in selecting a coating material, the considerations above discussed should be borne in mind.

In selecting a coating material, the nature and composition of the fibre treated,—whether cotton, wool, silk or other material, whether dyed, etc.,—should also be considered.

The coating material may be applied to the fabric from a solution, for example a solution in water, or alcohol, or water and alcohol, or other solvent, preferably a solvent which tends to have a greater attraction for the hydrophilic end of the molecule than for the hydrophobic end. The most advantageous concentration of the solution will depend on the wetting agent used and on the density of the material treated, lower concentrations of solution being usable with higher count materials. Although preferred coating materials are soluble in aqueous mixtures, it is not necessary that the coating material be so soluble. The coating may be applied as a vapor or a spray, or even as a solid, in which last case the application will preferably be followed by heating to spread the coating. The important consideration in applying the coating is that, when in the oriented state upon the surface of the fibre, this material shall present a water wettable surface.

In applying the film or coating to the fibres in our process, it should be borne in mind that the large amount of water held by cotton or other cloth or fibrous masses is held between the fibres, threads or layers of cloth, depending upon the way in which the absorbent structure is built up. It is our object to apply the coating material in such manner and in such amount to surfaces of the fibres that the fibres will be externally water wettable, as distinguished from water entering into the structure of the fibre itself.

As stated above, one method of defining the water-wettability of a substance is in terms of its wetting angle. A more convenient test is to observe the time required for a small pad of the material to sink beneath the surface of a body of water, under standard conditions. In this test, one-half square yard of the material to be tested is folded into a pad four inches square. This pad is dropped from a height of two inches onto the surface of a body of distilled water at 25°C. , and the time required for the pad to pass through the surface of the water is noted. We have found that materials which have a sinking time greater

than two minutes are not suitable for most uses requiring wettability. Materials which after treatment sink in thirty seconds or less are preferred. We have prepared quality products which

5 sink in ten seconds or less.

The above test is based on the use of low count woven or knitted cotton materials (say up to 44 x 40 count). If applied to heavier materials, or to materials comprising substances having

10 higher specific gravity than cotton, allowance must of course be made for this.

The following is an example of one treatment which gives very satisfactory results: Gray cloth (which may be washed with soap, although this

15 step is optional) is immersed in 0.1% to 3.0% solution of sulphated or sulphonated fatty alcohol in water. The cloth, after immersion in the bath, is squeezed to the point at which it retains in the neighborhood of 100% by weight of the

20 solution, as compared with the weight of the cloth. The cloth is then dried.

This treatment results in the deposit on the cloth of the interface material in amount from 0.1% to something more than 3% of the weight

25 of the cloth. The amount actually left on the cloth may be greater than the amount calculated from the strength of the solution and the amount of solution left on the cloth after squeezing, because of selective adsorption from the solution.

30 We claim:

1. As an article of manufacture, a resilient, soft, absorbent fibrous material consisting of an

aggregation of fibres of the class consisting of natural fibres such as cotton, wool, linen and silk, which of themselves contain natural water repellent constituents to an extent rendering them

5 difficultly wettable by water, said fibres having on their surfaces a dried, adherent coating of a hydrophilic wetting agent which also includes in the molecule a hydrophobic group, said agent being present in quantity sufficient to impart to the fibrous material the property of capillary ab-

10 sorbency of water, said material having a sinking time, as herein defined, of less than two minutes.

2. As an article of manufacture, a resilient, soft, absorbent fibrous material consisting of an aggregation of fibres of the class consisting of natural

15 fibres such as cotton, wool, linen and silk, which of themselves contain natural water repellent constituents to an extent rendering them difficultly wettable by water, said fibres having on their surfaces a dried, adherent coating of a hydrophilic wetting agent which also includes in the

20 molecule a hydrophobic group, said agent being selected from the group consisting of sulphonated and sulphated compounds, the molecule of which contains a chain of at least ten carbon atoms, said agent being present in quantity sufficient to

25 render the material as a whole readily wettable by water, said material having a sinking time, as herein defined, of not more than thirty seconds.

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