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ANTIBACTERIAL TEXTILE FABRICS

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This invention relates to novel antibacterial textile
fabrics and to novel processes for preparing same.

An object of this invention is to furnish antibacterial
textile fabrics capable of substantially retaining their
antibacterial effectiveness after repeated launderings.

Another object of the present invention is to provide
the aforesaid fabrics in a technically simple and com-
mercially feasible manner.

Other objects of this invention will become apparent
from the following detailed description.

We have found that the objects of this invention may
be attained by bringing a dilute aqueous solution of the
complex salt of silver nitrate and ethylenethiourea into
contact with a textile fabric and drying the same, e.g.,
by air drying, whereby a small amount of said complex
salt is retained by said fabric.

We are aware that the incorporation of antibacterial
substances into textile fabrics in order to render the same
antibacterial has been suggested by others. The incor-
poration of substances such as quaternary ammonium
compounds, e.g., higher alkyl dimethyl benzyl ammonium
chloride; organometallic compounds; and others may be
noted. The resulting articles are, for the most, non-
durable in antibacterial effect because they, among other
things, do not resist normal laundering processes on ac-
count of the detergents, bleaching agents, or other mate-
rials commonly employed in such processes.

The complex salt formed from 4 moles of ethylene-
thiourea and 1 mol of silver nitrate useful in accordance
with this invention, and its method of preparation, are
described in the Journal of the Chemical Society (Lon-
don), 1928, page 150. The aforesaid complex salt may
be referred to as tetrakisethylenethiocarbamido-argentous
nitrate. It is a white solid, melting at 96°–97° C., solu-
ble in water, very slightly soluble in alcohol and insoluble
in other organic solvents, in general. In aqueous media,
the aforesaid reaction product reacts with the sodium salt
of various acids, often forming water-insoluble deriva-
tives. It exhibits a bacteriostatic end point of about 20
to 50 parts per million against common gram-negative
and gram-positive organisms.

Relatively small amounts of the aforesaid complex
silver salt, hereafter referred to as A-151, are sufficient
to impart laundry-resistant, antibacterial properties to tex-
tiles. Amounts as low as about 0.02 percent to about
2.0 percent of the total dry weight of the treated fabric
have proved satisfactory. However, it is preferred to
use amounts of the order of about 0.1 percent to about
0.5 percent, on the same basis. The upper limit of the
amount of A-151 employed is determined by practical
considerations, etc. For this reason no practical ad-
vantageous results flow from the use of larger amounts
of A-151, although larger amounts in general do en-
hance the antibacterial properties of the treated fabric.

The incorporation of the predetermined amount of
A-151 into textile fabric will depend on the method em-
ployed, as is well-known to those skilled in the art. For
example, if the well-known technique referred to as
padding is employed, under conditions such that the
fabric picks up an amount of aqueous solution of A-151
equivalent to 75 percent by weight of the textile fabric
itself, we have found that solutions from about 0.026 per-

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cent to about 2.6 percent in strength, i.e., by weight of
silver product based on the total solution, yield treated
textile fabrics having about 0.02 percent to about 2.0 per-
cent by weight of reaction product on the dry treated
fabric. Similarly, following the same padding technique,
aqueous solutions of about 0.13 percent to about 0.65 per-
cent strength, on the aforesaid basis, yield treated fabrics
having from about 0.1 percent to about 0.5 percent by
weight on the dry treated fabric.

If desired, other methods known to the art may be
used to incorporate the aforesaid silver salt on the fabric.

It has been found that the advantageous results of the
present invention are obtained with textiles in general.
Thus, e.g., cotton, nylon and wool may be specifically
mentioned by way of illustration and not by way of
limitation. Fabrics made from other cellulosic, natural
or synthetic, fibers may be used, if desired.

As already noted, fabrics treated in accordance with
our invention possess laundry-resistant, antibacterial prop-
erties, in addition to the properties attributable to the
fabric itself. This resistance was found, irrespective of
the laundering agent, i.e., whether the laundering agent
was soap or synthetic detergents of various kinds. The
treated fabrics are not adversely affected by bleaching
agents, e.g., immersion in aqueous sodium hypochlorite
does not affect the color of white fabrics nor the anti-
bacterial properties of the treated fabric.

Specific uses of fabrics treated in accordance with our
invention include use in clothing items, diapers, and
hospital fabrics such as blankets, sheets, etc. Practically
speaking, fabrics treated in accordance with the present
invention are non-toxic.

The method employed to test for the antibacterial
properties against gram-positive organisms is the agar
plate method as given in Circular 198, December 1931,
of the U.S. Food and Drug Administration.

To test for activity against gram-negative organisms
and to test some practical applications of these fabrics, a
modified urease test procedure was used. This method
consisted of placing a 1 inch square of fabric on the
bottom of a 4 oz. jar, saturating the fabric with urine,
inoculating with *Proteus mirabilis* and incubating the jars
tightly capped at 37° C. A piece of pH paper suspended
from the jar cap was used as a visual means of detecting
ammonia production due to bacterial growth and periodi-
cally the jars were opened and the presence of ammonia
determined organoleptically.

The laundry conditions employed involved the im-
mersion of 5 gram samples of fabric in Erlenmeyer flasks
containing 100 ml. of a 0.2 percent solution of a deter-
gent or soap, e.g. "Fab" arylalkyl sulfonate powder
(Colgate-Palmolive) in water at 45° C., and agitating
the flasks for 12 minutes on a rotary shaker (New Brun-
swick Scientific Co.). The laundered fabrics were rinsed
by agitating in 100 ml. of hot water (45° C.) three
times.

In order more fully to explain our invention, we give
the following examples by way of illustration and not by
way of limitation.

Example 1

Following the method above described, standard 2.66
oz. of bleached, completely de-sized, mercerized cotton
sheeting (Style 405, Test Fabrics Inc.) was treated with
aqueous solutions of tetrakisethylenethiocarbamido-arg-
entous nitrate (A-151) of various strengths so that the
concentrations of material retained by the cotton sheet-
ing were 0.02%, 0.05%, 0.1%, 0.25%, 0.50%, 0.75%
and 1.0%.

The so-treated sheetings were exposed to the laundering
procedure described above and tested in accordance with
the aforementioned F.D.A. method, Circular 198.

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It was found that even the fabric with only 0.02 percent of A-151 gave a measurable zone of protection even after laundering. Fabrics with 0.05 percent of compound A-151 exhibited a wide zone of protection even after 5 launderings. Fabrics with 0.1 percent of A-151 and higher exhibited strong bactericidal properties after 15 launderings. Fabrics with 0.25 percent or more of A-151 still showed large zones of inhibition following 45 launderings.

Where the foregoing example was repeated, employing other laundering agents in place of Fab detergent, the results were substantially the same. The other agents employed were soap powder (Lever Brothers), Tide-alkylaryl sulfonate (Procter and Gamble), Lux-soap flakes (Lever Brothers), All-non-ionic detergent (Lever Brothers), and Duz-anionic detergent (Procter and Gamble).

Example II

The procedure of Example I was repeated twice, once employing nylon fabric (taffeta nylon, semi-dull staple), in place of the cotton sheeting, and the other time employing wool fabric, in place of the cotton sheeting.

The results showed that the treated nylon and wool retained their antibacterial properties after repeated launderings, but not to the same extent as in the case of cotton sheeting.

Example III

Samples of the untreated cotton sheeting used in Example I and the same cotton sheeting treated in accordance with the procedure described herein above so as to contain (a) 0.10% and (b) 0.25% of A-151 on the dry weight of the treated sheeting were exposed to the modified urease test described above.

The samples of untreated cotton sheeting showed a visual pH change after 1½ hours of incubation and a significant ammonia odor after 3 to 4 hours.

The treated samples, even after 5 launderings as aforesaid with "Fab" arylalkyl sulfonate, showed no pH change or ammonia odor throughout a 3 day incubation period. This was even true of the treated fabric containing 0.25 percent of A-151 after 15 launderings as aforesaid.

Example IV

The cotton sheeting employed in Example I was treated in accordance with the aforementioned process of this invention so as to yield a treated fabric containing 1.0 percent by weight of A-151.

Samples of the so-treated fabric were separately subjected to the aforementioned padding procedure in 1.0 percent aqueous baths of the sodium salt of various acids

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and sodium hydroxide. These after-treated fabrics as well as a sample of the untreated cotton sheeting and a sample of the cotton sheeting containing 1.0 percent of A-151 but with no "after-treatment" were subjected to the afore described laundering procedure using "Fab" arylalkyl sulfonate. The results showed that the untreated sheeting gave no protection at all and that the sheeting containing A-151, with no after-treatment, gave substantially the same antibacterial protection as was true of the after-treated fabrics, even after 15 launderings.

The sodium compounds used in the "after-treatment" were sodium benzoate, tri-sodium phosphate, sodium carbonate, mono-sodium, citrate, sodium chloride, sodium sulfate, sodium thiocyanate, sodium tripolyphosphate, sodium oleate, sodium benzenesulfinate, and sodium hydroxide.

Accordingly, wherever the context of the specifications and claims permit or require, the term "complex salt of ethylenethiourea and silver nitrate" is to include, as equivalents thereof, products made by reacting said complex salt with the aforementioned water-soluble sodium compounds as well as known equivalents thereof.

The foregoing illustrates the practice of this invention, which, however, is not to be limited thereby, but is to be construed as broadly as permissible in view of the prior art and limited solely by the appended claims.

We claim:

1. An article of manufacture comprising textile fabric having uniformly incorporated thereon the complex salt of silver nitrate and ethylenethiourea in a minor proportion sufficient to impart laundry-resistant, antibacterial properties to said textile fabric.

2. An article of manufacture in accordance with claim 1, wherein said textile fabric comprises cotton fibers.

3. An article of manufacture in accordance with claim 1, wherein said minor proportion is within the range from about 0.02 percent to about 2.0 percent, based on the total dry weight of the treated fabric.

4. An article of manufacture in accordance with claim 2, wherein said minor proportion is within the range from about 0.02 percent to about 2.0 percent, based on the total dry weight of the treated fabric.

References Cited in the file of this patent

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