United States Patent Office 3,310,459
Patented Mar. 21, 1967

3,310,459

METHOD OF FORMING A LATEX IMPREGNATED CELLULOSIC WATER-LAID WEB FOR USE AS A SURGICAL DRAPE

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No Drawing. Filed July 20, 1964, Ser. No. 383,903
7 Claims. (Cl. 162—12)

This invention is directed to a composition of matter which is suitable for use as a surgical drape. This invention also relates to a surgical drape which is prepared from an elastomer impregnated cellulosic web.

For at least 11 years, evidence has been available, (Am. J. Surg., 83: 125, 1952), that the elaborate procedure routinely followed in hospital operating rooms to drape patients, operating tables, stands, and so forth in one or more layers of sterile linen largely represents poor technique and gives an entirely false feeling of security, at least in terms of preventing the migration of bacteria. Under the present circumstances, textile drapes should be abandoned.

Moisture seems to be the crucial factor. If linen drapes become wet they become freely permeable to bacteria, no matter how many layers are applied. But it is obviously impossible to keep linen drapes dry. Even if completely dry when taken from the sterlizer, they cannot be kept that way during the course of an operation. Here other agents combine to wet the drapes—the patient's perspiration, sponges saturated with blood, saline-soaked laparotomy sponges, blood, amniotic fluid, and even saline solution dripping from the surgeon's hands after immersion in a basin. All these will seriously vitiate any barrier effect of the linen drapes. The appearance of the multiple layers of towels, sheets, and drapes may give the operating team a false feeling of security, but it might be better, actually, if there were no drapes at all and the surgeon kept his hands and instruments limited to the area of the surgically prepared field.

It would be better, that is, unless a drape material were available which would retain its bacterial screening properties no matter how wet it became.

Moisture-proof plastic sheeting might seem at first to be suitable for this purpose. Aware of the dangers posed by damp operating-room textile drapes, experimenters have attempted to expand the use of a plastic sheet from the immediate surgical field to the draping of the entire patient. But while a plastic sheet makes an ideal bacterial barrier between aseptic and unclean zones when attached to the skin with an adhesive substance, it has the unfortunate property of preventing normal sweat evaporation. At the same time, it increases the amount of sweating. Anyone who has ever worn a plastic raincoat knows how hot and uncomfortable it is apt to become after a few moments.

Other experimentation with plastic sheeting has tended to confirm the conclusion that while such material has advantages in preparation of the immediate operative field, it should be avoided as a surgical drape.

However, my invention provides the almost ideal surgical drape. It has the advantages of plastic sheeting in being completely impermeable to bacteria whether it is wet or dry. At the same time, although it prevents passage of liquids, it permits passage of air.

The drape feels and drapes very much like cloth. On the other hand, being paper-like, it is relatively inexpensive disposable. It can be sewed, dyed, or glued. It can be processed to suit any type of surgical draping need. The material used for my surgical drape, an elastomer impregnated cellulosic web, is known in the art, and may be prepared in varying ways. However, for

use as a surgical drape, it is preferred that the cellulosic web is prepared using the following method:

Cellulosic fibers are curled and twisted by a chemical treatment which comprises mercerizing a beaten pulp suspension of cellulosic fibers, separating the mercerized pulp from the mercerizing solution in such manner to obtain a suspension containing approximately 10 to 50% (preferably 20 to 25) by weight of the pulp, swelling the pulp, and either washing the pulp to a neutral pH or acidifying the pulp suspension to a pH below 7, generally not below pH 5. This suspension is then beaten and formed directly into a web.

This suspension supra can be processed into a cellulosic web on a sheet mold, or by any of the conventional paper-making procedures. The web formed is suitable for impregnation with any latex or elastomeric substance, such as styrene-butadiene rubber, since the web will have sufficient pore volume to allow uptake of at least its own weight of such impregnant.

The impregnation procedure and impregnating agents do not form a specific part of this invention. Any conventional impregnation procedure, such as mentioned in U.S. Patent No. 2,697,048 may be used. Conventional impregnating agents, such as styrene-butadiene rubber, acrylic rubbers, polyvinyl chloride latexes, and the like are suitable for usage in this invention.

The cellulosic web can also be impregnated with water repellent, or bateriocidal substances to further enhance those properties of the finished drape. Examples of water repellent substances include alkyl ketene dimers, stearato chromic chloride, chromium compexes of fluorinated hydrocarbons, chromium salts of fluorinated acids, etc. Suitable bateriocidal substances are exemplified by sodium pentachlorophenate, sodium orthophenyl phenate, dibutyl dithiocarbamate, silver oleate, etc.

The finished surgical drape made by my method possesses all the desirable qualities necessary for hospital use. These are:

(1) Soft, clothlike drape and comfortable feel.
(2) A high tear strength.
(3) Non-water absorbent.
(4) Light-weight and porous enabling patient to breathe.
(5) Readily burnable, but not so burnable as to present dangerous flashing tendencies.
(6) Non-toxic.
(7) Able to retain dyes.
(8) Resistant to pilling and abrasion, so no lint contaminates the surgical wound.

This invention is further described by, but not limited to the following examples.

Example 1

Ten grams of Oulu Polaris Rex pulp (a commercially available unbeaten softwood pulp) was beaten in 600 ml. of water in a Waring Blendor for eight minutes until it had a Canadian Standard Freeness (CSF) of 475 ml. It was collected in a wet mat, immersed in 12% aqueous sodium hydroxide solution at 25° C. for one minute, and pressed free of excess liquor in a sintered glass funnel to provide a suspension containing approximately 20% by weight of pulp. It was then immersed immediately in a liter of water at 90° C. and stirred until all the pulp was dispersed. The pulp was collected, washed free of alkali with cold water, then beaten again for 22 minutes (to a CSF of 750 ml.). Two grams of the treated pulp (dry basis) was made into a sheet of paper on a 7¾ inch circular sheet mold, dried in the air, and impregnated with half of its own weight of a styrene/butadiene rubber, having a weight ratio of 25:75 of styrene/butadiene.

The resulting web was 13 mils thick, had a starting tear

strength of 7.4 lbs. and was very porous and soft. Water poured on the drape beaded on the surface, and did not wet the drape or soak through it, even after 7–8 hours. It burned in an incinerator, but no spark hazard has been noted from it. The drape is non-toxic, and took standard print and dryes easily without any significant dye loss when wet. The surgical drape is also completely impervious to bacterial passage.

Example 2

Procedure, equipment, and reagents in Example 1 were used, except that beating time before mercerization to a CSF of 560 ml. was 4 minutes, and beating time after mercerization to a CSF of 750 ml. was 11 minutes. Physical properties of the finished drape were the same as in Example 1, except that the starting tear strength was 5.4 lbs.

Example 3

Ten grams of bleached Dryden (a softwood kraft pulp) were beaten in 600 ml. of water in a Waring Blendor for five minutes until a Canadian Standard Freeness of 537 ml. was reached. The pulp was collected in a wet mat, and immersed in about 600 ml. of a 12% aqueous sodium hydroxide solution at 15° C. for one minute. The alkaline pulp suspension was then added to an equal volume of water at 95° C. After the addition, the temperature of the suspension dropped to 55° C. and external heat was applied to bring the temperature to 80° C. The suspension was then pressed free of excess liquid on a sintered glass filter, and collected. The pulp was then washed free of alkali with cold water to a pH of about 7.5, then beaten for two minutes to a Canadian Standard Freeness of 790 ml. Two grams of the treated pulp (dry basis) was made into a sheet of paper on a 7¾ inch circular sheet mold, dried in the air, and impregnated with half of its weight with a styrene/butadiene rubber, having a weight ratio of 25:75, styrene/butadiene.

The resulting web was 17 mils thick, had a starting tear strength of 8.8 lbs. and was very porous and soft, possessing the same desirable surgical qualities as did the drape made in Example 1.

The preferred embodiments of my invention are as follows:

Mercerization conditions which have been found to be especially suitable are an aqueous solution of sodium hydroxide of from 2 to 20 weight percent concentration and a temperature of from 0 to 50° C. It is preferable that the mercerization be instantaneous, but it can be conducted for a longer period of time if desired. It has also been found to be advantageous to the mercerization process if the cellulosic fibers are beaten very thoroughly in a suitable apparatus prior to mercerization, as well as after.

The fibers may be thoroughly beaten in any of the commercial devices such as a Ball mill, Jordan or Hollander mill or in laboratory apparatus such as a Waring Blendor. The length of beating, will vary depending upon the efficiency of the apparatus. In general, this time will be in the range of from 2 to 30 minutes prior to mercerization to a Canadian Standard Freeness of 400–600 ml. and for about 2–30 minutes, after mercerization to a Canadian Standard Freeness of 650–800 ml. It is well known in the art that beating time required to reach a CSF value is strongly dependent on the type of fiber used, and also that paper pulp after mercerization is quite resistent to beating. Therefore, beating time of fibers other than those illustrated should be adjusted to give CSF values of 400–600 before mercerization and a CSF of 650–800 after mercerization.

When the mercerized pulp is separated from the mercerizing solution, the pulp retains a considerable amount of the mercerizing solution. In order to remove undesirable impurities, such as lignin which is dissolved in the alkaline liquor, it is advantageous that the pulp be as dry as possible. However, the pulp cannot be permitted to become completely dry as the mercerizing solution (sodium hydroxide) which has been absorbed into the pulp will tend to carbonate the pulp. To preclude this carbonation, the pulp is retained as a suspension in the mercerizing solution containing approximately 20 to 50%, preferably 20 to 25% by weight of the pulp. The separation of the pulp from the mercerizing solution is by mechanical separation, such as centrifugation, filtration, or by running on a paper machine.

The swelling of the cellulosic fibers is performed by adding suspension of pulp in the mercerizing solution to a stirred vessel containing hot water or a suitable dilute, water soluble acid, such as acetic acid. When water is the swelling medium, the temperature may be from 60 to 100° C., preferably 90 to 100° C., and the treatment time can range from 5 minutes to 1 hour. The final pH of the pulp suspension is 6–8. If the swelling medium is a dilute acid, the temperature should be in the range of from 0 to 40° C. The treatment time should again be in the range of from 5 minutes to 1 hour. The concentration of the dilute acid should be in the range of from about 1 to 40 weight percent since a more concentrated acid will produce hydrolysis of the cellulose. It is to be understood that any dilute, water soluble acid may be used as the swelling medium. Examples of such acids are: oxalic, sulfuric, hydrochloric, nitric, acetic, etc. Final pH of the swollen pulp is 5–7.

Care must be taken that the swollen pulp suspension must not be alkaline in nature if the resulting web is to have the improved physical properties. If the suspension is not neutral or acidic, the fibers will be hard and stiff.

At this point, the mercerized fibers are again beaten as described to a CSF of 650–800 ml.

In general, any known cellulose fiber may be used as the fiber to be subjected to the chemical treatment described above. In regard to the untreated cellulose fiber, any known cellulose fiber may be used. Illustrative examples are wood pulp, cotton, hemp, regenerated cellulose (rayon), and bamboo.

It will be seen that the inventive procedure is easily put into commercial scale operation, using 50–500 lbs. of pulp and increasing reagents proportionately.

Example 4

100 pounds of bleached Dryden (a softwood kraft pulp) were beaten in a 300 gallon stainless steel pulper in 200 gallons of water for 20 minutes to a Canadian Standard Freeness value of 500 ml. The pulp was collected in a wet mat, and immersed in a solution of NaOH. The NaOH solution had previously been made from 320 lbs. of NaOH and 2150 lbs. of water, so that when the 300 lbs. of pulp and water were added, the concentration of NaOH was 12% (weight/weight). This alkaline suspension was at a temperature of about 10–15° C. The alkaline suspension was then pumped into a 1000 gallon stainless steel tank, half full of water at 100° C. Temperature of the now diluted suspension was brought up to about 85° C., by means of external heat sources.

The pulp suspension was then run out onto a cylinder-type paper making machine, and washed on the machine until the pH of the pulp was 7.5–8.0, without sheeting out the pulp as paper. The last wash was a dilute sulfuric acid solution, to bring the final pH of the pulp to 7, substantially neutral. The pulp suspension was then returned to the 300 gallon pulper and beaten again for 7 minutes to a CSF of 770 ml. The pulp was then passed through the paper making machine, and allowed to sheet out as a continuous sheet of paper. After the paper was dried, it was impregnated with half its weight with the styrene/butadiene latex used in the other examples. The finished paper web was 15 mils thick, and had a starting tear strength of 7 lbs. The web also possessed desirable characteristics as a surgical drape.

What is claimed is:

1. The method of making a surgical drape which comprises

(a) beating a pulp suspension of cellulosic fibers for 2 to 30 minutes to a Canadian Standard Freeness of 400–600 ml.,

(b) mercerizing said pulp suspension in an aqueous solution of sodium hydroxide of from 2 to 20 weight percent concentration at a temperature of from 0 to 50° C.,

(c) separating the mercerized pulp from the mercerizating solution to obtain a suspension containing approximately 10 to 50 percent by weight of the pulp,

(d) swelling the pulp in a liquid selected from the group consisting of hot water at 60 to 100° centigrade and dilute acid of from 1 to 40 weight percent at 0 to 40° centigrade for five minutes to one hour to obtain a final pH of 5–7,

(e) washing the pulp in cold water,

(f) beating said washed pulp for 2 to 30 minutes to a Canadian Standard Freeness of 650–800 ml.,

(g) forming the treated pulp into a web,

(h) and then impregnating said web with a latex material.

2. The method of claim 1 in which the pulp suspension contains approximately 20 to 25 percent by weight of the pulp when separated from the mercerizing solution.

3. The method of claim 2 in which the separation of the mercerized pulp from the mercerizing solution is done by filtration.

4. The method of claim 2 in which the pulp is swelled in hot water at a temperature of 90° C.

5. The method of claim 2 in which the cellulosic web is impregnated with half its weight of said latex material.

6. The method of claim 5 in which the latex material is a styrene/butadiene vulcanizable copolymer.

7. The method of claim 1 in which the cellulosic fibers are softwood pulp fibers.

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