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PRODUCTION OF NON-WOVEN FIBER WEBS STABLE TO WATER

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This invention relates to new and useful improvements in the production of fiber webs stable to water.

Sheets or webs of textile-like materials composed of cardable fibers bound together at their crossing points are known. These non-woven textile webs are generally produced by treating a fleece of more or less randomly distributed fibers with a bonding agent which is subsequently set, and cementing the fibers together at their crossing points, forming a non-woven textile. The instant invention has particular reference to non-woven fiber webs produced by treatment of the fleece with an aqueous solution of a binder material containing in addition to hydroxyl groups also carboxyl groups, in the form of its water-soluble salt. These binder materials include the carboxymethylcelluloses and alginates.

The production of non-woven fiber webs is carried out industrially on a very large scale. In the main, in the known methods of production the cementing or bonding of the fibers at their crossing points mostly takes place by impregnation with binder materials, such as natural and/or synthetic vulcanizable or pre-vulcanizable rubber latexes and/or synthetic resins, such as thermoplastic or thermosetting resins or the like. Non-woven fiber webs of this type are generally deleteriously affected by agents used in commercial cleaning and also are frequently thermoplastic. Further, non-woven fiber webs so produced cannot be dyed homogeneously in that the fibers, as, for example, cellulose fibers used in forming the web and the binding agents react quite differently with respect to the dyes and the dyeing procedures.

It has already been proposed to use for the cementing of the fibers in non-woven fiber fleeces, water-soluble binding materials as, for example, starch, carboxymethylcellulose or alginates. In practice, however, this has not proved successful as the non-woven fiber webs thereby obtained are not resistant or stable to water, and on being wetted or washed the binder is washed out and the web caused to disintegrate.

Numerous attempts to improve the resistance and stability of the web to water have been proposed. According to British Patent No. 734,725 water-soluble ammonium salts of carboxymethylcellulose or of carboxyethylcellulose have been employed as binding materials for setting the fibers in the web. After the fiber web impregnated with the aforesaid agents has been dried, the temperature is raised whereby ammonia is split off and the free acid formed which, in turn, on further heat treatment is converted into the water-insoluble state. If, in place of the ammonium salt, a water-soluble alkali salt which still contains at least 50% free carboxyl groups is used, the same results are obtained. The process of the British patent results, for example, in connection with paper webs in an improvement of the strength of the paper on its being weighed. However, on exposure to

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larger quantities of water, as, for example, on washing, the strength is wholly inadequate.

It has also been proposed that the water-soluble salts of carboxymethyl or carboxyethylcellulose or of alginic acids be converted with acids or with metal salts as, for example, with aluminum salts, into the corresponding less water-soluble compounds and that these latter compounds be employed as bonding materials. However, such compounds are also unsatisfactory in that on exposure to water in the presence of the conventional alkaline washing agents, they are reconverted into the originating water-soluble alkali salts.

One object of this invention is a novel method for the preparation of non-woven fiber webs free of the above named disadvantages.

Another object of the invention is a novel non-woven fiber web characterized by its stability to water as well as to organic solvents as conventionally employed in commercial cleaning establishments.

Still a further object of the invention is a novel, non-woven fiber web characterized by its hydrophobic properties.

These and still further objects will become apparent from the following description:

These and other objects are achieved in accordance with the present invention wherein a fibrous fleece is bonded together in a manner which securely holds the fibers providing a resulting article both stable and resistant to water.

In accordance with the invention, a dry, non-woven, fiber is uniformly treated with an aqueous solution of a water-soluble bonding agent which contains, in addition to hydroxyl groups, also carboxyl groups, and thereafter the non-woven fiber web is treated with an aqueous solution of (1) a water-soluble synthetic resin capable of reaction at increased temperature and in the presence of an acid catalyst with the hydroxyl groups of the bonding agent in combination with (2) a water-soluble metal salt capable of reaction with the carboxyl groups of the bonding agent. Thereafter, the non-woven fiber web is heated to bind the fibers together primarily at their crossing points to thereby obtain by reaction of the hydroxyl groups of the bonding agent with the synthetic resin and of the carboxyl groups with the metal salt a non-woven fiber web stable and resistant to water.

It is only when using in combination with the water-soluble bonding material containing both hydroxyl and carboxyl groups a water-soluble synthetic resin capable of reacting with the hydroxyl groups and a water-soluble metal salt capable of reacting with the carboxyl groups of the bonding material is it possible to prepare a non-woven fiber web possessing the above set-forth desirable properties.

The fiber fleeces may be prepared in the conventional manner by, for example, forming a single layer fleece of intermingled fibers, or, preferably by superimposing multiple, individual, thinner webs of intermingled fibers. Individual fleece webs may be prepared by using the conventional carding roll or by flocculation, using the known suction drums. When using carded fleece, preferably multiple thin webs are superimposed at an angle with respect to the principal direction of the fibers of the individual webs to thereby obtain a multitude of

crossed points between fibers composing the aggregate fleece.

In the preparation of a multiple layer fleece, for example, 2 to about 30 or more thin webs of fibers, such as staple fibers, may be used, each component web having, for example, a thickness of 0.1 to 1.2 mm. or more and weighing, for example, about 3-35 grams or more per square meter. Examples of suitable fibers which may be used in forming the fleeces include cardable vegetable fibers, such as cotton, ramie, denatured flax, hemp, jute, animal fibers, such as wool, goats hair, camel hair or the like, synthetic fibers, such as rayon acetate, alginate, polysupra-amides such as 6 nylon, 6, 6 nylon, 6, 10 nylon, polyesters, such as polyethylene terephthalate, cellulose triacetate, higher molecular polyolefins, such as polyethylene, polypropylene, polyvinyl fibers, protein fibers and mineral fibers such as glass rock or asbestos fibers and the like.

The bonding agents may be any of the known alkali salts of carboxymethyl- or ethyl-cellulose, or of alginic acid.

In order to obtain a completely thorough impregnation of the web and thereby a good bonding of the fibers, it is preferable to employ as bonding agents those materials which in aqueous solution have a comparatively low viscosity. Particularly suitable for the purpose of the invention are the bonding agents which in the form of their aqueous 1% solutions have a viscosity of 100 cp.

As synthetic reactive resins for reaction with the hydroxyl groups of the bonding material, there may be used tetramethylacetylenediurea, dimethyloldihydroxyethyleneurea or dimethylolethyleneurea.

The metal salts which may be used are preferably those which form on hydrolysis strong salts such as, for example, aluminum formate, and which therefore serve simultaneously as the catalyst for the reaction of the reactive synthetic resins with the hydroxyl groups of the bonding agent.

The bonding agent used in accordance with the invention results in a superior cementing or binding of the fibers and, in addition, where cellulosic fibers are used in forming the fleece results in a web, the fiber material and bonding agent of which may be homogeneously dyed. This is not possible in those instances where rubber, thermosetting or thermoplastic synthetic resin bonding agents are employed.

The hydrophobic properties of the non-woven fiber web may be further improved if there is incorporated in the aqueous solution of the bonding agent, water-soluble soaps, as, for example, sodium or ammonium oleate, which thereafter are converted with, for example, aluminum formate into water-insoluble highly hydrophobic aluminum salts. The solution of bonding agent may, for example, contain, in addition to the binder materials, suitable quantities of wetting agent, softener agent, fillers, pigments, dyestuffs, anti-rot agents, fireproofing agents and the like.

When cellulosic fibers are used in forming the web in addition to the reaction of the reactive synthetic resin with the hydroxyl groups of the bonding agent, there takes place a reaction with the hydroxyl groups of the cellulosic fibers whereby a particularly good bonding is obtained and, additionally, the resistance to swelling and the resiliency of the non-woven material is improved.

The impregnation of the fiber fleeces with the solution of the bonding agent is carried out in the conventional manner and, additionally, by conversion of the solution to the form of a stable flowable foam. The impregnation may be carried out by passing the fleece sandwiched between two wire screens through an impregnation bath or by first superficially treating the web on its surface with a small quantity of the bonding agent which is dried in order to stabilize the fleece and allow the subsequent handling and thereafter forcing the bonding agent in the form of a foam through the untreated surfaces of the fleece.

The fleece is thereafter with or without prior drying subjected to treatment with an aqueous solution containing the reactive synthetic resin and alkali salt.

The reactive synthetic resin may be added to the solution of bonding agent. In the latter case it is necessary, however, that there be added to the solution consisting of bonding agent and reactive synthetic resin an acid catalyst or catalyst splitting off acid, as, for example, ammonium nitrate. Further, it is necessary that the thusly impregnated material be dried after first squeezing off excess impregnating agent and heated to between 120 and 160° C. for a period time sufficient to substantially complete the reaction between the resin and the hydroxyl groups of the bonding agent.

The quantity of reactive resin used depends entirely on the quantity of the bonding agent present and on the degree of cross-linking desired to be effected. The more reactive resin present, the more hydroxyl groups are converted.

It is preferably to incorporate into the metal salt solution more metal salt than is required for the conversion of the hydroxyl groups present since thereby it is prevented that any bonding agent which has not as yet been converted with the reactive resin go into solution, and, further, because of the excess of metal salt to obtain an improvement in the hydrophobic properties of the web.

After the impregnation, the impregnated web is treated in the conventional manner, as, for example, by passing the same through a drying chamber at a temperature and for a time sufficient to cause a setting of the binding agent.

The web, after the drying treatment, may be finished in any other desired or conventional manner, as, for example, calendered to give a specific surface finish and washed and dried.

Throughout the specification and in the claims the term "bonding agent" has been used to designate the water-soluble substance containing both hydroxyl and carboxyl groups and the term "binding agent" to designate the combination of the bonding agent, water-soluble reactive synthetic resin and water-soluble metallic salt.

I claim:

1. In the process for the production of non-woven sheet material in which a loose fiber fleece is impregnated with a binding agent and thereafter the binding agent set, bonding the fibers together at their crossing points, the improvement for imparting stability to water and hydrophobic properties to the resulting sheet material, which comprises impregnating the fleece with an aqueous solution of a bonding agent containing both hydroxyl and carboxyl groups in the molecule selected from the group consisting of water-soluble derivatives of carboxy alkyl cellulose and alginic acid, thereafter impregnating the resulting fleece with an aqueous solution of (1) a water-soluble synthetic resin capable of reacting at increased temperature and in the presence of an acid catalyst with the hydroxyl groups of the bonding agent in combination with (2) a water-soluble metal salt capable of reacting with the carboxyl groups of the bonding agent with coagulation of said bonding agent, and (3) an acid catalyst and heating to a temperature from 120 to 160° C., said synthetic resin being a member selected from the group consisting of tetramethylacetylenediurea, dimethyloldihydroxyethyleneurea, and dimethylolethyleneurea.

2. In the process for the production of non-woven sheet material in which a loose fiber fleece is impregnated with a binding agent and thereafter the binding agent set, bonding the fibers together at their crossing points, the improvement for imparting stability to water and hydrophobic properties to the sheet material, which comprises impregnating the fleece with (1) an aqueous solution consisting of a water-soluble bonding agent containing both hydroxyl and carboxyl groups in the molecule selected from the group consisting of water-soluble derivatives of carboxy alkyl, cellulose and alginic acid, in combination with (2) a water-soluble reactive thermosetting synthetic

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resin capable of reacting at increased temperatures and in the presence of an acid catalyst with the hydroxyl groups of the bonding agent with coagulation of said bonding agent, and (3) an acid catalyst, thereafter drying said fleece at a temperature of between 120 and 160° C. for a period of time sufficient to substantially complete the reaction between the reactive resin and the hydroxyl groups of the bonding agent, and thereafter impregnating the fleece thus obtained with an aqueous solution of a water-soluble metal salt capable of reacting with the carboxyl groups of the bonding agent, said synthetic resin being a member selected from the group consisting of tetramethylacetylenediurea, dimethyloldihydroxyethyleneurea, and dimethylolethyleneurea.

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