United States Patent Office

3,157,562

Patented Nov. 17, 1964

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3,157,562

BONDED NON-WOVEN FIBROUS PRODUCTS AND METHODS OF MAKING THEM

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No Drawing. Filed July 27, 1959, Ser. No. 829,492
15 Claims. (Cl. 161—170)

This invention relates to bonded non-woven fibrous or filamentous products having a carded fiber structure or comprising fibrous mats in which the fibers or filaments are distributed haphazardly or in random array. The invention also relates to methods for producing the bonded non-woven fibrous products or shaped articles therefrom. The bonded non-woven fibrous products are useful in the production of articles of either flat or three-dimensional shape, including insulating material and the like as will be described more particularly hereinafter.

Hereinafter, the expression "random array" is intended to include the array of fibers in a carded web wherein partial orientation is frequently present as well as other arrays in which the fibers are in a completely haphazard distributional relationship.

Urea-formaldehyde and melamine-formaldehyde condensates have been suggested for use as binders for the fibers in non-woven fabrics but when employed alone they produce undesirably stiff products which are unsuitable for textile use because of poor draping qualities and harsh feel or hand. In addition, the products bonded therewith cannot be employed satisfactorily in articles of dress which may need bleaching more or less frequently. Examples thereof are interliners for the collars and cuffs of shirts, especially the relatively open-weave type used for summer wear. The bleaching of such articles with the hypochlorites commonly used results in discoloration and loss of strength of the goods, especially when the bleaching is followed by heating or ironing. The application of such condensates in conjunction with certain addition polymers, such as described in United States Patent 2,823,142 produces a bonded product which initially has a soft hand and desirable draping quality. However, on dry-cleaning the product, the addition polymer is gradually removed. Consequently the soft hand and draping quality are both lost and the product, though the fibers thereof are still bonded by the thermosetting condensate, acquires a harsh hand and does not drape in a desirable fashion. Besides, the products of this patent show discoloration (yellowing) and loss of strength on bleaching.

It is an object of the present invention to provide a modified amide-containing linear addition copolymer which is capable of being applied as a binder for the fibers of non-woven fabrics and yielding products, after curing, which have sufficient resistance to washing and dry-cleaning by chlorinated hydrocarbons for most practical purposes even without the employment of a thermosetting condensate such as an aminoplast or polyepoxide in conjunction with the amide-containing polymer. Other objects and advantages of the invention will be apparent from the description thereof hereinafter.

In accordance with the present invention, it has been discovered that certain linear addition copolymers containing N-methylolamide groups and amide (—$CONH_2$) groups in certain proportions, when applied to non-woven fabrics and cured by heating at elevated temperatures, impart resistance to normal laundering operations such as may be performed with modern detergents of the type represented by Tide, All, and Fab, as well as resistance to dry-cleaning by chlorinated hydrocarbons such as carbon tetrachloride.

The linear addition copolymers of the present invention

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are water-insoluble copolymers obtained by emulsion copolymerization of a mixture of copolymerizable monoethylenically unsaturated molecules comprising (A) 0.5 to 6% by weight of N-methylolacrylamide, N-methylolmethacrylamide, or a mixture thereof which compounds may be repressented by the generic formula

$$H_2C{=}\underset{\underset{CONHCH_2OH}{|}}{C}{-}(CH_2)_{n-1}H \qquad (I)$$

in which n is an integer having a value of 1 to 2, and (B) 0.5 to 25% by weight of a monomer which contains an amide (—$CONH_2$) group coreactive with the N-methylolamide group. The copolymers should have an apparent second order transition temperature T_i, which is not over 20° C. The molecular weight may be from 100,000 to 10,000,000. The T_i value referred to herein is the transition temperature or inflection temperature which is found by plotting the modulus of rigidity against temperature. A convenient method for determining modulus of rigidity and transition temperature is described by I. Williamson, British Plastics 23, 87–90, 102 (September 1950). The T_i value here used is that determined at 300 kg./cm.^{2}.

The coreactive monomers are those which contain reactive hydrogen atoms in amide groups (—$CONH_2$), especially acrylamide and methacrylamide.

Besides the N-methylolamide and coreactive monomer, the copolymer comprises units which may be obtained from one or more of the following: acrylonitrile, styrene, vinyltoluene, vinyl acetate, and esters of the formula

$$H_2C{=}\underset{\underset{COOR}{|}}{C}{-}(CH_2)_{n-1}H \qquad (II)$$

wherein n is an integer having a value of 1 to 2 and R is an alkyl group having 1 to 18 carbon atoms. Examples of the latter esters are methyl methacrylate, butyl methacrylate, methyl acrylate, ethyl acrylate, butyl acrylate, t-octyl acrylate and methacrylate, and octadecyl acrylate and methacrylate. When monomers, such as acrylonitrile, methyl methacrylate, vinyl acetate, and styrene, which produce homopolymers having high T_i values are used, the proportion thereof in the copolymer is limited to that which will produce, with the other monomers used in the particular copolymer, such as ethyl acrylate, methyl acrylate, butyl acrylate, or octyl acrylate or methacrylate, a T_i value of 20° C. or less.

The N-methylolamide of Formula I may be used in greater amounts than the 6% upper limit mentioned and the coreactive monomer may be used in greater amounts than the 25% upper limit mentioned above, but generally the optimum results are obtained when these monomers are used in the ranges heretofore given. Higher proportions of the compound of Formula I tends to make the product excessively stiff and higher proportions of the coreactive compound tend to reduce the wash-resistance of the products. The preferred copolymers are those employing N-methylolacrylamide. In general, these copolymers are twice as efficient for a given content of the monomer of Formula I and for the same content of the coreactive monomer, other components and all conditions being the same, as the copolymers obtained from N-methylolmethacrylamide.

It is noteworthy that the application of acrylamide or methacrylamide copolymers in conjunction with free formaldehyde, other conditions being the same, does not produce products having the laundering-resistance and dry-cleaning resistance obtained with the copolymers of the present invention.

The N-methylolamide copolymers may be produced by conventional emulsion polymerization procedures employing a suitable emulsifier such as a non-ionic, cationic, or an anionic emulsifier or mixtures of a non-ionic with a cationic or an anionic emulsifier in conjunction with a

free-radical initiator which may, if desired, be a component of any of the well-known redox systems. Examples of emulsifiers that may be used include sodium lauryl sulfate, t-octylphenoxypolyethoxyethanols containing from about 10 to 50 oxyethylene units per molecule, and lauryl pyridinum chloride. The amount of emulsifier may range from about ½% to 6% on the weight of monomers. Any free-radical initiator such as azodiisobutyronitrile, t-butyl hydroperoxide, and ammonium or potassium persulfates may be employed. The proportion of initiator may be from 0.1% to 2% on the weight of monomers.

The polymers used as binders of the present invention may also be graft or block copolymers wherein one or more, but not all, of the monomers are first polymerized and then one or more other monomers are copolymerized with the first polymer obtained. Thus, methacrylamide or N-methylolacrylamide may first be homopolymerized or copolymerized with one or more, but less than all, of the comonomers to be introduced into the ultimate copolymer, and then the last monomer or monomers are added to the system and copolymerized or grafted on to the first homopolymer or copolymer formed. The same procedure may be used in reverse order to graft the methacrylamide or N-methylolacrylamide on to a previously-formed homopolymer or copolymer of other monomeric units. Again, a plurality of monomeric units may be introduced in succession and the methacrylamide or N-methylolacrylamide may be introduced at the beginning, at any intermediate stage, or at the end as desired.

The fibrous webs may be formed in any suitable manner such as by carding, garnetting, or by dry deposition from an air suspension of the fibers. The thin web or fleece obtained from a single card may be treated in accordance with the present invention, but generally it is necessary and desirable to superpose a plurality of such webs to build up the mat to sufficient thickness for the end use intended, particularly in the making of heat insulation. In building up such a mat, alternate layers of carded webs may be disposed with their fiber orientation directions disposed at 60° or 90° angles with respect to intervening layers.

The fibers from which the webs may be made include cellulosic fibers such as cotton, rayon, jute, ramie, and linen; also cellulose esters such as cellulose acetate; silk, wool, casein, and other proteinaceous fibers; polyesters such as poly-(ethylene glycol terephthalate); polyamides such as nylon; vinyl resin fibers such as the copolymer of vinyl chloride and vinyl acetate, polymers of acrylonitrile containing 70% to 95% by weight of acrylonitrile including those available under the trademarks Orlon and Acrilan; siliceous fibers such as glass and mineral wools.

The aqueous dispersion of the water-insoluble copolymer of the present invention may be applied to the web or mat of fibers in any suitable fashion such as by spraying, dipping, roll-transfer, or the like. The concentration may be from 5% to 60% by weight, and preferably from 5% to 25%, at the time of application as an aqueous dispersion.

The binder dispersion or powder may be applied to the dry fibers after the formation or deposition of the web or mat so as to penetrate partially into or completely through the interior of the fibrous products. Alternatively, the binder dispersion or powder may be applied to the fibers as they fall through the settling chamber to their point of deposition. This is advantageously obtained by spraying the binder dispersion or powder into the settling chamber at some intermediate point between the top and the bottom thereof. By so spraying the fibers as they descend to the point of collection, it is possible to effect a thorough distribution of the binder among the fibers before they are collected into the product. In the production of certain fibrous products wherein a hot molten mass of a polymer, such as nylon or a fused siliceous mass or glass, is disrupted by jets of heated air or steam, the binder dispersion or powder may be sprayed directly on the fibers while still hot and very shortly before their deposition so that quickly after deposition the binder is set and bonds the fibers in proper relationship. Preferably, however, application of the binder dispersion to the fibrous product is made at room temperature to facilitate cleaning of the apparatus associated with the application of the binder dispersion. The binder dispersion may be applied to one or both surfaces of the fibrous product or it may be distributed through the interior as well.

The binder of the present invention may be applied in conjunction with other binders, such as glue. Similarly, the use of potentially adhesive fibers within the fibrous product may also be resorted to in conjunction with the use of a binder of the present invention.

If desired, the aqeuous dispersion of the polymer and condensate may also contain a wetting agent to assist penetration of the fibrous web or mat to which it is applied, and it may contain either a foaming agent to provide the binder in a foamed condition in the final product or it may contain a defoamer when the ingredients of the aqueous dispersion have a tendency to give rise to foaming and in a particular case such foaming is undesirable. The conventional wetting agents, such as the sodium salt of dioctylsulfosuccinic acid may be used and the conventional foaming and defoaming agents may be employed, such as sodium soaps, including sodium oleate for foaming and octyl alcohol or certain silicones for defoaming.

An acid catalyst may be included in the aqueous dispersion at the time it is applied to the fibrous web or it may be applied to the fibrous web before or after the copolymer is applied. Examples of acidic catalysts that may be employed include oxalic acid, dichloroacetic acid, para-toluenesulfonic acid, and acidic salts such as ammonium sulfate and amine salts, such as the hydrochloride of 2-methyl-2-aminopropanol-1.

The proportion of the polymer that is applied to the web or mat is such as to provide 15 to 50% (or, in some cases, even up to 75%) by weight of copolymer based on the total weight of copolymer and fibers. After application of the aqueous dispersion of the water-insoluble copolymer to the fibrous web, the impregnated or saturated web is dried either at room temperature or at elevated temperatures. The web is subjected, either after completion of the drying or as the final portion of the drying stage itself, to a baking or curing operation which may be effected at a temperature of about 210° to 750° F. for periods which may range from about one-half hour at the lower temperature to as low as five seconds at the upper temperature. The conditions of baking and curing are controlled so that no appreciable deterioration or degradation of the fibers or copolymer occurs. Preferably, the curing is effected at a temperature of 260° to 325° F. for a period of 2 to 10 minutes.

It is believed that the curing operation in some way causes reaction of the polymer molecules to effect cross-linking thereof to a condition in which the binder is highly resistant to laundering and dry-cleaning. This reaction involves the N-methylol groups of some polymer molecules with the reactive hydrogen-containing groups of others of the polymer molecules. It is also believed that the curing causes some reaction between the N-methylol groups of the polymer molecules and reactive groups in the fibers such as the hydroxyl groups of the cellulose fibers While the precise nature of the reaction and the products thereby obtained are not clearly understood, it is presumed that the resistance to laundering and dry-cleaning is the result of the reaction between binder polymer molecules to cross-link them and/or the reaction between the binder polymer molecules and reactive sites of the fiber molecules. However, it is not intended to limit the invention by any theory of action herein stated.

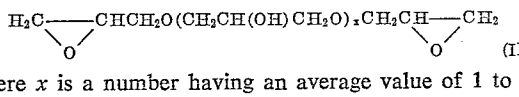
The bonded fibrous products of the present invention are characterized by softness, flexibility, resistance to discoloration on exposure to ultraviolet light, resistance to chlorinated hydrocarbon dry-cleaning fluids, and resistance

to laundering. Because of the softness and flexibility and good draping qualities of the products of the present invention, they are particularly well-adapted for use in garments where porosity, especially to moisture vapor, and soft hand and feel, make the products advantageous where contact with the skin of a wearer may be involved. In general, the products are quite stable dimensionally and have good resilience and shape-retention properties. They are adapted for use not only in garments but as padding or cushioning, and moisture-absorbing articles, such as bibs and diapers. They are also useful as heat- and sound-insulating materials and as filtration media, both for liquids and gases. They can be laminated with paper, textile fabrics, or leather to modify one or both surfaces of the latter materials. They may be adhered to films of cellophane, polyethylene, saran, polyethylene glycol terephthalate (Mylar) or metallic foils, such as of aluminum, to improve the tear strength of such films and foils, to make the latter more amenable to stitching, and to modify other characteristics including strength, toughness, stiffness, appearance, and handle.

As stated hereinabove, the products obtained from nonwoven fibrous webs employing the aqueous dispersion of the N-methylol-amide-containing copolymers of the present invention impart good resistance to laundering and dry-cleaning when applied as the sole binder and cured in the manner stated hereinabove. Such products are also free of any tendency to become discolored on chlorination and ironing. However, for some purposes, particularly where chlorination and/or ironing are not encountered, the copolymer of the present invention may be employed in conjunction with a thermosetting resin condensate such as an aminoplast or polyepoxide. The amount of such condensate that may be included in the binder compositions may be as high as 20% by weight of the copolymer, a proportion of 3% to 10% being preferred when such condensate is used.

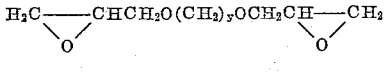
The aminoplast condensates which may be employed are the low molecular weight or monomeric reaction products of formaldehyde with urea, thiourea, biuret, or other homologs or derivatives thereof, such as N,N-ethyleneurea, N,N'-ethyleneurea, N,N'-dimethylurea, N,N'-diethylurea, N,N'-dimethoxymethylurea, N,N-dimethyoxymethylurea, N,N'-diethoxyethylurea, tetramethoxymethylurea, tetraethoxyethylurea. Similar reaction products of formaldehyde with triazines, such as melamine may also be employed, such as N,N-dimethylmelamine and alcohol-modified melamine-formaldehyde thermosetting resin condensates, e.g. of methyl and ethyl alcohols, for example, dimethoxymethylmonomethylolmelamine. preferably, the extent of condensation of these resin-forming aminoplast condensates is such that they are still soluble in water or self-dispersible therein to a colloidal condition.

The epoxy thermosetting resin-forming condensates may be either water-soluble or self-dispersible in water. The water-soluble types may be any of those having the Formulas III, IV, V, and VI:



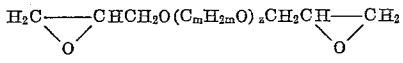
(III)

where x is a number having an average value of 1 to 3;



(IV)

where y is a number having an average value of 2 to 4; and

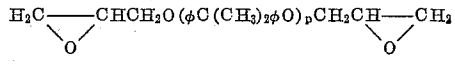


(V)

where m is an integer having a value of 2 to 4, and z is a number having an average value of 1 to 5.

The water-insoluble but self-dispersible condensates containing epoxide groups include the compounds of

Formula IV above wherein y has an average value of 5 to 10 and also compounds of formula VI:



(VI)

where ϕ is the p-phenylene group, and p is a number having an average value of 1 to 3.

While the binder may be preferentially applied, if desired, to portions of the fibrous product, such as one or both of the faces thereof, it is characteristic of the binder of the present invention that, if such preferential treatment is not desired, substantially uniform distribution may be obtained because of the reduced tendency of the binder after initial distribution throughout the body of the fibrous product to migrate to the surfaces thereof during drying.

In the examples, parts and percentages are by weight unless otherwise indicated.

Example 1

An aqueous dispersion containing 45% by weight of an emulsion copolymer of about 0.8% of acrylamide, 98% of ethyl acrylate, and 1.2% of N-methylolacrylamide was prepared by emulsion copolymerization. A carded web of viscose rayon fibers, 2 denier, 1.5 inch length, weighing about 0.5 oz./sq. yd. was padded through the polymer dispersion to provide an 125% wet pickup. After air-drying, the treated web was heated at 300° F. for five minutes. The resulting bonded web was quite flexible and soft and withstood laundering in an automatic washer employing ¼ cup of Tide in 15 gallons of water at 140° F. The fabric also withstood dry-cleaning in a cleaning fluid formed of three gallons of carbon tetrachloride, one ounce of water, and 4.5 grams of the sodium salt of dicapryl sulfosuccinate. The dry-cleaning was effected in a portable agitator type of washer for a period of 30 minutes.

The bonded fabric was also bleached and scorched according to the AATCC test for "damage caused by retained chlorine" (69–1958). No discoloration of the fabric occurred as a result of this treatment.

Example 2

The procedure of Example 1 was repeated using a copolymer of 95.5% of ethyl acrylate, 2% of acrylamide, and about 2.5% of N-methylolacrylamide. The product was resistant to dry-cleaning and survived ten cycles of washing under the conditions of Example 1.

Example 3

The procedure of Example 1 was repeated using a copolymer of 94% of ethyl acrylate, 2% of methacrylamide, and 4% of N-methylolmethacrylamide. The product was resistant to dry-cleaning and survived seven cycles of washing under the conditions of Example 1.

Example 4

(*a*) The procedure of Example 2 was repeated except the web was replaced with a 75/25 viscose rayon (3 denier, 1-inch staple) bleached cotton (middling, 15/16 inch) carded web weighing about 0.75 ounce/square yard. The wet-pickup was 600% on the weight of the fibers and in the final fabric the fiber to binder weight ratio was about 33:67.

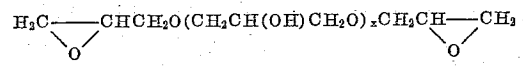
(*b*) The procedure of part (*a*) was repeated except that the aqueous dispersion of the copolymer also contained 3.5% of dimethylol-N,N'-ethyleneurea.

(*c*) Part (*a*) was repeated except that the aqueous dispersion of the copolymer also contained 3% of dimethoxymethylurea.

(*d*) Part (*a*) was repeated except that the aqueous dispersion of the copolymer also contained 2.5% of trimethoxydimethylolmelamine.

(*e*) Part (*a*) was repeated except that the aqueous dis-

persion of the copolymer also contained 4% of a polyepoxide of the formula



in which x has an average value of about 4.

The products of parts (*b*), (*c*), (*d*), and (*e*) were more resilient than that of part (*a*) and withstood a greater number of washing and dry-cleaning operations.

Example 5

The procedure of Example 2 was repeated on air-deposited webs of the following fibers:

(1) 100% regenerated cellulose (2.0 denier, 1.5 inch staple) 2 oz./sq. yd. carded web,

(2) 55% polyamide 66 nylon and 45% regenerated cellulose both 5 denier, 1.75 inch staple,

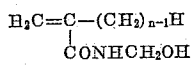
(3) 100% cotton (garnetted card waste, roving and yarns) 4 oz./sq. yd. carded web,

(4) 35% cotton and 65% poly(ethylene glycol terephthalate) 1.25 oz./sq. yd. carded web.

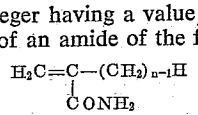
It is to be understood that changes and variations may be made without departing from the spirit and scope of the invention as defined in the appended claims.

We claim:

1. As an article of manufacture, a soft non-woven fibrous product resistant to dry-cleaning and laundering in which the fibers are distributed in random array, fibers in the product being bonded together by a binder comprising a heat-cured product of a water-insoluble linear copolymer, having a T_1 value not over 20° C., and a molecular weight of 100,000 to 10,000,000, of copolymerizable monoethylenically unsaturated molecules comprising 0.5 to 6% by weight of an N-methylolamide of the formula



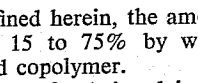
wherein n is an integer having a value of 1 to 2, and 0.5 to 25% by weight of an amide of the formula



wherein n is as defined herein, the amount of copolymer being from about 15 to 75% by weight of the total weight of fibers and copolymer.

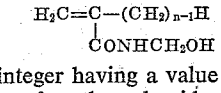
2. A product as defined in claim 1 in which the product comprises cellulose fibers.

3. As an article of manufacture, a soft non-woven fibrous product resistant to dry-cleaning and laundering in which the fibers are distributed in random array, fibers in the product being bonded together by a binder comprising a heat-cured product of a water-insoluble linear copolymer, having a T_1 value not over 20° C., and a molecular weight of 100,000 to 10,000,000, of copolymerizable monoethylenically unsaturated molecules comprising 0.5 to 6% by weight of an N-methylolamide of the formula



wherein n is an integer having a value of 1 to 2, and 0.5 to 25% by weight of acrylamide, the amount of copolymer being from about 15 to 75% by weight of the total weight of fibers and copolymer.

4. As an article of manufacture, a soft non-woven fibrous product resistant to dry-cleaning and laundering in which the fibers are distributed in random array, fibers in the product being bonded together by a binder comprising a heat-cured product of a water-insoluble linear copolymer, having a T_1 value not over 20° C., and a molecular weight of 100,000 to 10,000,000, of copolymerizable monoethylenically unsaturated molecules comprising 0.5 to 6% by weight of an N-methylolamide of the formula

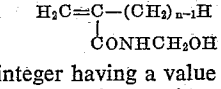


wherein n is an integer having a value of 1 to 2, and 0.5 to 25% by weight of methacrylamide, the amount of copolymer being from about 15 to 75% by weight of the total weight of fibers and copolymer.

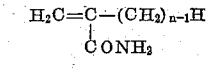
5. As an article of manufacture, a soft non-woven fibrous product resistant to dry-cleaning and laundering in which the fibers are distributed in random array, fibers in the product being bonded together by a binder comprising a heat-cured product of a water-insoluble linear copolymer, having a T_1 value not over 20° C., and a molecular weight of 100,000 to 10,000,000, of copolymerizable monoethylenically unsaturated molecules comprising 0.5 to 6% by weight of N-methylolacrylamide, and 0.5% to 25% by weight of acrylamide, the amount of copolymer being from about 15 to 75% by weight of the total weight of fibers and copolymer.

6. As an article of manufacture, a soft non-woven fibrous product resistant to dry-cleaning and laundering in which the fibers are distributed in random array, fibers in the product being bonded together by a binder comprising a heat-cured product of a water-insoluble linear copolymer, having a T_1 value not over 20° C., and a molecular weight of 100,000 to 10,000,000, of copolymerizable monoethylenically unsaturated molecules comprising 0.5 to 6% by weight of N-methylolacrylamide, and 0.5% to 25% by weight of methacrylamide, the amount of copolymer being from about 15 to 75% by weight of the total weight of fibers and copolymer.

7. As an article of manufacture, a soft non-woven fibrous product resistant to dry-cleaning and laundering in which the fibers are distributed in random array, fibers in the product being bonded together by a binder comprising a heat-cured product of a water-insoluble linear copolymer, having a T_1 value not over 20° C. and a molecular weight of 100,000 to 10,000,000, of neutral copolymerizable monoethylenically unsaturated molecules comprising (A) at least 0.5% by weight of an N-methylolamide of the formula



wherein n is an integer having a value of 1 to 2, and (B) at least 0.5% by weight of an amide of the formula



wherein n is as defined herein, the total of (A) and (B) being from about 2 to 6% by weight, the amount of copolymer being from about 15 to 75% by weight of the total weight of fibers and copolymer.

8. A process of making a non-woven fabric which comprises associating in random array within a web or mat a mass of fibers, bringing into contact with the fibers a binder comprising an aqueous dispersion containing, dispersed therein, from 5% to 60% by weight of a water-insoluble linear addition emulsion copolymer, having a T_1 value not over 20° C. and a molecular weight of 100,000 to 10,000,000, of 0.5 to 6% by weight of N-methylolacrylamide, 0.5 to 25% by weight of acrylamide, and the balance to make 100% of ethyl acrylate, controlling the application of the dispersion to deposit the copolymer in an amount in the range of about 15 to 75% by weight, based on the total weight of fibers and copolymer, drying the fibrous mass containing the binder at a temperature above the T_1 of the polymer to effect fusion of the polymer and bonding of the fibers thereby, and then heating the fibrous product at a temperature of 210° F. to 750° F. to render the bonded fibrous product resistant to laundering and dry-cleaning.

9. A process of making a non-woven fabric which com-

prises associating in random array within a web or mat a mass of fibers, bringing into contact with the fibers a binder comprising an aqueous dispersion containing, dispersed therein, from 5% to 60% by weight of a water-insoluble linear addition emulsion copolymer, having a T_1 value not over 20° C. and a molecular weight of 100,000 to 10,000,000, of 0.5% to 6% by weight of N-methylolacrylamide, 0.5% to 25% by weight of methacrylamide, and the balance to make 100% of ethyl acrylate controlling the application of the dispersion to deposit the copolymer in an amount in the range of about 15 to 75% by weight, based on the total weight of fibers and copolymer, drying the fibrous mass containing the binder at a temperature above the T_1 of the polymer to effect fusion of the polymer and bonding of the fibers thereby, and then heating the fibrous product at a temperature of 210° F. to 750° F. to render the bonded fibrous product resistant to laundering and dry-cleaning.

10. A process of making a non-woven fabric which comprises associating in random array within a web or mat a mass of fibers, bringing into contact with the fibers a binder comprising an aqueous dispersion containing, dispersed therein, from 5% to 60% by weight of a water-insoluble linear addition emulsion copolymer, having a T_1 value not over 20° C. and a molecular weight of 100,000 to 10,000,000, of 0.5 to 6% by weight of N-methylolacrylamide, 0.5% to 25% by weight of an amide of the formula

$$H_2C{=}\underset{\underset{CONH_2}{|}}{C}{-}(CH_2)_{n-1}H$$

wherein n is an integer having a value of 1 to 2, and the balance to make 100% by weight, of at least one member selected from the group consisting of acrylonitrile, styrene, vinyltoluene, vinyl acetate and esters which are the esterification products of an acid of the formula

$$H_2C{=}\underset{\underset{COOH}{|}}{C}{-}(CH_2)_{n-1}H$$

wherein n is as defined herein with an alkanol having 1 to 18 carbon atoms, controlling the application of the dispersion to deposit the copolymer in an amount in the range of about 15 to 75% by weight, based on the total weight of fibers and copolymer, drying the fibrous mass containing the binder at a temperature above the T_1 of the polymer to effect fusion of the polymer and bonding of the fibers thereby, and then heating the fibrous product at a temperature of 210° F. to 750° F. to render the bonded fibrous product resistant to laundering and dry-cleaning.

11. A process of making a non-woven fabric which comprises associating in random array within a web or mat a mass of fibers, bringing into contact with the fibers a binder comprising an aqueous dispersion containing, dispersed therein, from 5% to 60% by weight of a water-insoluble linear addition emulsion copolymer, having a T_1 value not over 20° C. and a molecular weight of 100,000 to 10,000,000, of (A) at least 0.5% by weight of N-methylol-acrylamide, (B) at least 0.5% by weight of an amide of the formula

$$H_2C{=}\underset{\underset{CHNH_2}{|}}{C}{-}(CH_2)_{n-1}H$$

wherein n is an integer having a value of 1 to 2, the total of (A) and (B) being from about 2 to 6% by weight, and the balance to make 100% by weight, of (C) at least one member selected from the group consisting of acrylonitrile, styrene, vinyltoluene, vinyl acetate and esters which are the esterification products of an acid of the formula

$$H_2C{=}\underset{\underset{COOH}{|}}{C}{-}(CH_2)_{n-1}H$$

wherein n is as defined herein, with an alkanol having 1 to 18 carbon atoms, controlling the application of the dispersion to deposit the copolymer in an amount in the range of about 15 to 75% by weight, based on the total weight of fibers and copolymer, drying the fibrous mass containing the binder at a temperature above the T_1 of the polymer to effect fusion of the polymer and bonding of the fibers thereby, and then heating the fibrous product at a temperature of 210° F. to 750° F. to render the bonded fibrous product resistant to laundering and dry-cleaning.

12. A composition adapted to be used for impregnating and coating purposes which is an aqueous dispersion containing, dispersed therein, from 5% to 60% by weight of a water-insoluble linear addition emulsion copolymer, having a T_1 value not over 20° C. and a molecular weight of 100,000 to 10,000,000, of 0.5 to 6% by weight of N-methylol-acrylamide, 0.5% to 25% by weight of an amide of the formula

$$H_2C{=}\underset{\underset{CONH_2}{|}}{C}{-}(CH_2)_{n-1}H$$

wherein n is an integer having a value of 1 to 2, and the balance to make 100% by weight, of at least one member selected from the group consisting of acrylonitrile, styrene, vinyltoluene, vinyl acetate and esters which are the esterification products of an acid of the formula

$$H_2C{=}\underset{\underset{COOH}{|}}{C}{-}(CH_2)_{n-1}H$$

wherein n is as defined herein, with an alkanol having 1 to 18 carbon atoms.

13. A composition adapted to be used for impregnating and coating purposes which is an aqueous dispersion containing, dispersed therein, from 5% to 60% by weight of a water-insoluble linear addition emulsion copolymer, having a T_1 value not over 20° C. and a molecular weight of 100,000 to 10,000,000, of (A) at least 0.5% by weight of an N-methylolamide of an acid of the formula

$$H_2C{=}\underset{\underset{COOH}{|}}{C}{-}(CH_2)_{n-1}H$$

wherein n is an integer having a value of 1 to 2, (B) at least 0.5% by weight of an amide of the formula

$$H_2C{=}\underset{\underset{CONH_2}{|}}{C}{-}(CH_2)_{n-1}H$$

wherein n is an integer having a value of 1 to 2, the total of (A) and (B) being from about 2 to 6% by weight, and the balance to make 100% by weight, of (C) at least one member selected from the group consisting of acrylonitrile, styrene, vinyltoluene, vinyl acetate and esters which are the esterification products of an acid of the formula above with an alkanol having 1 to 18 carbon atoms.

14. A composition adapted to be used for impregnating and coating purposes which is an aqueous dispersion containing, dispersed therein, from 5% to 60% by weight of a water-insoluble linear addition emulsion copolymer, having a T_1 value not over 20° C. and a molecular weight of 100,000 to 10,000,000, of (A) at least 0.5% by weight of N-methylol-acrylamide, (B) at least 0.5% by weight of acrylamide, the total of (A) and (B) being from about 2 to 6% by weight, and the balance to make 100% by weight, of at least one member selected from the group consisting of acrylonitrile, styrene, vinyltoluene, vinyl acetate and esters which are the esterification products of an acid of the formula

$$H_2C{=}\underset{\underset{COOH}{|}}{C}{-}(CH_2)_{n-1}H$$

wherein n is an integer having a value of 1 to 2, with an alkanol having 1 to 18 carbon atoms.

15. A composition adapted to be used for impregnating and coating purposes which is an aqueous dispersion containing, dispersed therein, from 5% to 60% by weight of a water-insoluble linear addition emulsion copolymer,

having a T_1 value not over 20° C. and a molecular weight of 100,000 to 10,000,000, of (A) at least 0.5% by weight of N-methylol-acrylamide, (B) at least 0.5% by weight of acrylamide, the total of (A) and (B) being from about 2 to 6% by weight, and the balance to make 100% by weight, of at least one ester of an acid of the formula

$$H_2C=\underset{\underset{COOH}{|}}{C}-(CH_2)_{n-1}H$$

wherein n is an integer having a value of 1 to 2, with an alkanol having 1 to 18 carbon atoms.

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