

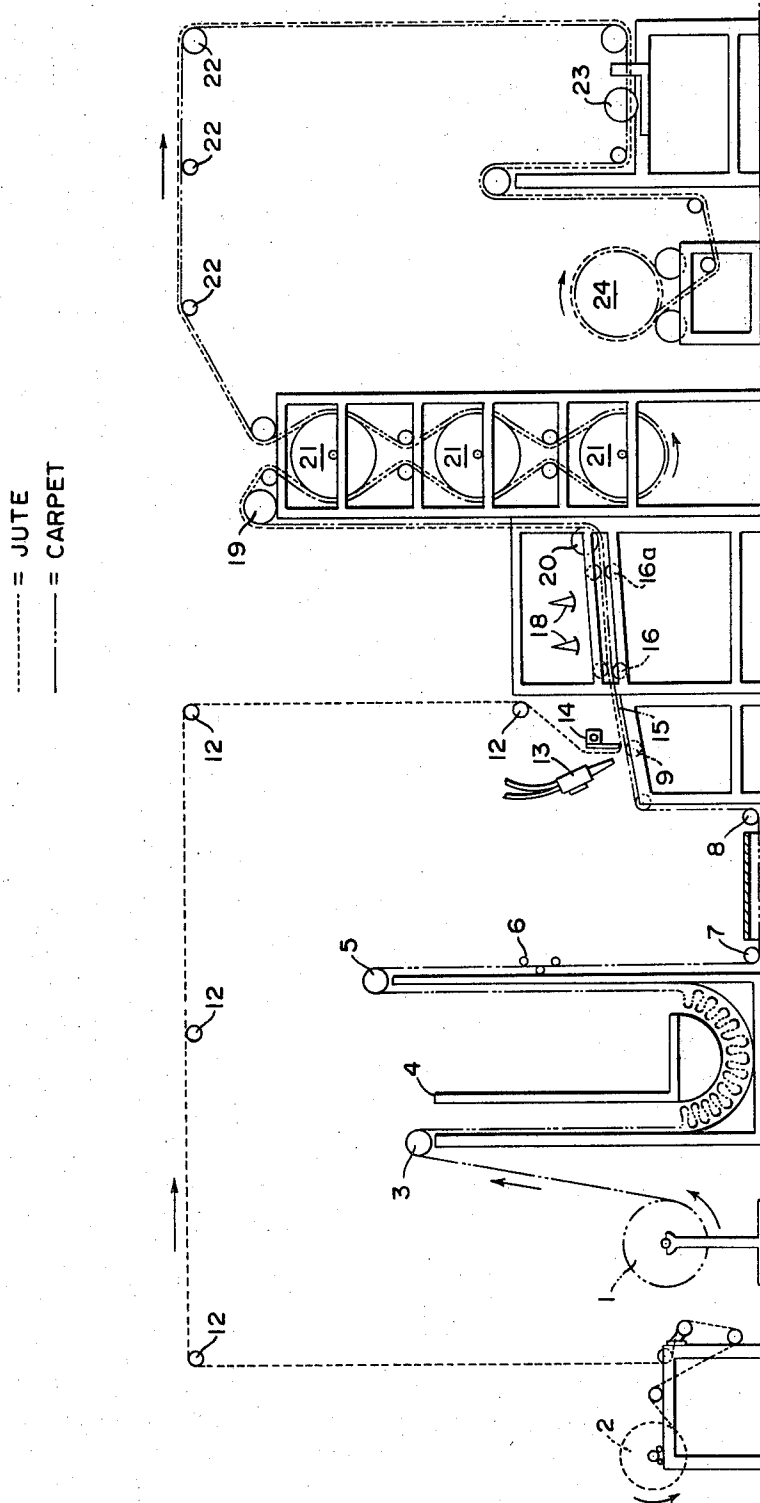
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METHOD OF APPLYING A BACKING TO A CARPET AND PRODUCT

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METHOD OF APPLYING A BACKING TO A
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4 Claims

ABSTRACT OF THE DISCLOSURE

A carpet is formed by adhering a secondary backing to a primary backing with a thixotropic polyurethane composition so that there is substantially complete saturation of the bundle wrap with the composition without penetration through the primary backing. The composition contains water, a polyol with a hydroxyl number less than 100, a diisocyanate, a filler and a catalyst and has an initial viscosity of between 30,000 and 100,000 cps. #7 spindle Brookfield RVF, a pot life of between 10 and 60 seconds and is expandable between 100 and 400 when completely reacted. It is applied to the underside of the primary backing with a doctor knife and heated. A secondary backing is applied to the uncured composition after it is spread on the primary backing and the resultant laminate is subjected to pressure prior to curing to disintegrate substantially all of the cells in the polyurethane.

This invention relates to a method for increasing the tuft lock of carpets and to the product obtained therefrom.

Presently, the large majority of the world's carpets are produced by a tufting process whereby yarn is stitched to a primary backing so that a portion of the yarn, known as the bundle wrap, protrudes through the primary backing. After the stitching step, a secondary backing, generally jute, is adhesively applied to the primary backing and the bundle wrap to provide dimensional stability, drape and enhance the tuft lock of the yarn, i.e., the strength with which the yarn is retained by the primary backing. The adhesive used to laminate the secondary backing to the bundle wrap and primary backing is of major importance to the quality and performance of the carpet. It retains the yarn in place, secures the individual fibers of the yarn, prevents pilling of the yarn, controls dimensional stability (handle or drape) and retains the secondary backing securely to the carpet. Also, it is extremely important that the adhesive not migrate past the primary backing into the exposed yarns otherwise the yarns will become stiff and the final carpet will be unacceptable.

Presently, the most widely used adhesive system is based upon a latex or a carboxylated latex that is applied to the underside of the primary backing. The water in the latex system migrates through the primary backing into the exposed yarns but the adhesive is retained by the primary backing and the bundle wrap. The latex then is cured and the final carpet dried in large ovens at elevated temperatures. This is a costly process due to the large expense of the ovens, energy requirements, floor space requirements, and labor to operate the ovens. A second adhesive system known as the "hot-melt" system based on the use of vinyl resins also is undesirable since it requires the expense of specially heated containers for transporting, storing, handling and applying the resin to the under surface of the primary backing. In addition, these melted resins tend to migrate into the exposed yarn thereby producing unsatisfactory carpets.

The tuft lock of the carpets produced with either latex

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adhesives or the hot-melt vinyl adhesives is undesirably low and the yarn can be pulled easily from the primary backing. This low tuft lock has necessitated laying carpets in one or a few large pieces that conform to the shape of the surface being covered rather than permitting the use of small rectangular pieces to cover the same area since the risk of pulling the yarn from the backing when using small pieces would be increased substantially. If carpets having desirable handle and drape were to have a tuft lock greater than presently available they could be laid in small rectangular pieces thus reducing installation labor costs greatly.

It has been proposed to employ stronger adhesives between the layers to increase tuft lock. However, adherence of a secondary backing to the bundle wrap of the carpet presents unique problems that have prevented the use of these stronger adhesives. In order for the adhesive to be fully effective in adhering the yarn to the primary backing, it must penetrate all or substantially all of the bundle wrap. However, the adhesive must not penetrate past the primary backing into the exposed yarn to any significant degree or the exposed yarn will become stiff and the resultant carpet will be unacceptable. Prior to the present invention, the use of strong adhesive compositions in carpets has been impractical.

It would be highly desirable to provide tufted carpets having improved tuft lock without increasing the stiffness of exposed yarn and to provide a process for making these carpets which eliminates the high heating requirements of present systems. In accordance with the present invention, there is provided a process for forming tufted carpets employing polyurethane-based adhesive composition. The polyurethane adhesive is a thixotropic composition comprising a polyol having a hydroxyl number less than 100, a polyisocyanate, a filler and a catalyst system that promotes reaction of the isocyanate and the polyol to form a polyurethane within a short time after mixing. Penetration of the thixotropic composition into the bundle wrap is controlled by regulating carefully its initial viscosity, its thixotropicity, its pot life and the amount of adhesive expansion during reaction so that the bundle wrap is at least 90% saturated with adhesive without significant penetration through the primary backing.

The thixotropic composition is formed by directing a polyol composition and a polyisocyanate composition separately to a mixing zone. The resultant composition is applied evenly to the underside of the primary backing before a significant degree of curing or blowing is effected. The composition is applied so that the resultant shear forces on the composition will reduce its viscosity sufficiently to promote spreading. The use of a doctor knife is particularly effective for the application. Reaction between the polyisocyanate and water or polyol is initiated when the reactants are mixed so that reaction occurs both prior to and after the composition passes under the doctor knife. After passing the knife, the composition again becomes thixotropic so that migration into the yarns on the upper side of the primary backing is prevented. The water in the composition causes controlled foaming which improves adhesive migration into the bundle wrap before the composition is cured and reduces the amount of composition needed to attain desired adhesion. After the secondary backing, polyurethane composition and primary backing have been contacted under pressure, the semi-cured polyurethane composition is crushed between two rollers, one contacting the exposed yarn and the other contacting the secondary backing so that any cells formed in the polyurethane are crushed thereby greatly reducing the concentration of cells in the final polyurethane composition. The subsequent crushing of substantially all foam produced prior to final curing is es-

sential since the presence of the cells in the final adhesive will greatly reduce the tuft lock of the final carpet.

The thixotropic composition must have an initial Brookfield viscosity between about 30,000 and about 100,000 cps. as measured on a Brookfield Viscometer, #7 spindle, to prevent migration thereof into the exposed yarn while permitting it to be spread by means of a doctor knife. The viscosity measurement is made on the composition not containing catalyst to eliminate the effects of curing. The Brookfield Viscometer and its operation is described in "Development of Research Technique for Evaluating the Low Temperature Fluidity of Automatic Transmission Fluids," published by Coordinating Research Council, Inc., published February 1963, appendix A and designated as CRC L-45-1262. It has been found that migration cannot be prevented merely by increasing the viscosity of the composition but that it is necessary that the composition be thixotropic. In order to attain these characteristics, it is essential that the polyol employed have a hydroxyl number less than 100 preferably less than 50. As is well known in the art, the hydroxyl number is defined as the number of milligrams of potassium hydroxide required for the complete neutralization of the hydrolysis product of the fully acetylated derivative prepared from one gram of polyether polyol. The hydroxyl number can also be defined by the equation:

$$OH = \frac{56.1 \times 1000 \times f}{MW}$$

wherein

OH=hydroxy number of the polyol

f=average functionality, i.e., the average number of hydroxyl groups per molecule of a polyol.

MW=average molecular weight of the polyol

It is necessary that the polyol react and have a low hydroxyl number to reduce the concentration of diisocyanate needed to effect complete reaction of the polyol to the polyurethane. When employing liquid diisocyanates, increased amounts of diisocyanate will reduce the viscosity of the resultant composition below that desired to prevent migration of the composition into the exposed yarn. On the other hand, when a solid diisocyanate reactant is employed, excessive amounts will cause the resultant composition to be paste-like rendering it very difficult to spread. Accordingly, while low molecular weight polyols can be employed with solid diisocyanates and high molecular weight polyols can be employed with liquid diisocyanates, in each case the hydroxyl number of the polyol must be low to attain proper physical characteristics of the resultant composition. Accordingly, when employing solid diisocyanate reactants, the polyol should have a molecular weight between about 1000 and about 3000 to attain the proper viscosity characteristics of the resultant composition. On the other hand, when the liquid diisocyanate reactant is employed, the polyol should have a molecular weight of between about 3000 and about 9000 to attain the desired viscosity characteristics of the resultant composition.

In one aspect of the present invention, a polyurethane prepolymer can be employed to replace or to be mixed with the polyol in the composition. These prepolymers are prepared by means well known in the art, i.e., by incomplete reaction of a polyol with a diisocyanate. The molecular weight of the prepolymer and the type of diisocyanate are chosen with the considerations described above in mind.

While careful selection of the polyol or prepolymer and the diisocyanate provide a means for controlling the viscosity of the resultant composition, the composition cannot be made thixotropic to the desired degree by controlling the relative concentrations of only these two reactants. A suitable filler must be added in amounts sufficient to

render the overall composition thixotropic to the desired degree but less than that which will cause the composition to become paste-like. The concentration of filler is dependent upon the type of filler employed since the degree of thixotropicity varies with the filler used. Generally, the filler, is employed in amounts of between 15 and about 300 per 100 parts of polyol or prepolymer reactant. Representative suitable fillers include asbestos, zinc oxide, clay, feldspar or the like, or mixtures thereof. Fillers such as silica, or calcium carbonate alone are not desirable since high concentrations are needed to attain the desired level of thixotropicity, but can be mixed with the suitable fillers. It is preferred to employ asbestos powder as the filler either alone or in conjunction with other fillers as satisfactory thixotropic characteristics and reduced flammability of the composition are achieved therewith.

The type of catalyst system employed in the thixotropic composition is such as to regulate the pot life i.e., the time for 100% viscosity increase, thereof to between about 10 and about 60 seconds at moderate temperatures up to about 23° C. after mixing the reactants so that the adhesive composition cures at a rate to permit even application, controlled foaming and foam crushing prior to final cure. It is necessary to employ a composition that cures quickly, otherwise even the thixotropic composition will penetrate through the primary backing into the exposed yarn prior to curing. Furthermore, it is not possible to employ compositions that cure at room temperature only at slow or moderate rates since the heat requirements to increase the rate of cure will cause a viscosity reduction that overcomes increase in viscosity due to curing thereby resulting in a net viscosity reduction and excessive penetration past the primary backing. After application of the adhesive, and prior to curing, the temperature should be maintained below that which causes adhesive penetration through the primary backing. Temperatures between 100 and 135° C. are particularly effective. The desired blowing is effected by controlling both the catalyst system and the water concentration in the thixotropic composition. Generally, water is present in the thixotropic composition between .01 and .75 parts per hundred parts of polyol reactant, over and above the water normally present as absorbed on the filler. The catalyst system not only must effect rapid curing but also must control formation of carbon dioxide resulting from the reaction of water and diisocyanate. Blowing must be controlled to effect adhesive expansion between about 100 and 400%, preferably between about 200 to 300% so that the bundle wrap is saturated with adhesive and the adhesive can be crushed subsequently to destroy substantially all of the foam cells prior to final curing. Suitable catalysts are those which do not promote the blowing reaction in preference to the polyurethane reaction and promote the urethane formation reaction at high rates and are well known in the art such as dibutyl tin dilaurate, stannous octoate, nickel acetyl acetate, ferric acetyl acetate and the like.

Suitable polyols which can be employed are the polyether polyols having an average molecular weight between about 1000 and 9000, preferably between 4000 and 8000 and having a hydroxyl number less than 100 including polybutylene ether glycol, polyethylene ether glycol, polypropylene ether glycol, 1,2-polydimethylene ether glycol, polydecamethylene ether glycol or polyurethane prepolymers obtained by incompletely reacting a polyol with a diisocyanate, and mixtures thereof. Particularly suitable polyol compositions are those having an average molecular weight of between about 6000 and about 7000. These polyethers have a functionality of at least 2.

A variety of polyisocyanates may be reacted with these polyols to obtain satisfactory polyurethane adhesives. Particularly suitable polyisocyanates are the aromatic diisocyanates as they are more reactive and less toxic than the aliphatic diisocyanates. Such diisocyanates include 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, naphthyl-

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ene 1,4-diisocyanate, and diphenylmethane-4,4'-diisocyanate, 3,3'-dimethoxy biphenylene diisocyanate, 4,4'-biphenylene diisocyanate and mixtures thereof. The diisocyanate usually is employed in stoichiometric excess to assure complete reaction with the functional groups of the polyol and with the water present.

The process of this invention can be employed to form a carpet having a primary and secondary backing and the piling yarn normally employed in carpets including nylon polyamides, rayon, polyesters, wool and acrylics.

This invention will be more fully described with reference to the accompanying drawing. A tufted primary backing is stored on roller 1 and a secondary backing is stored on roller 2. The tufted primary backing is unrolled from roller 1, passed over guide roll 3 and into "J" box 4 wherein it is stored. The primary backing is passed over guide rollers 5, 6, 7 and 8 and over adhesive applicator backup roller 9. Simultaneously, the secondary backing is unrolled from roller 2, passed over overhead rollers 12 onto adhesive applicator backup roller 9. The polyol composition and isocyanate are dispensed from mixing nozzle 13 onto the underside of the primary backing. The composition is spread and the secondary backing is applied to the primary backing by passing the secondary backing under the doctor blade 14 with the polyol-isocyanate composition sandwiched between the secondary backing and the primary backing. The resulting laminate 15 is passed between pressure rollers 16 into oven 17 provided with infrared heaters 18. Substantially, all of the polyurethane foam is crushed between rollers 16a. The heated laminate is passed out of the oven 17 over turn rollers 19 and 20 into contact with dryer rollers 21 which may be heated with, for example, steam. The heated laminate is passed over overhead rollers 22, through a nap sensor and trimmer assembly 23 onto a finished carpet storage roll 24.

The following examples illustrate the present invention and are not intended to limit the same.

EXAMPLE I

To a mixing head apparatus adapted to spread a mixture onto a moving carpet are separately charged (1) a polyol composition comprising 100.0 pounds of a polypropylene oxide glycol having a hydroxyl number of about 25, 0.50 pounds of water, 15.0 pounds of asbestos having an average particle size of about 5-50 microns, 100.0 pounds of calcium carbonate having an average particle size of about 50-150 microns and 0.06 pound of a catalyst comprising di-butyl tin dilaurate and (2) a modified diphenylmethane-4,4 diisocyanate. The resultant mixture has a viscosity (in the absence of catalyst) of about 88,000 when measured on a Brookfield Viscometer with spindle No. 7, 10 r.p.m., RVF. The resultant mixture was metered onto the underside of a primary backing through which nylon yarn had been tufted by means of a doctor knife around which the secondary backing was applied, so that the adhesive was applied in an amount of about 18.0 ounces per square yard. After passing the doctor knife, the adhesive was subjected to a gas flame to elevate the temperature to about 135° C.

Both prior to and after passing the doctor knife, the thixotropic composition reacted to form a foamed polyurethane composition. After the secondary backing had been applied, the resulting laminate was passed between two rollers to subject the adhesive to the pressure of about 4 p.s.i. thereby crushing substantially all of the cells formed in the adhesive. The resulting laminate was passed under heat source and over a series of heated rolls maintained at about 135° C. and then rolled on a storage roller. About 90 seconds was required between adhesive application and storage.

The resulting laminated carpet was then tested for strength by the delamination, bundle wrap and tuft lock tests. The carpet was found to have a tuft lock of about 25 pounds. The bundle wrap was found to be about 100

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percent saturated with polyurethane adhesive and there was no migration of the polyurethane past the primary backing.

EXAMPLE II

This example illustrates the use of a polyurethane-forming composition in a process which is ineffective for adhering a secondary backing to a tufted primary backing.

The following formulation was prepared and mixed.

Materials:	Parts by weight
6500 M.W. polypropylene oxide glycol, OH #25	100.00
Water	0.50
Calcium carbonate	100.00
Dibutyltin dilaurate	.09
Diisocyanate (NCO Eq. 143)	27.0

The mixture had a viscosity of approximately 20,000, spindle No. 7, 10 r.p.m., RVF. Thirty seconds reaction time was allowed prior to mixing and before application to a primary backing tufted with nylon yarn, after which a puddle of the mixture was applied to 12" x 12" sample of underside of the primary backing. The mixture was doctored or spread with a knife edge to a level of approximately 18 ounces per square yard. A similar size sample of woven jute was pressed against the surface and rolled with a heavy metal roll. The sample was placed in a lab air circulating oven for three minutes at 270° F.

After the three-minute cure, the sample was observed and found to have excessively deep penetration of the mixture into the fabric. Also, the mixture had penetrated into the jute and very little adhesive was retained between the backings, thereby producing a poorly bonded sample of jute to the carpet. No asbestos was present in this sample and the viscosity was low, not thixotropic and very temperature unstable (thinned as temperature increased).

EXAMPLE III

This example illustrates that a thixotropic polyurethane-forming composition will effect unsatisfactory adhesion under processing conditions differing from this invention. The following formulation was prepared and mixed.

Material:	Parts by weight
6500 M.W. polypropylene oxide glycol, OH #25	100.00
Water	.50
Calcium carbonate	100.00
Dibutyltin dilaurate	.005
Asbestos	15.00
Diisocyanate	27.00

The resulting mixture had a viscosity of approximately 100,000, No. 7 spindle, 10 r.p.m., RVF. This mixture was given approximately 30 seconds after mixing and prior to application and was spread with knife edge to a level of approximately 18 ounces per square yard. A similar size sample of woven jute was pressed to the adhesive surface and rolled in place by means of a heavy metal roll and the resultant composite was placed in an air circulating oven for approximately ten minutes at 270° F.

When the sample was removed from the oven, it was found that excessive penetration of the adhesive into the jute and carpet had taken place, very little adhesive was found between the carpet and jute and the lamination was poor.

The increase in temperature of the adhesive caused a severe drop in viscosity, a drop which greatly exceeded the viscosity build-up caused by the reaction.

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EXAMPLE IV

This example illustrates the unsatisfactory results obtained when using a polyol with a hydroxyl number above 100. The following formulation was prepared and mixed.

Material:	Parts by weight
425 M.W. polypropylene oxide glycol, OH	
#270 -----	100.00
Water -----	0.50
Dibutyltin dilaurate -----	0.06
Calcium carbonate -----	100.00
Asbestos -----	15.00
Diisocyanate -----	80.00

The resultant mixture had a relatively low viscosity, approximately 22,000, No. 4, at 10 r.p.m. A 30-second period was elapsed between mixing and applying said material. As the material was applied to the carpet by knife edge it was observed that the adhesive was being absorbed into the carpet. Jute was applied to the adhesive and rolled in place. The sample was placed in an air circulating oven for approximately 4 minutes at 270° F. When cured the sample was examined and found the adhesive had penetrated into the yarn and into the jute and there was very little adhesion of jute to carpet.

I claim:

1. The process of producing carpeting which comprises applying to the underside of a pile-faced primary backing a thixotropic polyurethane composition having an initial viscosity of between 30,000 and 100,000 as measured on spindle No. 7, 10 r.p.m., RVF of a Brookfield Viscometer and having a pot life of between about 1 and about 60 seconds comprising a polyol having a hydroxyl number

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less than 100 and a functionality of at least 2, a diisocyanate, sufficient water to effect between 100 and 400 percent expansion of the thixotropic composition during reaction of the polyol and the diisocyanate, a catalyst to effect reaction of the diisocyanate with the water and the polyol and sufficient filler to render the composition thixotropic, shearing said composition on said primary backing to reduce the viscosity of the composition while applying the composition to the primary backing, applying a secondary backing to the composition after or as said composition has been sheared, crushing substantially all of the cells formed in the composition, and curing said composition.

2. The process of claim 1 wherein the filler is asbestos.

3. The process of claim 1 wherein the polyurethane adhesive is expanded to between 200 and 300 percent.

4. The process of claim 1 wherein the laminate is heated to about 100 to 135° C. after applying the secondary backing.

References Cited

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WILLIAM A. POWELL, Primary Examiner

U.S. Cl. X.R.

156—79; 161—66, 67

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,700,515 Dated October 24, 1972

Inventor(s) Claude Edward Terry

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 41 delete "warp" and add -wrap-

Column 4, line 6 insert "about" before -15-

Column 5, line 31 delete "rolers" and add -rollers-

Column 7, line 32 delete "1" and add -10-

Signed and sealed this 8th day of May 1973.

(SEAL)

Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

-ROBERT GOTTSCHALK
Commissioner of Patents