United States Patent
Stein et al.

[54] BOWLING LANE FINISH CONTAINING A POLYURETHANE AND A POLYOLEFIN

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[58] Field of Search 260/858, 859

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[57] ABSTRACT
A moisture curable polyurethane coating composition, suitable for finishing bowling lanes, contains from about 0.2 to about 10 percent by weight, based on the weight of the polyurethane prepolymer, of a finely divided slip agent such as polyethylene.

7 Claims, No Drawings
3,670,049

BOWLING LANE FINISH CONTAINING A POLYURETHANE AND A POLYOLEFIN

This application is a continuation-in-part of copending application Ser. No. 642,332 filed May 31, 1967 now aban-
doned.

This invention relates to a new and improved coating for finishing bowling lanes and to a bowling lane finished with the new coating. More particularly, the invention relates to a coating composition which uses a moisture curable polyurethane as the film-forming material and which contains a finely divided slip-producing agent in order to provide improved ball control on a bowling lane.

Bowling lanes are commonly finished with wood finishing nitrocellulose lacquers which may include a plasticizer for the nitrocellulose and also may include a relatively small amount of polyorganosiloxane which functions as a flow control agent and as a temporary slip-producing agent. The purpose of the lacquers is to provide finish coatings having good resistance to abrasion, dirt pick-up and scuffing. Bowling lanes, as is well known, are commonly fabricated of wood blocks, wherein a plane surface is provided with a serviceable finish, such as the nitrocellulose lacquers mentioned above. In order to decrease the coefficient of friction between the lacquers and the bowling ball and to provide a bowling surface with the correct slippage or coefficient of friction, this finish is periodically dressed with an oil, e.g., mineral oil. In practice, the dressing or conditioner is applied to the bowling surface on a daily basis in order to reduce wear and adjust the slip qualities of the surface. This oil also has a cleaning function.

During the subsequent bowling play, much of the oil is picked up or displaced by the bowling balls. As the oil is picked up, the residual oil on the lane decreases and the resulting slip qualities of the surface and the coefficient of friction between the ball and the surface is changed. This is neces-
sarily undesirable since a similarly thrown bowling ball will not hook to the same extent as the coefficient of friction changes, and the bowler is thus unable to control his ball.

The provision of bowling lane surfaces which furnish a substantially constant degree of ball control is a problem which has not been solved by the prior art. The ball control frequently will vary on the same lane during several hours of bowling as the conditioner gradually loses its lubricating qualities.

It has now been discovered that a finish providing improved ball control may be achieved by incorporating in a moisture curable polyurethane coating a slip-producing agent such as polyethylene. A bowling lane finished with the polyurethane coating containing the slip-producing agent, in accordance with the present invention, gives the bowler greater control over the lateral movements of his ball; thus, a hook bowler is better able to control the hooking action of the ball and the ball control is uniform from lane to lane, as well as on the same lane over an extended period of bowling. A bowling lane treated with the finish of this invention can be used with a minimum amount of conditioner, or with no conditioner at all.

Polyurethane polymers have long been known for their tough abrasive resistant finishes, but heretofore have been unsuitable for use in the finishing of bowling lanes due to their high coefficient of friction. The present invention overcomes this high coefficient of friction, yet takes advantage of any tough, long-wearing characteristics of the polyurethane polymers.

The polyurethane film forming polymers which can be used as the resinous portion of the finish and is used in the moisture curable, chemically reacting type, which are generally the product of a stoichiometric excess of an organic diisocyanate compound and one or more hydroxy terminated polystyres or polycarbonatepolys. Since the finishes of the present invention must be applied under ambient conditions, the time required to completely cure the urethanes is substan-
tial. Since the unreacted isocyanates in the urethane film for-
ters tend to react with moisture in the air during the curing, the urethane film forming compositions must be prepared to contain a stoichiometric excess of isocyanate, and generally at least a 5% excess must be used and a 10% excess is preferred.

The polyurethane film forming polymers may be of the one package type, wherein a single package contains all of the components needed to produce the film and the curing is induced prin-
cipally by the moisture which is present in the air. Such one package systems may be used with or without catalysts, but catalysts which are mixed with the prepolymer just prior to use are preferred. Such a one package system is illustrated by Ex-
ample I herein.

Alternatively, the polyurethane film forming composition is of the two-package type wherein one package contains the iso-
cyanate component and the other package contains the hydroxy functional component. The isocyanate component
package may contain a prepolymer similar to the one package type prepolymer. The hydroxy functional package can con-
veniently serve as the carrier for the slip agent and any catalysts which may be required. The two package systems are used by mixing the packages together just prior to use. For the purposes of the present invention, the two packages must be mixed in amounts which provide a stoichiometric excess of isocyanate groups in order to make the film forming resin at least partially moisture curing. This permits the urethane film to completely cure even though a portion of the isocyanate is consumed by the moisture present in the air.

The polyethers useful in forming the urethane compositions of the present invention preferably contain the reaction product of a dihydric alcohol or other polyhydric alcohols etherified to form the polyether polyol.

Examples of useful branched chain polyether-polyols con-
taining a plurality of functional hydroxyl terminal groups are the reaction products of glycerol, 1,5-pentanediol, trimethyl propane, pentaerythritol, 1,2,6-hexane triol, phloroglucinol, dimethyl benzene, trimethyl benzene, dimethyl phenol, trimethyl phenol, sucrose sorbitol and similar polyhydric alcohols with glycols such as propylene glycol, butylene glycol, ethylene glycol, mixtures thereof, and the like. The polyols may also be reacted with alkylene oxides such as propylene oxide, butylene oxide, ethylene oxide, mixtures thereof, and the like. Mixtures of the monomers forming the polyether polyols as well as the mixtures of branched chain polyether polyols themselves may be used. Catalysts and the removal of water may be used to shorten the reaction time.

Examples of useful linear or substantially linear polyether polyols are those polyalkylene ether glycols derived from al-
kylen oxide glycols, glycols, heterocyclic ethers and other materials by polymerization or copolymerization using conventional procedures. For example, tetrahydro-furan may be polymerized in the presence of catalytic amounts of fluoro sul-
monic acid to make a polytetramethylene ether glycol.

Ethylene oxide - propylene oxide mixtures, propylene oxide and the like may be used to make other polyalkylene ether glycols via polymerization or copolymerization reactions.

More specifically, polyethylene-propylene ether glycol, polynoventylene ether glycol, polytetramethylene ether glycol, polypropylene ether glycol, polyhexamethylene ether glycol, poly-4-phenol hexamethylenel ether glycol, poly-
1,6-hepamethylene ether glycol and the like may be used as the polyether-polyol in the present invention. The molecular weight of these polyether-polyols may vary from about 180 to about 3,500 or more.

The polyesters employed in the forming of the compositions of the present invention preferably comprise the polyhydric alcohol component with a glycol, such as ethylene glycol, poly-
ol, diethylene glycol, propylene glycol, dioxane glycol, trimethylene glycol or the like. The polyhydric alcohol com-
ponent may also include certain amounts (for example up to 50 percent) of polyethylene glycol having a molecular weight averaging within a range of about 1,000 to 4,000. Small amounts of polyhydric alcohols containing more than two hydroxyls per molecule may be used in forming the polyester, but catalysts must be added. Excessive amounts of these usually are to be avoided since the inclusion of such amounts tends to cause the polyesters to set prematurely.
The dicarboxylic acid components of the polyester should be free of unsaturation, other than that characterizing aromatic nuclei, in order to produce polymerization by esterification reaction only. Suitable dicarboxylic acids include: Phthalic acid, terephthalic acid, isophthalic acid, naphthalic acid, tetracarboxylic acid, and similar arylic dicarboxylic acids, as well as dicarboxylic acids of the aliphatic type such as: Succinic acid, glutaric acid, adipic acid, pimelic acid, sebacic acid, suberic acid, azelaic acid and the like. The term acids includes the anhydrides thereof.

The preparation of such polyesters is now well recognized in the art and elaboration thereof is not deemed to be necessary. It is sufficient to state that they can conveniently be prepared by mixing the polyhydric component and the dibasic acid or acids substantially in excess of stoichiometric ratio with respect to each other, e.g., 2 to 40 percent excess of the polyhydric alcohol component. In cooking the mixture, a small amount of xylene or other non-reactive solvent medium adapted to distill azeotropically with water is usually added.

The mixture is heated in a pot or kettle preferably with agitation, to distill off water and medium, the water being separated and the medium being returned to the reaction zone. The reaction is continued until the acid value had been reduced to a sufficient point, as for example, below about 60 and preferably lower. Economics usually dictate that the acid value be well below 45 or even down to zero or near thereto. The hydroxyl value usually falls in a range of about 25 to 600. In any event, the esterification reaction should be stopped before the polyester becomes insubstantial and insoluble.

The present invention contemplates the use of various isoocyanate compounds containing a plurality of isocyanate groups. Typical compounds of this class comprise: ditylene disiocyanate, chloroprenyl-2,4-diisocyanate, ethylene diisocyanate, 1,4-tetramethylene diisocyanate, p-phenylene diisocyanate, tolylene diisocyanate (usually as mixed isomers), di-anisidine diisocyanate, p-p-diisocyanatodiphenylmethane, hexamethylene disiocyanate, and others.

Because of availability and generally satisfactory behavior, the tolylene diisocyanate mixed isomers are at the present time preferred and the use thereof is illustrated in the subsequent examples. Commercial examples of the mixed isomers comprise:

- Mondur TD, which is understood to be a mixture comprising 65 percent of 2,4-tolylene diisocyanate and 35 percent of 2,6-tolyene diisocyanate;
- Hylene TM, which is understood to be a mixture of 80 percent, 2,4-tolyene diisocyanate and 20 percent of 2,6-tolyene diisocyanate;
- Hylene TM-65, which is understood to be a mixture of 65 percent, 2,4-telylene diisocyanate and 35 percent, 2,6-tolyene diisocyanate;
- Mondur C, which is understood to comprise a prepolymer of 3 moles of tolylene diisocyanate and 1 mole of hexametrol. This prepolymer may be substituted for at least a part of the tolylene diisocyanate.

The moisture polyurethanes polymers employed with the present invention may be prepolymer, of the one package type. These are usually prepared in solution using volatile solvents. They may be further thinned and reduced with blends of solvents in order to provide a suitable application viscosity and film thickness.

The alternative form of urethane is a two package system whereon one package contains the isocyanate component and the other package contains the hydroxy component. The two packages must be mixed so there is a stoichiometric excess of isocyanate whereby the excess isocyanate will react with the moisture present in the air. The polyurethane prepolymer, being a chemically converting type, will cure to a tough durable crosslinked polymer. Since the curing process may be too slow for some circumstances, the polyurethane prepolymer of this invention may be used in conjunction with various crosslinking agents and/or reaction catalysts such as 1,3-propylene glycols, various or gano metallics, triethylene diamine, and other tertiary amines in order to speed up the curing process. These catalysts may be used individually or in combination depending upon the conditions under which the application of the coating composition is to be made.

The polyurethane prepolymers of the present invention are generally sensitive to active hydrogen-bearing products such as water and alcohols, among others. Therefore, precautions must be taken that such contaminants are excluded during the preparation of the polymer and excluded from the solvents which are used for reducing purposes. This means that special polyurethane grade solvents, free of water and alcohols, must be used. Examples of suitable solvents are: ethyl acetate, ethylene glycol monomethyl ether acetate (both polyurethane grade), some ketones such as methyl ethyl ketone, methyl isobutyl ketone and methyl isoamyl ketone. Diluent types of solvents are also used such as aromatic hydrocarbons including toluene and xylene as well as some aliphatic hydrocarbons in the form of aliphatic naphtha.

The polyethylene slip agent is conveniently added to the polyurethane solution as a dispersion in suitable solvents. The dispersion may be prepared by mixing a finely powdered grade of polyethylene with the solvent and then grinding the mixture in a pebble mill. The polyethylene also may be so finely pulverized that milling is not required, and it can be uniformly dispersed throughout the resin simply by pouring it into the resin and mixing. Another procedure for its preparation is to heat the polyethylene and solvent mixture until the combination liquefies then it may be cooled with agitation or ground while cooling in a pebble mill. The solvents are usually aromatic or aliphatic hydrocarbons such as xylene or aliphatic naphtha. A suitable mineral oil may also be used as a dispersing medium in place of the solvent.

Polyethylene is the preferred slip-producing agent for the present invention. Although many forms of ethylene polymers may be used, it is preferred that the polyethylene be a solid crystalline type having a relatively low molecular weight, preferably from about 500 to about 4,000. It is essential that the polyethylene be at solid at room temperature.

The polyethylene is employed in minor proportions with respect to the binder resin. It is preferred that the polyethylene be present in the finish in the range of from about 0.2 percent to about 10 percent by weight and more preferably from about 0.5 percent to about 5 percent.

There are other types of slip-producing agents which may be used in place of polyethylene such as nylon or dispersions of fluorocarbon polymers of high molecular weight. Polypropylene, and polyolefin mixtures, of a solid crystalline type and pulverized to a fine particle size suitable for dispersing, may be used under some circumstances.

The following examples are given by way of illustration and not limitation. Throughout the specification and claims the parts and percentages are given on a weight basis.

**EXAMPLE 1**

A flak was charged with 7.35 grams of 2,6-di-tert-butyl-4-methyl phenol (an anti-oxidant), 55 grams of 1,5-pentanediol (0.51 moles), 150.5 grams of trimethyl propane (1.12 moles), 510 grams of polypropylene glycol (about 0.51 moles - molecular weight about 1,000), 500 grams of urethane grade cellosolve acetate, and 57 grams of xylene. This provided approximately 5.4 OH equivalents. This mixture was then blended with an unreacive gas (composed of nitrogen, carbon monoxide and carbon dioxide). This mixture was heated to reflux in order to remove the water and cooled after 30 minutes' heating to 140°F.

A second flask was charged with 440 grams of xylene and 765 grams of tolylene diisocyanate (4.4 moles). This mixture was then heated to about 80 percent of the 2,4 and about 20 percent of the 2,6 isomer. This flask was blended with the reactive gas and heated to 120°F. The contents of the flask were then added to the first flask while keeping the temperature to below 170°F.
by cooling water. When the addition was completed, the temperature was raised to 190° and held there for 3 hours. This mixture then was cooled and packaged in tin cans. The NCO—OH ratio was about 1.62 to 1.0. The viscosity was 1 (as measured by Gardner Holdt Bubble Viscosity tubes), the color was 1 (as determined on the Gardner Hellige Color comparator), and the weight was 8.85 pounds per gallon. The solids of the polyurethane polymer content is about 60 percent by weight.

In order to prepare a typical coating, the moisture curing polyurethane prepolymer, as prepared above, is mixed in the following recipe:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyurethane prepolymer</td>
<td>100 parts by weight</td>
</tr>
<tr>
<td>Polyethylene (25 percent)</td>
<td>1.5 parts by weight dispersion</td>
</tr>
</tbody>
</table>

A polyethylene dispersion is prepared by mixing one part of finely pulverized grade polyethylene having an average molecular weight of 2,000 melting point of 219° to 226° F, hardness 3-5, specific gravity of 0.92 and average viscosity of 180 cps at 140° C with 3 parts of xylene. Thus, based upon the weight of the polyurethane prepolymer, only 0.375 percent of polyethylene was used.

Before application, 8 volumes of the mixture of polyurethane prepolymer and the polyethylene dispersion are mixed with three volumes of a catalyst mixture of the following composition:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triethylene Diamine Catalyst</td>
<td>2.5 grams</td>
</tr>
<tr>
<td>Xylene</td>
<td>66.2 grams</td>
</tr>
<tr>
<td>N-Butyl Acetate (polyurethane grade)</td>
<td>66.2 grams</td>
</tr>
</tbody>
</table>

This mixture provides 70.8 parts by weight of the prepolymer (60% solids) and 21.8 parts by weight of the catalyst solution.

This coating may be applied to bowling lane surfaces by any desired means including brushing, drawbar applicator, or lane finish applicator. One or several coats may be applied allowing each coat to dry under ambient conditions before applying another coat. It is preferred that the total thickness of the film on the bowling lane be 3 or 4 mils thick when dry. The dry film is finally buffed or polished before applying any conditioners in preparation to bowling. As mentioned above, it is not always necessary to apply a conditioner, although it is usually desired.

A comparative test was set up, whereby 3 regulation bowling lanes were finished with the following coatings and conditioners:

1. A straight polyurethane polymer film with no conditioners.
2. Polyurethane polymer film containing the polyethylene dispersion as described in the example above, with no conditioner.
3. The same film as 2, above, only with a normal application of conditioner. A professional bowler tested each lane by means of throwing a bowling ball several times on each lane. He attempted to throw the ball at the same speed and with the same spin in each case in order to create the closest possible comparison of the lane finishes. With respect to the first lane, which was coated with unmodified polyurethane film, the transverse movement, or the hook of the bowling ball was extreme, and it was impossible for the professional bowler to control his ball by any of the usual bowling standards. On lane 2, the lateral movement or hook of the ball was considerably more moderate. It was the bowler’s opinion that the ball control on this lane was adequate. On lane 3, the transverse movement of the ball, in the judgment of the professional bowler, was at an optimum for ball control and good scoring.

Although there is no clear correlation between desired ball control and laboratory tests for coefficient of friction, surfaces coated with unmodified polyurethane finishes do not have enough slip to provide good bowling lane finishes. In laboratory tests, it was determined that the coefficient of friction of a dried unmodified polyurethane film is in the range of 0.5 to 0.6. The same film when modified by the addition of polyethylene will have a coefficient of friction of 0.17 to about 0.2.

It has been observed that a bowling ball thrown in a normal manner on a bowling lane finished with an unmodified urethane polymer tends to tear the wood which makes up the bowling lane. A thrown bowling ball initially contacts the bowling lane over a very small area, and the force of throw is partially transmitted to the bowling lane and is distributed over this very small area in which the ball contacts the bowling lane. If the coefficient of friction between the ball and the bowling lane is too high (as in the case of a lane finished with unmodified polyurethane), either the wood is torn or the finish pulls away from the wood at the point where the ball contacts the bowling lane. The addition of a slip-producing agent such as polyethylene to a urethane prepolymer based finish in accordance with this invention permits a thrown bowling ball to slide when it comes in contact with the lane and thus overcomes the problem of wood tearing. It is believed that the presence of the polyethylene materially weakens the strength of the urethane polymer, and as a result, a bowling ball thrown on a lane finished in accordance with this invention, will chip or break away microscopic flakes or pieces of urethane polymer. Although this chipping away effect causes the finish to be abraded away at a relatively high rate, it also has the effect of exposing the polyethylene particles which are soft enough to be smeared along the surface of the bowling lane, and thus provide a certain amount of lubrication for the bowling balls. Thus it can be seen that the polyethylenes replace the oil usually used on bowling lanes.

A coating composition of this invention may also contain a compatible polyorganosiloxane flow control agent. These polyorganosiloxanes may include the methyl, ethyl, propyl, butyl, and amylpolysiloxane homopolymers and copolymers, as well as a mixture of the copolymeric and homopolymeric lower alkyl polysiloxanes. These flow control agents are preferably in the range of 0.01 to about 1 part more preferably 0.01 to about 0.4 parts per 100 parts of polyurethane polymer.

This invention contemplates the use of a wide variety of moisture curable urethane prepolymer for use as the film-forming resin. For instance, it is contemplated that polyurethane prepolymer of sufficiently low viscosity may be combined with finely divided polyethylene without the use of solvents or diluents.

It will be apparent to those skilled in the art that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, and therefore, it is not intended to be limited except as indicated in the appended claims.

We claim:
1. A bowling lane finished with a cured coating composition, said composition comprising from about 5 to about 100 percent by weight of an organic film-forming material consisting essentially of a moisture-curable polyurethane precursor having uniformly dispersed therein from about 0.2 percent to about 10 percent by weight, based on the weight of the polyurethane, of a finely divided slip-producing agent selected from the group consisting of a polyethylene, polypropylene, fluorocarbon polymers, fluorocarbon telomers, and nylon.
2. A bowling lane as described in claim 1, wherein said slip-producing agent is a polyethylene which is solid at room temperature.
3. A bowling lane as described in claim 1, wherein said slip-producing agent is a crystalline polyethylene having an average molecular weight of 2,000.
4. A bowling lane as described in claim 1, wherein the polyurethane is a moisture-cured reaction product of a polyether-polyol.
5. A bowling lane as described in claim 1, wherein the coating contains from about 0.5 percent to about 5 percent by weight, based on the weight of the polyurethane, of crystalline polyethylene.

6. A bowling lane as described in claim 5, wherein the polyurethane is a moisture-cured reaction product of a polyether-polyol.

7. A bowling lane as described in claim 6, wherein the polyurethane is produced from a polyether which is a reaction product of 1,5-pentanediol, trimethylol propane and polypropylene glycol.