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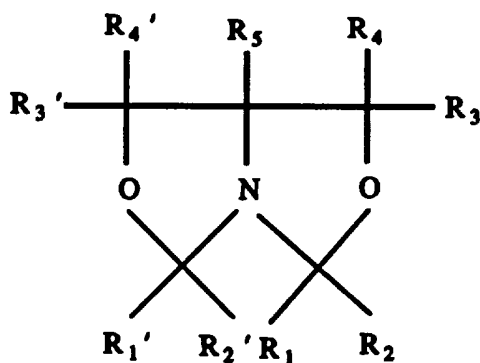
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(54) Title: BIS-OXAZOLIDINES AND THEIR USE

**(57) Abstract**

The present invention provides compositions and methods of using a bis-oxazolidine compound having formula (I), wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; $R_2, R_3, R_4, R_2', R_3'$ and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group. The bis-oxazolidines are useful in improving the physical properties of a coating. Weatherability, impact resistance, abrasion resistance, chip resistance, salt resistance, acid resistance and organic chemical resistance of a coating is improved by the use of a bis-oxazolidine. Further, the bis-oxazolidine is used as a reactive diluent in polyurethane coating systems. The compound is admixed with a preparation to reduce volatile organic content of the preparation and improve rheological properties of the preparation. In another aspect, a polyurethane coating composition that includes a blocked polyisocyanate, and a bis-oxazolidine is provided.

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BIS-OXAZOLIDINES AND THEIR USE

This application is a continuation-in-part of co-pending application Serial No. 08/156,955, filed on November 22, 1993, which is a continuation-in-part to application Serial No. 07/624,062, filed December 14, 1990, which issued as U.S. Patent No. 5,204,148 on November 23, 1993.

5 FIELD OF THE INVENTION

The present invention is generally related to methods of using bicyclic oxazolidine compounds. In particular, the present invention relates to methods of using the compounds as a corrosion inhibitor, moisture scavenger, reactive diluent, rheological modifier, drying agent, and potlife extender in a coating, sealant or
10 adhesive. Further, bicyclic oxazolidine compounds are used to improve the physical properties of a preparation including resistance to weathering, impact resistance, abrasion resistance, chip resistance, salt resistance, acid resistance, organic chemical resistance, minimizing downglossing in a coating, and minimizing bubble formation.

BACKGROUND OF THE INVENTION

15 Polyurethane coatings are extensively used as commercial and industrial protective and/or decorative coatings. Polyurethane coatings, known in the industry as one of the toughest coatings available, are routinely applied as protective coatings on exterior walls of buildings, industrial machinery, military equipment and vehicles, commercial and passenger vehicles, and any other surface requiring a protective
20 coating. Polyurethane systems are also used extensively as sealants and adhesives.

Protective coatings, as the name suggests, protect the surface on which it is applied from destructive environmental conditions. These conditions include exposure to ultraviolet radiation (UV), acid rain, salt, chipping agents such as stones and hail, and extremes in temperature and humidity. Protection of the substrate
25 surfaces is particularly important in geographical areas with harsh environmental conditions. For example, in arid regions, substrates and coatings are exposed to high amounts of UV radiation. In other geographical regions, substrates and coatings are exposed to ocean spray and/or road salt, or acid rain.

A survey of the effects of environmental conditions on automotive coatings
30 was described by David R. Bauer in *J. Coat. Tech.*, **66:835**, 57-65, (1994). UV

damage occurs primarily through free radical oxidation. When a coating absorbs UV radiation, a free radical is generated and combines with oxygen to produce a peroxy radical. The peroxy free radical then abstracts a hydrogen from the coating creating a carbon based radical. The hydrogen abstraction propagates until two free radical
5 combine in a termination step. UV damage of coatings result in loss of film properties, including loss of gloss. Ultimately, degradation of the coating is the final product of UV exposure.

In all of the diverse geographic regions, the coating must be able to withstand these environmental condition if it is to protect the substrate. Consequently, there is
10 a need for coatings with improved physical properties including resistance to UV radiation, impact resistance, salt resistance, acid resistance, organic chemical resistance, chip resistance and abrasion resistance. Furthermore, for a coating to be useful, it must have a reasonable pot life to provide a sufficient time for application of the coating and to provide for longer storage time.

U.S. Patent No. 4,504,647 describes aldimine oxazolidine compounds as
15 curing agents which exhibit a long shelf life when mixed with isocyanate. However, the mixture cures very quickly into an elastic or hard polymer in the presence of water or humidity. Coatings require an adequate potlife in order to be used commercially as automotive refinish coatings and the like. Coatings such as those
20 described in U.S. Patent No. 4,504,647 rapidly react with water to form a gel. These coatings have a short potlife which can prevent use of the coating formulation in typical commercial applications. There is a need for methods and compositions for improving the potlife of coatings.

Polyurethane coating systems typically include a polyisocyanate component
25 and a polyol which react to form the polyurethane film. Alternatively, a polyurethane coating can include only the polyisocyanate component. When only the polyisocyanate component is included, polyisocyanate molecules cross-react with each other and with moisture to form a useful coating. A polyisocyanate is a molecule with multiple isocyanate groups. A polyol is a molecule with multiple hydroxyl
30 groups. Exemplary polyols include polyester polyol, polyether polyol and acrylic polyol. In some polyurethane coating systems, the polyisocyanate component is blocked to prevent the polyisocyanate from reacting with the polyol prematurely.

Upon exposure to deblocking conditions, the blocking groups are removed and the polyisocyanate reacts with the polyol to form the useful coating. Polyurethane coating systems also include pigments, volatile organic solvents, and a variety of adjuvant components, e.g., surface active agents, dispersants, diluents, and fillers.

5 Moisture curing polyurethane coating systems include a polyisocyanate component which reacts with atmospheric water at room temperature to form useful films. These systems also include pigments, organic solvents, and a variety of adjuvant components, e.g., surface active agents, dispersants, diluents, and fillers. Since the polyisocyanate component reacts with even trace amounts of moisture,
10 extreme care must be taken so that the polyisocyanates do not contact water until they are applied to a surface to be coated. Water is, however, unintentionally and unavoidably introduced into the formulation process in the form of dissolved water in solvents, adsorbed and absorbed moisture on the surfaces of fillers and pigments, and atmospheric moisture. Subsequent reaction of the water with the polyisocyanate
15 component of the system results in an irreversible reaction which will harden the product, making it unusable before it can be applied to the surface to be coated. This water must be removed in order to produce an acceptable product. The existing methods for preparing color-pigmented moisture curable polyurethane coatings require expensive equipment to dry the pigments, solvents, and fillers. In the
20 alternative, moisture scavenging agents are added to the coating preparation or are added to the pigments, solvents and other raw materials prior to preparing the coating.

One group of water scavenging agents widely used to prevent moisture contamination of moisture curable polyurethane coating systems is the monomeric
25 isocyanates. A typical monomeric isocyanate, such as p-toluenesulfonyl isocyanate (Vanchem, Inc. Lockport, Connecticut), reacts with water to generate carbon dioxide and the corresponding sulfonamide, e.g., p-toluenesulfonamide. The carbon dioxide diffuses from the pigment grind during the dehydration phase as carbon dioxide gas. A disadvantage of monomeric isocyanates is that they are harmful if swallowed,
30 inhaled, or absorbed through the skin and are extremely corrosive to the tissues of the mucous membranes, upper respiratory tract, and skin.

There is a need for a moisture scavenger which efficiently, cost effectively, and safely removes water from moisture curable coating systems and from any other preparation where residual water is a problem, without seriously detracting from the performance of the cured coating.

5 Currently, there are available commercially, two types of polyurethane systems, a one component system (1-K), and a two component system (2-K). Both the 1-K and the 2-K systems are widely used in commercial applications depending upon the specific needs of the coating system.

10 In the two component system, the polyisocyanate and the polyol are segregated into two separate containers until use. When the two components are mixed together, the coating cures in which the polyisocyanate cross-links with the polyol to form the polyurethane coating.

15 In the one component system, the polyisocyanate and the polyol are both included in one package. To prevent premature curing, the polyisocyanate is chemically blocked or is in the form of a prepolymer. Upon exposure to deblocking conditions (moisture, heat or radiation, etc.), the blocking group is removed and the polyurethane coating cures into a film. Well known blocking groups of the polyisocyanate include diethyl malonate, 3,5-dimethylpyrazole, MEK Oxime, ϵ -caprolactam and 2-ethyl hexanol. While the one component system is convenient to use, the blocked polyisocyanates are either very viscous or are solids. As a result, one component polyurethane systems require large amounts of volatile organic solvents to reduce the viscosity or to solubilize the individual components. Typically, one gallon of a one component polyurethane system contains about four to five pounds of volatile organic compounds.

25 Coatings which contain volatile organic components release these organic compounds into the atmosphere during application and upon curing. Once released into the atmosphere, most volatile organic compounds cause far reaching environmental damage. Recently, there has been much interest in reducing the amount of volatile organic compounds released into the atmosphere. The United States Environmental Protection Agency (EPA) estimated that 31 million tons of volatile organic compounds were released into the atmosphere in the United States alone in 1975. To reduce the amount of organic pollutants emitted into the

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atmosphere, there is a need for a polyurethane coating with reduced volatile organic content (VOC).

Restrictions on solvent content in the atmosphere have increased efforts to provide coatings which do not contain any volatile components, but instead include
5 components which form either the whole or a part of the hardened film itself.

Reactive diluents are used to lower the volatile content of the coatings by reducing the loss of organic solvents into the atmosphere. For purposes of the present invention, reactive diluents are compounds of low volatility which reduce the viscosity and VOC of a coating, adhesive, elastomer, epoxy or sealant formulation
10 and become a permanent part of the formulation through chemical reaction.

Accordingly, reactive diluents are added to coatings not only as a diluent, but to reduce viscosity, react with the oligomers and polymers to form a part of the coating, and contribute to the final properties of the cured film.

Reactive diluents are compounds used to lower the volatile organic content of coatings by reducing the amount of organic solvents in the coating and becoming a
15 part of the coating through chemical reaction. In polyurethane coating systems, reactive diluents function as a solvent and also react with polyisocyanate to form useful polyurethane coatings. Because the reactive diluent becomes a part of the coating, the reactive diluent is not released into the atmosphere. Reactive diluents
20 reduce the viscosity of the coating by functioning as a non-volatile solvent and also improves the rheology of the coating. Rheology is the flow and leveling properties of a coating during the preparation and application of that coating. As discussed above, in 1-K coating systems, the use of viscous or solid blocked polyisocyanates requires the use of large amounts of volatile organic compounds. There is a need for
25 a 1-K and 2-K coatings system with lowered viscosity and improved rheological properties.

Some reactive diluents pose problems which limit their use in coatings. The diluents are known to produce brittle films with severe shrinkage and poor adhesion to substrates, exhibit slow cure response, poor solvency effects or color instability,
30 ineffectively reduce viscosity, or cause serious skin irritancy problems. Furthermore, some reactive diluents provide a coating with short pot life which reduces the usability of a coating. There is a need for a reactive diluent which lowers the VOC

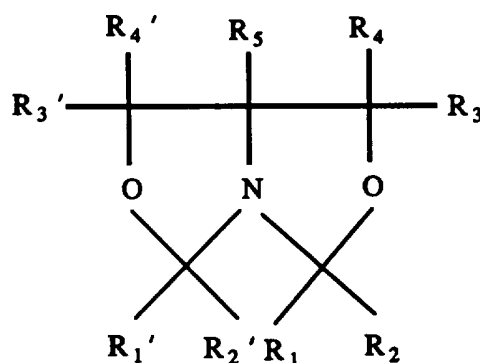
of a polyurethane coating and exhibits good cure response, color stability, good potlife, low intrinsic viscosity, low film shrinkage, excellent solvating or viscosity reducing properties.

Corrosion is often prevalent in engine cooling systems. Metals such as copper, iron, steel, aluminum, magnesium and the like are often exposed to high temperatures, pressures and flow rates in these cooling systems. These conditions corrode metal forming corrosion products which may cause engine overheating or engine failure. Lightweight metals in engine components such as aluminum and magnesium are subject to pitting of radiator tubes, crevice corrosion at hose connections, and deposit corrosion from deposition of corrosion products. Corrosion inhibitors are added to antifreeze/coolant compositions and functional fluids which contact metal to prevent and control corrosion in engine cooling systems and other machinery. U.S. Patent No. 4,282,108 describes oxazolidine derivatives which are used as chelants, anti-copper-corrosion additives and frictional modifiers in automatic transmission fluid, and oxidation inhibitors in middle distillate fuels.

There is a need for a corrosion inhibitor which effectively reduces the incidence of corrosion of metals or alloys, and which may be applied to a surface of a metal or alloy or may be incorporated in a functional fluid which contacts a surface of a metal or alloy.

20 SUMMARY OF THE INVENTION

The present invention provides a method of improving the physical properties of a preparation by admixing with the preparation an effective amount of a bis oxazolidine compound having the structure:



wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group.

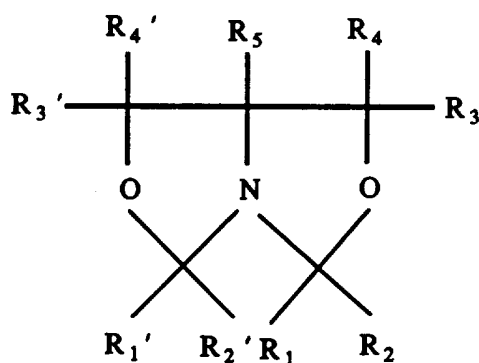
In one embodiment, the effective amount of a bis-oxazolidine compound is from about 1 to about 80 weight percent of the total weight of the preparation.

The improved physical properties include resistance to weathering, impact resistance, abrasion resistance, chip resistance, salt resistance, acid resistance and organic chemical resistance. The preparation is a composite, sacrificial pigment, ink, industrial fluid, coating, adhesive, sealant, or coating component. In a preferred embodiment, the preparation is a polyurethane coating.

A second aspect of the invention provides a method of improving the potlife of a preparation. According to the method, potlife is improved by admixing an effective amount of a bis-oxazolidine compound as described above with the preparation. Preferably, the effective amount of a bis-oxazolidine compound is from about 1 to about 80 weight percent of total weight of the preparation.

A third aspect of the invention provides a method of inhibiting corrosion in a refrigeration system by admixing with the refrigerant an effective amount of a moisture scavenging bis-oxazolidine compound. In a preferred embodiment, the effective amount the moisture scavenging bis-oxazolidine compound is from about 1 to about 30 weight percent based on the weight of the refrigerant.

In another aspect, the invention provides a method of reducing the volatile organic content of a polyisocyanate containing coating by admixing with the coating an effective amount of a bis-oxazolidine compound having the formula:



wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group.

In a preferred embodiment, the effective amount of the bis-oxazolidine compound is from about 1 to about 80 weight percent of the total weight of the coating.

Another aspect of the invention is directed to a method of improving the rheological properties of 1-K and 2-K coatings by using a bis-oxazolidine as described above.

Still another aspect of the invention provides a coating composition that includes a polyisocyanate and a bis-oxazolidine compound as described above. The coating can also include polyol, pigment, filler, adjuvants and other components. A preferred coating is a 1 component polyurethane coating that includes blocked polyisocyanate, bis-oxazolidine, and polyol. In one embodiment, the polyurethane coating is an automotive coating. In yet another embodiment, the polyurethane coating is a sprayable coating.

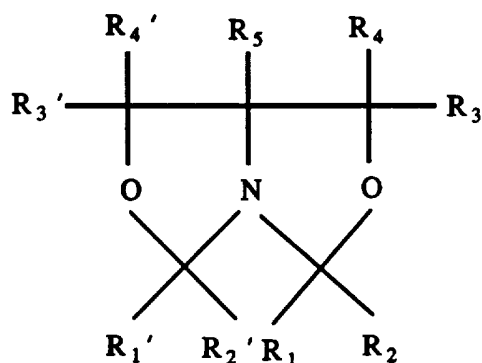
DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a bis-oxazolidine compound which can be advantageously used to improve the physical properties of a preparation. Preparations which are the subject of the present invention include sealants, adhesives, elastomers, epoxy resin formulations, and coatings. As used herein, a coating is any reactive coating.

In one embodiment, the present invention provides a method of improving the physical properties of the preparation comprising admixing an effective amount of a bis-oxazolidine compound with the preparation. The physical properties of the preparation improved by the disclosed bis-oxazolidine include resistance to weathering, impact resistance, abrasion resistance, chip resistance, salt resistance, acid resistance, organic chemical resistance, reduction in downglossing, and reduction in bubble formation. The improvements in these physical properties are disclosed in the examples below and in co-pending application serial no. 08/156,955.

Oxazolidine compounds have been used as curing and crosslinking reagents, reacting with polyfunctional isocyanates in the presence of polyols or water to form polymeric coatings. United States Patent No. 4,101,527 discloses an equimolar reaction of an oxazolidine with a polyfunctional isocyanate in the presence of water to form a polyurethane coating. United States Patent No. 3,941,753 describes pre-polymers for coating formation prepared from the reaction of a ketiminoalkanol with an isocyanate. However, neither of these two patents disclose the use of bis-oxazolidines to improve the physical properties of the polyurethane coatings. (?) As used herein, the term "bis-oxazolidine" is a synonym of "bicyclic oxazolidine". The terms "bis-oxazolidine" and "bicyclic oxazolidine" are used interchangeably.

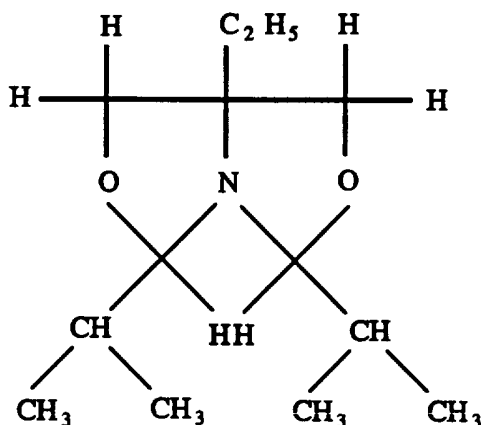
The bis-oxazolidines of the present invention have the formula:



wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group.

Preferred R group substituents of a bis-oxazolidine compound are those that increase the physical properties of the preparation. In a preferred embodiment, the R_1 and R_1' substituents are, individually, a methyl group or a ($C_2 - C_5$) straight or branched chain alkyl or alkanol group; the R_2 , R_2' , R_3 , R_3' , R_4 and R_4' substituent groups are hydrogen atoms; and the R_5 substituent group is a methyl group or a ($C_2 - C_5$) straight or branched chain alkyl or alkanol group. According to another preferred embodiment, the R_1 and R_1' substituents are isopropyl groups. Without

limiting the scope of the invention, applicants have discovered that 1-aza-3,7-dioxo-2,8-diisopropyl-5-ethyl bicyclo(3,3,0)octane (RD-20) is a particularly useful bis-oxazolidine



The effective amount of a bis-oxazolidine compound is from about 1 to about 5
80 weight percent of the total weight of the preparation. Preferably, the effective amount is from about 1 to about 30 weight percent.

In another aspect, the physical properties of polyisocyanate containing coatings are improved by admixing an effective amount of a bis-oxazolidine compound with the coating. Polyurethane coatings are available commercially as 1 component (1-K)
10 or 2 component (2-K) coatings (see background section). These coatings are typically cured by moisture, ambient, thermal, forced dry, radiation or bake curing.

Typically, 1-K polyurethane coatings contain prepolymers and/or blocked polyisocyanates while 2-K polyurethane coatings contain polyisocyanates. A bis-oxazolidine compound of the present invention improves the physical properties of
15 both polyisocyanate and blocked polyisocyanate containing coatings.

In still another aspect, the bis-oxazolidine compound as disclosed herein improves the potlife of a preparation. Pot-life is improved by admixing with the preparation an effective amount of a bis-oxazolidine compound.

Pot-life is the time that a preparation can be stored without gelling. Coatings
20 require an adequate potlife in order to be useful as coatings. Example 4 describes how potlife is determined. Preferably, the potlife of a preparation is increased from about 1 to about 100% by admixing the preparation with a bis-oxazolidine compound.

The effective amount of a bis-oxazolidine compound that increases the potlife

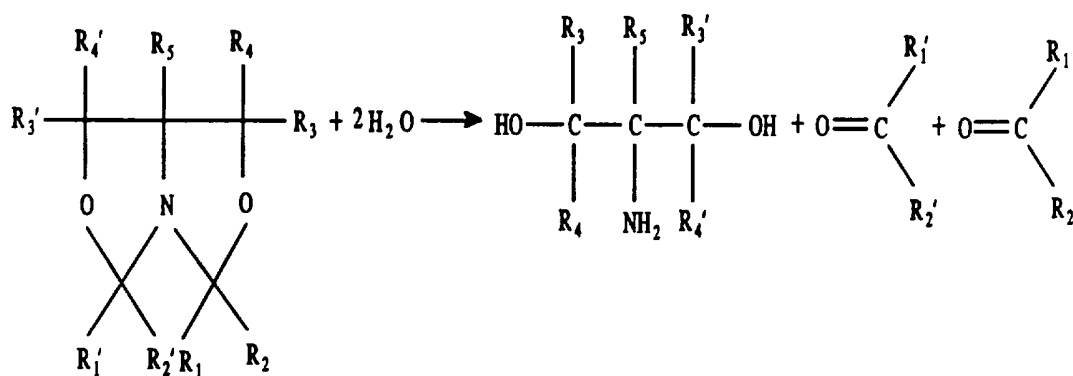
of a preparation is from about 1 to about 80 weight percent of the total weight of the preparation. Preferably, the effective amount is from about 1 to about 30 weight percent of the total weight of the preparation.

5 The potlife of an adhesive, sealant, elastomer, or coating is increased by the use of a bis-oxazolidine. Preferably, the coating is a coating that contains a polyisocyanate or a blocked polyisocyanate.

A further aspect of the present invention provides a method of inhibiting corrosion in a refrigeration system comprising admixing an effective amount of a moisture scavenging bis-oxazolidine with the refrigerant of a refrigeration system.

10 Refrigerants cool by successive cycles of vaporization and condensation. During this process, moisture can enter the refrigeration system where it corrodes the components of the refrigeration system. Commonly used refrigerants include fluorocarbons and other halogenated hydrocarbons.

15 A bis-oxazolidine compound as disclosed herein inhibits corrosion by scavenging moisture that enters the refrigeration system. The bicyclic oxazolidine compounds of the present invention react chemically with water in the following manner:



20 As shown above, the reaction products are an amino alcohol and carbonyl compounds. One mole of bicyclic moisture-scavenging oxazolidine will react with and remove two moles of water. Therefore, it is preferred that the moisture-scavenging compositions of the invention containing bicyclic oxazolidines include at least one-half mole of the bicyclic moisture-scavenging oxazolidine for each mole of water to be removed. However, since a perfectly efficient reaction environment cannot be guaranteed in industrial settings, it is preferable that from 0.5 to about 10

moles of the moisture-scavenging bicyclic oxazolidine be included in the inventive composition for every mole of water to be removed.

As a refrigerant undergoes successive cycles of vaporization and condensation, moisture enters the refrigeration system. In a refrigeration system, the amount of moisture that enters cannot be reliably predicted. A bis-oxazolidine compound as disclosed by the present invention reacts with the moisture that enters the refrigeration system and protects the refrigeration system from corrosion. Preferably, the effective amount of a moisture scavenging bis-oxazolidine is from about 1 to about 30 weight percent of the total weight of the refrigerant.

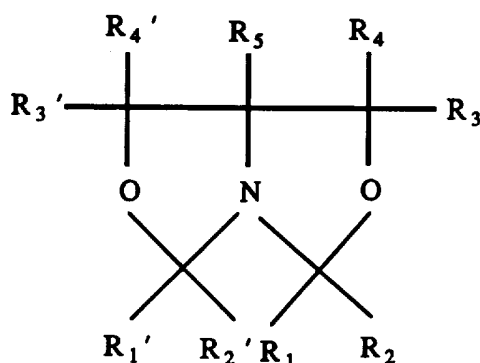
R group substituents of a bis-oxazolidine compound which facilitate the reaction of water with the bicyclic moisture-scavenging oxazolidines of the present invention are preferred. According to one preferred embodiment, the R_1 and R_1' substituents are, individually, a methyl group or a ($C_2 - C_5$) straight or branched chain alkyl or alkanol group; the R_2 , R_2' , R_3 , R_3' , R_4 and R_4' substituent groups are hydrogen atoms; and the R_5 substituent group is a methyl group or a ($C_2 - C_5$) straight or branched chain alkyl or alkanol group. According to another preferred embodiment, the R_1 and R_1' substituents are isopropyl groups.

The present invention further provides a reactive diluent which can be advantageously used in the formulation of coating preparations. As used herein, the term "polyurethane coating" is a generic term used to describe a polymeric coating formed from the reaction of polymeric isocyanate with water, polymeric polyol, or bis-oxazolidine as disclosed herein.

Currently there are available two kinds of polyurethane systems: a two component system and a one component system. A polyurethane coating is the product of a curing reaction between a polyisocyanate and water or polyol. Polyurethane systems also typically include other components including fillers, pigments, solvents and a variety of adjuvant compounds to impart useful film properties including weatherability, impact resistance, abrasion resistance, chip resistance, salt resistance, acid resistance, organic chemical resistance, etch resistance, adhesion, cure temperature, and appearance.

As discussed above, a one component polyurethane system includes in one pot (container) all of the components required to produce a polyurethane coating

including both polyisocyanate and polyol if desired. In a 1-K system, the polyisocyanate is prevented from prematurely reacting with the polyol (or a bis-oxazolidine) by chemical blocking groups or is in the form of a prepolymer. Thus a 1-K polyurethane system contains in one pot a blocked polyisocyanate, a prepolymer and/or polyol and adjuvant compounds. Because the blocked polyisocyanates are typically very viscous or are solids, large amounts of volatile organic solvents are required to make a one component polyurethane coating sprayable. In one aspect, part or all of the organic solvents required to prepare a polyurethane coating is replaced with a bis-oxazolidine compound having the formula:



wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group.

In another aspect, a bis-oxazolidine compound of the present invention is useful in that it functions as a reactive diluent: the bis-oxazolidine compound functions as a solvent but unlike a typical solvent which increases the VOC of the coating, a bis-oxazolidine compound disclosed herein reduces the volatile organic content of the coating by becoming chemically incorporated into the polyurethane coating.

In yet another aspect, a polyurethane coating comprising a polyisocyanate and a bis-oxazolidine compound is provided by the present invention. In one

embodiment, the polyisocyanate is a blocked polyisocyanate. In a preferred embodiment, the polyurethane coating further includes a component selected from the group consisting of polyol, pigment, filler, adjuvant and solvent.

5 In a preferred embodiment, the polyurethane coating is a one-component polyurethane system or a two-component polyurethane system. In another preferred embodiment, a coating of the present invention is an automobile coating or a clearcoat. In yet another embodiment, a preferred coating is a sprayable coating.

The composition is preferably a polyurethane coating in which an effective amount of a bis-oxazolidine compound is intimately admixed with the polyurethane
10 formulation. An effective amount of the bis-oxazolidine compound of the present invention is an amount sufficient to reduce the viscosity and volatile organic content of the preparation and provide an acceptable potlife or stability and cure rate while maintaining or improving the film properties of the preparation. The quantity of reactive diluent in the composition will vary with the viscosity and volatile organic
15 content of the formulation. Generally, the effective amount will range from about 1 to about 80 weight percent based on the total weight of the formulation. In a preferred embodiment, the effective amount includes from about 1 to about 50 weight percent of the compound based on the total weight of the formulation. Most preferably, from about 1 to about 30 weight percent of the compound based on the
20 total weight of the formulation is added.

The polyisocyanates of the composition include those conventionally used in forming polyurethane coatings as described in U.S. Patent No. 3,743,626. Since the polyisocyanate component reacts with even trace amounts of moisture, extreme care must be taken so that the polyisocyanates do not contact water until the formulation is
25 to be used. The formulation may be dehydrated prior to addition of the polyisocyanate through the use of drying equipment or moisture scavengers. Alternatively, the bis-oxazolidine of the present invention can be used as a moisture scavenger. Alternatively, in a one-component polyurethane system, the polyisocyanate component can be a blocked polyisocyanate. Exemplary blocking
30 groups are known and include diethyl malonate, 3,5-dimethylpyrazole, MEK Oxime, ϵ -caprolactam and 2-ethyl hexanol.

The solvents generally used in the formulation of specialty polyurethane systems are also compatible with the bis-oxazolidine compounds of the present invention. Solvents generally used in the preparation of polyurethane preparations including aprotic solvents, such as ketones, esters, ethers, nitroparaffins, glycol esters, glycol ether esters, halogenated hydrocarbons, and alkyl and aromatic hydrocarbons can be added to the formulation.

A further aspect of the present invention is directed to a method of improving rheological properties and decreasing the viscosity, improving flow and leveling of a polyurethane preparation using a bis-oxazolidine compound. The bis-oxazolidine compounds improve the rheology of a coating by reducing the viscosity and improving the flow and leveling of the coating. Unlike the solvents it replaces, the bis-oxazolidine compound is not released into the atmosphere because it is incorporated into the polyurethane coating. An effective amount of the bis-oxazolidine compound of the present invention is substituted for the volatile organic solvents or higher viscosity polyols and reacts to form a part of the preparation as discussed above. Greater amounts of the bis-oxazolidine compound are added to further reduce the viscosity and improve flow and leveling and/or reduce the volatile organic content of the preparation. An effective amount is that amount sufficient to reduce the viscosity and improve flow and leveling of the preparation.

In another aspect, the bis-oxazolidine compounds when added to polyurethane formulations maintain or prolong the potlife or shelf life of the formulation while providing good cure response. The bis-oxazolidines of the present invention maintain or prolong potlife by functioning as moisture scavengers, or by reducing the reactivity of the formulation.

Pigments, fillers, and adjuvants can be added to the coating compositions. For the purposes of this invention the term "fillers" is intended to include those non-reactive materials added to a coating preparation to increase the solids content of the coating. The term "adjuvants" is intended to include those materials which are added to the coating formulation to aid application or formation, such as surface active agents, anti-settling agents, diluents, suspending agents, dispersants, flow additives, UV inhibitors and the like.

The following examples are presented to describe preferred embodiments and utilities of the present invention and are not meant to limit the present invention unless otherwise stated in the claims appended hereto.

EXAMPLES

5 **Example 1: Preparation of 1-aza-3,7-dioxo-2,8-diisopropyl-5-ethyl bicyclo (3.3.0) octane**

In a 12-liter, 4-neck, round-bottom flask equipped with a 1-liter addition funnel and a Dean-Stark receiver, (500 ml. liter capacity) was charged with 2-amino-2-ethyl-1, 3-propanediol (3,618 grams; 30.29 mol.) under a nitrogen-atmosphere.
10 The liquid was rapidly stirred. To the liquid, isobutyraldehyde (4,468 grams; 60.72 mol.; 98% pure) was added through the 1-liter addition funnel over a period of 115 minutes. After the addition of the isobutyraldehyde was completed, the reactor and the Dean-Stark receiver were insulated with glass wool, and heating was started. The reaction mixture was heated to reflux continuously for about 24 hours. After this
15 time, a total of 1,060 grams of water had been removed. Thereafter, the reaction mixture was allowed to cool overnight. Vacuum stripping to remove any remaining water and any excess isobutyraldehyde was initiated at 40-45 mm Hg, and continued for 5 hours. During this procedure, a total of 364 grams of liquid (two layers) was removed, 51 grams of which was water and 313 grams of which was organic liquid
20 (mainly isobutyraldehyde). After the vacuum stripping was completed, 6,558.7 grams of a yellow liquid. Gas chromatographic analysis showed that 86.88% of this remaining liquid was 1-aza-3,7-dioxo-2,8-bicyclo-diisopropyl-5-ethyl (3.3.0) octane.

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example and were
25 herein described in detail. It should be understood, however, that it is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

Example 2: Preparation of Coatings

30 Clear and pigmented polyester based coatings and clear and pigmented acrylic based coatings were prepared. The ingredients listed as Component I in the tables below were combined in an air-mixer (Fawcett Co. Inc., Richfield, Ohio). After

Component I was prepared, the ingredients listed as Component II were added to Component I in the same air-mixer or by hand to prepare a polyurethane coating.

TABLE 1

TWO-COMPONENT POLYURETHANE ACRYLIC CLEAR COAT		
PARTS BY WEIGHT (g)		
	CONTROL	RD-20 (20%)
<u>Component I</u>		
Desmophen LS2945 [®]	514.79	407.23
RD-20	-	67.47
MEK	79.83	66.27
MIBK	39.91	33.13
Exxate 600 [®]	39.91	22.13
<u>Component II</u>		
Desmodur XP7014 [®]	162.91	240.96
<u>Total</u>	<u>837.35</u>	<u>848.20</u>

TABLE 2

2K POLYURETHANE COATING ACRYLIC-PIGMENTED				
MATERIAL	CONTROL WEIGHT (g)	RD-20 10% WEIGHT (g)	RD-20 20% WEIGHT (g)	RD-20 30% WEIGHT (g)
<u>Component I</u>				
Desmophen LS2945 [®]	380.96	358.30	304.96	282.46
Anti Terra U [®]	18.02	19.66	18.72	18.24
TiO ₂ (R-960)	360.28	408.94	389.41	379.49
MEK (UG)	102.16	81.13	86.93	74.13
MIBK (UG)	51.69	40.54	43.52	37.07
Exxate 600 [®]	51.69	40.54	43.52	37.07
<u>Component II</u>				
RD-20	-	26.97	50.53	75.08
Desmodur XP7014 [®]	120.55	158.75	180.45	216.14
% Solids by wt.	69.70	75.37	75.42	78.37
VOC lbs/gal*	3.29	2.80	2.75	2.42

Note: Formulas may vary slightly depending on raw materials variations.

* VOC if all RD-20 reacted into film.

TABLE 3

2K POLYURETHANE COATING POLYESTER CLEAR COAT		
MATERIAL	PARTS BY WEIGHT (g)	
	CONTROL	RD-20 (20%)
Component I		
Desmophen 670-80 [®]	482.42	367.10
RD-20	-	69.21
MEK	57.96	46.13
Xylene	57.96	46.13
Component II		
n-Butyl Acetate	57.96	46.13
Desmodur N3390 [®]	217.31	300.90

TABLE 4

2K POLYURETHANE COATING POLYESTER-PIGMENTED				
MATERIAL	PARTS BY WEIGHT (g)			
	CONTROL	RD-20 (10%)	RD-20 (20%)	RD-20 (30%)
Component I				
Desmophen 670-80 [®]	375.34	343.89	285.53	258.47
RD-20	-	29.87	54.37	81.62
Anti Terra U [®]	15.63	15.57	14.83	15.57
TiO ₂ (R-960)	367.03	381.09	360.60	375.03
MEK	66.55	53.50	57.39	44.56
n-Butyl Acetate	66.55	53.50	57.39	44.56
Component II				
Xylene	66.55	53.50	57.39	44.56
Desmodur N3390	169.54	214.54	236.69	278.36
% Solids by weight	73.43	77.43	76.84	80.66
VOC lbs/gal*	3.00	2.59	2.60	2.21

* VOC if all RD-20 reacted into film.

Example 3: Physical Properties

The physical properties of a cured coating as described in example 2 were determined as follows.

Weatherability

5 The destructive action of natural outdoor weather produces changes in the properties of the coating including changes in color, texture, strength, chemical composition and loss of gloss. Weathering properties of coatings are tested by two well known standardized techniques.

10 Accelerated weathering tests (ASTM G-53, D-523, and D-2244) were performed on a QUV accelerated weathering tester (Model QUV, Q-Panel, Cleveland, Ohio). A polyester pigmented coating and an acrylic pigmented coating were prepared according to example 2. A 1.8-2.2 mil thick coating was applied to a metal panel and cured. The coating was exposed to 2,000 hours of QUV condensation exposure. QUV is ultraviolet radiation of 190 nm to 250 nm.

15 After 2,000 hours of QUV exposure, gloss retention and color retention were measured. As shown in table 6, after 2,000 hours of QUV condensation exposure, when gloss was measure at 20°, a coating which did not contain RD-20 retained only 2.6% of the original gloss. In marked contrast, the coating with 30% RD-20 retained 100% of the original gloss. Table 5 shows similar improvements in gloss retention at
20 60° and 85° for acrylic based coatings with the indicated amounts of RD-20.

Table 6 further shows the color retention of polyester coatings with and without RD-20. Delta E is the color cumulative change which occurs after 2,000 hours of QUV condensaton exposure.

25 Weatherability can also be tested by exposing coatings to natural outdoor weather (ASTM D-4141, Procedure C; D-1641, Section 5; D-523 and D-2244). These procedures are carried out by exposing coated panels to southern exposure at 90°, 45°, or 5° (from ground).

Impact Resistance

30 Impact resistance is the ability of a coating to resist deformation upon impact. Impact resistance was tested according to ASTM D-2794. Briefly, a weighted plunger was dropped from various distances feet onto the front (direct) or the back

(reverse) of a panel coated with a 2-K pigmented acrylic based coating of Example 2. The distance at which the plunger is dropped onto the panel is increased until the coating film is broken. Coatings containing no RD-20 were damaged by 35 pounds/in² (direct impact) and less than 5 pounds/in² was required to damage the coating from the reverse impact (Table 8) The addition of RD-20 increased the impact resistance of the coatings. Coatings which contain 30% RD-20 were not damaged from a direct impact until 160 pounds/in² was dropped onto the coated pane. Similarly, the reverse impact strength was also increased to 110 pounds/in². In summary, the direct impact resistance was increased by about 450% and the reverse impact strength was increased by over 2,200%.

Abrasion Resistance

Abrasion resistance is the ability of a coating to resist being worn away. Abrasion (taber) resistance was tested according to ASTM D-4060. A 2-K pigmented acrylic based coating of Example 2 was applied to a pre-wetted panel and placed on a turntable. The turntable rotated the panel under a 1 Kg abrading wheel (CS-17) for 1,000 revolutions. The abrading wheel wears away the coating through side-slip. After 1,000 revolutions, the panel was weighed to determine the amount of loss. Table 8 shows that the addition of RD-20 improves the abrasion resistance of a 2-K coating. Coatings without RD-20 lost 78 mg while coatings with 30% RD-20 and 0.01% T-12 catalyst lost only 55 mg.

Chemical Resistance

Chemical resistance is the ability of a coating to resist attack by organic chemicals. Typical solvents include xylenes, toluenes, alcohols, and methyl ethyl ketone (MEK). Chemical resistance was tested according to ASTM D-4752. A polyester pigmented coating of Example 2 was applied and cured. The coating was then subjected to 100 double rubs with a cheesecloth which was soaked with an organic chemical (Table 9). The numbers in the chemical resistance row of table 9 are arbitrary numbers from 1-10 (10 being best) based upon loss of gloss or burnishing after exposure to the identified chemical. 10% RD-20 improved the coating's resistance to MEK and toluene.

Chip Resistance

Chip resistance is the ability of a coating or layers of coating to resist a total or partial removal from impact by hard objects such as gravel or rocks. The chip resistance of a 2-K pigmented acrylic based coating of Example 2 was tested according to ASTM D-3170. The number and letter combination of table 8 are arbitrary numbers defined by the number and size of the chips on a 4" X 4" panel. High numbers and early letters signify better chip resistance. For example, a coating with a rating of 3A shows better chip resistance than a coating with a rating of 2B. An acrylic coating with 20% RD-20 showed superior chip resistance to coatings without RD-20 (Table 8).

Salt Resistance

Salt resistance is the ability of a coating to resist corrosion by aqueous salt solutions such as found near oceans and on salted roads. Salt resistance is tested according to ASTM B-117. In this test, a coated panel is sprayed with an acidic acid salt solution and steam (salt spray) and incubated at 95° F for a specified number of days. The salt resistance of the coating is determined by the amount of corrosion and blistering observed on the panel and how quickly the corrosion and blistering occurs and compared with a coated panel that has not been exposed to the salt spray.

Acid Resistance

Acid resistance is the ability of a coating to resist attack by acids such as that found in acid rain and other acidic environmental conditions. Acid resistance is tested according to ASTM D-1308. Acid resistance is determined by exposing a coated panel to an acidic solution for a specified number of hours. The acid resistance of the coating is determined by the amount of staining and/or loss of gloss in comparison with a coated panel that has undergone similar treatment without exposure to the acidic solution.

TABLE 5

ACRYLIC PIGMENTED SYSTEM (2,000) HRS QUV				
	CONTROL (No RD-20)	RD-20 (10%)	RD-20 (20%)	RD-20 (30%)
Gloss Original/ % Retention				
20°	84/76.2	83/81.9	79/79.8	85/83.5
60°	88/94.3	87/96.6	87/95.4	92/98.9
85°	100/97.0	100/97.0	100/95.0	100/99.0
Color Retention				
Delta E L* a* b*	2.27	2.06	2.28	2.47

TABLE 6

POLYESTER PIGMENTED SYSTEM (2,000) HRS QUV				
	CONTROL (No RD-20)	RD-20 (10%)	RD-20 (20%)	RD-20 (30%)
Gloss Original/ % Retention				
20°	88/2.2	85/43	82/79.6	76/100.0
60°	94/24	90/92	90/100.0	91/100.0
85°	96/82	95/100	93/100.0	97/100.0
Color Retention				
Delta E L* a* b*	0.67	0.17	0.62	0.48

TABLE 7

POLYESTER PIGMENTED SYSTEM				
	CONTROL (No RD-20)	RD-20 (10%)	RD-20 (20%)	RD-20 (30%)
Potlife Zahn #3 (hrs)	6+	5-1/2	8	9

TABLE 8

ACRYLIC PIGMENTED SYSTEM						
	CONTROL No RD-20	RD-20 10%	RD-20 20%	RD-20 20%*	RD-20 30%	RD-20 30%*
Speed of Dry Set to Touch (minutes)	40	60		60	7-16 hrs.	60
Taber Abrasion (CS-17 wheel, 1000g wt) Wt loss/1,000 cycles (mg)	78,109	68	86	59	75	55
Impact Resistance (direct) in. lbs	35	45		105	160	155
Impact Resistance (reverse) in. lbs	<5	<5		45	110	80
Chip Resistance	2B		3A/4B			

* These coatings contained 0.01% dibutyltin dilaurate (T-12 catalyst).

TABLE 9

POLYESTER PIGMENTED SYSTEM					
	CONTROL No RD-20	RD-20 10%	RD-20 20%	RD-20 30%	RD-20 20%*
Chemical Resistance					
MEK	9	10	10	10	10
IPA	10	10	10	10	10
Toluene	9	10	10	10	10

* This coating contained 0.005% dibutyltin dilaurate and 1.25% pentane dione as catalysts.

Example 3: Potlife

Pot-life is the time that a preparation can be stored without gelling. Potlife is determined by observing the viscosity of a coating at timed intervals. The time required for the viscosity increase to a predetermined level is the potlife of the sample. As used herein, potlife is defined as the increase in viscosity from an initial viscosity of 18 seconds to a viscosity of 30 seconds on a Zahn #3 cup. A 2 component polyester based clear-coat with a viscosity of 18 seconds on a Zahn #3 cup was prepared. The viscosity of the coating was determined every 30 minutes until a viscosity of 30 seconds was reached. The addition of RD-20 increased the potlife from about 3.5 hours to over 4.5 hours, an increase of about 30%. The use of RD-20 not only provided longer pot life but also lowered the VOC and provided better film properties as shown in the tables and examples above.

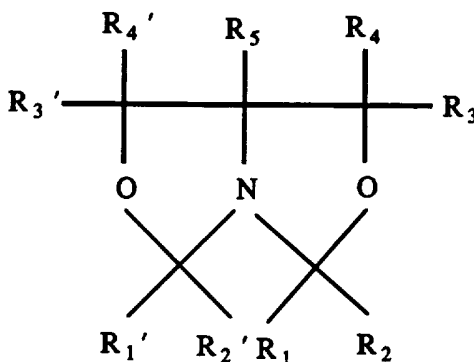
TABLE 10

2K POLYESTER CLEAR COAT		
	CONTROL (NO RD)	RD-20 (20%)
Potlife Zahn #3 (hrs)	3-1/2	4-1/2+

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example and were herein described in detail. It should be understood, however, that it is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims. Any R group substituents which increase the reactivity of a compound of the present invention to water are within the scope of the present invention. For example, alkenyl and alkynyl groups or substituent R groups may be selected as R group substituents if these groups increase the reactivity of the compound to water or formaldehyde. Likewise, any R group substituents which increase the reactivity of a reactive diluent compound to the active material whose concentration is to be reduced are within the scope of the present invention. Additionally, any R group substituents which improve the physical properties of a preparation are within the scope of the present invention.

WHAT IS CLAIMED:

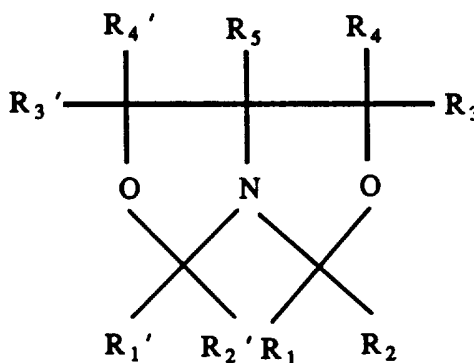
1. A method of improving the physical properties of a preparation, comprising admixing with the preparation an effective amount of a bis-oxazolidine compound having the structure:



wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group.

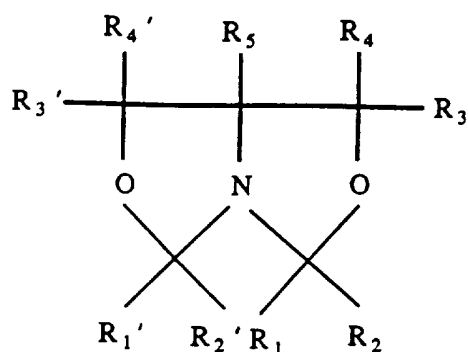
2. The method of improving the physical properties of claim 1, wherein said physical property is resistance to weathering.
3. The method of improving the physical properties of claim 1, wherein said physical property is impact resistance.
4. The method of improving the physical properties of claim 1, wherein said physical property is chip resistance.
5. The method of improving the physical properties of claim 1, wherein said physical property is abrasion resistance.
6. The method of improving the physical properties of claim 1, wherein said physical property is salt resistance.
7. The method of improving the physical properties of claim 1, wherein said physical property is acid resistance.
8. The method of improving the physical properties of claim 1, wherein said physical property is organic chemical resistance.

9. The method of improving the physical properties of claim 1, wherein said preparation is a coating, elastomer, adhesive or sealant.
10. The method of improving the physical properties of claim 1, wherein said preparation is a polyurethane coating.
11. The method of claim 10, wherein said polyurethane coating further includes a blocked polyisocyanate.
12. The method of claim 10, wherein said preparation is a two component polyurethane coating.
13. The method of claim 10, wherein said preparation is a one component polyurethane coating.
14. The method of improving the physical properties of claim 1, wherein the effective amount of said bis-oxazolidine compound is from about 1 to about 80 weight percent of the total weight of said preparation.
15. The method of improving the physical properties of claim 1, wherein the effective amount of said bis-oxazolidine compound is from about 1 to about 50 weight percent of the total weight of said preparation.
16. The method of improving the physical properties of claim 1, wherein the effective amount of said bis-oxazolidine compound is from about 1 to about 30 weight percent of the total weight of said preparation.
17. A method of improving the potlife of a preparation, comprising admixing with the preparation an effective amount of a bis-oxazolidine compound having the structure:



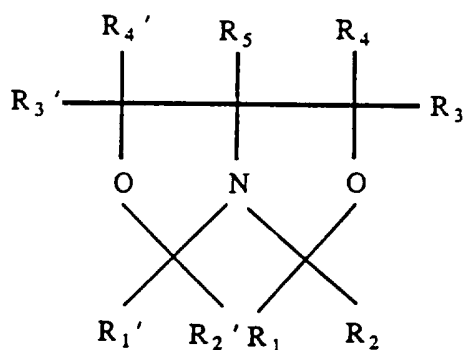
wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group.

18. The method of improving the potlife of claim 17, wherein said preparation is a coating, elastomer, adhesive or sealant.
19. The method of improving the potlife of claim 17, wherein said preparation is a polyurethane coating.
20. The method of improving the potlife of claim 19, wherein said polyurethane coating further includes a blocked polyisocyanate.
21. The method of improving the potlife of claim 19, wherein said preparation is a two component polyurethane coating.
22. The method of improving the potlife of claim 19, wherein said preparation is a one component polyurethane coating.
23. The method of improving the potlife of claim 17, wherein the effective amount of said bis-oxazolidine compound is from about 1 to about 80 weight percent of the total weight of said preparation.
24. The method of improving the potlife of claim 17, wherein the effective amount of said bis-oxazolidine compound is from about 1 to about 50 weight percent of the total weight of said preparation.
25. The method of improving the potlife of claim 17, wherein the effective amount of said bis-oxazolidine compound is from about 1 to about 30 weight percent of the total weight of said preparation.
26. A method of inhibiting corrosion in a refrigeration system comprising admixing with the refrigerant of said refrigeration system an effective amount of a bis-oxazolidine compound having the formula:



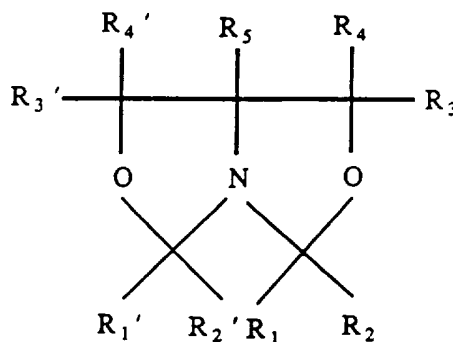
wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group.

27. The method of inhibiting corrosion of claim 26, wherein the effective amount of said bis-oxazolidine compound is from about 1 to about 30 weight percent of the total weight of said refrigerant.
28. The method of inhibiting corrosion of claim 26, wherein the effective amount of said bis-oxazolidine compound is from about 1 to about 20 weight percent of the total weight of said refrigerant.
29. The method of inhibiting corrosion of claim 26, wherein the effective amount of said bis-oxazolidine compound is from about 1 to about 10 weight percent of the total weight of said refrigerant.
30. A method of reducing the volatile organic content of a coating containing a polyisocyanate comprising admixing said coating with an effective amount of a bis-oxazolidine compound having the formula:



wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group.

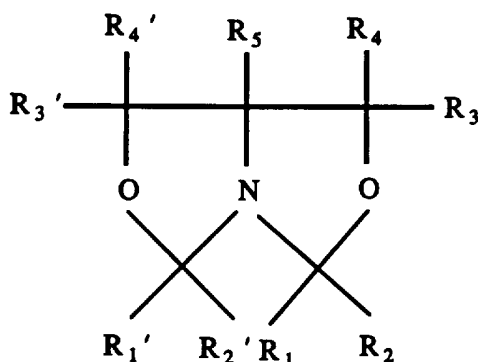
31. The method of reducing the volatile organic content of a coating of Claim 30, wherein said coating is a polyurethane coating.
32. The method of reducing the volatile organic content of a coating of Claim 31, wherein said coating is a one component polyurethane coating.
33. The method of reducing the volatile organic content of a coating of Claim 30, wherein said coating is an automotive coating.
34. The method of reducing the volatile organic content of a coating of Claim 33, wherein said coating is a clearcoat.
35. The method of reducing the volatile organic content of a coating of Claim 30, wherein said coating is a sprayable coating.
36. The method of reducing the volatile organic content of a coating of Claim 30, wherein the effective amount, in weight, of said bis-oxazolidine compound is from about 1 to about 80 weight percent of the total weight of said coating.
37. The method of reducing the volatile organic content of a coating of Claim 30, wherein the effective amount, in weight, of said bis-oxazolidine compound is from about 1 to about 50 weight percent of the total weight of said coating.
38. The method of reducing the volatile organic content of a coating of Claim 30, wherein the effective amount, in weight, of said bis-oxazolidine compound is from about 1 to about 30 weight percent of the total weight of said coating.
39. A method of improving the rheological properties of a preparation comprising admixing said preparation with an effective amount of a bis-oxazolidine compound having the formula:



wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group, wherein said coating further includes a blocked polyisocyanate.

40. The method of improving the rheological properties of a coating of Claim 39, wherein said preparation is a coating, elastomer, adhesive or sealant.
41. The method of improving the rheological properties of a coating of Claim 39, wherein said coating is a polyurethane coating.
42. The method of improving the rheological properties of a coating of Claim 41, wherein said polyurethane coating further includes a blocked polyisocyanate.
43. The method of improving the rheological properties of a coating of Claim 41, wherein said preparation is a two component polyurethane coating.
44. The method of improving the rheological properties of a coating of Claim 41, wherein said preparation is a one component polyurethane coating.
45. The method of improving the rheological properties of a coating of Claim 39, wherein said coating is an automotive coating.
46. The method of improving the rheological properties of a coating of Claim 45, wherein said coating is a clearcoat.
47. The method of improving the rheological properties of a coating of Claim 39, wherein said coating is a sprayable coating.
48. The method of improving the rheological properties of a coating of Claim 39, wherein the effective amount, in weight, of said bis-oxazolidine compound is from about 1 to about 80 weight percent of the total weight of said coating.
49. The method of improving the rheological properties of a coating of Claim 39, wherein the effective amount, in weight, of said bis-oxazolidine compound is from about 1 to about 50 weight percent of the total weight of said coating.
50. The method of improving the rheological properties of a coating of Claim 39, wherein the effective amount, in weight, of said bis-oxazolidine compound is from about 1 to about 30 weight percent of the total weight of said coating.

51. A coating composition comprising a polyisocyanate, a bis-oxazolidine compound having the formula:



- wherein: R_1 and R_1' are, individually, a methyl group, or a branched or straight chain alkyl or alkanol group; R_2 , R_3 , R_4 , R_2' , R_3' , and R_4' are, individually, a hydrogen atom, a methyl group, a straight chain or branched chain alkyl or alkanol group, a cyclic alkyl or an aryl group; and R_5 is a methyl or methylol group, or a branched chain or straight chain alkyl or alkanol group and at least one component selected from the group consisting of polyol, pigment, filler, adjuvant, and solvent.
52. The coating composition of Claim 51, wherein said polyisocyanate is a blocked polyisocyanate.
53. The coating composition of Claim 51, wherein said coating is a polyurethane coating.
54. The coating composition of Claim 53, wherein said coating is a one component polyurethane coating.
55. The coating composition of Claim 53, wherein said coating is a two component polyurethane coating.
56. The coating composition of Claim 51, wherein said coating is an automotive coating.
57. The coating composition of Claim 56, wherein said coating is a clearcoat.
58. The coating composition of Claim 51, wherein said coating is a sprayable coating.

59. The coating composition of Claim 51, wherein the amount, in weight, of said bis-oxazolidine compound is from about 1 to about 80 weight percent of the total weight of said coating.
60. The coating composition of Claim 51, wherein the amount, in weight, of said bis-oxazolidine compound is from about 1 to about 50 weight percent of the total weight of said coating.
61. The coating composition of Claim 51, wherein the amount, in weight, of said bis-oxazolidine compound is from about 1 to about 30 weight percent of the total weight of said coating.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/11810

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(6) : B01J 13/00; C09K 5/00, 3/00; C08K 5/34, 5/48; B01D 19/04
 US CL : 252/315.1, 67; 524/94
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
 Minimum documentation searched (classification system followed by classification symbols)
 U.S. : 252/315.1, 67-69, 321, 387, 388, 397, 399, 405, 407; 524/94, 589; 106/13, 14.05, 14.16, 14.37, 20R, 287.2, 287.21, 287.23

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 Please See Extra Sheet.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 APS Text Search

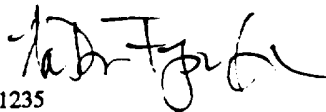
C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US, A, 4,101,527 (CUNNINGHAM ET AL.) 18 July 1978, see abstract, Tables I and II, and claims 1-10.	1-25, 30-61 ----- 26-29
X --- Y	US, A, 4,046,744 (JENKINS) 06 September 1977, see abstract, examples 1-7, and claims 1-18.	1-25, 30-61 ----- 26-29
X --- Y	US, A, 5,126,421 (MAJEWSKI ET AL.) 30 July 1992, see abstract, column 2, line 46 to column 3, line 16, and claims 1-40.	1-25, 30-61 ----- 26-29
Y	US, A, 5,328,635 (CHOU ET AL.) 12 July 1994, see abstract, examples 1-16 and claims 1-17.	1-61
Y	US, A, 4,227,353 (DEEN ET AL.) 07 July 1981, see abstract, examples 1-4 and claims 1-5.	1-61

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents: *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art *&* document member of the same patent family
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Date of the actual completion of the international search 27 DECEMBER 1995	Date of mailing of the international search report 23 JAN 1996
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Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JOSEPH D. ANTHONY  Telephone No. (703) 308-1235
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INTERNATIONAL SEARCH REPORTInternational application No.
PCT/US95/11810

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4,629,753 (QUINN) 16 December 1986, see abstract, column 20, line 28 to column 21, line 19, and claims 1-65.	1-61
A	US, A, 4,627,932 (GOEL ET AL.) 09 December 1986, see abstract, and claims 1-4.	1-61