Title: METHOD FOR PRODUCING SPRAYABLE MIXTURE CONTAINING PROTECTED CROSSLINKABLE GROUPS

Abstract: The present disclosure relates to a method for producing a sprayable mixture containing protected crosslinkable groups. The sprayable mixture has a substantially consistent viscosity and can produce a crosslinked coating composition having a good appearance useful in the painting industry.
The present invention is directed to a painting operation and method for controlling the viscosity of a coating composition wherein the coating composition is a sprayable mixture containing protected crosslinkable groups. This spray-applied mixture subsequently forms a layer of the coating composition which can be dried and cured to form a durable protective coating on a substrate.

BACKGROUND OF INVENTION
[02] Automobile coatings typically comprise crosslinked polymer network formed by multiple reactive components. The coatings are typically sprayed onto a substrate such as automobile vehicle body or body parts using a spray device and then cured to form a coating layer having such crosslinked polymer network.

[03] In spray technologies currently used, multiple reactive components of a coating composition are mixed to form a pot mix prior to spraying and placed in a cup-like reservoir or container that is attached to a spraying device such as a spray gun. Due to the reactive nature of the multiple reactive components, the pot mix will start to react as soon as they are mixed together causing continued increase in viscosity of the pot mix. Once the viscosity reaches a certain point, the pot mix becomes practically un-sprayable. The possibility that the spray gun itself may become clogged with crosslinked polymer materials is also disadvantageous. The time it takes for the viscosity to increase to such point where spraying becomes ineffective, generally up to a two-fold increase in viscosity, is referred to as "pot life".

[04] Long pot life coating mixtures can be produced using crosslinkable groups that are protected. The protected crosslinkable groups do not react to form the crosslinked network until they have undergone a deprotection reaction. Protected crosslinkable groups are able to form pot mixes containing the crosslinkable components, the crosslinking components and the crosslinking catalysts having a long pot life. When these pot mixes are
spray applied to a substrate, humidity in the air can be enough to cause the 
hydrolysis reaction to occur and form a crosslinked network. However, there 
is a relatively narrow range of ambient humidity that will allow this coating 
composition to crosslink at a useful rate. Too much humidity and the 
appearance can be unacceptable, and too low of a humidity and the applied 
layer of coating composition can cure too slowly. 

Another way to extend "pot life" is to add a greater amount of thinning 
solvent, also known as thinning agent, to the pot mix. However, thinning 
agent, such as organic solvent, contributes to increased emissions of volatile 
organic compounds (VOC) and also increases the curing time. 

Other attempts to extend "pot life" of a pot mix of a coating composition 
have focused on "chemical-based" solutions. For example, it has been 
suggested to include modifications of one or more of the reactive components 
or certain additives that would retard polymerization reaction of the multiple 
components in the pot mix. The modifications or additives must be such that 
the rate of curing is not adversely affected after the coating is applied to the 
surface of a substrate. 

Another approach is to mix one or more key components, such as a 
catalyst, together with other components of the coating composition 
immediately prior to spraying. One example is described in U.S. Patent No. 
7,201,289 in that a catalyst solution is stored in a separate dispenser and 
being dispensed and mixed with a liquid coating formulation before the 
coating formulation is atomized. 

Yet another approach is to separately atomize two components, such 
as a catalyst and a resin, of a coating composition, and mix the two atomized 
components after spray. One such example is described in U.S. Patent No. 
4,824,017. However, such approach requires atomization of two components 
separately by using separate pumps and injection means for each of the two 
components. 

**STATEMENT OF THE INVENTION** 

The following disclosure relates to a painting operation and a method 
for controlling the viscosity of a coating composition wherein said coating 
composition is a sprayable mixture, said method comprising the steps of:
(A) producing a first atomized stream of a first coating component of said coating composition through an orifice of said spray gun with a stream of a pressurized carrier, wherein said first coating component is stored in a first storage container and conveyed through a first inlet of said spray gun to said orifice and wherein the viscosity of said first coating component remains substantially constant prior to being conveyed through said first inlet;

(B) producing a second atomized stream of a second coating component of said coating composition, wherein the second atomized stream is produced by siphoning the second coating component with a siphoning stream selected from the first atomized stream of the first coating component, the stream of the pressurized carrier, or a combination thereof, from at least one delivery outlet coupled to a second storage container containing said second coating component, said delivery outlet being positioned at said orifice;

(C) optionally, regulating the supply of the second coating component to said delivery outlet by coupling a regulatory device to said delivery outlet;

(D) intermixing the first atomized stream and the second atomized stream to form a coating mixture; and

(E) applying the coating mixture on the substrate to form the layer of said coating composition thereon; and

wherein the coating composition comprises protected crosslinkable functional groups.

[10] The present disclosure also describes a method comprising the steps of:

(A) producing a first atomized stream of a first coating component of said coating composition through an orifice of said spray gun with a stream of a pressurized carrier, wherein said first coating component is stored in a first storage container and conveyed through a first inlet of said spray gun to said orifice and wherein the viscosity of said first coating component remains substantially constant prior to being conveyed through said first inlet;
(B) producing a second atomized stream of a second coating component of said coating composition, wherein the second atomized stream is produced by siphoning the second coating component with a siphoning stream selected from the first atomized stream of the first coating component, the stream of the pressurized carrier, or a combination thereof, from at least one first delivery outlet of a delivery device coupled to a second storage container containing said second component, said first delivery outlet being positioned at said orifice;

(C) optionally, regulating the supply of the second coating component to said first delivery outlet by coupling a first regulatory device to said first delivery outlet;

(D) producing a subsequent atomized stream of a subsequent coating component of said coating composition, wherein the subsequent atomized stream is produced by siphoning the subsequent coating component with the siphoning stream from at least one subsequent delivery outlet coupled to a subsequent storage container containing said subsequent component, said subsequent delivery outlet being positioned at said orifice;

(E) optionally, regulating the supply of the subsequent coating component to said subsequent delivery outlet by coupling a subsequent regulatory device to said subsequent delivery outlet;

(F) intermixing the first atomized stream, the second atomized stream and the subsequent atomized stream to form a coating mixture; and

(G) applying the coating mixture on the substrate to form the layer of said coating composition thereon; and

wherein said coating composition comprises protected crosslinkable functional groups.

**BRIEF DESCRIPTION OF DRAWING**

[11] **Figure 1** shows a spray gun affixed with an example of a representative delivery device of this invention.

[12] **Figure 2** shows frontal views of the delivery device viewed from the direction 2A indicated in Figure 1. (A) A schematic presentation of a representative example of the delivery device 2D constructed as an add-on device. (B) A schematic presentation of a representative example of the
delivery device 2' having one delivery outlet constructed into the air cap of the spray gun. (C) A schematic presentation of a representative example of the delivery device 2'' having two delivery outlets constructed into the air cap of the spray gun. (D) A schematic presentation of a representative example of the delivery device 2''' having three delivery outlets (14) constructed into the air cap of the spray gun.

[13] Figure 3 shows an enlarged frontal view, in a schematic presentation, of a representative example of the delivery device 2D constructed as an add-on device that can be affixed to an air cap of a spray gun. A single intake coupling (8) is shown.

[14] Figure 4 shows an enlarged frontal view, in a schematic presentation, of another representative example of the delivery device 2D' constructed as an add-on device that can be affixed to an air cap of a spray gun. Two intake couplings (8) are shown.

[15] Figure 5 shows an enlarged frontal view of details of the delivery device and the relative position of the delivery device and the orifice of the spray gun. Two delivery outlets (14), two connection paths (11) and one orifice (13) are shown. The arrows 6 indicate the direction of a cross-sectional view used in Figures 6, 7 and 8.

[16] Figure 6 shows an enlarged side cross sectional view of details of one example of the delivery device and the relative position of the delivery device and the orifice of the spray gun. The orifice (13) can be positioned in three different regions indicated with a, b and c, respectively.

[17] Figure 7 shows schematic presentations of examples of the formation of a coating mixture. (A) An example of a first coating component that is atomized at an orifice of a spray gun without the introduction of a second coating component. (B) An example of the coating mixture formed by an atomized first coating component and an atomized second coating component.

[18] Figure 8 shows schematic presentations of another example of the formation of a coating mixture. (A) A first coating component atomized at an orifice of a spray gun without the introduction of a second coating component. (B) A coating mixture formed by an atomized first coating component and an atomized second coating component.
Figure 9 shows additional examples of the delivery device of this invention constructed as an add-on device. (A) An example of the delivery device that has a configuration of two intake couplings (8) and two delivery outlets (14). (B) An example of the delivery device that has a configuration of two intake couplings (8) and one common delivery outlet (14). The orifice (13) is shown in the figure to indicate relative position of the delivery device when affixed to the air cap. The orifice (13) is part of the spray gun.

Figure 10 shows schematic presentations of different configurations of the delivery device of this invention. (A) An example of a delivery device having one intake coupling that is coupled to one storage container. (B) An example of a delivery device having one intake coupling that is coupled to two individual storage containers. (C) An example of a delivery device having two intake couplings that are coupled to two storage containers. (D) An example of a delivery device having three intake couplings that all three of them are coupled to a single storage container. (E) An example of a delivery device having three intake couplings that one of them is coupled to an individual storage container while other two are coupled to a single container. (F) Another example of a delivery device having three intake couplings that only one of them is coupled to a single storage container. (G) Another example of a delivery device having three intake couplings that two of them are coupled to a single storage container. (H) Another example of a delivery device having three intake couplings that each of the first and the second is coupled to an individual storage container while the third is not coupled to any container. The schematic representations are for illustration purposes only and items in the presentations may not be to scale. The orifice (13) is part of the spray gun.

Figure 11 shows an example of another representative configuration.

DETAILED DESCRIPTION

The features and advantages of the present invention will be more readily understood, by those of ordinary skill in the art, from reading the following detailed description. It is to be appreciated that certain features of the invention, which are, for clarity, described above and below in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention that are, for
brevity, described in the context of a single embodiment, may also be provided separately or in any sub-combination. In addition, references in the singular may also include the plural (for example, "a" and "an" may refer to one, or one or more) unless the context specifically states otherwise.

5 [23] The use of numerical values in the various ranges specified in this application, unless expressly indicated otherwise, are stated as approximations as though the minimum and maximum values within the stated ranges were both proceeded by the word "about". In this manner, slight variations above and below the stated ranges can be used to achieve substantially the same results as values within the ranges. Also, the disclosure of these ranges is intended as a continuous range including every value between the minimum and maximum values.

[24] As used herein:

[25] The phrase "coating composition" means a solventborne or waterborne liquid composition that can be applied to a substrate via a spray gun. The coating composition comprises a crosslinkable component and a crosslinking component. Other additives that are used to produce a coating composition are known in the art and, in general, are not discussed herein. Such additives can include organic solvents, aqueous solvents, pigments, rheology control agents, light stabilizers and leveling agents. In one embodiment, the coating composition comprises crosslinkable and crosslinking components that can be mixed together to form a pot mix prior to being spray applied using the method described herein. In another embodiment, the coating composition comprises crosslinkable and crosslinking components as separate components that can be applied as separate components using the method described herein.

[26] The phrase "pot mix" means a mixture comprising a crosslinkable component and a crosslinking component that is formed prior to spray application. The pot mix can be added to the first storage container (3).

[27] "Low VOC coating composition" means a coating composition that includes less than 0.6 kilograms per liter (5 pounds per gallon), preferably less than 0.52 kilograms per liter (4.3 pounds per gallon) and most preferably, less than 0.42 kilograms per liter (3.5 pounds per gallon), of volatile organic component, such as certain organic solvents. The phrase "volatile organic
component" is herein referred to as VOC. VOC level is determined under the procedure provided in ASTM D3960.

[28] The phrase "viscosity of a component remains substantially constant" means that the viscosity of the component shows, in one embodiment, an increase of less than 40% over an 8 hour period. In another embodiment, the increase in viscosity is less then 25% over a 12 hour period, and in a third embodiment, the viscosity increase is less than 10% over a 16 hour period. To measure the viscosity change over time, the viscosity of a component is measured at the time when the component is initially prepared; the component is stored in a covered container at room temperature for 8, 12 or 16 hours; the viscosity of the component is measured again using the same technique. The difference in the two viscosity measurements should not vary by more than percentages listed above. Several methods to measure the viscosity of a liquid are available. In one embodiment, the Zahn viscosity (in seconds) is measured.

[29] "Productive paint" describes a coating composition wherein an applied layer of the coating composition, 10 to 150 micrometers thick, can be dried and cured, in one embodiment, in less than 20 minutes at 60°C or in less than 90 minutes at room temperature. In another embodiment, the 10 to 150 micrometers thick layer of productive paint can be dried and cured in less than 10 minutes at 60°C or in less than 45 minutes at room temperature. In a third embodiment, the 10 to 150 micrometers thick layer of productive paint can be dried and cured in less than 5 minutes at 60°C or in less than 20 minutes at room temperature. Room temperature being defined as a temperature in the range of from 21°C to 24°C.

[30] By "dried and cured" is meant that the coating composition is crosslinked to the point that handling the substrate will not mar the surface, the substrate is dry to the touch and that dirt or dust won’t stick to the surface. While some crosslinking has occurred, additional crosslinking can continue over time which will allow for the sanding and/or buffing of the applied layer, if necessary. Preferably, the sanding and/or buffing operations can occur within one hour of being dried and cured, and more preferably within one-half hour.

[31] The phrase "consistent appearance" means that a measured appearance value of a layer of a dried and cured coating composition applied
at a time when the painting operation begins, does not vary by a given percentage over the measured appearance value of a layer of the same dried and cured productive paint applied at a time that is 8 hours after the painting operation began. The measured appearance values can be one or more of the distinctness of image (DOI), the long and short wavescan measurements of an applied coating. For the DOI measurement, the percentage change should be less than 10 percent and for the long and short wavescan measurements, the change should be less than 20 percent. As an example, a layer of a coating composition is applied to a first substrate using the method described herein. The applied layer of coating composition is dried and cured and the DOI, long and/or short wavescan measurements of the coating is obtained. After at least 8 hours, a similarly prepared second substrate is coated using the same method and with the same coating composition as was used to coat the first substrate. This second substrate is dried and cured using the same conditions as was used to dry and cure the first substrate. The measured appearance values should not vary by more than the percentages listed.

Distinctness of image and the long and short wavescan measurements can be measured using glossmeters or wavescan instruments available from Byk-Gardner USA, Columbia, Maryland.

The phrase "good appearance" means that a dried and cured multilayer of a coating composition applied using the method described herein has a short wavescan measurement of less than 40. Preferably, the short wavescan is less than 30. Most preferably, the short wavescan is less than 20. The long wavescan can also be measured, and to be considered as having a good appearance, the long wavescan measurement should be less than 15. To determine the wavescan measurement, at least one of the applied primer, basecoat or clearcoat layers should be applied according to the present method. In one embodiment, at least the clearcoat composition is applied according to the disclosed method, and in a second embodiment, at least the primer and clearcoat compositions are applied according to the disclosed method. In a third embodiment a layer of primer, basecoat and clearcoat compositions are applied using the disclosed method.
As used herein, "Crosslinkable component" includes a compound, oligomer or polymer having protected crosslinkable functional groups positioned in each molecule of the compound, oligomer, the backbone of the polymer, pendant from the backbone of the polymer, terminally positioned on the backbone of the polymer, or a combination thereof. The term "protected" means that the crosslinkable functional groups are not immediately available for curing with the crosslinking groups, but first must undergo a reaction to produce the crosslinkable functional groups. Suitable protected crosslinkable components having protected crosslinkable groups include, for example, amide acetal, orthocarbonate, orthoacetate, orthoformate, spiroorthoester, orthosilicate, oxazolidine or combinations thereof.

The protected crosslinkable groups generally are not crosslinkable without an additional chemical transformation. The chemical transformation for these groups can be a hydrolysis reaction that unprotects the group to form a crosslinkable group that can then be reacted with the crosslinking component to produce a crosslinked network. Each one of these protected groups, upon the deprotection reaction, forms at least one crosslinkable group. For example, upon hydrolysis, an amide acetal can form an amide diol or one of two amino alcohols. As another example, the hydrolysis of an orthoacetate can form a hydroxy group.

While the embodiments disclosed herein are intended to contain protected crosslinkable groups, a portion of the crosslinkable component can contain compounds, oligomers and/or polymers that have crosslinkable functional groups that do not need to undergo a chemical reaction to produce the crosslinkable group. Such crosslinkable groups are known in the art and include, for example, hydroxyl, acetoacetoxy, thiol, carboxyl, primary amine, secondary amine, epoxy, anhydride, imino, ketimine, aldimine, silane, aspartate or a suitable combination thereof.

"Crosslinking component" is a component that includes a compound, oligomer or polymer having crosslinking functional groups positioned in each molecule of the compound, oligomer, the backbone of the polymer, pendant from the backbone of the polymer, terminally positioned on the backbone of the polymer, or a combination thereof, wherein these functional groups are capable of reacting with the deprotected crosslinkable functional groups on
the crosslinkable component (during the curing step) to produce a coating in
the form of crosslinked structures. The crosslinking component can have on
an average 2 to 25, preferably 2 to 15, more preferably 2 to 7, and even more
preferably 3 to 5 crosslinking groups per molecule. Typical crosslinking
components can be selected from a compound, oligomer or polymer having
crosslinking functional groups selected from the group consisting of
isocyanate, amine, ketimine, melamine, epoxy, carboxylic acid, anhydride,
and a combination thereof.

[38] A coating composition can further comprise a catalyst, an initiator, an
activator or a combination thereof.

[39] A catalyst can initiate or promote the reaction between reactants, such
as between the deprotected crosslinkable functional groups of a crosslinkable
component and crosslinking functional groups of a crosslinking component of
a coating composition. The amount of the catalyst depends upon the reactivity
of functional groups. Generally, in the range of from about 0.001 percent to
about 5 percent, preferably in the range of from 0.01 percent to 2 percent,
more preferably in the range of from 0.02 percent to 1 percent, all in weight
percent based on the total weight of the crosslinkable component solids, of
the catalyst is utilized. A wide variety of catalysts can be used, such as, for
example, organotin compounds such as tin catalysts, dibutyl tin dilaurate, tin
(II) octanoate; 1,4-diazabicyclo[2.2.2]octane, zinc octoate, thphenyl
phosphine, quaternary ammonium compounds, strong bases, aluminum
halides, alkyl aluminum halides or tertiary amines, such as,
triethylenediamine, depending upon the deprotected crosslinkable and
crosslinking functional groups. These catalysts can be used alone or in
conjunction with carboxylic acids, such as, acetic acid. One example of
commercially available catalysts is dibutyl tin dilaurate as FASCAT® series
sold by Arkema, Bristol, Pennsylvania, under respective trademark.

[40] In one embodiment, an activator can be used to deprotect the
protected crosslinkable groups. Suitable activators include, for example,
water, water and acid, organic acids or a combination thereof. In one
embodiment, water or a combination of water and acid can be used as an
activator to deprotect the crosslinkable component. For example, water or
water with acid can be an activator for a coating described in PCT publication
WO2005/092934, published on October 6, 2005, wherein water activates hydroxyl groups by hydrolyzing orthoformate groups that block the hydroxyl groups from reacting with crosslinking functional groups.

[41] In another embodiment, an activator can be a compound, oligomer or polymer containing crosslinkable functional groups that react very quickly with the functional groups of the crosslinking group or the activator can be polymers having a high concentration of crosslinkable groups, for example, non-aqueous dispersion or hyperbranched polymers. Such fast reacting compounds, oligomer or polymers can be added as one of the components described herein to help to build the crosslinked network of the applied layer of coating composition. Examples of crosslinkable functional groups that react quickly with a crosslinking component comprising isocyanate groups include, amines and/or aspartates.

[42] An initiator can initiate one or more reactions. Examples can include photo initiators and/or sensitizers that cause photopolymeization or curing of a radiation curable coating composition, such as a UV curable coating composition upon radiation, such as UV irradiation. Many photo initiators are known to those skilled in the art and can be suitable for this invention. Examples of photo initiators can include, but not limited to, benzophenone, benzoin, benzoin methyl ether, benzoin-n-butyl ether, benzoin-iso-butyl ether, propiophenone, acetophenone, 1-hydroxycyclohexyl phenyl ketone, 2, 2-diethoxyacetophenone, ethylphenylpyloxylate, diphenyl (2,4,6-thmethylbenzoyl)-phosphine oxide, phosphine oxide, phenyl bis (2,4,6-trimethyl benzoyl), phenanthraquinone, and a combination thereof. Other commercial photo initiator products, or combinations thereof, include, for example, DAROCURE® and IRGACURE® products available from Ciba Specialty Chemicals Corporation, New York.

[43] In conventional coating practice using protected crosslinkable functional groups, the crosslinkable components and the crosslinking components can be mixed with the crosslinking catalyst and/or activators immediately prior to spraying. These catalyzed pot mixtures can have a pot life on the order of a few minutes to several hours, after which the viscosity has increased to the point where the spray application of the composition can become difficult. The pot life can depend on the ambient humidity, the
amount of water added to deprotect the protected crosslinkable groups and other factors. Too much or too little water available either from the ambient humidity or water added as an activator can impact not only pot life but the rate of curing and the appearance of the dried and cured coating composition. The present disclosure provides a method for controlling the viscosity of a coating composition so that the pot life can be increased over conventional coating practice and that the appearance of the dried and cured coating composition has a consistent appearance during the entire application period. A layer of dried and cured coating composition applied according to the disclosed method can also have a good appearance. [44] One embodiment of the disclosure is directed to a painting operation and a method for controlling the viscosity of a coating composition wherein said coating composition is a sprayable mixture comprising a protected crosslinkable functional group. The coating composition can comprise two or more coating components. The method can comprise the following steps:

(A) producing a first atomized stream of a first coating component of said coating composition through an orifice of said spray gun with a stream of a pressurized carrier, wherein said first coating component is stored in a first storage container and conveyed through a first inlet of said spray gun to said orifice, and wherein the viscosity of said first coating composition remains substantially constant prior to being conveyed through first inlet;

(B) producing a second atomized stream of a second coating component of said coating composition, wherein the second atomized stream is produced by siphoning the second coating component with a siphoning stream selected from the first atomized stream of the first coating component, the stream of the pressurized carrier, or a combination thereof, from at least one delivery outlet of a delivery device coupled to a second storage container containing said second component, said delivery outlet being positioned at said orifice;

(C) optionally, regulating the supply of the second coating component to said delivery outlet by coupling a regulatory device to said delivery outlet;
(D) intermixing the first atomized stream and the second atomized stream to form a coating mixture; and

(E) applying the coating mixture on the substrate to form the layer of said coating composition thereon,

wherein the coating composition comprises protected crosslinkable functional groups.

Another embodiment of the method to control the viscosity of a coating composition, wherein said coating composition is a sprayable mixture comprising a protected crosslinkable functional group, can comprise the steps of:

(A) producing a first atomized stream of a first coating component of said coating composition through an orifice of said spray gun with a stream of a pressurized carrier, wherein said first coating component is stored in a first storage container and conveyed through a first inlet of said spray gun to said orifice, and wherein the viscosity of said first coating composition remains substantially constant prior to being conveyed through first inlet;

(B) producing a second atomized stream of a second coating component of said coating composition, wherein the second atomized stream is produced by siphoning the second coating component with a siphoning stream selected from the first atomized stream of the first coating component, the stream of the pressurized carrier, or a combination thereof, from at least one first delivery outlet of a delivery device coupled to a second storage container containing said second component, said first delivery outlet being positioned at said orifice;

(C) optionally, regulating the supply of the second coating component to said delivery outlet by coupling a first regulatory device to said first delivery outlet;

(D) producing a subsequent atomized stream of a subsequent component of said coating composition, wherein the subsequent atomized stream is produced by siphoning the subsequent coating component with the siphoning stream from at least one subsequent delivery outlet of the delivery device coupled to a
subsequent storage container containing said subsequent component, said subsequent delivery outlet being positioned at said orifice;

(E) optionally, regulating the supply of the subsequent coating component to said subsequent delivery outlet by coupling a subsequent regulatory device to said subsequent delivery outlet;

(F) intermixing the first atomized stream, the second atomized stream and the subsequent atomized stream to form a coating mixture; and

(G) applying the coating mixture on the substrate to form the layer of said coating composition thereon,

wherein the coating composition comprises protected crosslinkable functional groups.

[46] Any spray gun that can produce a stream of atomized coating composition can be suitable for use with this method. A gravity feed spray gun is preferred. A gravity feed spray gun using a pressurized carrier as an atomization carrier is further preferred. The pressurized carrier can be selected from compressed air, compressed gas, compressed gas mixture, or a combination thereof. Typically, the pressurized carrier can be compressed air. Typically, a spray gun comprises a spray gun body (1), a nozzle assembly (2) including an orifice (13) and an air cap (24), a carrier coupling (12) for coupling to a source of a pressurized carrier, such as compressed air, an air regulator assembly (25) for regulating flow rate and pressure of the carrier, a coating flow regulator (21) for regulating the flow of the first coating component that is stored in a main reservoir also known as a first storage container (3), and a first inlet (10) coupling the spray gun (1) to the first storage container (3). The spray gun typically also includes additional controls such as a trigger (22) and a spray fan regulator (20) for regulating compressed air. In a typical gravity feed spray gun, the first coating component is typically not pressurized and stored in the first storage container (3) which is at atmosphere pressure. The first coating component can be conveyed to the orifice by gravity, siphoning, or a combination of gravity and siphoning.
The pressurized carrier can be selected from compressed air, compressed gas, compressed gas mixture, or a combination thereof. Typically, the pressurized carrier is compressed air. Compressed gas, such as compressed nitrogen, compressed carbon dioxide, compressed fluorocarbon, or a mixture thereof, can also be used. The compressed carrier can also include gases produced from compressed liquids, solids, or reactions from liquids or solids.

The coating composition can be a primer, a basecoat, a pigmented basecoat, or a clearcoat composition. The coating layer formed therefrom can be a primer layer, a basecoat layer, a pigmented basecoat layer, or a clearcoat layer, respectively.

In one embodiment of the present method, the first coating component can be a pot mix comprising a mixture of the crosslinkable and crosslinking components of a coating composition and the second coating component can include one or more materials selected from a catalyst, an initiator, an activator or a combination thereof.

In some embodiments, mixtures of protected crosslinkable functional groups and crosslinkable functional groups that are not protected can also be used. For example, the crosslinkable component can be a mixture of compounds, oligomers or polymers containing both hydroxy functional groups and amide acetal functional groups. In another example, the crosslinkable component can be a blend of compounds, oligomers and polymers containing hydroxy functional groups and compounds, oligomers and polymers containing orthoacetate functional groups.

In another embodiment, the crosslinkable component can be the first coating component, the crosslinking component can be the second coating component and a subsequent coating component can be added that can be a catalyst, activator and/or initiator. In another embodiment, the crosslinking component can be the first coating component, the crosslinkable component can be the second coating component and, a subsequent coating component can be added that can be a catalyst, activator and/or initiator.

In another embodiment, the first coating component can comprise a mixture of protected crosslinkable functional groups and crosslinking components and the second coating component can comprise water and/or
acid to unprotect the protected crosslinkable groups and subsequent coating components can be added which include one or more of a catalyst, activator, and/or initiator.

[53] In a further embodiment, the first coating component can comprise the protected crosslinkable groups, the second coating component can comprise the crosslinking groups, and subsequent coating components can include water and/or acid; catalysts; activators and/or initiators.

[54] The crosslinking reactions used to form the crosslinked network can be addition reactions from the polymerization of unsaturated double bonds using any of the disclosed initiators, condensation reactions resulting from the condensation of, for example, a deprotected crosslinkable functional group and an isocyanate group, or a combination of addition and condensation reactions can form the crosslinked network.

[55] Examples of the protected crosslinkable groups and the crosslinkable groups that are produced after being unprotected are listed in Table 1. The crosslinkable groups attained after unprotecting can determine the crosslinking groups that can be suitable for use with each protected crosslinkable group.

**TABLE 1**

<table>
<thead>
<tr>
<th>Protected Crosslinkable group</th>
<th>Crosslinkable groups attained after unprotecting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amide acetal</td>
<td>Amide diol and/or amino alcohols</td>
</tr>
<tr>
<td>Orthocarbonate</td>
<td>Hydroxyl</td>
</tr>
<tr>
<td>Spiroorthocarbonate</td>
<td>Hydroxyl</td>
</tr>
<tr>
<td>Orthoacetate/orthoformate</td>
<td>Hydroxyl</td>
</tr>
<tr>
<td>orthosilicate</td>
<td>Silanol</td>
</tr>
<tr>
<td>oxazolidine</td>
<td>Amine and alcohol</td>
</tr>
</tbody>
</table>

[56] The current method refers to a painting operation and helps to control the viscosity of a coating composition wherein said coating composition is a sprayable mixture. Controlling the viscosity of the coating composition prior to applying to the substrate helps to maintain a consistent appearance of the subsequently cured coating composition over the entire application period.
The disclosed method for controlling the viscosity of a coating composition can result in a layer of a dried and cured coating composition having a consistent appearance. The disclosed method can use a productive paint and provide a layer of a dried and cured coating composition having a consistent appearance. The length of time that it takes to apply the coating composition according to the present method is not particularly critical, and can generally range from several minutes to 8 or more hours. While the method can be used in any painting operation, it can be suitable to use in the automobile refinish, the original equipment manufacturer (OEM) aviation, heavy duty truck and marine industries, and many other industries that apply coating to substrates.

The method, as described herein, can be applicable in many commercial painting industries. In the Fleet and auto auction markets, a quick curing coating is desired so as to maximize production output. Generally, quick curing compositions are produced by increasing the amount of catalyst added to the pot mix, which results in short pot life. With the current method, the pot mix viscosity remains substantially constant during the application, because the catalyst is not added until the atomization step. In the aviation, heavy duty truck and marine coating industries, the substrates can be very large. To coat such large areas, a long pot life composition is needed. Currently, pot mixes with low levels of catalysts are able to provide the necessary pot life. However, a low catalyst level results in a long cure time, which is undesirable. The method as described herein can provide the desired long pot life and also a relatively quick cure. In many other industrial coating operations, a very low VOC coating is desired due to the expensive solvent/air separation techniques necessary to comply with environmental regulations. These low VOC coatings typically have a short pot life. The current method can provide for low VOC compositions and extended pot life. In the primer/undercoat industry, large amounts of pigments and/or fillers are necessary to give the coatings the desired properties and the pigments and/or fillers can affect the catalyst activity over time due to the absorption of the catalyst onto the pigment/filler surface. This can result in inconsistent curing and pot life issues. Adding the catalyst at the atomization stage reduces the absorption of the catalyst onto the pigment/filler surface which can help to
eliminate the curing and pot life issues. It is also known that catalysts and other ingredients that are typically added to clearcoat compositions can lead to the discoloration of the uncured compositions prior to application. The discoloration is often seen as a yellowing of the clearcoat compositions on storage. The present method can be used to add the catalysts and other ingredients during the spraying operation so that there is no color development prior to the application of the composition.

[59] In the above embodiments, the one or more components of the second coating component can be siphoned separately such as in the configurations shown in Figures 9A, 10C, 10E or 10H. The one or more sub-components of the second coating component can be siphoned together such as in the configurations shown in Figure 10B.

[60] The second coating component can be siphoned from at least one delivery outlet (14) with a siphoning stream selected from the first atomized stream of the first coating component, the stream of the pressurized carrier, or a combination thereof. The delivery outlet is coupled to a second storage container containing said second component, said delivery outlet being positioned at said orifice. Said delivery outlet and said orifice can be positioned at any relative angles or relative positions such that the siphoning can effectively take place. While not wishing to be bound by any particular theory, "siphoning" is believed to occur when the siphoning stream is moving at high speed at the delivery outlet causing negative air pressure around the delivery outlet. Such negative air pressure is believed to cause the second coating component to be conveyed to the delivery outlet. High velocity of the stream of the pressurized carrier and sudden change in air pressure associated with the negative air pressure at the delivery outlet are believed to cause the second coating component to become atomized and intermixed into the siphoning stream and the first atomized stream of the first coating component. In this invention, the first and the second coating components can be mixed at a pre-determined mixing ratio to form the coating mixture. The second coating component can also be conveyed to the delivery outlet by gravity or a combination of gravity and siphoning in certain embodiments of configurations disclosed herein.
[61] Both the first and the second coating component can be stored in respective storage containers at atmosphere pressure.

[62] Depending upon the relative position between the orifice (13) and the delivery outlet (14), the second coating component can be siphoned with different siphoning stream. When the orifice is positioned in the position illustrated by the region 13a and 13b in Figure 6, the second coating component can be siphoned primarily by the pressurized carrier moving at high speed in the direction shown by the arrow (32). Figure 7 shows examples of a delivery device having two delivery outlets. Figure 8 shows examples of a delivery device having one delivery outlet. The pressurized carrier then continues to produce atomized first coating component at the orifice (13). The atomized first and second coating component can be intermixed to form the coating mixture (16) (Figures 7B and 8B). When the orifice is positioned in the position illustrated by the region 13c in Figure 6, the second coating component can be siphoned primarily by a combination of the pressurized carrier moving at high speed in the direction shown by the arrow (32) and the first atomized stream of the first coating component. If the second coating component is not supplied to the delivery outlet, for example, if a regulatory device (32) is turned off, then only the first coating component is atomized (15) (Figures 7A and 8A). Flow of the first coating component is indicated by the arrow (31). Flow of the second coating component is indicated by the arrows (30).

[63] The coating mixture can be applied over a substrate. Typically, a painter can hold the spray gun at a certain distance from the substrate and move it in desired directions so the coating mixture can be sprayed over the substrate forming a layer of the coating composition. This invention can further comprise the step of curing the layer of the coating composition on the substrate to form a coating thereon. This curing step can depend upon the coating composition used. The layer can be cured at ambient temperatures, or at elevated temperatures, such as up to 180°C. The curing can also be done by exposing the coating layer to radiation, such as UV light or electron beam, when the coating composition is radiation curable.

[64] The substrate can include wood, plastic, leather, paper, woven and nonwoven fabrics, metal, plaster, cementitious and asphaltic substrates, and
substrates that have one or more existing layers of coating thereon. The substrate can be a vehicle, vehicle body, or vehicle body parts.

In another embodiment, the method to control the viscosity of a coating composition can comprise the steps of:

(A) producing a first atomized stream of a first coating component of said coating composition through an orifice of said spray gun with a stream of a pressurized carrier, wherein said first coating component is stored in a first storage container and conveyed through a first inlet of said spray gun to said orifice, and wherein the viscosity of said first coating composition remains substantially constant prior to being conveyed through first inlet;

(B) producing a second atomized stream of a second coating component of said coating composition, wherein the second atomized stream is produced by siphoning the second coating component with a siphoning stream selected from the first atomized stream of the first coating component, the stream of the pressurized carrier, or a combination thereof, from at least one first delivery outlet of a delivery device coupled to a second storage container containing said second component, said first delivery outlet being positioned at said orifice;

(C) optionally, regulating the supply of the second coating component to said delivery outlet by coupling a first regulatory device to said first delivery outlet;

(D) producing a subsequent atomized stream of a subsequent component of said coating composition, wherein the subsequent atomized stream is produced by siphoning the subsequent coating component with the siphoning stream from at least one subsequent delivery outlet of the delivery device coupled to a subsequent storage container containing said subsequent component, said subsequent delivery outlet being positioned at said orifice;

(E) optionally, regulating the supply of the subsequent coating component to said subsequent delivery outlet by coupling a subsequent regulatory device to said subsequent delivery outlet;
intermixing the first atomized stream, the second atomized stream, and the subsequent atomized stream to form a coating mixture; and

applying the coating mixture on the substrate to form the layer of said coating composition thereon, wherein the coating composition comprises protected crosslinkable functional groups.

The first delivery outlet and the subsequent delivery outlet can be separate delivery outlets or combined into a single delivery outlet. Figures 2C, 2D, 4, 5, 6, 7, 9A show some examples of separate delivery outlets. Figure 9B shows one example where two delivery outlets can be combined into a single delivery outlet. Based on disclosure of this invention herein, more delivery outlets and/or different placement and positioning of delivery outlets can be configured by those skilled in the art without departing from the scope and spirit of this invention.

All the components, including the first and the second coating component, and any subsequent component can be stored in respective storage containers at atmosphere pressure.

One advantage of this invention is that said atomized first coating component, said atomized second coating component, and any subsequent coating component if present, can be mixed at a pre-determined mixing ratio to form said coating mixture without the need for complex controls such as those described in aforementioned U.S. Patent No. 4,824,017. The pre-determined mixing ratio can be determined by modulating or selecting the size of the delivery outlet (14), the size of connecting path (11), or by providing a regulatory device such as a flow rate controller functionally coupled to said delivery device, or a combination thereof. It can be configured that one regulatory device can regulate the flow rate of one or more delivery outlets. Mixing ratio can also be controlled by modulating the viscosity of the first, the second or both the first and the second coating components. In one example, viscosity of the second coating component can be increased to reduce the amount being siphoned into the coating mixture. In another example, viscosity of the second coating component can be reduced to increase the amount being siphoned into the coating mixture. Similarly, viscosity of the first coating
component can be reduced or increased as needed to achieve a desired mixing ratio.

[69] The applicants unexpectedly discovered that using the method of this invention, mixing ratio can be constant within a wide range of pressures of the pressurized carrier ranging from 20 - 80 pounds per square inch gauge (psig). In one example, pressure of the pressurized carrier can be in a range of from 25 to 70 psig. In another example, pressure of the pressurized carrier can be in a range of from 28 to 65 psig. In yet another example, pressure of the pressurized carrier can be in a range of from 30 to 60 psig.

[70] In one example, the mixing ratio can be determined by selecting different sizes of the diameter of the delivery outlet. Coating mixtures formed by using different sizes of the outlets can be sprayed onto suitable substrates. Properties of the coating layers formed thereon can be measured. Based on the property measurement, a suitable size or a range of suitable sizes of the delivery outlets can be selected. In another example, the mixing ratio can be determined by selecting different size of diameter of the connection path.

[71] The regulatory device can be selected from a mechanical flow restrictor, an electric flow restrictor, a pressure controlled flow restrictor, an actuated pneumatic flow restrictor, or a combination thereof. Examples of a mechanical flow restrictor can include a tube with a pre-determined flow pass diameter that is coupled to the delivery outlet, or a mechanical valve that can control flow passage. Examples of an electronic flow restrictor can include electrical valves or a electrical valve actuator. A pressure controlled flow restrictor can be any mechanical or electric controllers that can control flow based on pressure.

[72] A flow rate controller, such as a valve or a commercial inline flow controller can be coupled to the delivery outlet to adjust the flow of the second coating component therefore affecting mixing ratio. A flow rate controller can also be a small insert that is placed inside a connection path or a tubing connected to a connection path that is coupled to the delivery outlet. Such an insert can effectively reduce the size of the connection path or the tubing therefore reduces the flow of the second coating component.

[73] Selection of sizes and the use of flow rate controller can be combined. For example, a size within a suitable range of the delivery outlet can be
selected and a valve can be coupled to the delivery outlet so the mixing ratio
can be fine tuned. Any flow rate controller that can be coupled to the delivery
outlet can be suitable for this invention.

[74] A regulatory device can be coupled to a delivery outlet at any places
that can effectively regulate flow to that delivery outlet. The regulatory device
can be coupled at an intake coupling or be placed in a connection path
connecting to that particular delivery outlet. The regulatory device can also be
placed at any place along a tubing that delivers the second or the subsequent
coating component from its storage container to the intake coupling of the
delivery device.

[75] Another advantage of this invention is to have fast curing while
maintaining extended pot life. In conventional process, short pot life is a
challenge when a coating composition is formulated to be fast curing since all
components are mixed together in a pot mix and curing reaction starts
immediately upon mixing. In this invention, the coating composition can have
extended pot life before spraying since one or more component for curing,
such as a catalyst, is not mixed together. The coating composition can then
be cured rapidly after spraying since the second coating component, such as
a catalyst, is mixed after atomization during spraying.

[76] Yet another advantage of this invention is that some aspects of
spraying or the coating property can be modified in an on-demand fashion.
For example, curing time of a coating composition can be modulated by
modifying the amount of a catalyst mixed into the coating composition during
spraying. It can be done by tuning the regulatory device while spraying.

[77] This disclosure is further directed to a system for controlling the
viscosity of a coating composition. The system can comprise:

(A) a spray gun comprising a spray gun body (1), one or more inlets, a
nozzle assembly (2) including an orifice (13) and an air cap (24);
and

(B) a delivery device comprising:

(i) at least one delivery outlet (14), wherein said delivery outlet
being positioned at said orifice (13);

(ii) at least one intake coupling (8); and
(iii) at least one connection path (11) connecting said intake coupling (8) and said delivery outlet (14), wherein said delivery outlet is coupled through said connection path and said intake coupling to a storage container (4) containing a second coating component;

(C) optionally, a regulatory device (32) coupled to said delivery outlet regulating the supply of the second coating component to said delivery outlet;

wherein a first atomized stream of a first coating component of said coating composition is produced at said orifice (13) with a stream of a pressurized carrier, wherein said first coating component is stored in a first storage container and conveyed through a first inlet of said spray gun to said orifice, and wherein the viscosity of the first coating component remains substantially constant prior to being conveyed through said first inlet;

wherein a second atomized stream of a second coating component of said coating composition is produced by siphoning the second coating component with a siphoning stream selected from the first atomized stream of the first coating component, the stream of the pressurized carrier, or a combination thereof, from said delivery outlet (14) coupled to a second storage container containing said second component, and wherein the coating composition comprises protected crosslinkable functional groups.

[78] The delivery outlet (14), the intake coupling (8), and the connection path (11) can be constructed as an add-on device affixed to the air cap of the spray gun, or can be constructed into the air cap of said spray gun.

Representative examples of the add-on device can include the ones shown in Figures 2A, 3, 4, 9A and 9B. The add-on device can be affixed to the air cap using conventional means such as one or more screws, clips, clamps, adhesives, latches, or a combination thereof. Examples of the delivery device constructed into the air cap can include those shown in Figures 2B, 2C and 2D. The delivery device can comprise one delivery outlet, such as those shown in Figures 2A, 2B and 3. The delivery device can also comprise two or
more delivery outlets, such as those shown in Figures 2C, 2D, 4, and 9A. Two or more delivery outlets can be combined into a single delivery outlet, such as the one shown in Figure 9B.

[79] Representative configurations of the add-on device (2D) can be shown in Figures 2A, 3, 4, 9A, and 9B. The system can have a single delivery outlet (14), such as shown in Figures 2A, 3, and 9B; or two or more delivery outlets (14) as shown in Figures 4 and 9A. Based on descriptions disclosed herein, those skilled in the art can make modifications and re-configurations so the add-on device can be used with other spray guns, nozzle assemblies, air caps, or a combination thereof.

[80] Figure 5 shows an enlarged frontal view of the orifice (13) and two of the delivery outlets (14). Figure 6 shows a cross sectional side view of the delivery device indicating the relative positions of two of the delivery outlets (14) and the orifice (13) wherein each of the delivery outlets (14) is positioned at said orifice (13). As described before, depending upon the relative position between the orifice (13) and the delivery outlet (14), the second (or a subsequent) coating component can be siphoned with different siphoning stream. Although perpendicular relative position is shown in the Figures and examples of this disclosure, the delivery outlet and the orifice can be positioned in any relative positions such that siphoning can effectively take place.

[81] The system described herein can be configured to siphon a third or a subsequent component. A delivery device of this invention can be configured to have multiple intake couplings (8), multiple connection paths (11) or multiple delivery outlets (14) as shown in representative examples in Figures 2C, 2D, 4, 9A, and 9B. Other examples of configurations are shown in Figures 10A through 10H. In another representative configuration, two or more connection paths can be combined at a point so the connection paths are connected to a single delivery outlet (14), which can be positioned at the orifice (13). One example is shown in Figure 9B.

[82] The one or more intake couplings (8) can be configured to couple with one or more individual storage containers (4) through direct coupling, such as plug on or screwed on, or via connection means such as fixed or flexible tubing. Additional hardware such as one or more "Y" shaped connectors can
also be used. Examples of suitable configurations are shown in Figure 10: (A) a delivery device having a single delivery outlet/intake coupling that is coupled to a single container; (B) a delivery device having a single intake coupling that is coupled to two individual containers; (C) a delivery device having two outlets/intake couplings that are coupled to two individual containers (shown) or a single container (not shown); (D) - (H) a delivery device having multiple outlets and intake couplings that only some of them are coupled to one or more containers, wherein the other intake(s) can be closed. When a delivery device has two or more intake couplings and only one of them is coupled to a container, it is preferred to close the un-coupled intake couplings via conventional means, such as a cap, a plug, or a valve. Optionally, one or more regulatory devices (32) that controls flow rate, such as a valve, an insert, a clamp, or a commercial inline flow controller can be positioned and configured to control flow rate of one or more components at one or more positions. The regulatory device can be selected from a mechanical flow restrictor, an electric flow restrictor, a pressure controlled flow restrictor, or a combination thereof. Those skilled in the art can design or modify configurations based on the descriptions disclosed herein without departing from the spirit and scope of this invention.

[83] Figure 11 shows an example of another representative configuration. In this example, the container (4) can be connected at the top of the intake coupling (8) via conventional connections, such as a screw connection or a plug-in connection. A regulatory device (32), such as a valve, can be placed in the path connecting the container (4) and the intake coupling (8). In one example, the regulatory device (32) is a valve has two coupling ends: one coupled to the intake coupling (8) and the other coupled to the container (4). In another example, the regulatory device (32) is a valve built in the container that can be coupled to the intake coupling (8). In yet another example, the regulatory device (32) is a valve built in the intake coupling (8) that can be coupled to the container (4). The regulatory device (32) can be turned on or off manually, or by connecting to the trigger (22) mechanically or electronically. It is preferred that the regulatory device (32) can be turned off when the spray gun is not spraying to prevent leaking of the contents in the
container (4) and can be turned on to allow the content in the container (4) to flow to the delivery outlet (14).

[84] The storage container (4) containing the second or a subsequent coating component can be a flexible container, such as a plastic bag; a fixed-shape container, such as a canister made of metal or hard plastic; or a flexible inner container inside a fixed-shape container, such as a flexible plastic bag placed inside a fixed-shape metal container. A flexible container that can be collapsed easily is preferred. The flexible container can be a collapsible liner that can be sealed and used directly or be placed inside a fixed shape container. The storage container can be transparent or have a transparent window so the level of the content in the container can be readily visible. The storage container can have an indicator to indicate the level of the contents in the container. The storage container can be disposable or reusable. The storage container can be coupled to an intake coupling (8) which is connected to the delivery outlet (14) through a connection path (11). The storage container can be coupled to the intake coupling (8) via conventional means, such as a clip, a clamp, a set of matching screw tracks, or a plug-in. In one example, the storage container comprises a tube that can be plugged into the intake coupling (8). In another example, the storage container is screwed onto the intake coupling (8) via matching screw tracks. In yet another example, the storage container is plugged into the intake coupling (8) and secured by an additional fastener. The storage container can further have a unidirectional flow limiter (26) to eliminate back flow, wherein said unidirectional flow limiter can only allow the content to flow in one direction, such as only from the container to the delivery outlet. Any back flow can be stopped by the directional flow limiter to avoid potential contamination. For a fixed-shape container, ventilation can be provided so the contents in the container can be maintained at atmosphere pressure.
CLAIMS

What is claimed is:

1. In a painting operation, a method for controlling the viscosity of a coating composition wherein said coating composition is a sprayable mixture, said method comprising the steps of:
   (A) producing a first atomized stream of a first coating component of said coating composition through an orifice of said spray gun with a stream of a pressurized carrier, wherein said first coating component is stored in a first storage container and conveyed through a first inlet of said spray gun to said orifice and wherein the viscosity of said first coating component remains substantially constant prior to being conveyed through said first inlet;
   (B) producing a second atomized stream of a second coating component of said coating composition, wherein the second atomized stream is produced by siphoning the second coating component with a siphoning stream selected from the first atomized stream of the first coating component, the stream of the pressurized carrier, or a combination thereof, from at least one delivery outlet coupled to a second storage container containing said second coating component, said delivery outlet being positioned at said orifice;
   (C) optionally, regulating the supply of the second coating component to said delivery outlet by coupling a regulatory device to said delivery outlet;
   (D) intermixing the first atomized stream and the second atomized stream to form a coating mixture; and
   (E) applying the coating mixture on the substrate to form the layer of said coating composition thereon; and
   wherein the coating composition comprises protected crosslinkable functional groups.

2. The method of claim 1, wherein said first coating component is mixture of a crosslinkable component and a crosslinking component.
3. The method of claim 1, wherein said protected crosslinkable functional groups are selected from the group consisting of amide acetal, orthocarbonate, orthoester, spiroorthoester, orthosilicate, oxazolidine and combinations thereof.

4. The method of claim 3, wherein the first coating component further comprises crosslinking components selected from a compound, oligomer or polymer having crosslinking functional groups and wherein the crosslinking functional groups are selected from the group consisting of isocyanate, amine, ketimine, melamine, epoxy, carboxylic acid, anhydride, and a combination thereof.

5. The method of claim 1, wherein the applied coating mixture can be dried and cured in less than 20 minutes at 60°C or in less than 90 minutes at room temperature.

6. The method of claim 1, wherein a layer of the coating composition applied over an 8 hour period provides a dried and cured layer of a coating composition having a consistent appearance.

7. The method of claim 6 wherein the dried and cured layer of coating composition has short wavescan measurements of less than 40.

8. The method of claim 1, wherein said layer is a primer layer, a basecoat layer, a pigmented basecoat layer, or a clearcoat layer.

9. The method of claim 1, wherein the second coating component comprises one or more materials selected from a catalyst, an initiator, an activator or a combination thereof.

10. The method of claim 1, wherein said second coating component comprises water or water with acid.
11. The method of claim 1, wherein said second atomized stream is produced by siphoning the second coating component with the first atomized stream.

12. The method of claim 1, wherein said second atomized stream is produced by siphoning the second coating component with the stream of the pressurized carrier.

13. The method of claim 1, wherein said second atomized stream is produced by siphoning the second coating component with a combination of the first atomized stream and the stream of the pressurized carrier.

14. The method of claim 1, wherein said substrate is a vehicle, vehicle body, or vehicle body parts.

15. The method of claim 1, wherein said regulatory device is selected from a mechanical flow restrictor, an electric flow restrictor, a pressure controlled flow restrictor, or a combination thereof.

16. The method of claim 1 further comprising the step of curing said layer of said coating composition on the substrate to form a coating thereon.

17. A coating layer produced by the method of claim 1.


19. In a painting operation, a method for controlling the viscosity of a coating composition wherein said coating composition is a sprayable mixture, said method comprising the steps of:

(A) producing a first atomized stream of a first coating component of said coating composition through an orifice of said spray gun with a stream of a pressurized carrier, wherein said first coating component is stored in a first storage container and conveyed
through a first inlet of said spray gun to said orifice and wherein the viscosity of said first coating component remains substantially constant prior to being conveyed through said first inlet;

(B) producing a second atomized stream of a second coating component of said coating composition, wherein the second atomized stream is produced by siphoning the second coating component with a siphoning stream selected from the first atomized stream of the first coating component, the stream of the pressurized carrier, or a combination thereof, from at least one first delivery outlet of a delivery device coupled to a second storage container containing said second component, said first delivery outlet being positioned at said orifice;

(C) optionally, regulating the supply of the second coating component to said first delivery outlet by coupling a first regulatory device to said first delivery outlet;

(D) producing a subsequent atomized stream of a subsequent coating component of said coating composition, wherein the subsequent atomized stream is produced by siphoning the subsequent coating component with the siphoning stream from at least one subsequent delivery outlet coupled to a subsequent storage container containing said subsequent component, said subsequent delivery outlet being positioned at said orifice;

(E) optionally, regulating the supply of the subsequent coating component to said subsequent delivery outlet by coupling a subsequent regulatory device to said subsequent delivery outlet;

(F) intermixing the first atomized stream, the second atomized stream and the subsequent atomized stream to form a coating mixture; and

(G) applying the coating mixture on the substrate to form the layer of said coating composition thereon; and

wherein said coating composition comprises protected crosslinkable functional groups.

20. The method of claim 19, wherein said first coating component is mixture of a crosslinkable component and a crosslinking component.
21. The method of claim 19, wherein said protected crosslinkable functional
groups are selected from the group consisting of amide acetal, orthocarbonate, orthoester, spiroorthoester, orthosilicate, oxazolidine
and combinations thereof.

22. The method of claim 19, wherein said second or said subsequent coating component comprises one or more materials selected from a catalyst, an initiator, an activator or a combination thereof.

23. The method of claim 19, wherein said second or said subsequent coating component comprises water or water with acid.