

**METHOD FOR MAKING BASE OIL WITH ENHANCED COLOR STABILITY****CROSS REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims the benefit of priority to U.S. Provisional Appl. Ser. No. 63/138,796, filed on January 19, 2021 and U.S. Patent Appl. Ser. No. 17/154,099, filed on January 21, 2021, the disclosures of which are herein incorporated in their entirety.

**FIELD OF THE INVENTION**

[0002] A method for providing a base oil having enhanced color stability and the base oil produced therefrom in which a phenyl benzotriazole compound is added to a base oil composition to form a color-stabilized base oil composition.

**BACKGROUND OF THE INVENTION**

[0003] Crude petroleum may be distilled and fractionated into many products such as gasoline, kerosene, jet fuel, asphaltene, and the like. One portion of the crude petroleum forms the base of lubricating oil base stocks used, e.g., in the lubrication of internal combustion engines.

[0004] The manufacture of lubricating base oils from crude petroleum oil is typically a multi-step process, although, in practice, there are many variations in the specifics of the processing steps within the industry. Each lube manufacturing facility may include one or more upgrade step(s) to remove heteroatoms and to increase the viscosity index of the final lube oil product, a dewaxing step to remove undesirable wax from the oil, and a finishing step to stabilize the oil to oxidation and thermal degradation. Increasing base oil quality demands, however, have challenged refiners to find new methods to produce base stocks which meet these product specifications. New processes are required to provide refiners with the tools for making modern base oils.

[0005] Base oils may be made by different processes, including, e.g., processes involving solvent dewaxing or catalytic dewaxing. A hydroisomerization catalytic dewaxing process for the production of base oils from a hydrocarbon feedstock involves introducing the feed into a reactor containing a dewaxing catalyst system in the presence of hydrogen. Within the reactor, the feed contacts the hydroisomerization catalyst under hydroisomerization dewaxing conditions to provide an isomerized stream. Hydroisomerization removes aromatics and residual nitrogen and sulfur and isomerizes the normal paraffins to improve the base oil cold properties. The isomerized stream may be further contacted in a second reactor with a hydrofinishing catalyst to remove traces of any aromatics, olefins, improve color, and the like from the base oil product. The hydrofinishing unit may include a hydrofinishing catalyst comprising an alumina support and a noble metal, typically palladium, or platinum in combination with palladium.

[0006] The challenges generally faced in typical hydroisomerization catalytic dewaxing processes include, among others, providing product(s) that meet pertinent product specifications, such as cloud

point, pour point, viscosity and/or viscosity index limits for one or more products, while also maintaining good product yield. In addition, further upgrading, e.g., during hydrofinishing, to further improve product quality may be used, e.g., for color and oxidation stability by saturating aromatics to reduce the aromatics content. The presence of residual organic sulfur and nitrogen from upstream hydrotreatment and hydrocracking processes, however, may also have a significant impact on downstream processes and final base oil product quality. Residual aromatics, e.g., multi-ring aromatics, present in a final base oil product may nonetheless lead to stability issues and color degradation over time.

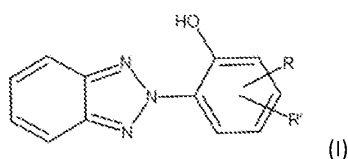
[0007] In light of the foregoing, a more robust method and means for providing base oil and lube products is needed to provide enhanced product color stability. A continuing need therefore exists for improved base oil and lube products through the use of the method.

### SUMMARY OF THE INVENTION

[0008] This invention relates to a method for improving the color stability of a base oil, base oil products produced therefrom having improved color stability, as well as products formed from such base oils. The method and base oil product provide improved color stabilization through the addition of a phenyl benzotriazole compound. The method provides color stability to base oils, where the improvement may generally be characterized by a reduction in the change in color over time for the color-stabilized base oil composition during exposure to UV radiation (including sunlight) as compared with the change in color over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized.

[0009] While not necessarily limited thereto, one of the goals of the invention is to provide a method of making a base oil having improved color stability characteristics, including, e.g., improved base oils that demonstrate reduced color degradation upon exposure to UV radiation. Such beneficial characteristics generally lead to improved base oil and lubes characteristics and extend the use lifetime of such products.

[0010] In general, the phenyl benzotriazole compound has the structural formula (I):



wherein,

R and R' are independently one or more substituents selected from hydrogen, substituted and unsubstituted alkyl, substituted and unsubstituted cycloalkyl, substituted and unsubstituted alkoxy, substituted and unsubstituted carboxyl, or a combination thereof, with the proviso that at least one of R and R' is a non-hydrogen substituent.

#### DETAILED DESCRIPTION

[0011] Although illustrative embodiments of one or more aspects are provided herein, the disclosed processes may be implemented using any number of techniques. The disclosure is not limited to the illustrative or specific embodiments, drawings, and techniques illustrated herein, including any exemplary designs and embodiments illustrated and described herein, and may be modified within the scope of the appended claims along with their full scope of equivalents.

[0012] Unless otherwise indicated, the following terms, terminology, and definitions are applicable to this disclosure. If a term is used in this disclosure but is not specifically defined herein, the definition from the IUPAC Compendium of Chemical Terminology, 2nd ed (1997), may be applied, provided that definition does not conflict with any other disclosure or definition applied herein, or render indefinite or non-enabled any claim to which that definition is applied. To the extent that any definition or usage provided by any document incorporated herein by reference conflicts with the definition or usage provided herein, the definition or usage provided herein is to be understood to apply.

[0013] "API gravity" refers to the gravity of a petroleum feedstock or product relative to water, as determined by ASTM D4052-11.

[0014] "Viscosity index" (VI) represents the temperature dependency of a lubricant, as determined by ASTM D2270-10(E2011).

[0015] "Vacuum gas oil" (VGO) is a byproduct of crude oil vacuum distillation that can be sent to a hydroprocessing unit or to an aromatic extraction for upgrading into base oils. VGO generally comprises hydrocarbons with a boiling range distribution between 343°C (649 °F) and 593°C (1100 °F) at 0.101 MPa.

[0016] "Treatment," "treated," "upgrade," "upgrading" and "upgraded," when used in conjunction with the processing of an oil feedstock, describes a feedstock that is being or has been subjected to hydroprocessing, or a resulting material or crude product, having a reduction in the molecular weight of the feedstock, a reduction in the boiling point range of the feedstock, a reduction in the concentration of asphaltenes, a reduction in the concentration of hydrocarbon free radicals, and/or a reduction in the quantity of impurities, such as sulfur, nitrogen, oxygen, halides, and metals.

[0017] "Hydroprocessing" refers to a process in which a carbonaceous feedstock is brought into contact with hydrogen and a catalyst, at a higher temperature and pressure, for the purpose of removing undesirable impurities and/or converting the feedstock to a desired product. Examples of hydroprocessing processes include hydrocracking, hydrotreating, catalytic dewaxing, and hydrofinishing.

[0018] "Hydrocracking" refers to a process in which hydrogenation and dehydrogenation accompanies the cracking/fragmentation of hydrocarbons, e.g., converting heavier hydrocarbons into

lighter hydrocarbons, or converting aromatics and/or cycloparaffins (naphthenes) into non-cyclic branched paraffins.

[0019] "Hydrotreating" refers to a process that converts sulfur and/or nitrogen-containing hydrocarbon feeds into hydrocarbon products with reduced sulfur and/or nitrogen content, typically in conjunction with hydrocracking, and which generates hydrogen sulfide and/or ammonia (respectively) as byproducts. Such processes or steps performed in the presence of hydrogen include hydrosulfurization, hydrodenitrogenation, hydrodemetallation, and/or hydrodearomatization of components (e.g., impurities) of a hydrocarbon feedstock, and/or for the hydrogenation of unsaturated compounds in the feedstock. Depending on the type of hydrotreating and the reaction conditions, products of hydrotreating processes may have improved viscosities, viscosity indices, saturates content, low temperature properties, volatilities and depolarization, for example. hydrocarbon dewaxing and may be disposed upstream from at least one hydroisomerization catalyst.

[0020] "Catalytic dewaxing", or hydroisomerization, refers to a process in which normal paraffins are isomerized to their more branched counterparts by contact with a catalyst in the presence of hydrogen.

[0021] "Hydrofinishing" refers to a process that is intended to improve the oxidation stability, UV stability, and appearance of the hydrofinished product by removing traces of aromatics, olefins, color bodies, and solvents. UV stability refers to the stability of the hydrocarbon being tested when exposed to UV light and oxygen. Instability is indicated when a visible precipitate forms, usually seen as Hoc or cloudiness, or a darker color develops upon exposure to ultraviolet light and air. A general description of hydrofinishing may be found in U.S. Patent Nos. 3,852,207 and 4,673,487.

[0022] The term "Hydrogen" or "hydrogen" refers to hydrogen itself, and/or a compound or compounds that provide a source of hydrogen.

[0023] "Cut point" refers to the temperature on a True Boiling Point (TBP) curve at which a predetermined degree of separation is reached.

[0024] "Pour point" refers to the temperature at which an oil will begin to flow under controlled conditions. The pour point may be determined by, for example, ASTM D5950.

[0025] "Cloud point" refers to the temperature at which a lube base oil sample begins to develop a haze as the oil is cooled under specified conditions. The cloud point of a lube base oil is complementary to its pour point. Cloud point may be determined by, for example, ASTM D5773.

[0026] "Saybolt color" refers to a standardized measurement test value used to assess color in light colored liquids. It is often used for manufacturing control purposes because it is an easy, rapid determination of product quality or contamination, allowing for the color grading of light colored petroleum products including aviation fuels, kerosene, naphthas, white mineral oils and other oil

products, hydrocarbon solvents and petroleum waxes. Saybolt color for petroleum products may be measured by, for example, ASTM D156 and D6045, with measurement units designated as Saybolt Color Units. The Saybolt color scale varies from near water white (30) to dark yellow (-16). Both ASTM methods are off-line manual laboratory methods.

[0027] "Hydrocarbonaceous", "hydrocarbon" and similar terms refer to a compound containing only carbon and hydrogen atoms. Other identifiers may be used to indicate the presence of particular groups, if any, in the hydrocarbon (e.g., halogenated hydrocarbon indicates the presence of one or more halogen atoms replacing an equivalent number of hydrogen atoms in the hydrocarbon).

[0028] The term "Periodic Table" refers to the version of the IUPAC Periodic Table of the Elements dated Jun. 22, 2007, and the numbering scheme for the Periodic Table Groups is as described in Chem. Eng. News, 63(5), 26-27 (1985). "Group 2" refers to IUPAC Group 2 elements, e.g., magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba) and combinations thereof in any of their elemental, compound, or ionic form. "Group 6" refers to IUPAC Group 6 elements, e.g., chromium (Cr), molybdenum (Mo), and tungsten (W). "Group 7" refers to IUPAC Group 7 elements, e.g., manganese (Mn), rhenium (Re) and combinations thereof in any of their elemental, compound, or ionic form. "Group 8" refers to IUPAC Group 8 elements, e.g., iron (Fe), ruthenium (Ru), osmium (Os) and combinations thereof in any of their elemental, compound, or ionic form. "Group 9" refers to IUPAC Group 9 elements, e.g., cobalt (Co), rhodium (Rh), iridium (Ir) and combinations thereof in any of their elemental, compound, or ionic form. "Group 10" refers to IUPAC Group 10 elements, e.g., nickel (Ni), palladium (Pd), platinum (Pt) and combinations thereof in any of their elemental, compound, or ionic form. "Group 14" refers to IUPAC Group 14 elements, e.g., germanium (Ge), tin (Sn), lead (Pb) and combinations thereof in any of their elemental, compound, or ionic form.

[0029] The term "support", particularly as used in the term "catalyst support", refers to conventional materials that are typically a solid with a high surface area, to which catalyst materials are affixed. Support materials may be inert or participate in the catalytic reactions and may be porous or non-porous. Typical catalyst supports include various kinds of carbon, alumina, silica, and silica-alumina, e.g., amorphous silica aluminates, zeolites, alumina-boria, silica-alumina-magnesia, silica-alumina-titania and materials obtained by adding other zeolites and other complex oxides thereto.

[0030] "Molecular sieve" refers to a material having uniform pores of molecular dimensions within a framework structure, such that only certain molecules, depending on the type of molecular sieve, have access to the pore structure of the molecular sieve, while other molecules are excluded, e.g., due to molecular size and/or reactivity. The term "molecular sieve" and "zeolite" are synonymous and include (a) intermediate and (b) final or target molecular sieves and molecular sieves produced by (1) direct synthesis or (2) post-crystallization treatment (secondary modification). Secondary synthesis techniques

allow for the synthesis of a target material from an intermediate material by heteroatom lattice substitution or other techniques. For example, an aluminosilicate can be synthesized from an intermediate borosilicate by post-crystallization heteroatom lattice substitution of the Al for B. Such techniques are known, for example as described in U.S. Patent No. 6,790,433. Zeolites, crystalline aluminophosphates and crystalline silicoaluminophosphates are representative examples of molecular sieves.

[0031] In this disclosure, while compositions and methods or processes are often described in terms of “comprising” various components or steps, the compositions and methods may also “consist essentially of” or “consist of” the various components or steps, unless stated otherwise.

[0032] The terms “a,” “an,” and “the” are intended to include plural alternatives, e.g., at least one. For instance, the disclosure of “a transition metal” or “an alkali metal” is meant to encompass one, or mixtures or combinations of more than one, transition metal or alkali metal, unless otherwise specified.

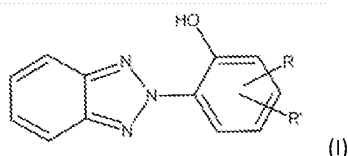
[0033] All numerical values within the detailed description and the claims herein are modified by “about” or “approximately” the indicated value, and take into account experimental error and variations that would be expected by a person having ordinary skill in the art.

[0034] In one aspect, the present invention is a method for improving the color stability of a base oil, base oil products produced therefrom having improved color stability, as well as products formed from such base oils, wherein improved color stabilization is provided through the addition of a phenyl benzotriazole compound. In general terms, the improvement is characterized by a reduction in the change in color over time for the color-stabilized base oil composition during exposure to UV radiation as compared with the change in color over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized.

[0035] The degree of base oil color stabilization may be assessed by any convenient means, including, e.g., through the use of conventional color analyzer equipment commonly used for petroleum products. Suitable Saybolt color analyzers are available commercially and provide a convenient and easy means for determining Saybolt color allowing for the color stabilization performance of additives to be determined. Such methods generally involve a base case determination of the color degradation of a base oil product over time during exposure to UV radiation and a comparison with the same base oil containing a color stabilizing additive that is also exposed to UV radiation under the same conditions. The addition of a phenyl benzotriazole compound allows the color stability improvement to be determined by measuring the reduction in the change in Saybolt color value over time for the color-stabilized base oil composition during exposure to UV radiation as compared with the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

[0036] The improvement in color stabilization may generally vary over a broad range, depending on, e.g., the specific additive and the amount of the additive used. In some cases, the change in Saybolt color value over a time period of 24 hrs for the color-stabilized base oil composition during exposure to UV radiation may be less than about 50%, or 40% or 30%, or 20%, or 10%, or 5% of the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

[0037] The phenyl benzotriazole compound has the structural formula (I):



wherein,

R and R' are independently one or more substituents selected from hydrogen, substituted and unsubstituted alkyl, substituted and unsubstituted cycloalkyl, substituted and unsubstituted alkoxy, substituted and unsubstituted carboxyl, or a combination thereof, with the proviso that at least one of R and R' is a non-hydrogen substituent.

[0038] Although not limited thereto, R and R' may be independently one or more substituents selected from hydrogen, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-alkyl, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-cycloalkyl, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-alkoxy, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-carboxyl, and combinations thereof. In some cases, R and R' are independently one or more substituents selected from substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-alkyl groups. R and R' may also be independently one or more substituents that are substituted with one or more substituents independently selected from C<sub>1-6</sub>-alkyl, hydroxyl, C<sub>1-6</sub>-alkoxy, C<sub>1-6</sub>-carboxyl, or a combination thereof.

[0039] While not limited thereto, in some cases, the phenyl benzotriazole compound may be selected from 2-(2-Hydroxy-5-methylphenyl)benzotriazole, 2-(2-Hydroxy-5-ethylphenyl)benzotriazole, 2-(2-Hydroxy-5-propylphenyl)benzotriazole, 2-(2-Hydroxy-5-butylphenyl)benzotriazole, 2-(2-Hydroxy-5-pentylphenyl)benzotriazole, 2-(2-Hydroxy-5-hexylphenyl)benzotriazole, 2-(2-Hydroxy-5-heptylphenyl)benzotriazole, 2-(2-Hydroxy-5-octylphenyl)benzotriazole, 2-(2-Hydroxy-5-nonylphenyl)benzotriazole, 2-(2-Hydroxy-5-decylphenyl)benzotriazole, 2-(2-Hydroxy-5-undecylphenyl)benzotriazole, 2-(2-Hydroxy-5-dodecylphenyl)benzotriazole, or a combination thereof.

[0040] While not limited thereto, in some cases, the phenyl benzotriazole compound may be selected from 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-

butylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-dodecylphenol, or a combination thereof.

[0041] While not limited thereto, in some cases, the phenyl benzotriazole compound may be selected from 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-dodecylphenol, or a combination thereof.

[0042] While not limited thereto, in some cases, the phenyl benzotriazole compound may be selected from 2-(2H-Benzotriazol-2-yl)-6-decyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-dodecylphenol, or a combination thereof.

[0043] While not limited thereto, in some cases, the phenyl benzotriazole compound may be selected from 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-dodecylphenol, or a combination thereof.

[0044] While not limited thereto, in some cases, the phenyl benzotriazole compound may be selected from 2-(2H-Benzotriazol-2-yl)-4,6-di-tert-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-hexylphenol, 2-(2H-Benzotriazol-2-

yl)-6-tert-propyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-dodecylphenol, or a combination thereof.

[0045] While not limited thereto, in some cases, the phenyl benzotriazole compound may be selected from 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-methylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-ethylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-propylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-butylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-pentylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-hexylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-heptylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-octylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-nonylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-decylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-undecylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-dodecylphenol, or a combination thereof.

[0046] Base oils that may be used in the method are not generally limited and include, e.g., base oils made through hydroisomerization ("catalytic dewaxing") processes as well as any other process. Such hydroisomerization processes typically comprise contacting a hydrocarbon (hydrocarbonaceous) feedstock with a hydroisomerization catalyst under hydroisomerization conditions to produce a base oil product or product stream. The feedstock may be contacted with a hydroisomerization catalyst composition to provide a base oil intermediate or final product, preceded or followed by additional hydroprocessing steps as may be needed. Any suitable hydroprocessing step may be used to produce base oils useful in the method, including, e.g., hydrotreating and/or hydrofinishing treatments. In general, the method, and the base oils having improved color stability produced therefrom, may be any Group I, II and/or III/III+ base oil. For example, commercially available Group I and II base oils may be provided with improved color stability through the addition of the phenyl benzotriazole compound.

[0047] Suitable base oils may include any conventional or useful base oil or a combination of base oils having useful properties, including, e.g., any cut point, pour point, cloud point, Viscosity Index (VI), and/or API gravity property value or range of property values. Useful base oil viscosity ranges include, e.g., base oils having a viscosity in the range of about 3-30 cSt at 100°C, or about 4-26 cSt at 100°C, or about 6-35 cSt at 100°C. Useful base oils having pour points include, e.g., base oils having pour points of less than about -5°C, or less than about -10°C, or less than about -15°C.

[0048] In general, any suitable hydrocarbon feedstock may be used to produce a base oil that may be color stabilized according to the invention. For example, suitable feedstocks may generally be selected from a variety of base oil feedstocks, and advantageously comprises gas oil; vacuum gas oil; long residue; vacuum residue; atmospheric distillate; heavy fuel; oil; wax and paraffin; used oil; deasphalted residue or crude; charges resulting from thermal or catalytic conversion processes; shale

oil; cycle oil; animal and vegetable derived fats, oils and waxes; petroleum and slack wax; or a combination thereof. The hydrocarbon feed may also comprise a feed hydrocarbon cut in the distillation range from 400-1300°F, or 500-1100°F, or 600-1050°F, and/or wherein the hydrocarbon feed has a KV100 (kinematic viscosity at 100°C) range from about 3 to 30 cSt or about 3.5 to 15 cSt.

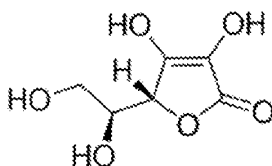
[0049] Suitable hydroisomerization catalysts for producing base oils include any such catalyst known in the art. Such catalysts may include those comprising support materials and/or molecular sieves such as zeolites without limitation. Typically, such catalysts comprise one or more Group 2-10 and 14 elements or compounds thereof of the Periodic Table.

#### EXAMPLES

[0050] The following examples provide representative embodiments for color stabilization of a heavy neutral base oil (grade 600) by the addition of various additive compounds according to the invention and comparative compound additives. Saybolt color unit values were determined according to ASTM D156 using a Saybolt Chromometer. All samples were exposed to UV light under controlled conditions as a means of assessing color stability during exposure to sunlight.

##### Example 1 – L-Ascorbic Acid additive (comparative)

[0051] A sample was prepared by mixing 100 ml of grade 600 base oil with 0.1 grams of L-Ascorbic Acid.



[0052] The sample was exposed to UV radiation to assess color stability by placing each sample under a UVB313 tube (40W with 280-365 nm UV light). Samples were exposed to UV radiation at different UV exposure times and the Saybolt color measured. Results are summarized in Table 1.

Table 1

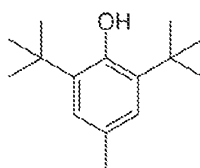
| UV exposure time (hrs) | Saybolt Color Unit Value |                                     |
|------------------------|--------------------------|-------------------------------------|
|                        | Base Oil                 | Base Oil + 0.1 g of L-Ascorbic Acid |
| 0                      | 30                       | --                                  |
| 2                      | 23                       | 26                                  |
| 4                      | 19                       | 18                                  |
| 6                      | 14                       | 14                                  |
| 8                      | 8                        | 8                                   |
| 24                     | <-16                     | <-16                                |

[0053] As shown in Table 1, the Saybolt color of the sample without the additive continued to be reduced as the UV exposure time increased. With time under UV exposure, the Saybolt color of the

600R sample was reduced continuously. At 24 hours, the Saybolt color is lower than -16. By comparison, the addition of L-ascorbic acid did not show any improvement in the color stability of the 600R base oil product.

**Example 2 – Butylated Hydroxytoluene additive (comparative)**

[0054] Samples were prepared by separately mixing 150 ml of grade 600 base oil with 0.1 wt.%, 0.2 wt.% and 0.4 wt.% butylated hydroxytoluene, respectively.



[0055] All the samples were placed under UV light as described in example 1. Saybolt color was measured at different UV exposure times. Results are summarized in Table 2.

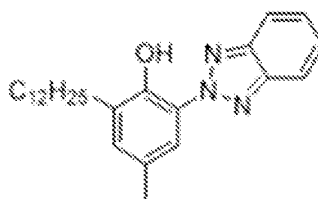
Table 2

| UV exposure<br>time (hrs) | Saybolt Color Unit Value |                            |                            |                            |
|---------------------------|--------------------------|----------------------------|----------------------------|----------------------------|
|                           | Base Oil                 | Base Oil +<br>0.1 wt.% BHT | Base Oil +<br>0.2 wt.% BHT | Base Oil +<br>0.4 wt.% BHT |
| 0                         | 29                       | 30                         | 30                         | 29                         |
| 4                         | 26                       | 22                         | 24                         | 26                         |
| 8                         | 17                       | 17                         | 17                         | 17                         |

[0056] As shown in Table 2, the Saybolt color of the sample without the additive continued to be reduced as the UV exposure time increased. By comparison, the addition of BHT did not show any improvement in the base oil product color stability; e.g., the addition of 0.4 wt.% BHT still showed the same reduction in the Saybolt color at 17 after 8 hours UV exposure as the comparative sample that did not contain BHT additive.

**Example 3 – Benzotriazol-2-yl)-6-dodecyl-4-methylphenol additive**

[0057] Samples were prepared by separately mixing 150 ml of grade 600 base oil with 0.005 wt.%, 0.01 wt.%, 0.02 wt.%, 0.05 wt.% and 0.2 wt.% 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-methylphenol, respectively.



[0058] All the samples were placed under UV light as described in example 1. Saybolt color was measured at different UV exposure times. Results are summarized in Table 3.

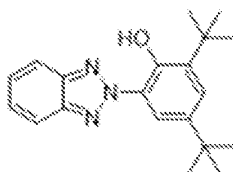
Table 3

| UV exposure time (hrs) | Saybolt Color Unit Value |                                 |                                |                                |                                |                               |
|------------------------|--------------------------|---------------------------------|--------------------------------|--------------------------------|--------------------------------|-------------------------------|
|                        | Base Oil                 | Base Oil + 0.005 wt. % Additive | Base Oil + 0.01 wt. % Additive | Base Oil + 0.02 wt. % Additive | Base Oil + 0.05 wt. % Additive | Base Oil + 0.2 wt. % Additive |
| 0                      | 29                       | 29                              | 29                             | 29                             | 29                             | 28                            |
| 4                      | 26                       | 26                              | 28                             | 26                             | 29                             | 28                            |
| 8                      | 17                       | 19                              | 23                             | 23                             | 28                             | 27                            |
| 24                     | -12                      | 2                               | 12                             | 13                             | 25                             | 26                            |

[0059] As shown in Table 3, the Saybolt color of the sample without the additive continued to be reduced as the UV exposure time increased. By comparison, the addition of 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-methylphenol significantly improved the color stability; e.g., the addition of 0.05 wt.% maintained the Saybolt color at 25 after 24 hours UV exposure.

**Example 4 – 2-(2H-Benzotriazol-2-yl)-4, 6-di-tert-propylphenol additive**

[0060] Samples were prepared by separately mixing 150 ml of grade 600 base oil with 0.005 wt.%, 0.01 wt.%, 0.02 wt.%, 0.04 wt.%, 0.05 wt.% and 0.2 wt.% 2-(2H-Benzotriazol-2-yl)-4, 6-di-tert-propylphenol, respectively.



[0061] All the samples were placed under UV light as described in example 1. Saybolt color was measured at different UV exposure times. Results are summarized in Table 4.

Table 4

| UV exposure time (hrs) | Saybolt Color Unit Value |                                |                                |                                |                                |                               |
|------------------------|--------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|-------------------------------|
|                        | Base Oil                 | Base Oil + 0.01 wt. % Additive | Base Oil + 0.02 wt. % Additive | Base Oil + 0.04 wt. % Additive | Base Oil + 0.05 wt. % Additive | Base Oil + 0.2 wt. % Additive |
| 0                      | 29                       | 30                             | 29                             | 29                             | 28                             | 26                            |
| 4                      | 26                       | 26                             | 28                             | 29                             | 28                             | 26                            |
| 8                      | 17                       | 22                             | 26                             | 27                             | 27                             | 26                            |
| 24                     | -12                      | 11                             | 16                             | 22                             | 26                             | 25                            |

[0062] As shown in Table 4, the Saybolt color of the sample without the additive continued to be reduced as the UV exposure time increased. By comparison, the addition of 2-(2H-Benzotriazol-2-yl)-4,6-di-tert-propylphenol significantly improved the color stability; e.g., the addition of 0.05 wt.% maintained the Saybolt color at 26 after 24 hours UV exposure.

[0063] The foregoing description of one or more embodiments of the invention is primarily for illustrative purposes, it being recognized that variations might be used which would still incorporate the essence of the invention. It will be understood that the invention is not limited to the embodiments described above and various modifications and improvements can be made without departing from the concepts described herein. Except where mutually exclusive, any of the features may be employed separately or in combination with any other features and the disclosure extends to and includes all combinations and sub-combinations of one or more features described herein. Reference should be made to the following claims in determining the scope of the invention.

[0064] For the purposes of U.S. patent practice, and in other patent offices where permitted, all patents and publications cited in the foregoing description of the invention are incorporated herein by reference to the extent that any information contained therein is consistent with and/or supplements the foregoing disclosure.

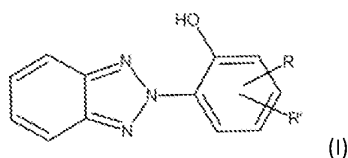
[0065] For the avoidance of doubt, the present application is directed to the subject-matter described in the following numbered P1 to P19 paragraphs. Within each paragraph, each reference to a P-numbered paragraph refers to one or more previous P-numbered paragraphs.

P1. A method for improving the color stability of a base oil, the method comprising  
adding a phenyl benzotriazole compound to a base oil composition to form a color-stabilized base oil composition.

P2. The method of P1, wherein the color stability improvement is characterized by a reduction in the change in Saybolt color value over time for the color-stabilized base oil composition during exposure to UV radiation as compared with the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

P3. The method of P2, wherein the change in Saybolt color value over a time period of 24 hrs for the color-stabilized base oil composition during exposure to UV radiation is less than about 50%, or 40% or 30%, or 20%, or 10%, or 5% of the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

P4. The method of any one of P1 to P3, wherein the phenyl benzotriazole compound has the structural formula (I):



wherein,

R and R' are independently one or more substituents selected from hydrogen, substituted and unsubstituted alkyl, substituted and unsubstituted cycloalkyl, substituted and unsubstituted alkoxy, substituted and unsubstituted carboxyl, or a combination thereof, with the proviso that at least one of R and R' is a non-hydrogen substituent.

P5. The method of P4, wherein R and R' are independently one or more substituents selected from hydrogen, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-alkyl, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-cycloalkyl, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-alkoxy, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-carboxyl, and combinations thereof.

P6. The method of P4 or P5, wherein R and R' are independently one or more substituents selected from substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-alkyl groups.

P7. The method of any one of P4 to P6, wherein R and R' are independently one or more substituents that are substituted with one or more substituents independently selected from C<sub>1-6</sub>-alkyl, hydroxyl, C<sub>1-6</sub>-alkoxy, C<sub>1-6</sub>-carboxyl, or a combination thereof.

P8. The method of P4, wherein the phenyl benzotriazole compound is selected from 2-(2-Hydroxy-5-methylphenyl)benzotriazole, 2-(2-Hydroxy-5-ethylphenyl)benzotriazole, 2-(2-Hydroxy-5-propylphenyl)benzotriazole, 2-(2-Hydroxy-5-butylphenyl)benzotriazole, 2-(2-Hydroxy-5-pentylphenyl)benzotriazole, 2-(2-Hydroxy-5-hexylphenyl)benzotriazole, 2-(2-Hydroxy-5-heptylphenyl)benzotriazole, 2-(2-Hydroxy-5-octylphenyl)benzotriazole, 2-(2-Hydroxy-5-nonylphenyl)benzotriazole, 2-(2-Hydroxy-5-decylphenyl)benzotriazole, 2-(2-Hydroxy-5-undecylphenyl)benzotriazole, 2-(2-Hydroxy-5-dodecylphenyl)benzotriazole, or a combination thereof.

P9. The method of P4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-decylphenol,

2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-dodecylphenol, or a combination thereof.

P10. The method of P4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-dodecylphenol, or a combination thereof.

P11. The method of P4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-6-decyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-dodecylphenol, or a combination thereof.

P12. The method of P4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-dodecylphenol, or a combination thereof.

P13. The method of P4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-4,6-di-tert-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-dodecylphenol, or a combination thereof.

decylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-dodecylphenol, or a combination thereof.

P14. The method of P4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-methylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-ethylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-propylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-butylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-pentylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-hexylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-heptylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-octylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-nonylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-decylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-undecylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-dodecylphenol, or a combination thereof.

P15. The method of any one of P1 to P14, wherein the base oil is Group I or II base oil.

P16. A color-stabilized base oil composition made according to the method of any one of P1 to P15, the color-stabilized base oil composition having improved color stability by comparison to the base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

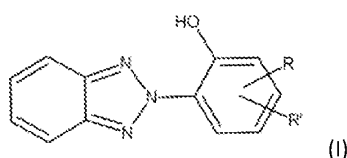
P17. The color-stabilized base oil composition of P16, wherein the color stability improvement is characterized by a reduction in the change in Saybolt color value over time for the color-stabilized base oil composition during exposure to UV radiation as compared with the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

P18. The color-stabilized base oil composition of P17, wherein the change in Saybolt color value over a time period of 24 hrs for the color-stabilized base oil composition during exposure to UV radiation is less than about 50%, or 40% or 30%, or 20%, or 10%, or 5% of the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

P19. A color-stabilized base oil composition made according to the method of P4, the color-stabilized base oil composition having improved color stability by comparison to the base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound having the structural formula (I).

**WHAT IS CLAIMED IS:**

1. A method for improving the color stability of a base oil, the method comprising adding a phenyl benzotriazole compound to a base oil composition to form a color-stabilized base oil composition.
2. The method of claim 1, wherein the color stability improvement is characterized by a reduction in the change in Saybolt color value over time for the color-stabilized base oil composition during exposure to UV radiation as compared with the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.
3. The method of claim 2, wherein the change in Saybolt color value over a time period of 24 hrs for the color-stabilized base oil composition during exposure to UV radiation is less than about 50%, or 40% or 30%, or 20%, or 10%, or 5% of the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.
4. The method of claim 1, wherein the phenyl benzotriazole compound has the structural formula (I):



wherein,

R and R' are independently one or more substituents selected from hydrogen, substituted and unsubstituted alkyl, substituted and unsubstituted cycloalkyl, substituted and unsubstituted alkoxy, substituted and unsubstituted carboxyl, or a combination thereof, with the proviso that at least one of R and R' is a non-hydrogen substituent.

5. The method of claim 4, wherein R and R' are independently one or more substituents selected from hydrogen, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-alkyl, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-cycloalkyl, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-alkoxy, substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-carboxyl, and combinations thereof.
6. The method of claim 4, wherein R and R' are independently one or more substituents selected from substituted and unsubstituted C<sub>1</sub>-C<sub>20</sub>-alkyl groups.

7. The method of claim 4, wherein R and R' are independently one or more substituents that are substituted with one or more substituents independently selected from C<sub>1-6</sub>-alkyl, hydroxyl, C<sub>1-6</sub>-alkoxy, C<sub>1-6</sub>-carboxyl, or a combination thereof.
8. The method of claim 4, wherein the phenyl benzotriazole compound is selected from 2-(2-Hydroxy-5-methylphenyl)benzotriazole, 2-(2-Hydroxy-5-ethylphenyl)benzotriazole, 2-(2-Hydroxy-5-propylphenyl)benzotriazole, 2-(2-Hydroxy-5-butylphenyl)benzotriazole, 2-(2-Hydroxy-5-pentylphenyl)benzotriazole, 2-(2-Hydroxy-5-hexylphenyl)benzotriazole, 2-(2-Hydroxy-5-heptylphenyl)benzotriazole, 2-(2-Hydroxy-5-octylphenyl)benzotriazole, 2-(2-Hydroxy-5-nonylphenyl)benzotriazole, 2-(2-Hydroxy-5-decylphenyl)benzotriazole, 2-(2-Hydroxy-5-undecylphenyl)benzotriazole, 2-(2-Hydroxy-5-dodecylphenyl)benzotriazole, or a combination thereof.
9. The method of claim 4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-dodecyl-4-dodecylphenol, or a combination thereof.
10. The method of claim 4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-undecyl-4-dodecylphenol, or a combination thereof.
11. The method of claim 4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-6-decyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-decylphenol,

2-(2H-Benzotriazol-2-yl)-6-decyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-decyl-4-dodecylphenol, or a combination thereof.

12. The method of claim 4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-nonyl-4-dodecylphenol, or a combination thereof.

13. The method of claim 4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-4,6-di-tert-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-methylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-ethylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-propylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-butylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-pentylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-hexylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-heptylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-octylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-nonylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-decylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-undecylphenol, 2-(2H-Benzotriazol-2-yl)-6-tert-propyl-4-dodecylphenol, or a combination thereof.

14. The method of claim 4, wherein the phenyl benzotriazole compound is selected from 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-methylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-ethylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-propylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-butylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-pentylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-hexylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-heptylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-octylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-nonylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-decylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-undecylphenol, 2-(2H-Benzotriazol-2-yl)-4-tert-propyl-6-dodecylphenol, or a combination thereof.

15. The method of claim 1, wherein the base oil is Group I or II base oil.

16. A color-stabilized base oil composition made according to the method of claim 1, the color-stabilized base oil composition having improved color stability by comparison to the base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

17. The color-stabilized base oil composition of claim 16, wherein the color stability improvement is characterized by a reduction in the change in Saybolt color value over time for the color-stabilized base oil composition during exposure to UV radiation as compared with the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

18. The color-stabilized base oil composition of claim 17, wherein the change in Saybolt color value over a time period of 24 hrs for the color-stabilized base oil composition during exposure to UV radiation is less than about 50%, or 40% or 30%, or 20%, or 10%, or 5% of the change in Saybolt color value over the same time period and under the same UV exposure conditions for the same base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound.

19. A color-stabilized base oil composition made according to the method of claim 4, the color-stabilized base oil composition having improved color stability by comparison to the base oil composition that is not color-stabilized by the addition of the phenyl benzotriazole compound having the structural formula (I).