Antioxidant Polymeric Diphenylamine Compositions

Technical Field

[0001] The present disclosure is directed to antioxidant diphenylamine polymer (e.g., oligomer) compositions. The antioxidant polymer compositions are suitable towards providing lubricant compositions viscosity control and deposits control.

Background

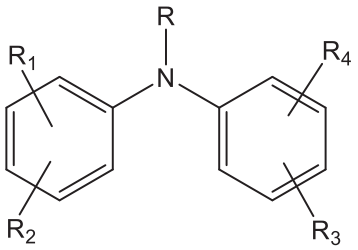
[0002] Lubricant oxidative stability is one of the key parameters controlling oil life, which translates to oil drain interval in practical terms. Additionally, deposit formation is an issue associated with the decomposition of the base stock molecules mostly propagated by oxidative chain reactions. There are several conventional approaches to improve the resistance to oxidation of a finished lubricant product, but most products are formulated using small molecules such as diphenylamine (DPA) or a phenolic antioxidant.

[0003] Improved oxidation stability is necessary to increase oil life and oil drain intervals, thus reducing the amount of used oil generated as a consequence of more frequent oil changes. Longer oil life and oil drain intervals are key benefits that are desirable to end customers. Traditional antioxidant packages provide standard protection leaving the main differentiation hinging on the quality of the base stock in the formulation.

[0004] What is needed are newly designed lubricants capable of controlling oxidation and oil thickening for longer periods of time as compared to conventional lubricants. Further, what are needed are newly designed lubricants that enable extended oil life in combination with desired deposit control and cleanliness performance.

Summary

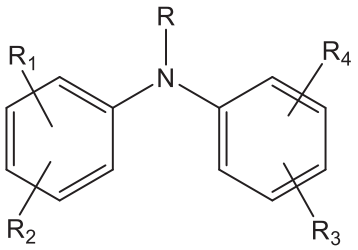
[0005] In certain examples, the disclosure is directed to an antioxidant polymer (e.g., oligomer) composition comprising repeat units of diphenylamine monomers of formula I



I

wherein R is H, C_1-C_{18} alkyl, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl, -C(O)C_1-C_{18} alkyl, -C(O)aryl; and R_1, R_2, R_3 and R_4 are each independently H or a linear or branched C_1-C_{18} alkyl, C_1-C_{18} alkoxy, C_1-C_{18} alkylamino, C_1-C_{18} dialkylamino, C_1-C_{18} alkylthio, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl or C_7-C_{21} aralkyl. In certain examples, the number average molecular weight (Mn) of the antioxidant polymer (e.g., oligomer) composition is at least about 350 g/mol or from about 350 g/mol to about 5000 g/mol.

[0005a] In an aspect, there is provided an antioxidant polymer composition comprising repeat units of diphenylamine monomers of formula I



I

wherein

R is H, C_1-C_{18} alkyl, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl, -C(O)C_1-C_{18} alkyl, -C(O)aryl and

R_1, R_2, R_3 and R_4 are each independently H or a linear or branched C_1-C_{18} alkyl, C_1-C_{18} alkoxy, C_1-C_{18} alkylamino, C_1-C_{18} dialkylamino, C_1-C_{18} alkylthio, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl or C_7-C_{21} aralkyl and

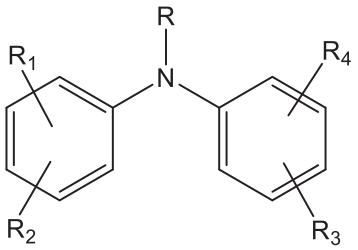
wherein

the number average molecular weight (Mn) of the polymer is from about 350 g/mol to about 5000 g/mol.

[0006] Also disclosed in certain examples is an antioxidant polymer (e.g., oligomer) composition comprising repeat units of diphenylamine monomers of formula I, wherein the composition comprises ≤ about 99 wt%, ≤ about 90 wt%, ≤ about 80 wt%, ≤ about 70 wt%, ≤ about 65 wt%, ≤ about 60 wt%, ≤ about 55 wt%, ≤ about 50 wt%, ≤ about 45 wt%, ≤ about 40 wt%, ≤ about 35 wt%, ≤ about 30 wt%, ≤ about 25 wt%, ≤ about 20

wt%, ≤ about 15 wt%, ≤ about 10 wt%, ≤ about 5 wt%, ≤ about 1 wt%, ≤ about 0.5 wt%, ≤ about 0.1 wt%, ≤ about .05 wt% or ≤ about 0.01 wt% residual monomers of formula I. For example, in certain examples, disclosed is an antioxidant polymer (e.g., oligomer) composition comprising repeat units of diphenylamine monomers of formula I, wherein the composition comprises from any one of about 0.01 wt%, about 0.05 wt%, about 0.1 wt%, about 0.5 wt%, about 1 wt%, about 2 wt% , about 3 wt%, about 4 wt%, about 5 wt%, about 7 wt%, about 9 wt%, ab about 70 wt%out 11 wt% or about 13 wt% to any one of about 15 wt%, about 18 wt%, about 21 wt%, about 24 wt%, about 27 about 70 wt% wt%, about 30 wt%, about 35 wt%, about 40 wt%, about 45 wt%, about 50 wt%, about 55 wt%, about 60 wt%, about 65 wt%, about 70 wt%, about 80 wt% or about 99 wt% residual monomers of formula I, based on the total weight of the antioxidant composition.

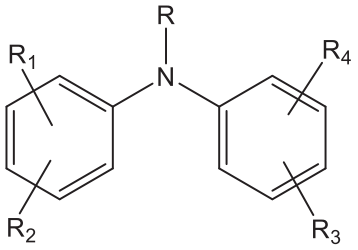
[0007] Also disclosed in certain examples is a process for preparing the antioxidant polymer (e.g., oligomer) composition, the process comprising subjecting one or more diphenylamine monomers of formula



I

wherein R is H, C_1-C_{18} alkyl, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl, -C(O)C_1-C_{18} alkyl, -C(O)aryl; and R_1, R_2, R_3 and R_4 are each independently H or a linear or branched C_1-C_{18} alkyl, C_1-C_{18} alkoxy, C_1-C_{18} alkylamino, C_1-C_{18} dialkylamino, C_1-C_{18} alkylthio, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl or C_7-C_{21} aralkyl.; to dehydrocondensation conditions. Also disclosed are products prepared by the processes disclosed herein.

[0007a] In another aspect, there is provided a process for preparing the antioxidant polymer composition as defined above, the process comprising subjecting one or more diphenylamine monomers of formula



I

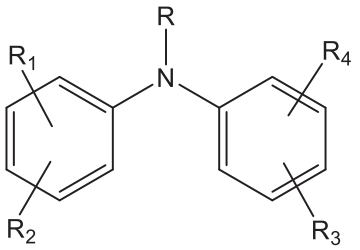
wherein

R is H, C_1-C_{18} alkyl, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl, -C(O)C_1-C_{18} alkyl, -C(O)aryl and R_1, R_2, R_3 and R_4 are each independently H or a linear or branched C_1-C_{18} alkyl, C_1-C_{18} alkoxy, C_1-C_{18} alkylamino, C_1-C_{18} dialkylamino, C_1-C_{18} alkylthio, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl or C_7-C_{21} aralkyl;

to dehydrocondensation conditions.

[0007b] In another aspect, there is provided an antioxidant polymer composition prepared according to the process as defined above.

[0007c] In another aspect, there is provided an antioxidant polymer composition comprising repeat units of diphenylamine monomers of formula I



I

wherein

R is H, C_1-C_{18} alkyl, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl, -C(O)C_1-C_{18} alkyl, -C(O)aryl and

R_1, R_2, R_3 and R_4 are each independently H or a linear or branched C_1-C_{18} alkyl, C_1-C_{18} alkoxy, C_1-C_{18} alkylamino, C_1-C_{18} dialkylamino, C_1-C_{18} alkylthio, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl or C_7-C_{21} aralkyl and

wherein the polymer comprises ≤ about 70 wt%, ≤ about 65 wt%, ≤ about 60 wt%, ≤ about 55 wt%, ≤ about 50 wt%, ≤ about 45 wt%, ≤ about 40 wt%, ≤ about 35 wt%, ≤ about 30 wt%, ≤ about 25 wt%, ≤ about 20 wt%, ≤ about 15 wt%, ≤ about 10 wt% or ≤ about 5 wt% residual monomers of formula I, based on the weight of the composition.

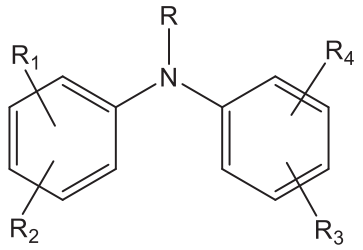
[0007d] In another aspect, there is provided a liquid blend comprising the antioxidant polymer composition as defined above and one to three components selected from the group consisting of solvents, base oils, further antioxidants, metal passivators, rust inhibitors, corrosion inhibitors, viscosity index improvers, extreme pressure agents, pour point depressants, dispersants, detergents, antifoams, color stabilizers, demulsifiers, friction modifiers and antiwear additives.

[0007e] In another aspect, there is provided a liquid concentrate comprising the antioxidant polymer composition as defined above and a solvent and/or a base oil, wherein the concentrate comprises from about 50 wt% to about 95 wt%, based on the total weight of the concentrate, of the antioxidant polymer composition.

[0007f] In another aspect, there is provided a method of preparing a liquid blend, the method comprising mixing an antioxidant polymer composition as defined above with one to three components selected from the group consisting of solvents, base oils, further antioxidants, metal passivators, rust inhibitors, corrosion inhibitors, viscosity index improvers, extreme pressure agents, pour point depressants, dispersants, detergents, antifoams, color stabilizers, demulsifiers, friction modifiers and antiwear additives.

Detailed Description

[0008] In certain embodiments, the present disclosure is directed to an antioxidant polymer (e.g., oligomer) composition comprising repeat units of diphenylamine monomers of formula I



I

wherein R is H, C_1-C_{18} alkyl, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl, -C(O)C_1-C_{18} alkyl, -C(O)aryl; and

R_1, R_2, R_3 and R_4 are each independently H or a linear or branched C_1-C_{18} alkyl, C_1-C_{18} alkoxy, C_1-C_{18} alkylamino, C_1-C_{18} dialkylamino, C_1-C_{18} alkylthio, C_2-C_{18} alkenyl, C_2-C_{18} alkynyl or C_7-C_{21} aralkyl. In certain embodiments, the degree of polymerization (e.g., oligomerization) is such that an antioxidant polymer (e.g., oligomer) composition has a number average molecular weight (Mn) of at least about 350 g/mol or from about 350 g/mol to about 5000 g/mol.

[0009] In other embodiments, the antioxidant polymer (e.g., oligomer) compositions of the disclosure have an Mn of from about 900 g/mol or about 1000 g/mol to about 1200 g/mol