Harrison et al., U.S. Patent No. 6,358,892 discloses a succinimide composition that is prepared by reacting a mixture of an alkenyl or alkylsuccinic acid derivative, an unsaturated acidic reagent copolymer, and a polyamine under reactive conditions; then treating the reaction product with either a cyclic carbonate or a linear mono- or polycarbonate or boron compound under reactive conditions.

Harrison et al., U.S. Patent No. 6,451,920 discloses a process for preparing a mixture of (1) a copolymer of a polyalkene and an unsaturated acidic reagent and (2) a polyalkenyl derivative of an unsaturated acidic reagent.

Harrison et al., U.S. Patent No. 6,617,396 discloses a process for preparing a mixture of (1) a copolymer of a polyalkene and an unsaturated acidic reagent and (2) a polyalkenyl derivative of an unsaturated acidic reagent.

Kaplan, U.S. Patent No. 5,266,186 discloses dispersants which comprise polyimides which are prepared by reacting fatty amines with maleic anhydride/alpha-olefin copolymers.

SUMMARY OF THE INVENTION

It has now been discovered that the reaction product of copolymers and specific amine linking agents (i.e., diamine linking agents), results in a "hybrid succinic anhydride copolymer" product. This hybrid succinic anhydride copolymer may be reacted further with other amines or polyamines or mixtures thereof to form succinimide products that have good dispersant qualities, low viscosity, and shear stability.

In one embodiment, there is provided a hybrid succinic anhydride copolymer obtainable by the process which comprises reacting a copolymer of an (i) an unsaturated acidic reagent; and (ii) a mono-olefin, with at least one linking hydrocarbyl di-primary amine, thereby producing a hybrid succinic anhydride copolymer having unreacted anhydride groups.

In one embodiment, there is provided a succinimide obtainable by a process comprising reacting the hybrid succinic anhydride copolymer as described herein with a second amine compound, thereby producing the succinimide.

In one embodiment, there is provided a lubricating oil composition comprising a major amount of an oil of lubricating viscosity and a minor amount of the succinimide as described herein.

In one embodiment, there is provided a method of making a lubricating oil additive composition which comprises (A) reacting a copolymer of an (i) an unsaturated acidic reagent; and (ii) a mono-olefin, with at least one linking hydrocarbyl di-primary amine, thereby producing a hybrid succinic anhydride copolymer having unreacted anhydride groups; and subsequently (B) reacting the hybrid succinic anhydride copolymer with a second amine compound, thereby producing the succinimide.

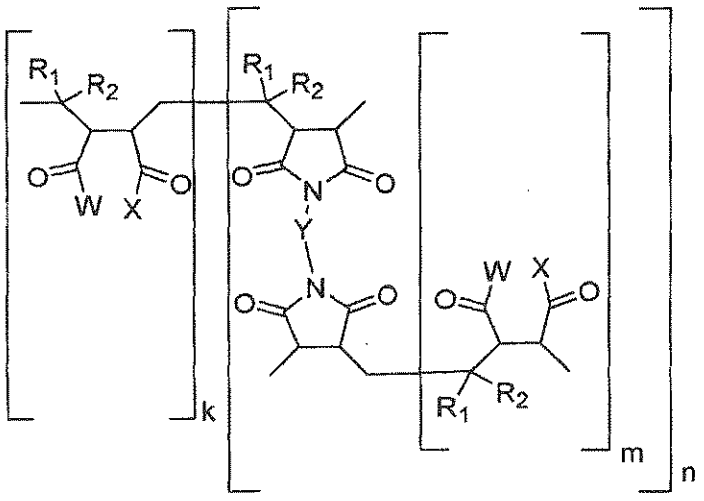
In one embodiment, there is provided a method of improving soot dispersancy in an internal combustion engine which comprises operating the engine with a lubricating oil composition comprising a major amount of oil of lubricating viscosity and an effective amount of the succinimide as described herein.

In one embodiment, there is provided a lubricating oil concentrate comprising from about 20 to about 80 weight percent of an organic diluent and the succinimide as described herein.

In one embodiment, there is provided a fuel composition comprising a hydrocarbon boiling in a gasoline or diesel range and from about 30 to about 5000 parts per million of a succinimide as described herein.

In one embodiment, there is provided a fuel concentrate comprising an inert stable oleophilic organic solvent boiling in the range of 150°F to 400°F and from about 5 to 50 weight percent of a succinimide as described herein.

In one embodiment, there is provided a hybrid succinic anhydride copolymer having the following formula:



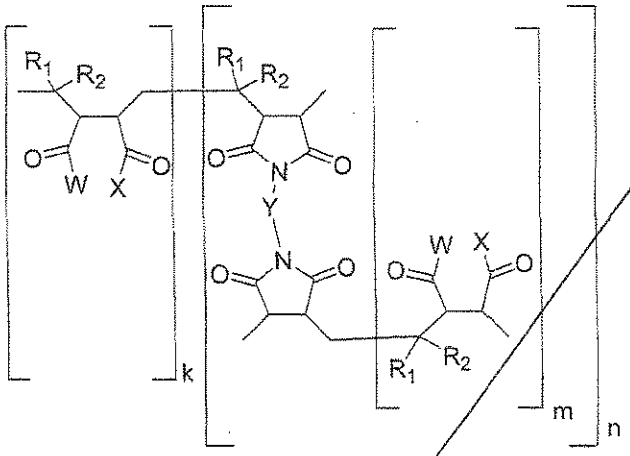
(I)

wherein one of R1 and R2 is either lower alkyl or hydrogen, and the other of R1 and R2 is polyalkyl, W and X are independently selected from the group consisting of -OH, -O-R' wherein R' is lower alkyl, or taken together are -O- to form a succinic anhydride group, n, m, and k are 1 to 20, and Y is alkylene having from about 2 to 20 carbon atoms.

In one embodiment, the present invention is directed to a hybrid succinic anhydride copolymer having the following formula:

WHAT IS CLAIMED IS:

1. A hybrid succinic anhydride copolymer having the following formula:



(I)

wherein one of R_1 and R_2 is either lower alkyl or hydrogen, and the other of R_1 and R_2 is polyalkyl, W and X are independently selected from the group consisting of –OH, -O-R' wherein R' is lower alkyl, or taken together are –O- to form a succinic anhydride group, n, m, and k are 1 to 20, and Y is alkylene having from about 2 to 20 carbon atoms.

2. A hybrid succinic anhydride copolymer prepared by the process which comprises reacting a copolymer of an (i) an unsaturated acidic reagent; and (ii) a mono-olefin, with at least one linking hydrocarbyl di-primary amine, thereby producing a hybrid succinic anhydride copolymer having from about 10% to about 90% unreacted anhydride groups.

3. The hybrid succinic anhydride copolymer of Claim 2 wherein the unsaturated acidic reagent is maleic anhydride.

4. The hybrid succinic anhydride copolymer of Claim 2 wherein the mono-olefin is at least one normal alpha olefin, 1-olefin, polyolefin, or mixtures thereof.

5. The hybrid succinic anhydride copolymer of Claim 2 wherein the mono-olefin is polybutene.

6. The hybrid succinic anhydride copolymer of Claim 5 wherein the mono-olefin is polyisobutene having at least about 20% of a methylvinylidene isomer.

7. The hybrid succinic anhydride copolymer of Claim 2 wherein the hybrid succinic anhydride copolymer contains from about 20% to about 80% unreacted anhydride groups.

8. The hybrid succinic anhydride copolymer of Claim 2 wherein the at least one linking hydrocarbyl di-primary amine is selected from the group consisting of ethylene diamine; 1,6-diaminohexane; and 1,12-diaminododecane.

9. The hybrid succinic anhydride copolymer Claim 2 wherein the charge mole ratio of the hydrocarbyl di-primary amine to anhydride is from about 0.05:1 to about 0.45:1.

10. A lubricating oil concentrate comprising from about 20 to about 80 weight percent of an organic diluent and the additive composition of claim 1.

WHAT IS CLAIMED IS:

1. A hybrid succinic anhydride copolymer obtainable by the process which comprises reacting a copolymer of an (i) an unsaturated acidic reagent; and (ii) a mono-olefin, with at least one linking hydrocarbyl di-primary amine, thereby producing a hybrid succinic anhydride copolymer having unreacted anhydride groups.

2. A hybrid succinic anhydride copolymer according to claim 1, having from about 10% to about 90% unreacted anhydride groups, or having from about 20% to about 80% unreacted anhydride groups.

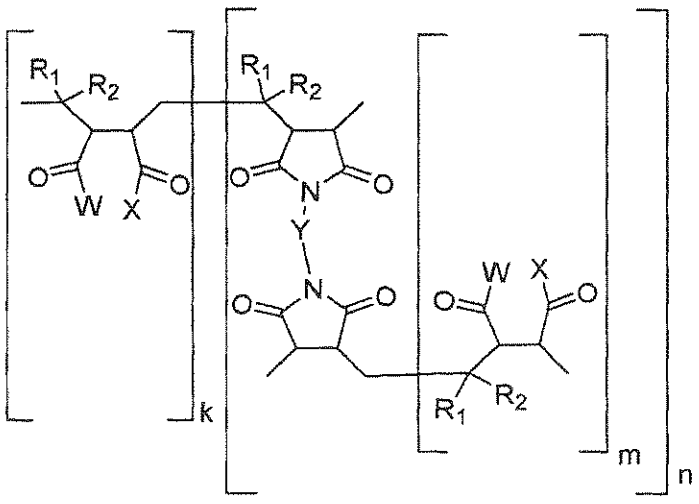
3. The hybrid succinic anhydride copolymer of Claim 1 or 2 wherein the unsaturated acidic reagent is maleic anhydride.

4. The hybrid succinic anhydride copolymer of Claim 1 or 2 wherein the mono-olefin is at least one normal alpha olefin, 1-olefin, polyolefin, or mixtures thereof; or wherein the mono-olefin is polybutene; or wherein the mono-olefin is polyisobutene having at least about 20% of a methylvinylidene isomer.

5. The hybrid succinic anhydride copolymer of Claim 1 or 2 wherein the at least one linking hydrocarbyl di-primary amine is selected from the group consisting of ethylene diamine; 1,6-diaminohexane; and 1,12-diaminododecane.

6. The hybrid succinic anhydride copolymer Claim 1 or 2 wherein the charge mole ratio of the hydrocarbyl di-primary amine to anhydride is from about 0.05:1 to about 0.45:1.

7. A hybrid succinic anhydride copolymer according to claim 1 or 2 having the following formula:



(I)

wherein one of R1 and R2 is either lower alkyl or hydrogen, and the other of R1 and R2 is polyalkyl, W and X are independently selected from the group consisting of -OH, -O-R' wherein R' is lower alkyl, or taken together are -O- to form a succinic anhydride group, n, m, and k are 1 to 20, and Y is alkylene having from about 2 to 20 carbon atoms.

8. A succinimide obtainable by a process comprising reacting the hybrid succinic anhydride copolymer according to any preceding claim with a second amine compound, thereby producing the succinimide.

9. The succinimide composition of Claim 8 wherein the second amine compound is at least one of an aliphatic or aromatic monoamine or polyamine or mixtures thereof.

10. The succinimide of Claim 9 wherein the second amine compound is a primary amine, or wherein the second amine compound is a polyamine, or wherein the second amine compound is a heavy polyamine, having at least 6.5 nitrogen atoms per mole of polyamine.

11. A lubricating oil composition comprising a major amount of an oil of lubricating viscosity and a minor amount of the succinimide as claimed in any one of claims 8-10.

12. A method of making a lubricating oil additive composition which comprises
(A) reacting a copolymer of an (i) an unsaturated acidic reagent; and (ii) a mono-olefin, with at least one linking hydrocarbyl di-primary amine, thereby producing a hybrid succinic anhydride copolymer having unreacted anhydride groups; and subsequently
(B) reacting the hybrid succinic anhydride copolymer with a second amine compound, thereby producing the succinimide.

13. A method according to claim 12, wherein the hybrid succinic anhydride copolymer has from about 10% to about 90% unreacted anhydride groups.

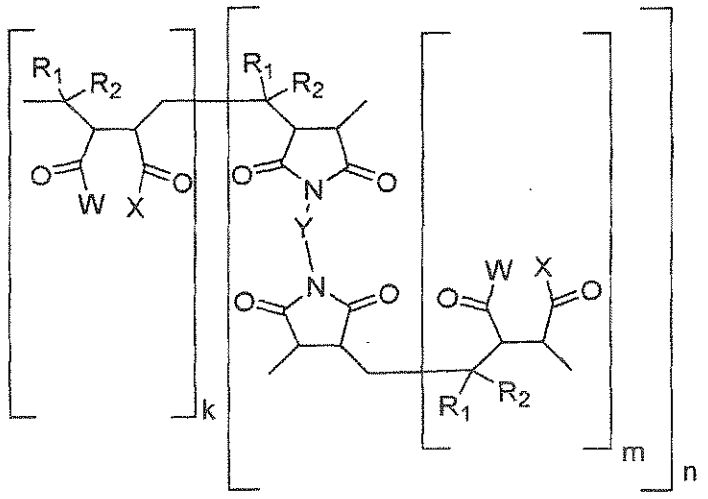
14. A method of improving soot dispersancy in an internal combustion engine which comprises operating the engine with a lubricating oil composition comprising a major amount of oil of lubricating viscosity and an effective amount of the succinimide of any one of claims 8-10.

15. A lubricating oil concentrate comprising from about 20 to about 80 weight percent of an organic diluent and the succinimide of any one of claims 8-10.

16. A fuel composition comprising a hydrocarbon boiling in a gasoline or diesel range and from about 30 to about 5000 parts per million of a succinimide according to any one of claims 8-10.

17. A fuel concentrate comprising an inert stable oleophilic organic solvent boiling in the range of 150°F to 400°F and from about 5 to 50 weight percent of a succinimide according to any one of claims 8-10.

18. A hybrid succinic anhydride copolymer having the following formula:



(I)

wherein one of R1 and R2 is either lower alkyl or hydrogen, and the other of R1 and R2 is polyalkyl, W and X are independently selected from the group consisting of -OH, -O-R' wherein R' is lower alkyl, or taken together are -O- to form a succinic anhydride group, n, m, and k are 1 to 20, and Y is alkylene having from about 2 to 20 carbon atoms.