What is claimed is:

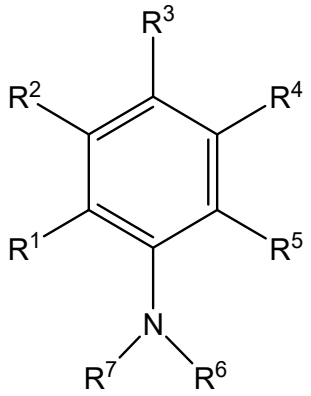
1. A method to impede formation of polymer in a monomer-containing composition, the method comprising

adding to a composition comprising a polymerizable monomer or a compound capable of forming a polymerizable monomer components comprising:

a benzoquinone or naphthoquinone compound, and

an oxygenated aminophenol compound,

the oxygenated aminophenol compound being a compound of Formula I:



(I)

wherein at least one of $–R^1$, $–R^2$, $–R^3$, $–R^4$, and $–R^5$ is or are –OH, and wherein any one or more of $–R^1$, $–R^2$, $–R^3$, $–R^4$, and $–R^5$ that is not –OH is or are selected from the group consisting of hydrogen, alkyl, aryl, alkyl aryl and aryl alkyl, or any two adjacent groups of $–R^1$, $–R^2$, $–R^3$, $–R^4$, and $–R^5$ that are not –OH form one or more ring structures;

wherein R^6 and R^7 are, independently, carbon-containing groups, and at least one of R^6 and R^7 comprises one or more oxygen atom(s) separated from the N atom by one or more carbon atoms;

wherein the benzoquinone or naphthoquinone compound, and the oxygenated aminophenol compound, impede formation of polymer in the composition.

2. The method of claim 1 wherein the oxygen atom(s) in the at least one of R^6 and R^7 group(s) is or are present in the form of a hydroxyl group, an ether group, or both.

3. The method of claim 1 or 2 wherein the one or more oxygen atom(s) are separated from the N atom by two or more carbon atoms.

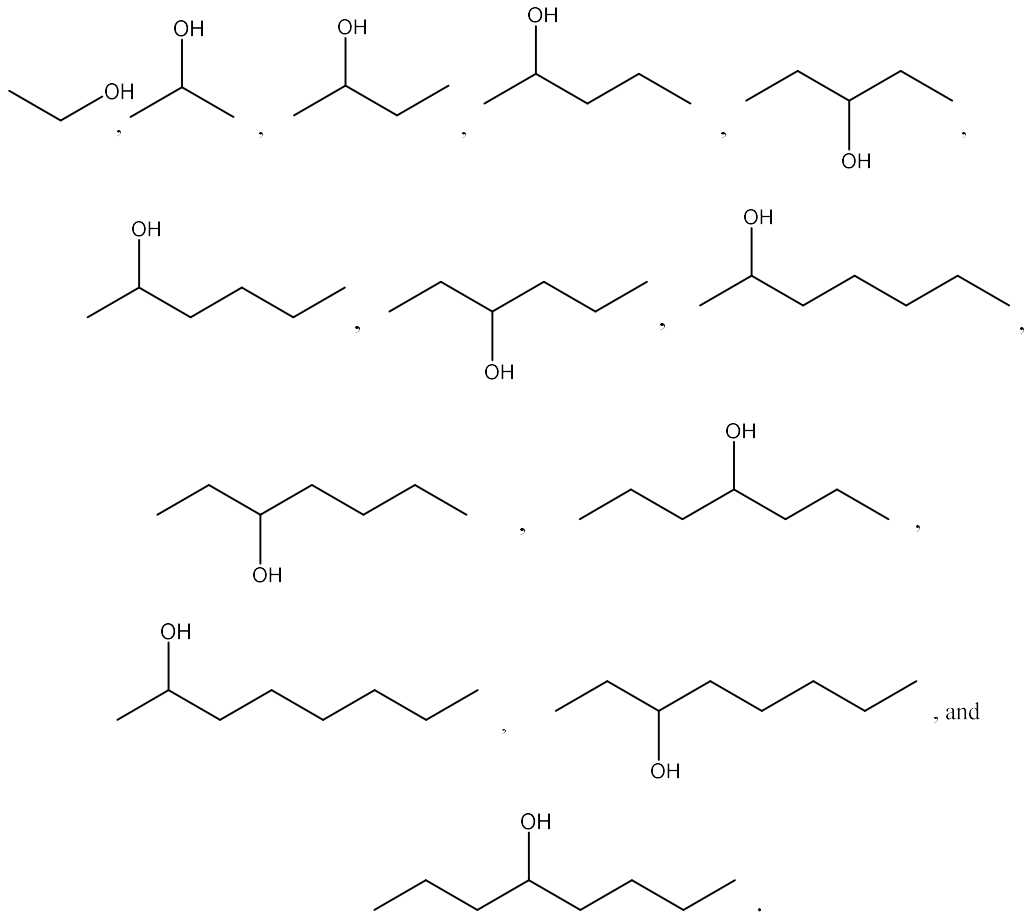
4. The method of any of claims 1-3 wherein R^6 or R^7 have a number of carbon atoms of 2, or more, 3 or more, 4 or more, 5 or more, 6 or more, or in the range of 2-18, 3-17, 4-16, 5-14, or 6-12 carbon atoms, or the total number of carbon atoms in R^6 and R^7 is in the range of 2-30, 4-26, or 6-24 carbon atoms.

5. The method of any of the previous claims, wherein one or both of R^6 and R^7 are of the formula: $–R^9OR^{10}$, wherein R^9 comprises a hydrocarbylene group, optionally substituted, and R^{10} comprises a hydrocarbyl group, optionally substituted.

6. The method of claim 5 wherein (a) R^9 is selected from the group consisting of methylene, ethylene, propylene, isopropylene, butylene, isobutylene, sec-butylene, tert-butylene, pentylene, and hexylene, (b) R^{10} is selected from the group consisting of linear, branched, or cyclic alkyl, aryl, alkyl-aryl, and aryl-alkyl having 1-18 carbon atoms, or both (a) and (b).

7. The method of claim 5 or 6, wherein R^9 is a hydroxylated hydrocarbylene group.

8. The method of claim 7 wherein R^9 is selected from the group consisting of


OH
OH
OH

4-bis[(2-butoxy-1-hydroxy-ethyl)amino]phenol, 4-bis[(3-butoxy-2-hydroxy-propyl)amino]phenol, 4-bis[(4-butoxy-2-hydroxy-butyl)amino]phenol, 4-bis[(5-butoxy-2-hydroxy-pentyl)amino]phenol, 4-bis[(6-butoxy-2-hydroxy-hexyl)amino]phenol, and 4-bis[(butoxyhydroxyphenyl)amino]phenol.

10. The method of any of the previous claims wherein (a) the benzoquinone or naphthoquinone compound is present in the composition in an amount in the range of 50 to 5000 ppm, (b) the oxygenated aminophenol compound is present in the composition in an amount in the range of 50 to 5000 ppm, or (c) both (a) and (b), and/or optionally wherein (d) the benzoquinone or naphthoquinone compound is present in the composition in an amount in the range of 150 to 750 ppm, (e) the oxygenated aminophenol compound is present in the composition in an amount in the range of 150 to 750 ppm, or (f) both (d) and (e).

11. The method of any of the previous claims wherein the benzoquinone or naphthoquinone compound is added to the composition prior at the same time the oxygenated aminophenol compound is added, or the benzoquinone or naphthoquinone compound is added to the composition prior at time that is different than when the oxygenated aminophenol compound is added.

12. The method of any one of the previous claims wherein adding is performed during purification or processing of one or more hydrocarbon components of the composition, and optionally wherein processing of the one or more hydrocarbons comprises a distillation step.

13. The method of any one of claims 1-11, which is performed prior to storage or transport of the composition.

14. The method of any of the previous claims wherein the polymerizable monomer comprises an ethylenically unsaturated group, optionally wherein the polymerizable monomer is selected from the group consisting of acrylic acid, acrylonitrile, alkylated styrene, butadiene, chloroprene, divinylbenzene, ethyl acrylate, ethyl methacrylate,

isoprene, methacrylic acid, methyl methacrylate, methyl acrylate, α-methylstyrene, methacrylonitrile, styrene, styrene sulfonic acid, vinyltoluene, and vinylpyridine.

15. The method of any of claims 1-14, wherein the composition comprises (a) styrene or ethylbenzene, (b) the composition includes one or more non-polymerizable hydrocarbons, or both (a) and (b).

16. The method of any of the previous claims wherein the composition has no, less than 5 ppm, or less than 0.5 ppm, of a nitroxyl group-containing antipolymerant.

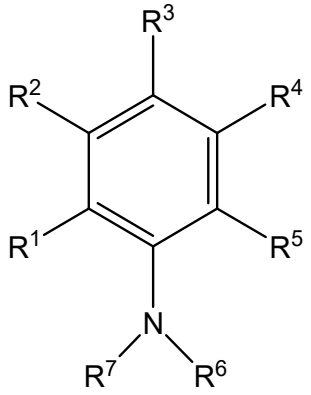
17. The method of any one of the previous claims wherein the benzoquinone or naphthoquinone is used at a first concentration, and the oxygenated aminophenol compound is used at a second concentration, wherein the first and second concentrations together are a total concentration, and the combination of the benzoquinone or naphthoquinone and oxygenated aminophenol compound together provide a level of polymer formation that is lower than the level of polymer formation observed when either the benzoquinone or naphthoquinone and oxygenated aminophenol compound are used alone at the total concentration, or at the average of the levels of polymer formation of the benzoquinone or naphthoquinone and oxygenated aminophenol compound when used alone at the total concentration, and optionally wherein the combination of the benzoquinone or naphthoquinone and oxygenated aminophenol compound impedes polymerization by an amount of 10% or greater, 20% or greater, 30% or greater, 40% or greater, 50% or greater, 60% or greater, 70% or greater, 80% or greater, or up to about 90 % or greater, or a reduction in an % amount in the range of any of these numbers, as compared to the average, or as compared to either the of benzoquinone or naphthoquinone and oxygenated aminophenol compound used individually at the total concentration.

18. An additive composition for inhibiting the polymerization of monomers, the composition comprising:

a benzoquinone or naphthoquinone compound, and

an oxygenated aminophenol compound,

the oxygenated aminophenol compound being a compound of Formula I:



(I)

wherein at least one of $–R^1$, $–R^2$, $–R^3$, $–R^4$, and $–R^5$ is or are –OH, and wherein any one or more of $–R^1$, $–R^2$, $–R^3$, $–R^4$, and $–R^5$ that is not –OH is or are selected from the group consisting of hydrogen, alkyl, aryl, alkyl aryl and aryl alkyl, or any two adjacent groups of $–R^1$, $–R^2$, $–R^3$, $–R^4$, and $–R^5$ that are not –OH form one or more ring structures;

wherein R^6 and R^7 are, independently, carbon-containing groups, and at least one of R^6 and R^7 comprises one or more oxygen atom(s) separated from the N atom by one or more carbon atoms.

19. The composition of claim 18, further comprising an organic solvent.

20. The composition of claim 19, wherein:

(A) the benzoquinone or naphthoquinone is in an amount in the range of 5 to 45% (wt); the oxygenated aminophenol compound is in an amount in the range of 5 to 45% (wt); and the organic solvent is in an amount in the range of 10 to 90% (wt); or

(B) the benzoquinone or naphthoquinone is in an amount in the range of 15 to 35% (wt); the oxygenated aminophenol compound is in an amount in the range of 15 to 35% (wt); and the organic solvent is in an amount in the range of 30 to 70% (wt).