CLAIMS

What is claimed is:

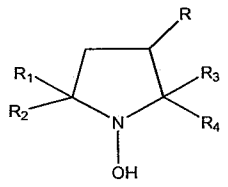
1. A method of inhibiting polymerization of an ethylenically unsaturated monomer comprising:

providing a fluid comprising an ethylenically unsaturated monomer;

adding an effective amount of a polymerization inhibitor composition to the fluid, wherein the polymerization inhibitor composition comprises an effective amount of at least one hydroxylamine of a nitroxide and an effective amount of at least one phenylenediamine; and

inhibiting polymerization of the ethylenically unsaturated monomer,

wherein the at least one hydroxylamine of a nitroxide comprises the following structure:



wherein each R_1, R_2, R_3 and R_4 is independently selected from an alkyl group and R is selected from the group consisting of hydrogen, oxygen, alkyl, hydroxyl, alkoxyl, amino, N-alkylamino, amido, N-alkylamido, carboxylate and carboxyl.

2. The method of claim 1, wherein the effective amount of the at least one hydroxylamine of a nitroxide and the effective amount of the at least one phenylenediamine is from about 1 ppm to about 2,000 ppm by weight of monomer.

3. The method of claim 1 or claim 2, wherein the ethylenically unsaturated monomer is selected from the group consisting of acrylic acid, methacrylic acid, acrylonitrile, methacrylonitrile, acrolein, methacrolein, acrylate, methacrylate, acrylamide, methacrylamide, vinyl acetate, butadiene, styrene, ethylene, propylene, and any combination thereof.

4. The method of any one of claims 1 to 3, wherein the polymerization inhibitor composition is added continuously or intermittently to the fluid.

5. The method of any one of claims 1 to 4, wherein the at least one phenylenediamine comprises the following structure:



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, alkyl, alkylaryl, hydroxyl-containing alkyl groups, ethoxylate-containing alkyl groups, and amino-containing alkyl groups.

6. The method of any one of claims 1 to 5, wherein the at least one phenylenediamine is selected from the group consisting of 1,2-phenylenediamine, 1,4-phenylenediamine, N,N'-di-methyl-p-phenylenediamine, N,N'-di-sec-butyl-1,4-phenylenediamine, N,N'-di-1,4-dimethylpentyl-1,4-phenylenediamine, N,N'-di-acetyl-1,4-phenylenediamine, N-tert-butyl-N'-phenyl-1,4-phenylenediamine, N,N'-di-phenyl-1,4-phenylenediamine, and any combination thereof.

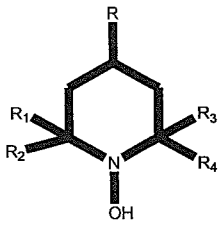
7. A method of inhibiting polymerization of an ethylenically unsaturated monomer comprising:

providing a fluid comprising an ethylenically unsaturated monomer;

adding an effective amount of a polymerization inhibitor composition to the fluid, wherein the polymerization inhibitor composition comprises an effective amount of at least one hydroxylamine of a nitroxide and an effective amount of at least one phenylenediamine; and

inhibiting polymerization of the ethylenically unsaturated monomer,

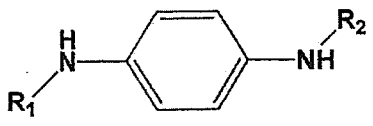
wherein the at least one hydroxylamine of a nitroxide comprises the following structure:



wherein each R_1, R_2, R_3 and R_4 is independently selected from an alkyl group and R is selected from the group consisting of hydrogen, oxygen, alkyl, hydroxyl, alkoxyl, amino, N-alkylamino, amido, N-alkylamido, carboxylate and carboxyl.

8. The method of claim 7, wherein the at least one hydroxylamine of a nitroxide is selected from the group consisting of 4-hydroxy-2,2,6,6-tetramethyl piperidinol, 4-oxo-2,2,6,6-tetramethyl piperidinol, 4-methoxy-2,2,6,6-tetramethyl piperidinol, 4-acetate-2,2,6,6-tetramethyl piperidinol, 4-amino-2,2,6,6-tertrmethyl piperidinol, 4-acetamido-2,2,6,6-tetramethyl piperidinol, 1,2,3,6-tetrahydro-2,2,6,6-tetramethyl piperidinol, bis(2,2,6,6-tetramethylpiperidinol) sebacate, and any combination thereof.

9. The method of claim 7 or claim 8, wherein the at least one phenylenediamine comprises the following structure:



wherein R_1 and R_2 are independently selected from the group consisting of hydrogen, alkyl, alkylaryl, aryl, and arylalkyl, and further wherein R_1 and R_2 optionally comprise heteroatoms, hydroxyl groups, and/or amino groups.

10. The method of any one of claims 7 to 9, wherein the at least one phenylenediamine is selected from the group consisting of 1,2-phenylenediamine, 1,4-phenylenediamine, N,N'-di-methyl-p-phenylenediamine, N,N'-di-sec-butyl-1,4-phenylenediamine, N,N'-di-1,4-dimethylpentyl-1,4-phenylenediamine, N,N'-di-acetyl-1,4-phenylenediamine, N-tert-butyl-N'-phenyl-1,4-phenylenediamine, N,N'-di-phenyl-1,4-phenylenediamine, and any combination thereof.

11. The method of any one of claims 7 to 10, wherein the ethylenically unsaturated monomer is selected from the group consisting of acrylic acid, methacrylic acid, acrylonitrile, methacrylonitrile, acrolein, methacrolein, acrylate, methacrylate, acrylamide, methacrylamide, vinyl acetate, butadiene, styrene, ethylene, propylene, and any combination thereof.