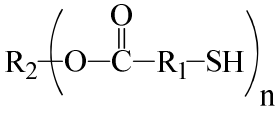
CLAIMS

1. An N-vinyl amide polymer which is a reaction product of:

a monomer component comprising an N-vinyl amide; and

a chain transfer agent of Formula (I):



Formula (I)

wherein

each occurrence of R_1 is independently a C_{1-20} alkylene, a C_{1-20} heteroalkylene, a C_{3-20} cycloalkylene, a C_{3-20} heterocycloalkylene, a C_{6-20} arylene, or a combination thereof, and R_1 is substituted or unsubstituted;

R_2 is a divalent or multivalent organic group having 2 to 40 carbon atoms; and

n is at least 2.

2. The N-vinyl amide polymer of claim 1, wherein each occurrence of R_1 is independently a C_{1-10} alkylene, a C_{6-12} arylene, or a combination thereof.

3. The N-vinyl amide polymer of claim 1, wherein R_2 is a substituted or unsubstituted C_{2-30} alkyl, C_{3-30} cycloalkyl, C_{2-30} heteroalkyl, C_{3-30} heterocycloalkyl, or a combination comprising at least one of the foregoing; and wherein optionally R_2 has one or more hydroxyl substituents.

4. The N-vinyl amide polymer of claim 1, wherein the chain transfer agent is a reaction product of a polyol and a mercaptan-containing carboxylic acid.

5. The N-vinyl amide polymer of claim 4, wherein the polyol and the mercaptan-containing carboxylic acid has a molar ratio of 1:20 to 1:1.

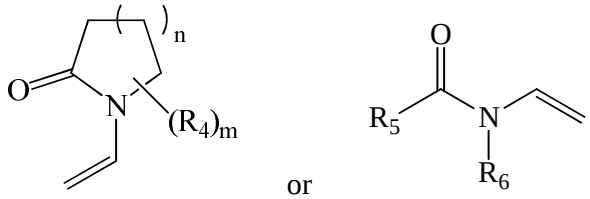
6. The N-vinyl amide polymer of claim 4, wherein

the polyol comprises ethylene glycol, glycerol, erythritol, threitol, arabitol, xylitol, ribitol, mannitol, sorbitol, galactitol, fucitol, iditol, inositol, volemitol, isomalt, maltitol, lactitol, maltotriitol, maltotetraitol, polyglycitol, 1,2-propanediol, 1,3-propanediol, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, 2,3-butanediol, 1,2,4-butanetriol, 1,1,1-tris(hydroxymethyl)ethane, 1,2,6-hexanetriol, diethylene glycol, triethylene glycol, dipropylene glycol, diglycerol, triglycerol, polyglycerol, pentaerythritol, dipentaerythritol, tripentaerythritol, 2,2-dibutyl-1,3-propanediol, or a combination comprising at least one of the foregoing; and the mercaptan-containing carboxylic acid comprises thioglycolic acid,

thiolactic acid, cysteine, mercaptosuccinic acid, 2-mercaptoisobutyric acid, 2-methyl-3-sulfanylpropanoic acid, 2-mercaptopropionic acid, 3-mercaptopropionic acid, 2-mercaptobutyric acid, 3-mercaptobutyric acid, 4-mercaptobutyric acid, 4-mercaptophenylacetic acid, or a combination comprising at least one of the foregoing.

7. The N-vinyl amide polymer of claim 1, wherein the chain transfer agent is a reaction product of a polyol, a mercaptan-containing carboxylic acid, and a carboxylic acid different from the mercaptan-containing carboxylic acid or a reaction product of sorbitol and thioglycolic acid or a reaction product of sorbitol, thioglycolic acid, and citric acid, or a combination thereof.

8. The N-vinyl amide polymer of claim 1, wherein the N-vinyl amide is of Formula (II) or Formula (III)



or

Formula (II) Formula (III)

wherein

each R_4 is independently a halogen atom or a C_{1-10} alkyl,

each of R_5 and R_6 is independently hydrogen or a C_{1-10} alkyl,

n is 1 to 5, and

m is 2+n, and

optionally the N-vinyl amide is of Formula (II), m is 0, and n is 1 to 2.

9. The N-vinyl amide polymer of claim 1, wherein the monomer component further comprises at least one of an acrylate or an acrylamide.

10. The N-vinyl amide polymer of claim 1, wherein the N-vinyl amide polymer is a reaction product of the monomer component, the chain transfer agent, and a crosslinking agent; and wherein optionally the crosslinking agent comprises glycerol dimethacrylate, e*thylene glycol dimethacrylate, di(ethylene glycol) dimethacrylate, triethylene glycol dimethacrylate, tetraethylene glycol dimethacrylate, poly(ethylene glycol) dimethacrylate, 1,3-butanediol dimethacrylate, 1,4-butanediol dimethacrylate, glycerol 1,3-diglycerolate diacrylate, ethylene glycol diacrylate, di(ethylene glycol) diacrylate, tri(ethyleneglycol) diacrylate, tetra(ethylene glycol) diacrylate, poly(ethylene glycol) diacrylate, or 1,4-butanediol diacrylate, or a combination comprising at least one of the foregoing.*

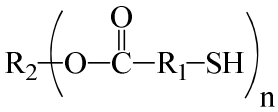
11. The N-vinyl amide polymer of claim 10, wherein the monomer component comprises 1-vinyl-2-pyrrolidinone and at least one of N-vinylcaprolactam and butyl acrylate.

12. A hydrate inhibitor composition comprising the N-vinyl amide polymer of any one of claims 1 to 11, and optionally the hydrate inhibitor composition further comprises a solvent, which comprises methanol, ethanol, propanol, butanol, ethylene glycol, 1,2-propylene glycol, 1,3-propylene glycol, glycerin, diethylene glycol monoethyl ether, ethoxylated propylene glycols, ethylene glycol monobutyl ether, 2-ethoxyethanol, 2-propoxyethanol, 2-isopropoxyethanol, 2-butoxyethanol, 2-isobutoxyethanol, 2-methoxyethanol, a ketone, or a combination comprising at least one of the foregoing.

13. The hydrate inhibitor composition of claim 12, wherein the N-vinyl amide polymer is present in an amount of 5 to 50 wt% based on the total weight of the hydrate inhibitor composition.

14. A method of controlling hydrate formation in a fluid comprising water and a hydrate-forming guest molecule, the method comprising contacting the fluid with an inhibitor composition comprising the polymer of any one of claims 1 to 11, and wherein optionally the hydrate-forming guest molecule comprises methane, ethane, ethylene, acetylene, propane, propylene, methylacetylene, n-butane, isobutane, 1-butene, trans-2-butene, cis-2-butene, isobutene, butene mixtures, isopentane, pentenes, natural gas, carbon dioxide, hydrogen sulfide, nitrogen, oxygen, argon, krypton, and xenon, or a combination comprising at least one of the foregoing.

15. A chain transfer agent of Formula (I):



Formula (I)

wherein

each occurrence of R_1 is $–CH_2–$, $–CH(CH_3)–$, $–CH(C_2H_5)–$, $–C(CH_3)_2–$, $–CH_2CH_2–$, $–CH(CH_3)CH_2–$, $–CH_2CH(NH_2)–$, $–CH_2CH(COOH)–$, or $–CH_2CH_2CH_2$;

R_2 is a divalent or multivalent organic group having 2 to 40 carbon atoms; and

n is at least 2; and

optionally wherein

R_2 is a substituted or unsubstituted C_{2-30} alkyl, C_{3-30} cycloalkyl, C_{2-30} heteroalkyl, C_{3-30}

heterocycloalkyl, or a combination comprising at least one of the foregoing; and preferably R_2 has one or more hydroxyl substituents.