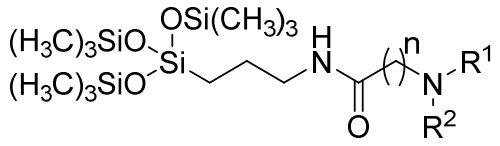
## CLAIMS

1. A hydrocarbon recovery formulation, comprising:

at least one surfactant of Formula I,



Formula I

wherein $R^1$ and $R^2$ may be the same or different, and comprise at least one group selected from the group consisting of $C_1$-$C_6$ alkyl, optionally the $C_1$-$C_6$ alkyl may include one or more of oxygen, nitrogen, or sulfur atoms or groups that include at least one of these atoms, and the alkyl chain may be optionally substituted with one or more substituents selected from the group consisting of hydroxyl, amino, amido, sulfonyl, sulfonate, carbonyl, carboxyl, and carboxylate;

n is an integer from 1 to 12;

the terminal nitrogen is optionally further substituted with $R^3$, wherein $R^3$ is selected from the group consisting of hydrogen, oxygen, hydroxyl, and $C_1$-$C_6$ alkyl;

an optional counterion associated with the compound which, if present, is selected from the group consisting of chloride, bromide, and iodide; and

an aqueous phase.

2. The formulation according to claim 1, further comprising at least one additional surfactant selected from the group consisting of: an anionic surfactant having a hydrophobic chain of 12 to 24 carbon atoms selected from the group consisting of sulfonate surfactants, sulfate surfactants, cationic surfactants, nonionic surfactants, and zwitterionic surfactants.

3. The formulation according to claim 1, wherein the aqueous phase includes at least one inorganic salt, selected from the group consisting of: sodium chloride, sodium sulfate, potassium chloride, magnesium sulfate, and magnesium chloride.

4. The formulation according to claim 1, further including at least one polymer.

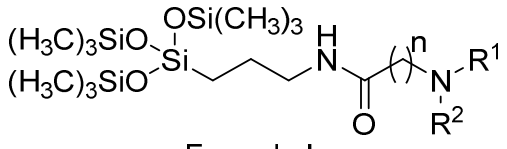
5. The formulation according to claim 4, wherein the at least one polymer is selected from the group consisting of: a quaternary ammonium compound, such as a cationic polymer comprising a quaternary diallyl dialkyl ammonium monomer, and/or an anionic surfactant, preferably an anionic polymer comprising an anionic monomer selected from the group consisting of acrylic acid, methacrylic acid, and combinations thereof, wherein the average molecular weight of said anionic polymer ranges from 50,000 to 10,000,000.

6. The formulation according to claim 1, further including:

a) lecithin or modified lecithin;
b) at least one water immiscible solvent;
c) at least one water miscible solvent;
d) at least one gas selected from the group consisting of; air, nitrogen, carbon dioxide, and natural gas; or
e) at least one additive selected from the group consisting of: hydrogen chloride, an ammonium salt, ammonium bicarbonate, ammonium carbonate, or ammonium hydroxide, alcohol, crosslinking agent, breaker delay agents, particles, proppants, gas component, breaker aids, oxygen scavengers, alcohols, scale inhibitors, corrosion inhibitors, fluid-loss additives, biocides/bactericides, friction reducers, and latex.

7. Use of a formulation for the recovery of hydrocarbons, the formulation comprising:

at least one surfactant of Formula I,



Formula I

wherein $R^1$ and $R^2$ may be the same or different, and comprise at least one group selected from the group consisting of $C_1$-$C_6$ alkyl, optionally the $C_1$-$C_6$ alkyl may include one or more of oxygen, nitrogen, or sulfur atoms or groups

that include at least one of these atoms, and the alkyl chain may be optionally substituted with one or more substituents selected from the group consisting of hydroxyl, amino, amido, sulfonyl, sulfonate, carbonyl, carboxyl, and carboxylate;

n is an integer from 1 to 12;

the terminal nitrogen is optionally further substituted with $R^3$, wherein $R^3$ is selected from the group consisting of hydrogen, oxygen, hydroxyl, and $C_1$-$C_6$ alkyl;

an optional counterion associated with the compound which, if present, is selected from the group consisting of chloride, bromide, and iodide; and

an aqueous phase.

8. The use according to claim 7, wherein the formulation further comprises at least one additional surfactant selected from the group consisting of: an anionic surfactant having a hydrophobic chain of 12 to 24 carbon atoms selected from the group consisting of sulfonate surfactants, sulfate surfactants, cationic surfactants, nonionic surfactants, and zwitterionic surfactants.

9. The use according to claim 7, wherein the aqueous phase includes at least one inorganic salt, selected from the group consisting of: sodium chloride, sodium sulfate, potassium chloride, magnesium sulfate, and magnesium chloride.

10. The use according to claim 7, wherein the formulation further includes at least one polymer.

11. The use according to claim 10, wherein the at least one polymer is selected from the group consisting of: a quaternary ammonium compound, such as a cationic polymer comprising a quaternary diallyl dialkyl ammonium monomer, and/or an anionic surfactant, preferably an anionic polymer comprising an anionic monomer selected from the group consisting of acrylic acid,

methacrylic acid, and combinations thereof, wherein the average molecular weight of said anionic polymer ranges from 50,000 to 10,000,000.

12. The formulation according to claim 7, further including:

a) lecithin or modified lecithin;

b) at least one water immiscible solvent;

c) at least one water miscible solvent;

d) at least one gas selected from the group consisting of; air, nitrogen, carbon dioxide, and natural gas; or

e) at least one additive selected from the group consisting of: hydrogen chloride, an ammonium salt, ammonium bicarbonate, ammonium carbonate, or ammonium hydroxide, alcohol, crosslinking agent, breaker delay agents, particles, proppants, gas component, breaker aids, oxygen scavengers, alcohols, scale inhibitors, corrosion inhibitors, fluid-loss additives, biocides/bactericides, friction reducers, and latex.

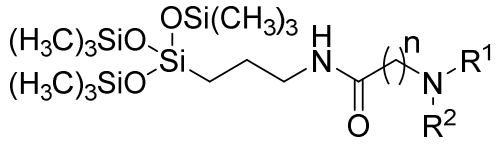
13. A method of recovering a hydrocarbon comprising the steps of:

introducing a foamed fluid composition within an oil or gas well and performing an operation with the foamed fluid composition wherein the foamed composition comprises:

a base fluid comprises: an oil-based or a water-based fluid;

a gas

at least one surfactant of Formula I,




Formula I

wherein $R^1$ and $R^2$ may be the same or different, and comprise at least one group selected from the group consisting of $C_1$-$C_6$ alkyl, optionally the $C_1$-$C_6$ alkyl may include one or more of oxygen, nitrogen, or sulfur atoms or groups that include at least one of these atoms, and the alkyl chain may be optionally substituted with one or more substituents selected from the group consisting

of hydroxyl, amino, amido, sulfonyl, sulfonate, carbonyl, carboxyl, and carboxylate;

n is an integer from 1 to 12;

the terminal nitrogen is optionally further substituted with $R^3$, wherein $R^3$ is selected from the group consisting of hydrogen, oxygen, hydroxyl, and $C_1$-$C_6$ alkyl; and

an optional counterion associated with the compound which, if present, is selected from the group consisting of chloride, bromide, and iodide.

14. The method of claim 13, wherein the operation is selected from the group consisting of: a gas lift operation, a drilling operation, a completion operation, a stimulation operation, a fracturing operation, an injection operation, an enhanced oil recovery operation, and combinations thereof.

15. The formulation of any one of claims 1 to 6, the use of any one of claims 7 to 12, or the method of any one of claims 13 or 14, wherein n is 5.