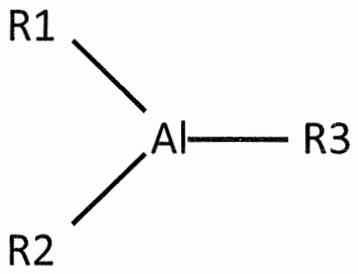
CLAIMS

1. A catalyst system that reduces polymeric fouling, the catalyst system comprising:

at least one titanate compound;

at least one aluminum compound; and

at least one antifouling agent or a derivative thereof, where the antifouling agent comprises the structure:



where one or more of the chemical groups R1, R2, and R3 are antifouling groups comprising the structure $-O((CH_2)_nO)_mR4$, where:

n is an integer from 1 to 20;

m is an integer from 1 to 100; and

R4 is a hydrocarbyl group; and

where the chemical groups R1, R2, or R3 that do not comprise the antifouling group, if any, are hydrocarbyl groups.

2. The catalyst system of claim 1, where n is from 1 to 5.

3. The catalyst system of claim 1, where m is from 1 to 20.

4. The catalyst system of claim 1, where R4 has from 1 to 100 carbon atoms.

5. The catalyst system of claim 1, further comprising an ether compound.

6. The catalyst system of claim 5, where the ether compound is tetrahydrofuran, a dioxane, or tetrahydropyran.

7. The catalyst system of claim 1, where at least one of the titanate compounds is an alkyl titanate.

8. The catalyst system of claim 7, where the alkyl titanate has the structure $Ti(OR)_4$, where R is a branched or straight chain alkyl radical comprising from 2 to 8 carbon atoms.

9. The catalyst system of claim 7, where the alkyl titanate is chosen from tetraethyl titanate, tetraisopropyl titanate, tetra-n-butyl titanate, or 2-tetraethylhexyl titanate.

10. The catalyst system of claim 1, where at least one of the aluminum compounds has the structure AlR'_3 or AlR'_2H, where R' is a branched or straight chain alkyl radical comprising from 2 to 8 carbon atoms.

11. The catalyst system of claim 1, where at least one of the aluminum compounds is chosen from triethylaluminum, tripropylaluminum, tri-iso-butylaluminum, trihexylaluminum, or an aluminoxane.

12. The catalyst system of claim 1, where a molar ratio of total titanate compound to total aluminum compound is from 1:10 to 1:1.5.

13. The catalyst system of claim 1, where a molar ratio of total titanate compound to total antifouling agent is from 1:5 to 1:0.01.

14. The catalyst system of claim 1, where a molar ratio of total titanate compound to total ether compound is from 1:10 to 1:0.

15. The catalyst system of any one of claims 1 through 14, further comprising at least two of:

where n is from 1 to 5;

where m is from 1 to 20; and

where R4 has from 1 to 100 carbon atoms.

16. The catalyst system of any one of claims 1 through 11, further comprising at least two of:

where a molar ratio of total titanate compound to total aluminum compound is from 1:10 to 1:1.5;

where a molar ratio of total titanate compound to total antifouling agent is from 1:5 to 1:0.01; and

where a molar ratio of total titanate compound to total ether compound is from 1:10 to 1:0.

17. The catalyst system of any one of claims 1 through 6 or 10 through 14, where at least one of the titanate compounds is an alkyl titanate, and further comprising at least one of:

where the alkyl titanate has the structure $Ti(OR)_4$, where R is a branched or straight chain alkyl radical comprising from 2 to 8 carbon atoms; and

where the alkyl titanate is chosen from tetraethyl titanate, tetraisopropyl titanate, tetra-n-butyl titanate, or 2-tetraethylhexyl titanate.

18. The catalyst system of any one of claims 1 through 9 or 12 through 14, further comprising at least one of:

where at least one of the aluminum compounds has the structure AlR'_3 or AlR'_2H, where R' is a branched or straight chain alkyl radical comprising from 2 to 8 carbon atoms; and

where at least one of the aluminum compounds is chosen from triethylaluminum, tripropylaluminum, tri-iso-butylaluminum, trihexylaluminum, or an aluminoxane.

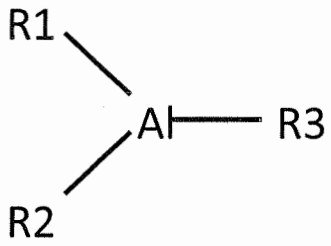
19. A method of producing 1-butene comprising:

contacting ethylene with a catalyst system to oligomerize the ethylene to form 1-butene, where the catalyst system comprises:

at least one titanate compound;

at least one aluminum compound; and

at least one antifouling agent or derivative thereof, where the antifouling agent comprises the structure:



where one or more of the chemical groups R1, R2, and R3 are antifouling groups comprising the structure $-O((CH_2)_nO)_mR4$, where:

n is an integer from 1 to 20;

m is an integer from 1 to 100; and

R4 is a hydrocarbyl group;

where the chemical groups R1, R2, or R3 that do not comprise the antifouling group, if any, are hydrocarbyl groups.