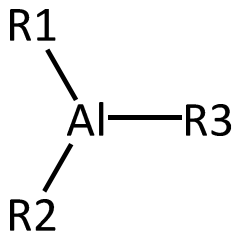
CLAIMS

1. A process for selectively producing 1-butene, the process comprising the following two steps:

Step 1: combining at least one antifouling agent and at least one aluminum alkyl compound to form an antifouling feed stream, wherein bringing the at least one antifouling agent into contact with the at least one aluminum alkyl compound forms at least one antifouling agent co-catalyst comprising the structure:



or its dimeric form, and

Step 2: feeding the antifouling feed stream, a catalyst comprising at least one titanate compound, and ethylene into a reactor to dimerize ethylene, wherein the catalyst comprising at least one titanate compound is fed as a stream separated from the antifouling feed stream;

wherein the molar ratio of the at least one antifouling agent and the at least one aluminum alkyl compound provided to form the antifouling feed stream may be varied in real-time via an inline mixer to adjust a ratio of the formed antifouling agent co-catalyst and residual aluminum alkyl compound or antifouling agent in the antifouling feed stream.

2. The process of claim 1, wherein the molar ratio of the at least one aluminum alkyl compound provided in step 1 to form the antifouling feed stream to the at least one titanate compound provided in Step 2 is equal to or greater than 1.5 and equal to or lower than 3.0.

3. The process of claim 1, wherein one or more of the chemical groups R1, R2, and R3 are antifouling groups comprising the structure $–O((CH_2)_nO)_mR4$, wherein:

n is an integer of from 1 to 20;

m is an integer of from 1 to 100; and

R4 is a hydrocarbyl group;

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

4. The process of any of claims 1-3, wherein the inline mixer is configured to allow ratios of antifouling agent to aluminum alkyl compound provided to the inline mixer from 0:1 to 1:0.

5. The process of any of claims 1-3, wherein the molar ratio of the at least one antifouling agent and the at least one aluminum alkyl compound is equal to or greater than 0.01 and equal to or lesser than 0.18.

6. The process of any of claims 1-3, wherein a level of antifouling agent co-catalyst introduced into the reactor is reduced during reaction start up to avoid passivation of the reactor by reducing the ratio of antifouling agent to aluminum alkyl compound provided to the inline mixer thereby generating less antifouling agent co-catalyst while maintaining flow of the aluminum alkyl compound to the reactor.

7. The process of claim 6, wherein the concentration of antifouling agent co-catalyst is monitored during reactor startup and the feed of the antifouling agent to the inline mixer is terminated upon reaching a predetermined concentration of the antifouling agent co-catalyst.

8. The process of any of claims 1-3, wherein to recover the dimerization reaction of ethylene in case of reaction loss, a level of the aluminum alkyl compound introduced into the reactor is increased while maintaining or reducing a level of the antifouling agent co-catalyst introduced into the reactor by increasing a flow rate of the aluminum alkyl compound to the antifouling feed stream in combination with maintaining or reducing a flow rate of the antifouling agent to the antifouling feed stream.

9. The process of claim 3, wherein n is from 1 to 5, m is from 1 to 20, R4 has from 1 to 100 carbon atoms, or combinations thereof.

10. The process of any of claims 1-2, wherein an atom existing in the chemical groups R1, R2, or R3 binds to the aluminum atom to form a chelate ring.

11. The process of any of claims 1-2, wherein one or more of the chemical groups R1, R2, and R3 are antifouling groups comprising a phosphonium moiety.

12. The process of claim 11, wherein the antifouling agent comprises one or more of a tetraalkyl phosphonium halide, a phosphonium malonate, a trihexyltetradecylphsophonium halide, a tetrabutylphosphonium halide, a tetrabutylphosphonium tetrahaloborate, a tetrabutylphosphonium halide, a tetrabutylphosphonium hexahalophosphate, and a tetrabutylphosphonium tetrahaloborate.

13. The process of any of claims 1-2, wherein one or more of the chemical groups R1, R2, and R3 are antifouling groups comprising a sulfonate moiety.

14. The process of claim 13, wherein the antifouling agent comprises one or more of sodium dodecylbenzenesulfonate, sodium dioctylsulfonsuccinate, tetrabutylphosphonium methanesulfonate, tetrabutylphosphonium p-toluenesulfonate, hexadecyltrimethylammonium p-toluenesulfonate, 3-(dimethyl(octadecyl)ammonio)propane-1-sulfonate, 3,3'-(1,4-didodecylpiperazine-1,4-diium-1,4-diyl)bis(propane-1-sulfonate), and 3-(4-(tert-butyl)pyridinio)-1-propanesulfonate.

15. The process of any of claims 1-2, wherein one or more of the chemical groups R1, R2, and R3 are antifouling groups comprising a sulfonium moiety.