Claims

1. A method for producing linear alpha olefins, comprising:

contacting ethylene, in a reactor under oligomerization conditions, with a heterogeneous catalytic composition to produce a first product stream, the heterogeneous catalytic composition containing a catalyst, a co-catalyst, and a solid support;

recovering, from the reactor, the first product stream including linear alpha olefins, unreacted ethylene, spent catalytic composition fraction, and usable catalytic composition fraction;

separating the spent catalytic composition fraction from the first product stream using a particle size-based separation process to produce a second product stream;

separating the usable catalytic composition fraction from the second product stream to produce a third product stream;

fractionating the third product stream to separate at least one linear alpha olefin product; and

recycling the usable catalytic composition fraction to the reactor;

wherein the spent catalytic composition fraction comprises a polymer byproduct of the oligomerization, said spent catalytic composition fraction has a size distribution in the range of 30-500 microns;

wherein the usable catalytic composition fraction has a size distribution of less than 30 micron, and

wherein the particle size-based separation process is filtration or centrifugation.

2. The method of claim 1, wherein the catalyst is one or more of an aluminum-based catalyst and a transition metal-based catalyst.

3. The method of claim 2, wherein the transition metal is at least one member of the group consisting of nickel, titanium, zirconium or chromium.

4. The method of claim 1, wherein the catalyst is one or more of a phosphorus-oxygen chelate of nickel (I) complex, a zirconium-aluminum alkyl halide, a tri-alkyl aluminum compound, a titanate-aluminum alkyl compound, a chromium(III) complex bearing imino-

furfural ligands, a titanium butoxidetriethylaluminum compound, a cyclopentadienyl-arene complex, and other ethylene oligomerization catalysts.

5. The method of claim 1, wherein the co-catalyst is methylaluminoxane.

6. The method of claim 1, wherein the catalyst is metal-organic framework-based catalyst.

7. The method of claim 1, wherein the solid support is at least one member of the group consisting of silica, clay, zeolite, aluminosilicate, and solid aluminoxane.

8. The method of claim 1, wherein the solid support and the co-catalyst comprise methylaluminoxane.

9. The method of claim 1, wherein the co-catalyst is at least one member of the group consisting of boron-based complex and organoaluminum compounds represented by the formula $R_1R_2R_3A$, wherein A is either boron or aluminum, and R_1, R_2, and R_3 are hydrocarbyl groups with or without heteroatom substitutions.

10. The method of claim 1, where the co-catalyst is at least one member of the group consisting of $B(C_6F_5)_3$, $Ph_3C(B(C_6F_5)_4$, and $[PhMe_2NH][B(C_6F_5)_4]$ or salts thereof.

11. A method for producing linear alpha olefins, comprising:

supplying a catalytic composition, containing a soluble catalyst and a soluble co-catalyst linked to a solid support, and ethylene to a reactor under oligomerization conditions, to produce a first product stream;

recovering, from the reactor, the first product stream including linear alpha olefins, unreacted ethylene, spent catalytic composition fraction, and usable catalytic composition fraction;

separating the spent catalytic composition fraction from the first product stream using a particle size-based separation process to produce a second product stream;

separating the usable catalytic composition fraction from the second product stream to produce a third product stream;

fractionating the third product stream to separate at least one linear alpha olefin product; and

recycling the usable catalytic composition fraction to the reactor;

wherein the spent catalytic composition fraction comprises a polymer byproduct of the oligomerization, said spent catalytic composition fraction has a size distribution in the range of 30-500 microns;

wherein the usable catalytic composition fraction has a size distribution of less than 30 micron, and

wherein the particle size-based separation process is filtration or centrifugation.

12. The method of claim 11, wherein the solid support is at least one member of the group consisting of silica, clay, zeolite, aluminosilicate, and solid aluminoxane.

13. The method of claim 11, wherein the catalyst is one or more of an aluminum-based catalyst and a transition metal-based catalyst.

14. The method of claim 11, wherein the co-catalyst is at least one member of the group consisting of boron-based complex and organoaluminum compounds represented by the formula $R_1R_2R_3A$, wherein A is either boron or aluminum, and R_1, R_2, and R_3 are hydrocarbyl groups with or without heteroatom substitutions.

15. The method of claim 14, where the boron based complex is at least one member of the group consisting of $B(C_6F_5)_3$, $Ph_3C(B(C_6F_5)_4$, and $[PhMe_2NH][B(C_6F_5)_4]$ or salts thereof.