CLAIMS

What is claimed is:

1. A process for producing a high comonomer content propylene-based polymer, the process comprising the step of contacting, under copolymerization conditions, (A) propylene, butene, and optionally ethylene, with one another within (B) a fluidized-bed reactor comprising a catalyst comprising (1) a supported Ziegler-Natta pro-catalyst, (2) a co-catalyst, and (3) a mixed external electron donor system comprising (a) an activity limiting agent, and (b) a selectivity control agent,

wherein the copolymerization conditions include a reactor temperature in a range, in units of °C, of (0.57 x SIT + 4) to (0.87 x SIT – 9.25) where SIT, the seal initiation temperature of the propylene-based polymer, is in a range of 75°C to 110°C.

2. The process of claim 1 in which the propylene-based polymer is one of ethylene-butene-propylene terpolymer (EBPT) and butene-propylene random copolymer (BPRCP).

3. The process of Claim 1 in which the co-catalyst is a trialkylaluminum.

4. The process of Claim 1 in which the activity limiting agent comprises at least one carboxylate ester functional group.

5. The process of Claim 1 in which the selectivity control agent is selected from the group consisting of dicyclopentyldimethoxysilane, n-propyltrimethoxysilane, and methylcyclohexyldimethoxysilane.

6. The process of Claim 1 in which the copolymerization conditions include a pressure of 1 MPa to 5 MPa.

7. A process of producing a propylene-based polymer in a fluidized-bed reactor comprising polymer product particles and a catalyst, the propylene-based polymer having a seal initiation temperature (SIT) of 75°C to 110°C, the process conducted under copolymerization conditions comprising a reactor temperature that is 20°C to 40°C less than the SIT of the propylene-based polymer.

8. The process of Claim 7 in which the catalyst comprises a catalyst/donor system comprising (1) a Ziegler-Natta pro-catalyst composition, (2) an internal electron donor co-catalyst, and (3) a mixed external electron donor (M-EED) system comprising (a) an activity limiting agent, and (b) a selectivity control agent.

9. The process of Claim 8 in which the activity limiting agent comprises at least one carboxylate ester functional group.

10. The process of Claim 8 in which the selectivity control agent is selected from the group consisting of dicyclopentyldimethoxysilane, n-propyltrimethoxysilane, and methylcyclohexyldimethoxysilane.

11. The process of Claim 7 in which the fluidized-bed reactor is fluidized with a pressurized gas having a gas velocity that is in a range of 5 times the minimum fluidization velocity to 1.6 times the flow regime transition velocity necessary to change the flow regime of the fluidized bed from turbulent fluidization to fast fluidization.

12. The process of Claim 7 having a propylene partial pressure in a range of 80% to 120% of the maximum partial pressure, PP_{C3_max}, as determined by the following equation:

$$PP_{C3_max} = 625 - 43.7E_t - 20.0B_t - 2.2T$$

where E_t, the ethylene content in the propylene-based polymer, is in a range of 0 to 2.5 wt%, B_t, the butene content in the propylene-based polymer, is in a range of 8 to 20 wt%, and where ($2*E_t + B_t$) is less than or equal to 21 wt%, and T is the reactor temperature with a unit of °C, and the partial pressure is with a unit of psi.

13. The process of Claim 12 in which E_t is in a range of 0 to 1.5 wt% and B_t is in a range of 8 to 18 wt%.

14. The process of Claim 7 in which the propylene-based polymer is one of EBPT and BPRCP.

15. A process of producing a propylene-based polymer in a fluidized-bed reactor comprising polymer product particles and a catalyst, the propylene-based polymer having a seal initiation temperature (SIT) of 75°C to 110°C, the process conducted under copolymerization conditions comprising a reactor temperature and a propylene partial pressure in a range of 80% to 120% of the maximum partial pressure, PP_{C3_max}, as determined by the following equation:

$$PP_{C3_max} = 625 - 43.7E_t - 20.0B_t - 2.2T$$

where E_t, the ethylene content in the propylene-based polymer, is in a range of 0 to 2.5 wt%, B_t, the butene content in the propylene-based polymer, is in a range of 8 to 20 wt%, and where ($2*E_t + B_t$) is less than or equal to 21 wt%, and T is the reactor temperature with a unit of °C, and the partial pressure is with a unit of psi.

16. The method of Claim 15 in which the process is conducted at a maximum reactor temperature that is 20°C less than the SIT of the propylene-based polymer.

17. The method of Claim 15 in which the process is conducted at a maximum reactor temperature that is 10°C less than the crystallization temperature (T_c) of the propylene-based polymer.

18. The process of Claim 15 in which the catalyst comprises a catalyst/donor system comprising (1) a Ziegler-Natta pro-catalyst composition, (2) a co-catalyst, and (3) a mixed external electron donor (M-EED) system comprising (a) an activity limiting agent, and (b) a selectivity control agent.

19. The process of Claim 15 in which the fluidized-bed reactor is fluidized with a pressurized gas having a gas velocity that is in a range of 5 times the minimum fluidization velocity to 1.6 times the flow regime transition velocity necessary to change the flow regime of the fluidized bed from turbulent fluidization to fast fluidization.

20. The process of Claim 15 in which the propylene-based polymer is one of EBPT and BPRCP.

21. The process of Claim 18 in which the activity limiting agent comprises at least one carboxylate ester functional group.

22. The process of Claim 18 in which the selectivity control agent is selected from the group consisting of dicyclopentyldimethoxysilane, n-propyltrimethoxysilane, and methylcyclohexyldimethoxysilane.

CLAIMS

1. A process for producing a high comonomer content propylene-based polymer, the process comprising the step of contacting, under copolymerization conditions, (A) propylene, butene, and optionally ethylene, with one another within (B) a fluidized-bed reactor comprising a catalyst comprising (1) a supported Ziegler-Natta pro-catalyst, (2) a co-catalyst, and (3) a mixed external electron donor system comprising (a) an activity limiting agent, and (b) a selectivity control agent,

wherein the copolymerization conditions include a reactor temperature in a range, in units of °C, of (0.57 x SIT + 4) to (0.87 x SIT – 9.25) where SIT, the seal initiation temperature of the propylene-based polymer, is in a range of 75°C to 110°C.

2. The process of claim 1 in which the propylene-based polymer is one of ethylene-butene-propylene terpolymer (EBPT) and butene-propylene random copolymer (BPRCP).

3. The process of claim 1 in which: (i) the activity limiting agent comprises at least one carboxylate ester functional group; (ii) the selectivity control agent is selected from the group consisting of dicyclopentyldimethoxysilane, n-propyltrimethoxysilane, and methylcyclohexyldimethoxysilane; or both (i) and(ii).

4. The process of claim 1 in which the copolymerization conditions include a pressure of 1 MPa to 5 MPa.

5. A process of producing a propylene-based polymer, the process comprising contacting, under copolymerization conditions, (A) propylene, butene and optionally ethylene, in a fluidized-bed reactor, the reactor containing (B) a fluidized bed comprising polymer product particles and a catalyst, the propylene-based polymer having a seal initiation temperature (SIT) of 75°C to 110°C, the process conducted under copolymerization conditions comprising a reactor temperature that is 20°C to 40°C less than the SIT of the propylene-based polymer.

6. The process of claim 5 in which the catalyst comprises a catalyst/donor system comprising (1) a Ziegler-Natta pro-catalyst composition, (2) a co-catalyst, and (3) a mixed external electron donor (M-EED) system comprising (a) an activity limiting agent, and (b) a selectivity control agent.

7. The process of claim 6 in which the activity limiting agent comprises at least one carboxylate ester functional group.

8. The process of claim 6 in which the selectivity control agent is selected from the group consisting of dicyclopentyldimethoxysilane, n-propyltrimethoxysilane, and methylcyclohexyldimethoxysilane.

9. The process of claim 5 in which the fluidized-bed reactor is fluidized with a pressurized gas having a gas velocity that is in a range of 5 times the minimum fluidization velocity to 1.6 times the flow regime transition velocity necessary to change the flow regime of the fluidized bed from turbulent fluidization to fast fluidization.

10. The process of claim 5 having a propylene partial pressure in a range of 80% to 120% of the maximum partial pressure, PP_{C3_max}, as determined by the following equation:

$$PP_{C3_max} = 625 - 43.7E_t - 20.0B_t - 2.2T$$

where E_t, the ethylene content in the propylene-based polymer, is in a range of 0 to 2.5 wt%, B_t, the butene content in the propylene-based polymer, is in a range of 8 to 20 wt%, and where ($2*E_t + B_t$) is less than or equal to 21 wt%, and T is the reactor temperature with a unit of °C, and the partial pressure is with a unit of psi.

11. The process of claim 10 in which E_t is in a range of 0 to 1.5 wt% and B_t is in a range of 8 to 18 wt%.

12. The process of claim 5 in which the propylene-based polymer is one of EBPT and BPRCP.

13. A process of producing a propylene-based polymer in a fluidized-bed reactor comprising polymer product particles and a catalyst, the propylene-based polymer having a seal initiation temperature (SIT) of 75°C to 110°C, the process conducted under copolymerization conditions comprising a reactor temperature and a propylene partial pressure in a range of 80% to 120% of the maximum partial pressure, PP_{C3_max}, as determined by the following equation:

$$PP_{C3_max} = 625 - 43.7E_t - 20.0B_t - 2.2T$$

where E_t, the ethylene content in the propylene-based polymer, is in a range of 0 to 2.5 wt%, B_t, the butene content in the propylene-based polymer, is in a range of 8 to 20 wt%, and where ($2*E_t +$

B_t) is less than or equal to 21 wt%, and T is the reactor temperature with a unit of °C, and the partial pressure is with a unit of psi.

14. The process of claim 13 in which the process is conducted at a maximum reactor temperature that is 20°C less than the SIT of the propylene-based polymer.

15. The process of claim 13 in which the process is conducted at a maximum reactor temperature that is 10°C less than the crystallization temperature (T_c) of the propylene-based polymer.

16. The process of claim 13 in which the catalyst comprises a catalyst/donor system comprising (1) a Ziegler-Natta pro-catalyst composition, (2) a co-catalyst, and (3) a mixed external electron donor (M-EED) system comprising (a) an activity limiting agent, and (b) a selectivity control agent.

17. The process of claim 13 in which the fluidized-bed reactor is fluidized with a pressurized gas having a gas velocity that is in a range of 5 times the minimum fluidization velocity to 1.6 times the flow regime transition velocity necessary to change the flow regime of the fluidized bed from turbulent fluidization to fast fluidization.

18. The process of claim 13 in which the propylene-based polymer is one of EBPT and BPRCP.

19. The process of claim 16 in which the activity limiting agent comprises at least one carboxylate ester functional group.

20. The process of claim 16 in which the selectivity control agent is selected from the group consisting of dicyclopentyldimethoxysilane, n-propyltrimethoxysilane, and methylcyclohexyldimethoxysilane.