CLAIMS

1. A method of operating a polyethylene reactor system, comprising:

discharging continuously a transfer slurry from a first polymerization reactor through a transfer line to a second polymerization reactor, the transfer slurry comprising diluent and a first polyethylene;

discharging a product slurry from a second polymerization reactor, the product slurry comprising diluent, the first polyethylene, and a second polyethylene;

determining a pressure loss due to friction in the transfer line; and adjusting a process variable in response to the pressure loss exceeding a specified value.

2. The method of claim 1, wherein the first polymerization reactor and the second polymerization reactor each comprise a liquid-phase reactor.

3. The method of claims 1 through 2, wherein the first polymerization reactor and the second polymerization reactor each comprise a loop reactor.

4. The method of claims 1 through 3, comprising:

feeding ethylene, diluent, and catalyst to the first polymerization reactor;

polymerizing ethylene in the first polymerization reactor to form the first polyethylene, wherein the transfer slurry comprises active catalyst; and

polymerizing ethylene in the second polymerization reactor to form the second polyethylene.

5. The method of claims 1 through 4, comprising feeding diluent to the second polymerization reactor.

6. The method of claims 1 through 5, comprising feeding a comonomer to the first polymerization reactor and/or to the second polymerization reactor.

7. The method of claims 1 through 6, wherein the comonomer comprises propylene, butene, 1-pentene, 1-hexene, 1-octene, and/or 1-decene.

8. The method of claims 1 through 7, comprising feeding a hydrogen to the first polymerization reactor and/or to the second polymerization reactor.

9. The method of claims 1 through 8, wherein adjusting a process variable comprises increasing pressure and/or allowing pressure to increase in the first polymerization reactor

10. The method of claims 1 through 9, wherein increasing pressure in the first polymerization reactor comprises increasing diluent feed pressure to the first polymerization reactor.

11. The method of claims 1 through 10, wherein adjusting a process variable comprises lowering slurry viscosity in the first polymerization reactor.

12. The method of claims 1 through 11, wherein lowering slurry viscosity comprises increasing diluent feed rate to the first polymerization reactor, decreasing solids concentration in the first polymerization reactor, and/or increasing temperature in the first polymerization reactor.

13. The method of claims 1 through 12, wherein adjusting a process variable comprises lowering pressure in the second polymerization reactor.

14. The method of claims 1 through 13, wherein lowering pressure in the second polymerization reactor comprises increasing an open position of a flow control valve through which the product slurry discharges from the second polymerization reactor.

15. The method of claims 1 through 14, wherein adjusting a process variable comprises placing in service another transfer line and discharging continuously at least a portion of the transfer slurry from the first polymerization reactor through the another transfer line to the second polymerization reactor.

What is claimed is:

1. A method of operating a polyethylene reactor system, comprising:

discharging continuously a transfer slurry from a first polymerization reactor through a first transfer line to a second polymerization reactor, the transfer slurry comprising diluent and a first polyethylene;

discharging a product slurry from a second polymerization reactor, the product slurry comprising diluent, the first polyethylene, and a second polyethylene;

calculating, during operation of the system, a pressure loss in the first transfer line by, determining a flow rate of the transfer slurry,calculating a velocity of the transfer slurry as a function of the flow rate,determining a density of the transfer slurry,calculating a Reynolds Number of the transfer slurry in the first transfer line as a function of the velocity, the density, a viscosity of the transfer slurry, and an internal diameter of the first transfer line, and determining a friction factor of an internal surface of the first transfer line as a function of the Reynolds number and a surface roughness to diameter ratio of the internal surface,wherein the calculated pressure loss is a function of the friction factor, a length to internal diameter ratio of the first transfer line, the density, and the velocity; and

measuring, during operation of the system, a pressure differential through the first transfer line to determine a measured pressure differential and adjusting a process variable in response to the measured pressure differential exceeding the calculated pressure loss by a specified amount,

wherein the adjusting of the process variable comprises increasing and/or allowing pressure to increase in the first polymerization reactor, lowering slurry viscosity in the first polymerization reactor, lowering pressure in the second polymerization reactor, or placing in service a second transfer line and discharging continuously at least a portion of the transfer slurry from the first polymerization reactor through the second transfer line to the second polymerization reactor.

2. The method of claim 1, wherein the first polymerization reactor and the second polymerization reactor each comprise a liquid-phase reactor.

3. The method of claim 1, wherein the first polymerization reactor and the second polymerization reactor each comprise a loop reactor.

4. The method of claim 1, further comprising:

feeding ethylene, diluent, and catalyst to the first polymerization reactor;

polymerizing ethylene in the first polymerization reactor to form the first polyethylene, wherein the transfer slurry comprises active catalyst; and

polymerizing ethylene in the second polymerization reactor to form the second polyethylene.

5. The method of claim 1, further comprising feeding diluent to the second polymerization reactor.

6. The method of claim 1, further comprising feeding a comonomer to the first polymerization reactor and/or to the second polymerization reactor.

7. The method of claim 6, wherein the comonomer comprises propylene, butene, 1-pentene, 1-hexene, 1-octene, and/or 1-decene.

8. The method of claim 1, further comprising feeding hydrogen to the first polymerization reactor and/or to the second polymerization reactor.

9. The method of claim 1, wherein the adjusting of the process variable comprises the increasing of the pressure and/or the allowing of the pressure to increase in the first polymerization reactor.

10. The method of claim 9, wherein the increasing of the pressure in the first polymerization reactor comprises increasing diluent feed pressure to the first polymerization reactor.

11. The method of claim 1, wherein the adjusting of the process variable comprises the lowering of the slurry viscosity in the first polymerization reactor.

12. The method of claim 11, wherein the lowering of the slurry viscosity comprises increasing diluent feed rate to the first polymerization reactor, decreasing solids concentration in the first polymerization reactor, and/or increasing temperature in the first polymerization reactor.

13. The method of claim 1, wherein the adjusting of the process variable comprises the lowering of the pressure in the second polymerization reactor.

14. The method of claim 13, wherein the lowering of the pressure in the second polymerization reactor comprises increasing an open position of a flow control valve through which the product slurry discharges from the second polymerization reactor.

15. The method of claim 1, wherein the adjusting of the process variable comprises the placing in service the second transfer line and discharging continuously at least a portion of the transfer slurry from the first polymerization reactor through the second transfer line to the second polymerization reactor.

16. The method of claim 1, wherein the specified value comprises a pressure loss in the range of about 5 pounds per square inch (psi) to 30 psi.

17. The method of claim 1, wherein the determining of the friction factor comprises calculating the friction factor using a Colebrook equation.

18. The method of claim 1, wherein the determining of the flow rate of the transfer slurry comprises determining the flow rate by mass balance of the polyethylene reactor system.

19. The method of claim 1, wherein the transfer slurry has a higher average solids concentration than a first slurry present in the first polymerization reactor.

20. A method of operating a polyethylene reactor system, comprising:

polymerizing ethylene in a first polyethylene reactor to form a first polyethylene;

discharging continuously from the first polyethylene reactor a transfer slurry comprising diluent and the first polyethylene through a transfer line to a second polyethylene reactor;

polymerizing ethylene in the second polyethylene reactor to form a second polyethylene;

discharging continuously from the second polyethylene reactor a product slurry comprising diluent, the first polyethylene, and the second polyethylene;

determining, during the operation of the system, a velocity of the transfer slurry in the transfer line between the first polyethylene reactor and the second polyethylene reactor, wherein the velocity is determined by dividing a flow rate of the transfer slurry by a cross-sectional area of the transfer line; and
maintaining, during the operation of the system, the velocity greater than a specified value by adjusting a diluent flush to the transfer line to increase the velocity of the transfer slurry if the velocity drops to the specified value.

21. The method of claim 20, wherein the specified value comprises a velocity in the range of about 95% to about 200% of a saltation velocity of the transfer slurry, and/or a velocity in the range of about 2 feet per second to about 10 feet per second.

22. The method of claim 20, wherein the first polyethylene and the second polyethylene combine to give a monomodal polyethylene or a bimodal polyethylene.

23. A method of controlling a polyethylene reactor system, comprising:

polymerizing ethylene in a first polymerization reactor to form a first polyethylene;

discharging continuously from the first polymerization reactor a transfer slurry comprising diluent and the first polyethylene through a transfer line to a second polymerization reactor, polymerizing ethylene in the second polymerization reactor to form a second polyethylene;

discharging continuously from the second polymerization reactor a product slurry comprising diluent, the first polyethylene, and the second polyethylene;

calculating, during the operation of the system, a pressure loss between the first polymerization reactor and the second polymerization reactor by using a fluid flow equation; and

maintaining, during the operation of the system, the first polymerization reactor and the second polymerization reactor at substantially the same pressure in response to the pressure loss being less than a specified value.

24. The method of claim 23, wherein the fluid flow equation comprises a Darcy-Weisbach equation.

25. The method of claim 23, wherein the specified value comprises a threshold amount as a percentage of the calculated pressure loss.

26. A method of operating a polyethylene reactor system, comprising:

discharging continuously a transfer slurry from a first polymerization reactor through a first transfer line to a second polymerization reactor, the transfer slurry comprising diluent and a first polyethylene;

discharging a product slurry from a second polymerization reactor, the product slurry comprising diluent, the first polyethylene, and a second polyethylene;

calculating, during operation of the system, a pressure loss in the first transfer line by using a fluid flow equation; and

measuring, during operation of the system, a pressure differential through the first transfer line to determine a measured pressure differential and adjusting a process variable in response to the measured pressure differential exceeding the calculated pressure loss by a specified amount,

wherein the adjusting of a process variable comprises increasing and/or allowing pressure to increase in the first polymerization reactor, lowering slurry viscosity in the first polymerization reactor, lowering pressure in the second polymerization reactor, or placing in service a second transfer line and discharging continuously at least a portion of the first transfer slurry from the first polymerization reactor through the second transfer line to the second polymerization reactor.

27. The method of claim 26, wherein the fluid flow equation is a Darcy-Weisbach equation defined as:
[mathematical formula]

wherein the pressure loss Δp is a function of:
the Darcy friction factor: a (dimensionless) coefficient of laminar or turbulent flow, fD;
the ratio of the length to diameter of the transfer slurry line, L/D;
the density of the transfer slurry, ρ; and
the mean velocity of the transfer slurry, V.

28. The method of claim 26, wherein the specified amount comprises a threshold amount as a percentage of the calculated pressure loss.

29. The method of claim 26, wherein measuring the pressure differential comprises measuring an inlet pressure of the first transfer line and measuring an outlet pressure of the first transfer line.