CLAIMS

The invention claimed is:

1. A method for altering polymer properties comprising:

polymerizing a feedstock in the presence of a metallocene catalyst in a loop reactor to produce a polyolefin product, the feedstock comprising two or more monomers, wherein at least one of the two or more monomers is a major monomer having highest weight concentration in the feedstock; and

broadening at least one of a molecular weight distribution and a chemical composition distribution (CCD) of the polyolefin product by adjusting a polymerization parameter selected from the group consisting of decreasing a recycle ratio, ~~increasing a polymer concentration,~~ increasing a LRSU number, and any combination thereof~~.~~,

wherein the recycle ratio is a ratio of reactor effluent recycled to the loop reactor and the polyolefin product from the loop reactor, and

wherein the LRSU number is equal to T * kp * Cmon * Ccat, where, T is residence time, kp is a polymerization rate constant of the major monomer, Cmon is concentration of the major monomer in the loop reactor, and Ccat is a reciprocal of catalyst activity.

2. The method of claim 1, wherein a first of the two or more monomers is selected from the group consisting of: ethylene, propylene, butene, pentene, hexene, heptene, octene, nonene, decene, dodecene, 4-methylpentene-1,3-methylpentene-1,3,5,5-trimethylhexene-1, and 5-ethylnonene-1.

3. The method of claim 2, wherein a second of the two or more monomers is different than the first and is selected from the group consisting of: ethylene, propylene, butene, pentene, hexene, heptene, octene, nonene, decene, dodecene, 4-methylpentene-1,3-methylpentene-1,3,5,5-trimethylhexene-1, 5-ethylnonene-1, styrene, alpha-methylstyrene, para-alkylstyrenes, vinyltoluenes, vinylnaphthalene, ~~allyl benzene, and~~ indene, ~~especially styrene,~~ paramethylstyrene, 4-phenyl-butene-1, allylbenzene, vinylcyclohexane, vinylcyclohexene, vinylnorbornene, ethylidene norbornene, cyclopentadiene, cyclopentene, cyclohexene, cyclobutene, butadiene, pentadiene, hexadiene, heptadiene, octadiene, nonadiene, decadiene, undecadiene, dodecadiene, tridecadiene, tetradecadiene, pentadecadiene, hexadecadiene, heptadecadiene, octadecadiene, nonadecadiene, icosadiene, heneicosadiene, docosadiene,

tricosadiene, tetracosadiene, pentacosadiene, hexacosadiene, heptacosadiene, octacosadiene, nonacosadiene, and triacontadiene.

4. The method of any preceding claim, wherein after adjusting the polymerization parameter, the molecular weight distribution as measured by polydispersity index of the polyolefin product is 3 or greater.

5. The method of any preceding claim, wherein the chemical composition distribution as measured by percent change of monomer content of the polyolefin product is 15% or greater.

6. The method of any preceding claim, wherein after adjusting the polymerization parameter the recycle ratio is 1 or less~~, the polymer concentration is 15 wt% or greater, and/or~~ or the LRSU number is 15 or greater.

7. The method of any preceding claim, wherein the polymerizing is a slurry polymerization process performed at 15 psi to 735 psi and 0°C to ~~about~~ 120°C.

8. The method of one of claims 1-6, wherein the polymerizing is a solution polymerization process performed at 120 psi to 1800 psi and 50°C to 220°C.

9. A method for altering polymer properties comprising:

polymerizing a feedstock in the presence of a metallocene catalyst in a loop reactor to produce a polyolefin product, the feedstock comprising two or more monomers; and

narrowing at least one of a molecular weight distribution and a chemical composition distribution of the polyolefin product by adjusting a polymerization parameter selected from the group consisting of increasing a recycle ratio, ~~decreasing a polymer concentration,~~ decreasing a LRSU number, and any combination thereof~~.~~,

wherein the recycle ratio is a ratio of reactor effluent recycled to the loop reactor and the polyolefin product from the loop reactor, and

wherein the LRSU number is equal to $T * k_p * Cmon * Ccat$, where, T is residence time, kp is a polymerization rate constant of the major monomer, Cmon is concentration of the major monomer in the loop reactor, and Ccat is a reciprocal of catalyst activity.

10. The method of claim 9, wherein a first of the two or more monomers is selected from the group consisting of: ethylene, propylene, butene, pentene, hexene, heptene, octene, nonene, decene, dodecene, 4-methylpentene-1,3-methylpentene-1,3,5,5-trimethylhexene-1, and 5-ethylnonene-1.

11. The method of claim 10, wherein a second of the two or more monomers is different than the first and is selected from the group consisting of: ethylene, propylene, butene, pentene, hexene, heptene, octene, nonene, decene, dodecene, 4-methylpentene-1,3-methylpentene-1,3,5,5-trimethylhexene-1, 5-ethylnonene-1, styrene, alpha-methylstyrene, para-alkylstyrenes, vinyltoluenes, vinylnaphthalene, ~~allyl benzene, and~~ indene, ~~especially styrene,~~ paramethylstyrene, 4-phenyl-butene-1, allylbenzene, vinylcyclohexane, vinylcyclohexene, vinylnorbornene, ethylidene norbornene, cyclopentadiene, cyclopentene, cyclohexene, cyclobutene, butadiene, pentadiene, hexadiene, heptadiene, octadiene, nonadiene, decadiene, undecadiene, dodecadiene, tridecadiene, tetradecadiene, pentadecadiene, hexadecadiene, heptadecadiene, octadecadiene, nonadecadiene, icosadiene, heneicosadiene, docosadiene, tricosadiene, tetracosadiene, pentacosadiene, hexacosadiene, heptacosadiene, octacosadiene, nonacosadiene, and triacontadiene.

12. The method of one of claims 9-11, wherein after adjusting the polymerization parameter, the molecular weight distribution as measured by polydispersity index of the polyolefin product is less than 3.

13. The method of one of claims 9-12, wherein the chemical composition distribution as measured by percent change of monomer content of the polyolefin product is less than 15%.

14. The method of one of claims 9-13, wherein after adjusting the polymerization parameter the recycle ratio is greater than 1, ~~the polymer concentration is less than 15 wt%, and/or~~ or the LRSU number is less than 15.

15. The method of one of claims 9-14, wherein the polymerizing is a slurry polymerization process performed at 15 psi to 735 psi and 0°C to ~~about~~ 120°C.

16. The method of one of claims 9-14, wherein the polymerizing is a solution polymerization process performed at 120 psi to 1800 psi and 50°C to 220°C.

17. A method for altering polymer properties comprising:

polymerizing a feedstock in the presence of a metallocene catalyst in a loop reactor to produce a polyolefin product, the feedstock comprising two or more monomers; and

altering a molecular weight distribution or a chemical composition distribution of the polyolefin product by adjusting a polymerization parameter selected from the group consisting of a recycle ratio, LRSU number, and any combination thereof, wherein:

the recycle ratio is a ratio of reactor effluent recycled to the loop reactor and the polyolefin product from the loop reactor,

the LRSU number is equal to (T * kp * Cmon * Ccat), where T is residence time, kp is a polymerization rate constant of the major monomer, Cmon is concentration of the major monomer in the loop reactor, and Ccat is a reciprocal of catalyst activity; and

after adjusting the polymerization parameter, the molecular weight distribution as measured by polydispersity index of the polyolefin product is 3 or greater.

18. The method of claim 17, wherein the polymerizing is a slurry polymerization process performed at 15 psi to 735 psi and 0°C to 120°C.

19. The method of claim 17 or 18, wherein the chemical composition distribution is altered, as measured by percent change of monomer content of the polyolefin product, by at least 15%.

20. The method of one of claims 17-20, wherein after adjusting the polymerization parameter, the recycle ratio is 1 or less, the polymer concentration is 15 wt % or greater, or the LRSU number is 15 or greater.