CLAIMS:

What is claimed is:

1. A process for C_{3+} monoolefin conversion, comprising:

providing a first mixture comprising a first process fluid and a first olefin mixture,

catalytically reacting at least a portion of the first olefin mixture's first process fluid with at least a portion of the first mixture's first olefin mixture to produce a first effluent comprising a first ether and unreacted first olefin mixture, wherein the first olefin mixture comprises ≥ 1 wt. % of a first C_{3+} monoolefin, wherein the first process fluid comprises ≥ 1 wt. % of a first oxygenate, and wherein the first effluent comprises < 1 wt. % of a first di-C_{3+} olefin;

separating a first product and a first byproduct from the first effluent, wherein the first product comprises at least a portion of the first ether, and wherein the first byproduct comprises at least a portion of any first di-C_{3+} olefin and at least a portion of the unreacted first olefin mixture;

combining a second olefin mixture, at least a portion of the first byproduct, and a second process fluid to produce a second mixture, wherein (i) the second olefin mixture comprises ≥ 1 wt. % of a second C_{3+} monoolefin, and (ii) the second process fluid comprises ≥ 1 wt. % of a second oxygenate; and

catalytically reacting two or more of (i) at least a portion of the second mixture's second process fluid, (ii) at least a portion of the second mixture's second olefin mixture, and (iii) at least a portion of the second mixture's first byproduct to produce a second effluent comprising a second di-C_{3+} olefin and a second ether, wherein the reaction produces a greater amount, on a mole basis, of the second di-C_{3+} olefin than that of the second ether;

wherein the second effluent further comprises unreacted first C_{3+} monoolefin, unreacted second C_{3+} monoolefin, or a mixture thereof, the process further comprising:

reacting at least a portion of any unreacted first C_{3+} monoolefin, at least a portion of any unreacted second C_{3+} monoolefin, or both to produce a third effluent comprising a third di-C_{3+} olefin, a third ether, and unreacted second mixture;

separating a second byproduct comprising at least a portion of the unreacted second mixture and a fourth effluent from the third effluent;

separating a second product, a third product, and a recycle from the fourth effluent; and

mixing a portion of the recycle with the first byproduct, the second olefin mixture, the second mixture, the second effluent, or a combination thereof, wherein:

the third di-C_{3+} olefin comprises diisobutylene,

the third ether comprises methyl *tert*- butyl ether, methyl *sec*-butyl ether, or a mixture thereof,

the second product comprises > 60 wt. % of diisobutylene based on the weight of the second product;

the third product comprises > 90 wt. % of one or more tri-C_{4+} olefins based on the weight of the third product,

the second byproduct comprises but-1-ene, *cis*-β-butylene, *trans*-β-butylene, *n*-butane, or a mixture thereof,

the recycle comprises methyl *tert*-butyl ether, methyl *sec*-butyl ether, or a mixture thereof, and

the second process fluid comprises a portion of the recycle.

2. The process of claim 1, wherein the first oxygenate comprises a first alcohol.

3. The process of claim 1 or 2, wherein the first oxygenate comprises methanol, ethanol, *n*-propanol, *n*-butanol, *n*-amylalcohol, or a mixture thereof.

4. The process of any one of claims 1 to 3, wherein the first olefin mixture and the second olefin mixture each further comprise but-1-ene, *cis*-β-butylene, *trans*-β-butylene, *n*-butane, or a mixture thereof.

5. The process of any one of claims 1 to 4, wherein the first ether, the second oxygenate, and the second ether each comprise methyl *tert*-butyl ether, and wherein the first di-C_{3+} olefin and the second di-C_{3+} olefin each comprise diisobutylene.

6. The process of any one of claims 1 to 5, wherein the first product comprises ≥ 98 wt. % of methyl *tert*-butyl ether, based on the weight of the first product.

7. The process of any one of claims 1 to 6, wherein the first mixture is reacted in the presence of a first catalyst to produce the first effluent, and wherein the second mixture is reacted in the presence of a second catalyst to produce the second effluent.

8. The process of any one of claims 1 to 7, further comprising separating a second product and a second byproduct from the second effluent, wherein the second product comprises at least a portion of any first di-C_{3+} olefin and at least a portion of the second di-C_{3+} olefin.

9. A process for C_{3+} monoolefin conversion, comprising:

combining a first olefin mixture and a first process fluid to produce a first mixture, wherein the first olefin mixture comprises ≥ 1 wt. % of a first C_{3+} monoolefin, and wherein the first process fluid comprises ≥ 1 wt. % of a first alcohol;

reacting the first mixture in the presence of a first catalyst to produce a first effluent comprising a first ether and unreacted first olefin mixture, wherein the first effluent comprises < 1 wt. % of a first di-C_{3+} olefin;

separating a first product and a first byproduct from the first effluent, wherein the first product comprises at least a portion of the first ether, and wherein the first byproduct comprises at least a portion of any first di-C_{3+} olefin and at least a portion of the unreacted first olefin mixture;

combining a second olefin mixture, at least a portion of the first byproduct, and a second process fluid to produce a second mixture, wherein the second olefin mixture comprises ≥ 1 wt. % of a second C_{3+} olefin;

reacting the second mixture in the presence of a second catalyst to produce a second effluent comprising a second di-C_{3+} olefin, a second ether, unreacted first olefin mixture, and unreacted second olefin mixture, wherein reacting the second mixture produces a greater amount, on a mole basis, of the second di-C_{3+} olefin than the second ether;

combining the second effluent and a third process fluid to produce a third mixture, wherein the third process fluid comprises ≥ 1 wt. % of a second alcohol;

reacting the third mixture in the presence of a third catalyst to produce a third effluent comprising a third ether, a third di-C_{3+} olefin, unreacted first olefin mixture, and unreacted second olefin mixture; and

separating a second product and a recycle from the third effluent, wherein the second product comprises at least a portion of any first di-C_{3+} olefin, at least a portion of the second di-C_{3+} olefin, and at least a portion of the third di-C_{3+} olefin, wherein the recycle comprises at least a portion of the second ether and at least a portion of the third ether, and wherein the second process fluid comprises ≥ 1 wt. % of the recycle.

10. The process of claim 9, wherein separating the second product and the recycle from the third effluent comprises:

separating a second byproduct and a fourth effluent from the third effluent, wherein the second byproduct comprises at least a portion of the unreacted first olefin mixture and at least a portion of the unreacted second olefin mixture; and

separating the second product, the recycle, and a third product comprising one or more tri-C_{3+} olefins from the fourth effluent.

11. The process of claim 9 or 11, wherein an amount of the second ether and the third ether in the second process fluid is ≥ 70 wt. % based on the weight of the second process fluid.

12. The process of any one of claims 9 to 11, wherein the first product comprises > 98 wt. % of methyl *tert*-butyl ether based on the weight of the first product.

13. The process of any one of claims 9 to 12, wherein the first effluent comprises ≤ 0.1 wt. % of any first di-C_{3+} olefin based on the weight of the first effluent, and wherein the second effluent comprises ≥ 8 wt. % of the second di-C_3+ olefin based on the weight of the second effluent.

14. The process of any one of claims 9 to 13, wherein at least one of the first, second, and third catalyst comprises ≥ 95 wt. % of at least one first cation exchange resin based on the weight of the first catalyst, and wherein reacting the first mixture comprises heating the first mixture to a temperature of ≥ 30°C under an absolute pressure of 10 bar to 20 bar.

15. The process of any one of claims 9 to 14, wherein:

the first olefin mixture comprises ≥ 90 wt. % of one or more C_4 monoolefins based on the weight of the first olefin mixture,

the first process fluid comprises ≥ 65 wt. % of the first alcohol based on the weight of the first process fluid,

the second olefin mixture comprises ≥ 90 wt. % of one or more C_4 monoolefins based on the weight of the second olefin mixture,

the second process fluid comprises ≥ 90 wt. % of the second ether, the third ether, or a combined amount of the second ether and the third ether based on the weight of the second process fluid, and

the third process fluid comprises ≥ 65 wt. % of the second alcohol based on the weight of the third process fluid.

16. The process of any one of claims 9 to 15, wherein:

the first olefin mixture and the second olefin mixture have substantially the same composition and further comprise but-1-ene, *cis*-β-butylene, *trans*-β-butylene, *n*-butane, or a mixture thereof,

the first alcohol and the second alcohol independently comprise methanol, ethanol, *n*-propanol, *n*-butanol, *n*-amylalcohol, or a mixture thereof,

any first di-C_{3+} olefin, the second di-C_{3+} olefin, and third di-C_{3+} olefin each comprise diisobutylene, and

the first product comprises ≥ 98 wt. % of methyl *tert*-butyl ether based on the weight of the first product.

17. A system for C_{3+} monoolefin conversion, comprising:

a first reactor comprising a first catalyst disposed therein and configured to react a first mixture comprising a first olefin mixture and a first process fluid in the presence of the first catalyst to produce a first effluent comprising a first ether and unreacted first olefin mixture, wherein (i) the first olefin mixture comprises ≥ 1 wt. % of a first C_{3+} monoolefin, (ii) the first process fluid comprises ≥ 1 wt. % of a first oxygenate, (iii) the first effluent comprises < 1 wt. % of a first di-C_{3+} olefin, and (iv) the first catalyst comprises a cation exchange resin;

a first separator configured to separate a first product and a first byproduct from the first effluent, wherein the first product comprises at least a portion of the first ether, and wherein the first byproduct comprises at least a portion of any first di-C_{3+} olefin and at least a portion of the unreacted first olefin mixture;

a second reactor comprising a second catalyst disposed therein and configured to react a second mixture comprising a second olefin mixture, at least a portion of the first byproduct, and a second process fluid in the presence of the second catalyst to produce a second effluent comprising a second ether and a second di-C_{3+} olefin, wherein (i) the second olefin mixture comprises ≥ 1 wt. % of a second C_{3+} monoolefin, (ii) the second process fluid comprises ≥ 1 wt. % of a second oxygenate, (iii) the reaction of the second reaction mixture produces a greater amount, on a mole basis, of the second di-C_{3+} olefin than the second ether; and (iv) the second catalyst comprises a cation exchange resin,

a catalytic distillation column comprising a third catalyst and configured to react at least a portion of any unreacted first C_{3+} monoolefin and at least a portion of any unreacted second C_{3+} monoolefin in the second effluent to produce a third effluent comprising a third ether and a third di-C_{3+} olefin, wherein the catalytic distillation column is configured to provide a second byproduct comprising one or more unreacted C_{3+} monoolefins and a fourth effluent; and

a second separator configured to separate a second product, a third product, and a recycle from the fourth effluent, wherein the second product comprises at least a portion of any first di-C_{3+} olefin, at least a portion of the second di-C_{3+} olefin, and at least a portion of the third di-C_{3+} olefin, wherein the third product comprises one or more tri-C_{3+} olefins, wherein the recycle comprises at least a portion of the second oxygenate, at least a portion of the second ether, and at least a portion of the third ether and wherein the second process fluid comprises a portion of the recycle.

18. The system of claim 17, further comprising a bypass line configured to bypass a portion of the second mixture around the second reactor by introducing the portion of the second mixture to the second effluent.

19. A process for C_{3+} monoolefin conversion, comprising:

separating a first olefin mixture and a second olefin mixture from a raffinate comprising

a mixture of isobutylene, but-1-ene, *cis*-β-butylene, *trans*-β-butylene, *n*-butane, and isobutane, wherein the first olefin mixture and the second olefin mixture have substantially the same composition;

combining methanol with the first olefin mixture to produce a first mixture;

reacting the first mixture in the presence of a first catalyst comprising a first cation exchange resin to produce a first effluent comprising a first methyl *tert*-butyl ether and unreacted first olefin mixture, wherein the first effluent comprises < 1 wt. % of any first diisobutylene;

separating a first product and a first byproduct from the first effluent, wherein the first product comprises ≥ 98 wt. % of the first methyl *tert*-butyl ether, and wherein the first byproduct comprises at least a portion of any first diisobutylene and at least a portion of the unreacted first olefin mixture;

combining the second olefin mixture, the first byproduct, and a recycle comprising methyl *tert*-butyl ether to produce a second mixture;

reacting the second mixture in the presence of a second catalyst comprising a second cation exchange resin to produce a second effluent comprising a second methyl *tert*-butyl ether, a second diisobutylene, unreacted first olefin mixture, and unreacted second olefin mixture, wherein reacting the second mixture produces a greater amount, on a mole basis, of the second diisobutylene than the second methyl *tert*-butyl ether;

combining methanol with the second effluent to produce a third reaction mixture;

reacting the third reaction mixture in the presence of a third catalyst comprising a third cation exchange resin to produce a third effluent;

separating a second byproduct and a fourth effluent from the third effluent, wherein the second byproduct comprises but-1-ene, *cis*-β-butylene, *trans*-β-butylene, *n*-butane, and isobutane;

separating a second product, a third product, and the recycle from the fourth effluent, wherein the second product comprises ≥ 60 wt. % of diisobutylene, and wherein the third product comprises oligomers of order 3 produced from one or more of isobutylene, bute-1-ene, *cis*-β-butylene, and *trans*-β-butylene.

20. A process for C_{3+} monoolefin conversion, comprising:

catalytically reacting a first process fluid with a first mixture comprising a first olefin mixture to produce a first effluent comprising a first ether and unreacted first olefin mixture, wherein the first olefin mixture comprises ≥ 1 wt. % of a first C_{3+} monoolefin, wherein the first process fluid comprises ≥ 1 wt. % of a first oxygenate, and wherein the first effluent comprises < 1 wt. % of a first di-C_{3+} olefin;

separating a first product and a first byproduct from the first effluent, wherein the first product comprises at least a portion of the first ether, and wherein the first byproduct comprises at least a portion of any first di-C_{3+} olefin and at least a portion of the unreacted first olefin mixture;

combining a second olefin mixture, at least a portion of the first byproduct, and a second process fluid to produce a second mixture, wherein the second olefin mixture comprises ≥ 1 wt. % of a second C_{3+} monoolefin, and wherein the second process fluid comprises ≥ 1 wt. % of a second oxygenate;

catalytically reacting the second mixture to produce a second effluent comprising (i) a second di-C_{3+} olefin and a second ether and (ii) unreacted first C_{3+} monoolefin, unreacted second C_{3+} monoolefin, or a mixture thereof, wherein reaction of the second mixture's second process fluid with the second mixture's second olefin mixture and the second mixture's first byproduct produces a greater amount, on a mole basis, of the second di-C_{3+} olefin than the second ether;

catalytically reacting at least a portion of any unreacted first C_{3+} monoolefin, at least a portion of any unreacted second C_{3+} monoolefin, or both to produce a third effluent comprising a third di-C_{3+} olefin, a third ether, and unreacted second mixture;

separating a second byproduct comprising at least a portion of the unreacted second mixture and a fourth effluent from the third effluent;

separating a second product, a third product, and a recycle from the fourth effluent; and

mixing a portion of the recycle with the first byproduct, the second olefin mixture, the second mixture, the second effluent, or a combination thereof, wherein:

the third di-C_{3+} olefin comprises diisobutylene,

the third ether comprises methyl *tert*- butyl ether, methyl *sec*-butyl ether, or a mixture thereof,

the second product comprises > 60 wt. % of diisobutylene based on the weight of the second product;

the third product comprises > 90 wt. % of one or more tri-C_{4+} olefins based on the weight of the third product,

the second byproduct comprises but-1-ene, *cis*-β-butylene, *trans*-β-butylene, *n*-butane, or a mixture thereof,

the recycle comprises methyl *tert*-butyl ether, methyl *sec*-butyl ether, or a mixture thereof, and

the second process fluid comprises a portion of the recycle.