

CLAIMS

What is claimed is:

1. A method of producing a fuel additive, comprising:
passing a first process stream comprising C4 hydrocarbons through a methyl tertiary butyl ether synthesis unit producing a first recycle stream;
passing the first recycle stream through a hydration unit producing the fuel additive and a second recycle stream;
passing the second recycle stream through a recycle hydrogenation unit and a deisobutanizer unit; and
recycling the second recycle stream to the methyl tertiary butyl ether synthesis unit.
2. The method of Claim 1, wherein a source of the first process stream comprises a product of an olefin cracking process and/or an olefin production process, wherein the first process stream comprises propane, propylene, ethyl acetylene, vinyl acetylene, 1,3-butadiene, 1,2-butadiene, isobutylene, cis-2-butene, trans-2-butene, 1-butene, isobutane, n-butane, or a combination thereof.
3. The method of any of the preceding claims, further comprising passing a first feed stream through a hydrocracking unit, forming a second feed stream and passing the second feed stream through a selective hydrogenation unit prior to passing through the methyl tertiary butyl ether synthesis unit, forming the first process stream.
4. The method of any of the preceding claims, further comprising contacting the first process stream with a catalyst within the methyl tertiary butyl ether synthesis unit, wherein the catalyst comprises an acid-type ion-exchange resin.
5. The method of any of the preceding claims, wherein a temperature within the methyl tertiary butyl ether synthesis unit is 15°C to 150°C and a pressure within the methyl tertiary butyl ether unit is 500 kiloPascals to 2800 kiloPascals.
6. The method of any of the preceding claims, wherein methanol and isobutylene are present in the methyl tertiary butyl ether unit in a molar ratio of one mole of isobutylene

to 0.1 mole to 5 moles of methanol; preferably, one mole of isobutylene to 1.06 moles to 1.2 moles of methanol.

7. The method of any of the preceding claims, wherein greater than or equal to 90% by weight of any isobutylene present in the first process stream is converted to methyl tertiary butyl ether within the methyl tertiary butyl ether unit, and further comprising withdrawing the methyl tertiary butyl ether as a product from the methyl tertiary butyl ether synthesis unit.

8. The method of any of Claims 3-7, wherein the first recycle stream comprises less than or equal to 3.0% by weight butadiene prior to passing through the hydration unit.

9. The method of any of Claims 3-8, wherein a temperature within the hydration unit is 30°C to 250°C and a pressure within the hydration unit is 500 kiloPascals to 20,000 kiloPascals.

10. The method of any of the preceding claims, wherein greater than or equal to 90% by weight of any butene present in the first recycle stream is converted to butanol within the hydration unit.

11. The method of any of the preceding claims, further comprising withdrawing a fuel additive product from the hydration unit.

12. The method of Claim 11, wherein the fuel additive product comprises 2-butanol, tert-butyl alcohol, a C4-dimer, or a combination thereof, preferably, wherein the C4-dimer comprises di-isobutylene, 2,2,4 trimethylpentane, 2,3,3 trimethylpentane, or a combination thereof.

13. The method of Claim 12, wherein an octane number of the fuel additive product is greater than or equal to 80 in accordance with the Anti-Knock Index, preferably wherein the octane number is greater than or equal to 83.

14. The method of Claim 12, wherein a Reid vapor pressure of the fuel additive product is less than or equal to 55 kiloPascals; preferably, wherein the Reid vapor pressure is 8 kiloPascals to 53 kiloPascals.

15. The method of any of the preceding claims, wherein greater than or equal to 90% by weight of any butene present in the second recycle stream is converted to butane within the recycle hydrogenation unit.

16. The method of any of the preceding claims, further comprising drying the second recycle stream before or after passing to the recycle hydrogenation unit.

17. The method of any of the preceding claims, wherein greater than or equal to 40% by weight of any butane present in the second recycle stream is converted to isobutylene in the deisobutanizer unit prior to recycling to the methyl tertiary butyl ether synthesis unit.

18. A method of producing a fuel additive, comprising:

passing a first feed stream comprising C4 hydrocarbons through a fluid catalytic cracking unit forming a second feed stream;

passing the second feed stream through a hydrogenation unit forming a first process stream;

passing the first process stream through a methyl tertiary butyl ether synthesis unit producing a first recycle stream, wherein methanol and isobutylene are present in the methyl tertiary butyl ether synthesis unit in a molar ratio of one mole of isobutylene to 0.1 mole to 2 moles of methanol;

withdrawing a methyl tertiary butyl ether product from the methyl tertiary butyl ether synthesis unit;

withdrawing the first recycle stream from the methyl tertiary butyl ether synthesis unit and passing the first recycle stream through a hydration unit producing the fuel additive and a second recycle stream, wherein a temperature within the hydration unit is 30°C to 200°C, a pressure within the hydration unit is 500 kiloPascals to 10,000 kiloPascals, and wherein greater than or equal to 90% by weight of any butene present in the first recycle stream is converted to butanol within the hydration unit;

withdrawing the fuel additive from the hydration unit, wherein the fuel additive comprises 2-butanol, tert-butyl alcohol, di-isobutene, or a combination thereof;

passing the second recycle stream through a recycle hydrogenation unit;

passing the second recycle stream through a deisobutanizer unit forming an isobutylene-containing recycle stream; and

recycling the isobutylene-containing recycle stream to the methyl tertiary butyl ether synthesis unit.

19. The method of Claim 18, wherein the deisobutanizer unit comprises a deisobutanizer column, an isomerization unit, and a dehydrogenation unit.