CLAIMS

What is claimed is:

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

passing a first process stream comprising C4 hydrocarbons and methanol through a methyl tertiary butyl ether synthesis unit producing a first recycle stream and a methyl tertiary butyl ether product, wherein the C4 hydrocarbons of the first process stream comprise at least one of isobutylene, butadiene and 2-butene;

passing the first recycle stream and water through a hydration unit producing the fuel additive and a second recycle stream, the first recycle stream and the second recycle stream each comprise a butene;

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;

wherein the fuel additive comprises at least one of 2-butanol, tert-butyl alcohol or a C4-dimer.

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 further comprises a propane, a propylene, an ethyl acetylene, a 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 15ºC to 150ºC and a pressure within the methyl tertiary butyl ether synthesis 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 synthesis unit in a molar ratio of at least one of one mole of isobutylene to 0.1 mole to 5 moles of methanol; and one mole of isobutylene to 1.06 moles to 1.2 moles of methanol.

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

8. The method of any of the preceding claims, 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 the preceding claims, wherein a temperature within the hydration unit is 30ºC to 250ºC 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 the 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 the fuel additive from the hydration unit.

12. The method of Claim 1, wherein the C4 hydrocarbon comprises at least one of di-isobutylene, 2,2,4 trimethylpentane, or 2,3,3 trimethylpentane.

13. The method of Claim 1, wherein an octane number of the fuel additive is one of greater than or equal to 80 in accordance with the Anti-Knock Index, and the octane number is greater than or equal to 83.

14. The method of Claim 1, wherein a Reid vapor pressure of the fuel additive is one of less than or equal to 55 kiloPascals; and 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 the 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 30ºC to 200ºC, 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.