CLAIMS

What is claimed is:

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

passing a feed stream comprising C_4 hydrocarbons through a first hydrogenation unit producing a first process stream, wherein the feed stream comprises methyl acetylene, propylene, 1, 3-butadiene, 1, 2-butadiene, isobutylene, cis-2-butene, trans-2-butene, 1-butene, isobutane, n-butane, or a combination thereof, and wherein at least a portion of the butadiene present in the feed stream is converted to 1-butene and 2-butene within the first hydrogenation unit;

passing the first process stream through a distillation unit;

withdrawing a 2-butene stream from the distillation unit;

withdrawing an iso-stream from the distillation unit, wherein the iso-stream comprises isobutane and isobutylene;

passing the 2-butene stream through a second hydrogenation unit producing a 1-butene stream;

passing at least a first portion of the 1-butene stream through a separation unit producing a separated 1-butene stream; and

passing the separated 1-butene stream and a water stream through a hydration unit producing the fuel additive.

2. The method of Claim 1, wherein the feed stream comprises a product of a catalytic cracking process and/or an olefin production process.

3. The method of any of the preceding claims, wherein the distillation unit comprises a kinetic distillation column.

4. The method of any of the preceding claims, wherein greater than or equal to 85% by weight, preferably, greater than or equal to 90% by weight, more preferably, greater than or equal to 95% by weight of butadiene present in the feed stream, based on the total weight of the butadiene present in the feed stream, is converted to 1-butene and 2-butene within the first hydrogenation unit.

5. The method of any of the preceding claims, further comprising adding tertiary butyl catechol and/or hydrogen to the feed stream prior to passing through the first hydrogenation unit.

6. The method of any of the preceding claims, further comprising withdrawing a butane stream comprising n-butane and/or isobutane from the distillation unit and passing the butane stream through a propylene and/or ethylene cracking unit.

7. The method of Claim 1, further comprising recycling the iso-stream back to the raw material stream; or

further comprising passing the iso-stream through a propylene and/or ethylene cracking unit; or

further comprising passing the iso-stream through the hydration unit.

8. The method of any of the preceding claims, further comprising after producing the 1-butene stream recycling at least a second portion of the 1-butene stream back to the distillation unit.

9. The method of any of the preceding claims, further comprising withdrawing a butane stream comprising n-butane and/or isobutane from the separation unit and passing the butane stream through a propylene and/or ethylene cracking unit.

10. The method of any of the preceding claims, wherein the hydration unit comprises an oscillating baffle reactor, a fixed bed reactor, a fluidized bed reactor, a membrane integrated reactor, or a combination thereof.

11. The method of any of the preceding claims, wherein greater than or equal to 99% by weight of butene present in the separated 1-butene stream, based on the total weight of the butene present in the separated 1-butene stream, is converted to butanol within the hydration unit.

12. The method of any of the preceding claims, further comprising withdrawing a fuel additive product from the hydration unit, wherein the fuel additive product comprises 1-butanol, 2-butanol, tert-butyl alcohol, C_4 dimer, or a combination thereof, preferably, wherein the C_4 dimer comprises di-isobutylene, 2,2,4 trimethylpentane, 2,3,3 trimethylpentane, or a combination thereof.

13. The method of Claim 12, wherein the fuel additive product comprises 1% to 20% by weight trimethylpentane based on the total weight of the fuel additive product, and the total weight of the fuel additive product is 100% by weight.

14. The method of Claim 12, wherein an octane number of the fuel additive product is greater than or equal to 85 in accordance with the Anti-Knock Index; and

wherein a Reid vapor pressure of the fuel additive product is less than or equal to 75 kilopascals, preferably, less than or equal to 65 kilopascals, preferably, less than or equal to 55.16 kilopascals.

15. The method of Claim 1 further comprising:

wherein greater than or equal to 90% by weight of butadiene present in the feed stream, based on the total weight of the butadiene present in the feed stream, is converted to 1-butene and 2-butene within the first hydrogenation unit;

after producing the 1-butene stream, recycling at least a second portion of the 1-butene stream back to the distillation unit; and

withdrawing a fuel additive product from the hydration unit, wherein the fuel additive product comprises greater than or equal to 20% by weight trimethylpentane based on the total weight of the fuel additive product, and the total weight of the fuel additive product is 100% by weight.