CLAIMS

1. A two-stage process for oligomerizing and hydrating a hydrocarbon feed comprising mixed olefins including mixed butenes including isobutene and n-butenes, the process comprising the steps of:

introducing the hydrocarbon feed into a first reactor vessel under reaction conditions that are operable to oligomerize the isobutene into diisobutenes wherein the hydrocarbon feed is introduced into the first reactor vessel in the absence of water;

contacting the mixed hydrocarbon feed with an oligomerization catalyst within the first reactor vessel, the oligomerization catalyst being of a type that selectively oligomerizes the isobutene into diisobutenes;

separating the diisobutenes from unreacted butenes to form a diisobutene stream;

introducing the unreacted butenes into a second reactor vessel in the presence of water and under reaction conditions that operable to hydrate the unreacted butenes including the unreacted n-butenes and any unreacted isobutene;

contacting the unreacted butenes with a hydration catalyst within the second reactor vessel to hydrate the unreacted butenes to form a mixed butanols stream; and

combining the diisobutene stream and mixed butanols stream to form a product stream.

2. The two-stage process of claim 1, wherein the n-butenes comprise 1-butene, 2-trans-butene, and 2-cis-butene.
3. The two-stage process of claim 1, wherein prior to introducing the hydrocarbon feed into the first reactor vessel, the hydrocarbon feed passes through: (a) a first compressor which compresses the hydrocarbon feed to a first predetermined pressure; and (b) a first heat exchanger that adjusts a temperature of the hydrocarbon feed to a first predetermined temperature.

4. The two-stage process of claim 3, wherein the first predetermined pressure is between about 5 bar and 100 bar and the first predetermined temperature is between about 30°C and about 250°C.

5. A two-stage process for oligomerizing and hydrating a hydrocarbon feed comprising mixed olefins including mixed butenes including isobutene and n-butenes, the process comprising the steps of:

introducing the hydrocarbon feed into a first reactor vessel under reaction conditions that are operable to oligomerize the butenes;

contacting the mixed hydrocarbon feed with an oligomerization catalyst within the first reactor vessel, the oligomerization catalyst being of a type that selectively oligomerizes isobutene into diisobutenes;

separating the diisobutenes from unreacted butenes to form a diisobutene stream, wherein the step of separating the diisobutenes from the unreacted butenes comprises the step of:

introducing the diisobutenes and the unreacted butenes from the first reactor vessel into a low pressure separator that is configured to separate the diisobutenes from the unreacted butenes including unreacted n-butenes and any unreacted isobutene;

introducing the unreacted butenes into a second reactor vessel in the presence of water and under reaction conditions that operable to hydrate the unreacted butenes including the unreacted n-butenes and any unreacted isobutene;

contacting the unreacted butenes with a hydration catalyst within the second reactor vessel to hydrate the unreacted butenes to form a mixed butanols stream; and

combining the diisobutene stream and mixed butanols stream to form a product stream.

6. The two-stage process of claim 5, wherein prior to introducing the unreacted butenes into the second reactor vessel, water is added to the unreacted butenes, including the unreacted n-butenes, to form an aqueous mixture that passes through: (a) a compressor which compresses the aqueous mixture to a predetermined pressure; and (b) a heat exchanger that adjusts a temperature of the aqueous mixture to a predetermined temperature.

7. The two-stage process of claim 6, wherein the predetermined pressure is between about 10 bar and 100 bar and the predetermined temperature is between about 80°C and about 250°C.

8. The two-stage process of claim 1, wherein the step of contacting the unreacted butenes with a hydration catalyst within the second reactor vessel results in the n-butenes being hydrated to 2-butanol and any isobutene being hydrated to tert-butanol.

9. A two-stage process for oligomerizing and hydrating a hydrocarbon feed comprising mixed olefins including mixed butenes including isobutene and n-butenes, the process comprising the steps of:

introducing the hydrocarbon feed into a first reactor vessel under reaction conditions that are operable to oligomerize the isobutene into diisobutenes;

contacting the mixed hydrocarbon feed with an oligomerization catalyst within the first reactor vessel, the oligomerization catalyst being of a type that selectively oligomerizes the isobutene into diisobutenes;

separating the diisobutenes from unreacted butenes to form a diisobutene stream;

introducing the unreacted butenes into a second reactor vessel in the presence of water and under reaction conditions that operable to hydrate the unreacted butenes including the unreacted n-butenes and any unreacted isobutene;

contacting the unreacted butenes with a hydration catalyst within the second reactor vessel to hydrate the unreacted butenes to form a mixed butanols stream;

passing the mixed butanols stream from the second reaction vessel through a high pressure separator which is configured to separate an organic phase containing unreacted mixed butenes along with extracted mixed butanols from an aqueous phase that is saturated with mixed butanols;

passing the separated organic phase through a debutenizer column in which the organic phase is separated and unreacted mixed butenes are removed;

passing the separated aqueous phase to an azeotropic distillation column in which alcohol-water azeotrope is distilled out of the aqueous phase; and

combining the diisobutene stream and the mixed butanols from the debutenizer to form a product stream.

10. The two-stage process of claim 9, wherein the unreacted mixed butenes removed from the debutenizer are recycled and combined with the hydrocarbon feed upstream of the first reactor vessel and the alcohol-water azeotrope is recycled back to the high pressure separator for further recover alcohols while water is recycled back to a location upstream of the second reactor vessel.
11. The two-stage process of claim 1, wherein the oligomerization conditions can be varied independent from the hydration conditions to maximize diisobutene formation in the first reactor vessel from 5 mol% to a maximum of up to 100 mol% of isobutene in the hydrocarbon feed.
12. The two-stage process of claim 1, wherein a conversion rate of converting isobutene to diisobutene in the first reactor vessel is between about 5 mol% and about 100 mol%.
13. The two-stage process of claim 1, wherein the hydrocarbon feed consists essentially of butenes.

14. The two-stage process of claim 1, further comprising the step of combining the product stream with a gasoline stream to produce a gasoline product having increased research octane number (RON) and reduced Reid vapor pressure (RVP) as compared to a second gasoline product having an absence of the product stream.
15. The two-stage process of claim 1, wherein each of the oligomerization catalyst and the hydration catalyst comprises at least one of an acidic catalyst and substituted/non-substituted heteropoly acids.
16. The two-stage process of claim 15, wherein the acidic catalyst comprises an ionic exchange resin.
17. The two-stage process of claim 1, wherein the oligomerization catalyst and hydration catalyst are the same.