CLAIMS

1. A process for simultaneously hydrating and oligomerizing a hydrocarbon feed comprising mixed olefins, the process comprising the steps of:

introducing the hydrocarbon feed in the presence of water into a fixed bed reactor under reaction conditions that are operable to hydrate the mixed olefins and oligomerize at least a portion of the mixed olefins, wherein the mixed olefins comprise mixed butenes;

contacting the hydrocarbon feed with a catalyst within the fixed bed reactor, wherein the catalyst is of the type that hydrates the mixed olefins to form mixed alcohols and oligomerizes at least a portion of the mixed olefins into one or more oligomers to produce a first product stream that includes an organic phase and an aqueous phase;

introducing the first product stream into a first separator which separates the organic phase from the aqueous phase;

introducing the separated organic phase into a second separator which separates unreacted olefins from a final product stream which comprises mixed alcohols and the one or more oligomers; and

introducing the separated aqueous phase into a third separator which separates an alcohol-water azeotrope component from water,

wherein the second separator comprises a debutenizer, which removes unreacted butenes and recycles the unreacted butenes back to the fixed bed reactor, and wherein the final product stream comprises mixed butanols and diisobutenes, and wherein the first separator comprises a high-pressure separator and a low pressure separator that are arranged in series with the low-pressure separator being downstream of the high-pressure separator, wherein each of the high and low-pressure separators is configured to separate the organic phase from the aqueous phase.

2. The process of claim 1, wherein the mixed butenes comprise 1-butene, 2-trans-butene, 2-cis-butene, and isobutene and the mixed alcohols comprise mixed butanols.

3. The process of claim 1, further including the steps of adjusting a pressure and temperature of the hydrocarbon feed and adjusting a pressure and temperature of the water.

4. The process of claim 3, wherein a pressure of the fixed bed reactor is between 10-70 bar, and the temperature of the fixed bed reactor is between 100-160°C.

5. The process of claim 1, wherein the hydrocarbon feed consists essentially of butenes.

6. The process of claim 1, further including the step of recycling back the unreacted butenes partially to the high pressure separator and partially to the low pressure separator.

7. The process of claim 1, where the aqueous phase from both the high pressure separator and the low pressure separator are combined prior to being introduced into the third separator.

8. The process of claim 1, wherein the third separator comprises an azeotropic distillation column in which the alcohol-water azeotrope is distilled out of the aqueous phase and recycled back to the first separator and water is recycled back to the fixed bed reactor.

9. The process of claim 1, further including the step of passing the aqueous phase from the first separator transported through a pervaporation membrane for removing water from the aqueous solution, wherein the removed water is recycled back to the fixed bed reactor, and the remaining aqueous solution is introduced into the third separator.

10. The process of claim 9, wherein the third separator comprises an azeotropic distillation column in which the alcohol-water azeotrope is distilled out of the aqueous phase and recycled back to the pervaporation membrane.

11. The process of claim 1, wherein the third separator comprises a double-column entrainer system that includes a contactor column into which an entrainer is

injected, and a solvent regenerator column that is located is series with and downstream of the contactor column.

12. The process of claim 11, wherein the aqueous phase from the first separator is first introduced into the contactor column in which mixed alcohols and oligomers are absorbed into the entrainer and are then introduced into the solvent regenerator column in which 1) the mixed alcohols and oligomers are removed and 2) the entrainer is regenerated and recycled back to the contactor column.
13. The process of claim 12, further including the steps of removing water from the mixed alcohols and oligomers in the contactor column, and recycling the water back to the fixed bed reactor.
14. The process of claim 12, wherein the entrainer is 1,3,5 Trimethyl benzene.
15. The process of claim 1, wherein the unreacted butenes removed from the debutenizer are transported to a hydration reactor containing a hydration catalyst and in which the unreacted butenes are reacted to form a mixed butanols stream.
16. The process of claim 15, wherein the mixed butanols stream formed in the hydration reactor is recycled back to the first separator.
17. The process of claim 1, further comprising the step of combining the final product stream with a gasoline stream to produce a gasoline product with reduced Reid vapor pressure (RVP) and increased research octane number (RON) compared with the gasoline stream alone.
18. The process of claim 1, wherein the catalyst present in the fixed bed reactor comprises an ion exchange resin catalyst.
19. The process of claim 1, wherein the fixed bed reactor comprises a multi-stage reactor, with each stage having an individual feed line that receives the hydrocarbon feed and an individual exit line that communicate with a common line that delivers the first product stream to the first separator.

20. The process of claim 1, further comprising receiving, by an isomerization unit that is fluidly connected between the second separator and the fixed bed reactor, the unreacted olefins from the second separator and converting the unreacted olefins from one isomer to another isomer prior to introduction into the fixed bed reactor.
21. The process of claim 20, wherein the isomerization unit comprises a 2-butenes to 1-butenes isomerization unit and the one isomer comprises a 2-butenes and the other isomer comprises 1-butenes.