isobutene formation because of the demand for MTBE. Because n-butenes are not typically sold commercially, there has been little incentive for research on the "reverse" conversion of isobutene to n-butenes.

[0017] Isobutane also does not form butadiene via its direct dehydrogenation, though it is not harmful in terms of reacting significantly to undesired byproducts. On the other hand, extra butadiene production can be obtained from isobutane if it is dehydrogenated to isobutene and then the isobutene undergoes the "reverse" isomerization described above, creating additional n-butenes that can eventually be converted to butadiene. Thus, a unit to dehydrogenate isobutane to isobutene may be added for this purpose in accordance with this invention.

[0018] A different dehydrogenation unit to convert n-butane to n-butenes and possibly some amount of butadiene may also be added to the overall process plant in accordance with the present invention.

[0019] While many industrial processes have been investigated for, and are related to, the production of butadiene, none have been developed and designed for the conversion of C_4 feed stocks containing a significant amount of isobutene and/or isobutane. As such, there exists an ongoing and unmet need in the industry for economical and efficient methods for butadiene production from these feed stocks.

Summary of the Invention

[0019a] In one aspect of the present invention, there is provided a process for the production of butadiene comprising: (a) feeding a first feed stream comprising a mixture

of C_4 olefins to a combination butene isomerization reaction and distillation tower to produce an overhead stream and a bottoms stream; (b) feeding a second feed stream comprising n-butanes to a first dehydrogenation unit to convert n-butanes to n-butenes; (c) feeding at least a portion of the effluent from the first dehydrogenation unit and at least a portion of the bottoms stream to an oxydehydrogenation unit to convert 2-butenes to butadiene; (d) feeding at least a portion of the effluent from at least one of the first dehydrogenation unit and the oxydehydrogenation unit to the combination butenes isomerization reaction and distillation tower; and (e) separating the butadiene in at least a portion of the effluent of the oxydehydrogenation unit from unreacted compounds and by-products.

[0019b] In another aspect, there is provided a process for the production of butadiene comprising: (a) feeding a first feed stream comprising a mixture of C4 olefins to a combination butene isomerization reaction and distillation tower to produce an overhead stream and a bottoms stream; (b) feeding at least a portion of a second feed stream comprising n-butanes and n-butenes to an oxydehydrogenation unit to convert n-butenes to butadiene; (c) feeding at least a portion of the effluent from the oxydehydrogenation unit to a first dehydrogenation unit to convert 2-butanes to 2-butenes; (d) feeding at least a portion of the effluent from the first dehydrogenation unit and at least a portion of the bottoms stream to the oxydehydrogenation unit to convert 2-butenes to butadiene; (e) feeding at least a portion of the effluent from at least one of the first dehydrogenation unit and the oxydehydrogenation unit to the combination butenes isomerization reaction and distillation tower; and (f) separating the butadiene in at least a portion of the effluent of the oxydehydrogenation unit from unreacted compounds and by-products.

[0020] The present invention relates generally to a method for the production of butadiene from mixed C_4 feed stocks after removing isobutene. The removal of isobutene

What is claimed is:

1. A process for the production of butadiene comprising the steps of:

(a) feeding a feed stream comprising a mixture of C_4 olefins to a combination butenes isomerization reaction and distillation tower to produce an overhead stream comprising isobutene and a bottoms stream comprising 2-butene;

(b) feeding at least a portion of the bottoms stream to an oxydehydrogenation unit to convert the 2-butenes to butadiene; and

(c) separating the butadiene in the oxydehydrogenation unit effluent from unreacted compounds and by-products

2. The process of claim 1, further comprising the steps of:

(d) feeding at least a portion of the overhead stream to a reverse isomerization unit to convert isobutene to n-butene; and

(e) feeding at least a portion of the effluent from the reverse isomerization unit to the combination butenes isomerization reaction and distillation tower.

3. The process of claim 1, further comprising the step of:

(d) recycling at least a portion of the effluent from the oxydehydrogenation unit to the feed to the oxydehydrogenation unit.

4. The process of claim 1, further comprising the step of:

(d) feeding at least a portion of the effluent from the oxydehydrogenation unit to the combination butenes isomerization reaction and distillation tower.

5. A process for the production of butadiene comprising the steps of:

(a) feeding a feed stream comprising a mixture of C_4 olefins and n-butane to a combination butene isomerization reaction and distillation tower to produce an overhead stream and a bottoms stream;

(b) feeding at least a portion of the bottoms stream to a dehydrogenation unit to convert n-butanes to n-butenes;

(c) feeding at least a portion of the effluent from the dehydrogenation unit to an oxydehydrogenation unit to convert n-butenes to butadiene;

(d) separating the butadiene in the oxydehydrogenation unit effluent from unreacted compounds and by-products.

6. The process of claim 5, further comprising the steps of:

(e) feeding at least a portion of the overhead stream to a reverse isomerization unit to convert isobutene to n-butene; and

(f) feeding at least a portion of the effluent from the reverse isomerization unit to the combination butenes isomerization reaction and distillation tower.

7. The process of claim 6, further comprising the step of:

(g) recycling at least a portion of the effluent from the dehydrogenation unit to the feed to the dehydrogenation unit.

8. The process of claim 6, further comprising the step of:

(g) recycling at least a portion of the effluent from the dehydrogenation unit to the combination butenes isomerization reaction and distillation tower.

9. The process of claim 6, further comprising the step of:

(g) recycling at least a portion of the effluent from the oxydehydrogenation unit to the feed to the dehydrogenation unit.

10. The process of claim 6, further comprising the step of:

(g) feeding at least a portion of the effluent from the oxydehydrogenation unit to the combination butenes isomerization reaction and distillation tower.

11. A process for the production of butadiene comprising the steps of:

(a) feeding a first feed stream comprising a mixture of C_4 olefins to a combination butene isomerization reaction and distillation tower to produce an overhead stream and a bottoms stream;

(b) feeding a second feed stream comprising n-butanes to a dehydrogenation unit to convert n-butanes to n-butenes;

(c) feeding at least a portion of the bottoms stream to an oxydehydrogenation unit to convert the 2-butenes to butadiene;

(d) feeding the effluent from the dehydrogenation unit to the oxydehydrogenation unit; and

(e) separating the butadiene in the oxydehydrogenation unit effluent from unreacted compounds and by-products.

12. The process of claim 11, further comprising the steps of:

(e) feeding at least a portion of the overhead stream to a reverse isomerization unit to convert isobutene to n-butene; and

(f) feeding the effluent from the reverse isomerization unit to the combination butenes isomerization reaction and distillation tower.

13. The process of claim 12, further comprising the step of:

(e) feeding at least a portion of the bottoms stream directly to the oxydehydrogenation unit.

14. The process of claim 12, further comprising the step of:

(g) recycling at least a portion of the effluent from the oxydehydrogenation unit to the feed to the oxydehydrogenation unit.

15. The process of claim 12, further comprising the step of:

(g) feeding at least a portion of the effluent from the dehydrogenation unit to the combination butenes isomerization reaction and distillation tower.

16. The process of claim 12, further comprising the step of:

(g) recycling at least a portion of the effluent from the dehydrogenation unit to the feed to the dehydrogenation unit.

17. The process of claim 12, further comprising the step of:

(g) feeding at least a portion of the effluent from the dehydrogenation unit to the combination butenes isomerization reaction and distillation tower.

18. A process for the production of butadiene comprising the steps of:

(a) feeding a first feed stream comprising a mixture of C_4 olefins to a combination butenes isomerization reaction and distillation tower to convert 1-butene to 2-butenes and produce an overhead stream and a bottoms stream;

(b) feeding a second feed stream comprising n-butanes to a first dehydrogenation unit to convert n-butanes to n-butenes;

(c) feeding at least a portion of the bottoms stream to an oxydehydrogenation unit to convert the 2-butenes to butadiene;

(d) feeding the effluent from the first dehydrogenation unit to the oxydehydrogenation unit;

(e) feeding at least a portion of the overhead stream to a second dehydrogenation unit to convert isobutane to isobutene;

(f) feeding at least a portion of the effluent from the second dehydrogenation unit to a reverse isomerization unit to convert isobutene to n-butenes;

(g) feeding at least a portion of the effluent from the second dehydrogenation unit to the combination butenes isomerization reaction and distillation tower;

(h) separating the butadiene in the oxydehydrogenation unit effluent from other compounds .

19. The process of claim 18, further comprising the steps of:

(i) feeding at least a portion of the overhead stream to a reverse isomerization unit to convert isobutene to n-butenes; and

(j) feeding at least a portion of the effluent from the reverse isomerization unit to the combination butenes isomerization reaction and distillation tower.

20. The process of claim 18, further comprising the step of:

(i) feeding at least a portion of the bottoms stream directly to the oxydehydrogenation unit.

21. The process of claim 19, further comprising the step of:

(k) recycling at least a portion of the effluent from the oxydehydrogenation unit to the feed to the oxydehydrogenation unit.

22. The process of claim 19, further comprising the step of:

(k) feeding at least a portion of the effluent from the first dehydrogenation unit to the combination butenes isomerization reaction and distillation tower.

23. The process of claim 19, further comprising the step of:

(k) recycling at least a portion of the effluent from the first dehydrogenation unit to the feed to the first dehydrogenation unit.

24. The process of claim 18, further comprising the step of:

(g) feeding at least a portion of the effluent from the first dehydrogenation unit to the combination butenes isomerization reaction and distillation tower.

25. A process for the production of butadiene comprising the steps of:

(a) feeding a first feed stream comprising a mixture of C_4 olefins to a combination butene isomerization reaction and distillation tower to produce an overhead stream and a bottoms stream;

(b) feeding at least a portion of a second feed stream comprising n-butanes and n-butenes to an oxydehydrogenation unit to convert n-butenes to butadiene;

(c) feeding at least a portion of the effluent from the oxydehydrogenation unit to a dehydrogenation unit to convert the 2-butanes to 2-butenes;

(d) feeding the effluent from the dehydrogenation unit to the oxydehydrogenation unit; and

(e) separating the butadiene in the oxydehydrogenation unit effluent from unreacted compounds and by-products.

Claims

1. A process for the production of butadiene comprising:

(a) feeding a first feed stream comprising a mixture of C_4 olefins to a combination butene isomerization reaction and distillation tower to produce an overhead stream and a bottoms stream;

(b) feeding a second feed stream comprising n-butanes to a first dehydrogenation unit to convert n-butanes to n-butenes;

(c) feeding at least a portion of the effluent from the first dehydrogenation unit and at least a portion of the bottoms stream to an oxydehydrogenation unit to convert 2-butenes to butadiene;

(d) feeding at least a portion of the effluent from at least one of the first dehydrogenation unit and the oxydehydrogenation unit to the combination butenes isomerization reaction and distillation tower; and

(e) separating the butadiene in at least a portion of the effluent of the oxydehydrogenation unit from unreacted compounds and by-products.

2. The process of claim 1, further comprising:

(f) feeding at least a portion of the overhead stream to a reverse isomerization unit to convert isobutene to n-butene; and

(g) feeding at least a portion of the effluent from the reverse isomerization unit to the combination butenes isomerization reaction and distillation tower.

3. The process of claim 2, further comprising:

(h) feeding at least a portion of the bottoms stream directly to the dehydrogenation unit.

4. The process of claim 2, further comprising:

(i) recycling at least a portion of the effluent from the oxydehydrogenation unit to the feed to the oxydehydrogenation unit.

5. The process of claim 2, further comprising:

(j) recycling at least a portion of the effluent from the first dehydrogenation unit to the feed to the first dehydrogenation unit.

6. The process of claim 1, further comprising:

(k) feeding at least a portion of the overhead stream to a second dehydrogenation unit to convert isobutane to isobutene.

7. The process of claim 6, further comprising:

(l) feeding at least a portion of the effluent from the second dehydrogenation unit to a reverse isomerization unit to convert isobutene to n-butenes.

8. The process of claim 7, further comprising:

(m) feeding at least a portion of the effluent from the second dehydrogenation unit to the combination butenes isomerization reaction and distillation tower.

9. The process of claim 8, further comprising:

(f) feeding at least a portion of the overhead stream to a reverse isomerization unit to convert isobutene to n-butenes; and

(g) feeding at least a portion of the effluent from the reverse isomerization unit to the combination butenes isomerization reaction and distillation tower.

10. The process of claim 8, further comprising:

(h) feeding at least a portion of the bottoms stream directly to the dehydrogenation unit.

11. The process of claim 9, further comprising:

(i) recycling at least a portion of the effluent from the oxydehydrogenation unit to the feed to the oxydehydrogenation unit.

12. The process of claim 9, further comprising the step of:

(j) recycling at least a portion of the effluent from the first dehydrogenation unit to the feed to the first dehydrogenation unit.

13. A process for the production of butadiene comprising:

(a) feeding a first feed stream comprising a mixture of C_4 olefins to a combination butene isomerization reaction and distillation tower to produce an overhead stream and a bottoms stream;

(b) feeding at least a portion of a second feed stream comprising n-butanes and n-butenes to an oxydehydrogenation unit to convert n-butenes to butadiene;

(c) feeding at least a portion of the effluent from the oxydehydrogenation unit to a first dehydrogenation unit to convert 2-butanes to 2-butenes;

(d) feeding at least a portion of the effluent from the first dehydrogenation unit and at least a portion of the bottoms stream to the oxydehydrogenation unit to convert 2-butenes to butadiene;

(e) feeding at least a portion of the effluent from at least one of the first dehydrogenation unit and the oxydehydrogenation unit to the combination butenes isomerization reaction and distillation tower; and

(f) separating the butadiene in at least a portion of the effluent of the oxydehydrogenation unit from unreacted compounds and by-products.