# CLAIMS

What is claimed as new and desired to be protected by Letters Patent is:

1. A process for producing a high purity isoamylene stream, the process comprising:

   purifying a crude tertiary amyl ether stream, comprising tertiary amyl ether, tertiary amyl alcohol, diisoamylene, C5 hydrocarbons including linear pentenes and pentanes, alcohol, and water, to recover a lights stream comprising the C5 hydrocarbons and tertiary amyl alcohol, a heavies stream comprising diisoamylene, and a tertiary amyl ether containing stream;

   feeding the tertiary amyl ether containing stream as a vapor to a decomposition reactor containing a decomposition catalyst;

   contacting the tertiary amyl ether with the decomposition catalyst to convert the tertiary amyl ether to isoamylene and alcohol and to recover an isoamylene containing rector effluent;

   feeding the isoamylene containing reactor effluent to a separation zone and separating the isoamylene containing reactor effluent into an alcohol stream, a vent stream, an isoamylene product stream, and a heavy oxygenate stream comprising unreacted ethers and tertiary amyl alcohol.

2. The process of claim 1, wherein the contacting occurs at a reaction temperature in a range from 130°C to 260°C and at a pressure in a range from about 2 barg to about 12 barg.

3. The process of claim 1, further comprising:

   feeding a C1-C2 alcohol and a mixed C5 stream to a fixed bed reactor containing an etherification catalyst, contacting the C1-C2 alcohol and isoamylene with the etherification catalyst to convert a portion of the isoamylene and C1-C2 alcohol to tertiary amyl ether, and recovering a fixed bed reactor effluent;

   feeding the fixed bed reactor effluent to a catalytic distillation reactor for concurrently (i) reacting isoamylene with the C1-C2 alcohol to produce additional tertiary amyl ether and (ii) recovering a bottoms stream comprising the tertiary amyl ether and an overhead stream comprising unreacted C5s and unreacted C1-C2 alcohol; and

   feeding the bottoms stream as the crude tertiary amyl ether stream to the purifying step.

4. The process of claim 1, wherein the purifying a crude tertiary amyl ether stream comprises feeding the crude tertiary amyl ether stream to a divided wall distillation

column, and recovering the tertiary amyl ether containing stream as a side draw from the divided wall distillation column.

5. The process of claim 1, wherein the isoamylene product stream comprises at least 99.8 wt% isoamylene.
6. The process of claim 1, wherein the alcohol comprises methanol, the tertiary amyl ether comprises tertiary amyl methyl ether, and wherein the alcohol stream comprises at least 99.8 wt% methanol.
7. The process of claim 1, wherein the alcohol comprises ethanol, and the tertiary amyl ether comprises tertiary amyl ethyl ether.
8. The process of claim 1, further comprising feeding the heavy oxygenate stream to the purifying step.
9. A system for producing a high purity isoamylene stream, the system comprising:
   a purification zone comprising a divided wall distillation column configured to receive a crude tertiary amyl ether from a feed source, the divided wall distillation column configured to separate the crude tertiary amyl ether into an overhead lights stream, a bottom heavies stream, and a tertiary amyl ether containing side draw stream;
   a heat exchanger for vaporizing the tertiary amyl ether containing side draw stream;
   a decomposition reactor containing a decomposition catalyst configured to convert the tertiary amyl ether into isoamylene and alcohol and to produce a reaction effluent;
   a separation zone configured to receive the reaction effluent and to separate the reaction effluent into an alcohol stream, a vent stream, a heavy oxygenate stream, and an isoamylene product stream.

10. The system of claim 9, further comprising a feed line for feeding the heavy oxygenate stream to the purification zone.

11. The system of claim 9, further comprising a reaction zone configured to react an isoamylene containing stream with methanol to produce the crude tertiary amyl ether.

12. The system of claim 11, wherein the separation zone comprises:

    an isoamylene lights column configured to receive the reactor effluent and to separate the reactor effluent into an overhead stream and a bottoms stream comprising the heavy oxygenates, recovered as the heavy oxygenate stream;

a methanol extraction column, configured to receive the overhead stream from the isoamylene lights column and to recover an overheads stream and to recover the alcohol stream as a bottoms stream;

an isoamylene finishing column, configured to receive the overheads stream from the methanol extraction column and to recover the vent stream as an overheads product and to recover the isoamylene product stream as a bottoms product.

13. The system of claim 12, further comprising a flow line for feeding the alcohol stream to the reaction zone.

14. The system of claim 9, wherein the separation zone comprises:

a methanol extraction column, configured to receive the reactor effluent and to separate the reactor effluent into an overhead stream and a bottoms stream comprising the alcohol, recovered as the alcohol stream;

an isoamylene lights column configured to receive the overhead stream from the methanol extraction column and to recover the vent stream as an overheads and a bottoms stream;

a heavies column, configured to receive the bottoms stream from the isoamylene lights column and to recover the isoamylene product stream as an overheads product and to recover the heavy oxygenate stream as a bottoms product.

15. The system of claim 14, further comprising a methanol finishing column configured for receiving the alcohol stream and for producing a purified alcohol product stream.