CLAIMS

1. A process for the selective dimerization and etherification of isoolefins, the process comprising:

   feeding a mixed C4 stream, comprising isoolefins, and an oxygenate stream to a first fixed bed reactor containing a first catalyst, producing a first reactor effluent comprising dimers of the isoolefin, unreacted C4s, and unreacted oxygenates;

   feeding the first reactor effluent directly to a second fixed bed reactor containing a second catalyst, producing a second reactor effluent comprising dimers of the isoolefin, unreacted C4s, and unreacted oxygenates;

   feeding the second reactor effluent to a catalytic distillation reactor system containing a third catalyst;

   concurrently in the catalyst distillation reactor system;

   reacting unreacted C4s in the presence of the third catalyst to form additional dimers of the isoolefin and/or ethers, and

   separating the dimers of the isoolefins from unreacted oxygenates and unreacted C4s, producing a bottoms stream comprising the dimers of the isoolefins, any produced trimers of the isoolefins, and heavy oxygenates, and an overhead stream comprising unreacted light oxygenates and C4s.

2. The process as claimed in claim 1, further comprising feeding the bottoms stream to a first fractionation column, and producing a second overhead stream comprising oxygenates and a second bottoms stream comprising dimers of the isoolefins and any trimers of the isoolefins.

3. The process as claimed in claim 1, further comprising feeding a second oxygenate stream to the second fixed bed reactor.

4. The process as claimed in claim 1, further comprising feeding methanol to the catalytic distillation reactor system.

5. The process as claimed in claim 1, further comprising recycling a portion of the second overhead stream to the first fixed bed reactor, the second fixed bed reactor, and/or the catalytic distillation reactor system.

6. The process as claimed in claim 2, further comprising feeding the second bottoms stream to a second fractionation column, producing a third overhead stream comprising dimers of the isoolefins and a third bottoms stream comprising trimers of the isoolefins.

7. The process as claimed in claim 6, further comprising hydrogenating the dimers of the isoolefin to form a hydrogenated product.
8. The process as claimed in claim 1, wherein the isoolefin is isobutylene, and wherein the oxygenate stream comprises methanol.
9. The process as claimed in claim 1, wherein the oxygenate is fed to the first and second fixed bed reactors at a concentration for the oxygenate to act as a selectivator for the dimerization of the isoolefin, and wherein the oxygenate is fed to the catalytic distillation reactor system at a concentration to act as a reactant producing ethers.
10. The process as claimed in claim 1, wherein the oxygenate is fed to each of the first and second fixed bed reactors and the catalytic distillation reactor system at a concentration for the oxygenate to act as a selectivator for the dimerization of the isoolefin.
11. The process as claimed in claim 1, wherein the first, second, and third catalysts are each a catalyst capable of being catalytically active for both dimerization and etherification at respectively appropriate reaction conditions.
12. A process for the flexible production of dimers and ethers comprising:

feeding a mixed C4 stream, comprising isoolefins, and an oxygenate stream to a first fixed bed reactor containing a first catalyst, producing a first reactor effluent comprising dimers of the isoolefin, unreacted C4s, and unreacted oxygenates;

feeding the first reactor effluent directly to a second fixed bed reactor containing a second catalyst, producing a second reactor effluent comprising dimers of the isoolefin, unreacted C4s, and unreacted oxygenates;

feeding the second reactor effluent to a catalytic distillation reactor system containing a third catalyst;

concurrently in the catalyst distillation reactor system;

reacting unreacted C4s in the presence of the third catalyst to form additional dimers of the isoolefin and/or ethers, and

separating the dimers of the isoolefins from uncreacted oxygenates and unreacted C4s, producing a bottoms stream comprising the dimers of the isoolefins, any produced trimers of the isoolefins, and heavy oxygenates, and an overhead stream comprising unreacted light oxygenates and C4s; and

for a first period of time, feeding the oxygenate to the first and second reactor at a concentration for the oxygenate to be effective as a selectivator, producing dimers of the isoolefins;

increasing the amount of oxygenates fed to the first and second reactors to a concentration for the oxygenate to be effective as a reactant, and for a second period of time producing ethers of the isoolefin.

13. The process as claimed in claim 12, further comprising decreasing the amount of oxygenates fed to the first and second reactors to a concentration for the oxygenate to be effective as a selectivator, and for a third period of time producing dimers of the isoolefins.

14. The process as claimed in claim 12, further comprising transitioning a temperature and/or pressure of the first and second reactors from a dimerization reaction condition used during the first period of time to an etherification reaction condition used during the second period of time.

15. The process as claimed in claim 12, further comprising, during the first period of time:

feeding the first bottoms fraction to a first fractionation column, and producing a second overhead stream comprising oxygenates and a second bottoms stream comprising dimers of the isoolefins and any trimers of the isoolefins; and

feeding the second bottoms stream to a second fractionation column, producing a third overhead stream comprising dimers of the isoolefins and a third bottoms stream comprising trimers of the isoolefins.

16. The process as claimed in claim 15, further comprising taking the first and second fractionation columns out of service during the second period of time.

17. A system for the flexible production of dimers and ethers comprising:

a first fixed bed reactor containing a first catalyst configured for reacting ng a mixed C4 stream, comprising isoolefins, and an oxygenate stream to a first fixed bed reactor containing a first catalyst, producing a first reactor effluent comprising dimers of the isoolefin, unreacted C4s, and unreacted oxygenates;

a second fixed bed reactor containing a second catalyst configured for reacting the first reactor effluent and producing a second reactor effluent comprising dimers of the isoolefin, unreacted C4s, and unreacted oxygenates;

a catalytic distillation reactor system containing a third catalyst;

concurrently in the catalyst distillation reactor system;

reacting unreacted C4s in the presence of the third catalyst to form additional dimers of the isoolefin and/or ethers, and

separating the dimers of the isoolefins from uncreacted oxygenates and unreacted C4s, producing a bottoms stream comprising the dimers of the isoolefins, any produced trimers of the isoolefins, and heavy oxygenates, and an overhead stream comprising unreacted light oxygenates and C4s; and

for a first period of time, feeding the oxygenate to the first and second reactor at a concentration for the oxygenate to be effective as a selectivator, producing dimers of the isoolefins;

increasing the amount of oxygenates fed to the first and second reactors to a concentration for the oxygenate to be effective as a reactant, and for a second period of time producing ethers of the isoolefin.

18. The system as claimed in claim 17, further comprising decreasing the amount of oxygenates fed to the first and second reactors to a concentration for the oxygenate to be effective as a selectivator, and for a third period of time producing dimers of the isoolefins.

19. The system as claimed in claim 17, further comprising transitioning a temperature and/or pressure of the first and second reactors from a dimerization reaction condition used during the first period of time to an etherification reaction condition used during the second period of time.

20. The system as claimed in claim 17, further comprising, during the first period of time:

a first fractionation column configured for fractionating the first bottoms fraction and producing a second overhead stream comprising oxygenates and a second bottoms stream comprising dimers of the isoolefins and any trimers of the isoolefins; and

a second fractionation column configured for fractionating the second bottoms stream and producing a third overhead stream comprising dimers of the isoolefins and a third bottoms stream comprising trimers of the isoolefins.

21. The system as claimed in claim 20, further comprising a valve located between the catalytic distillation reactor system and the first fractionation column configured for taking the first and second fractionation columns out of service during the second period of time.