CLAIMS

1. A process for producing C5 olefins from a mixed C5 feed, the process comprising:

feeding hydrogen and a mixed hydrocarbon stream comprising cyclopentadiene, linear C5 olefins, cyclic C5 olefins, C6+ hydrocarbons, and a diluent compound to a catalytic distillation reactor system having a lower catalyst zone and an upper catalyst zone;

concurrently in the catalytic distillation reactor system:

separating the linear C5 olefins from the cyclic C5 olefins, C5 dienes, and C6+ hydrocarbons; and

selectively hydrogenating at least a portion of the C5 dienes to form additional linear C5 olefins;

withdrawing a liquid side draw from a stage below a mixed hydrocarbon feed location and a hydrogen feed location and above a main reboiler, at least partially vaporizing the liquid side draw in an intermediate reboiler, and returning the at least partially vaporized liquid side draw to the catalytic distillation reactor system;

recovering linear C5 olefins as an overhead distillate from the catalytic distillation reactor system;

recovering cyclic C5 olefins as a bottoms product from the catalytic distillation reactor system;

measuring a concentration of the diluent compound at an elevation below the lower catalyst zone; and

measuring a concentration of the diluent compound at an elevation intermediate the upper and lower catalyst zones; or

measuring a concentration of the diluent compound at an elevation above the upper catalyst zone.

2. The process of claim 1, further comprising operating the main reboiler of the catalytic distillation reactor system at a temperature of less than 302°F.

3. A system for producing C5 olefins from a mixed C5 hydrocarbon feedstock, comprising:

a catalytic distillation reactor system for concurrently converting C5 dienes to C5 olefins and separating the mixed C5 hydrocarbon feedstock into an overheads olefin product and a bottoms product, the catalytic distillation reactor system having at least three reaction zones, including:

a first reaction zone disposed below a C5-olefin containing stream feed elevation and containing a nickel-based catalyst;

a second reaction zone disposed above the C5-olefin containing stream feed elevation and containing a nickel-based catalyst; and

a third reaction zone disposed above the second reaction zone and containing a palladium-based catalyst;

a feed line configured to feed a diluent compound to the catalytic distillation reactor system;

an analyzer for determining a density profile or a composition profile of the diluent compound within the catalytic distillation reactor system; and

a controller configured to adjust one or more operating parameters to maintain a set point density profile or composition profile of the diluent compound within the catalytic distillation reactor system.

4. The system of claim 3, further comprising a fractionator configured to concurrently (a) convert cyclopentadiene in a mixed hydrocarbon to dicyclopentadiene and produce a dimerization reactor effluent, and (b) separate the mixed hydrocarbon to form a bottoms fraction including the dicyclopentadiene and an overheads fraction comprising the mixed C5 hydrocarbon feedstock.

5. The system of claim 3, further comprising:

a dimerization reactor for converting cyclopentadiene in a mixed hydrocarbon to dicyclopentadiene and producing a dimerization reactor effluent; and

a separator for separating the dimerization reactor effluent to form a bottoms fraction including the dicyclopentadiene and an overheads fraction comprising the mixed C5 hydrocarbon feedstock.

6. The system of claim 3, further comprising a total hydrogenation reactor for converting cyclopentene in the bottoms product to cyclopentane.

7. The system of claim 6, further comprising a flow conduit for recycling an effluent from the total hydrogenation reactor to the catalytic distillation reactor system.

8. A process for the selective hydrogenation of C5 dienes in a mixed C5 hydrocarbon stream, comprising:

feeding hydrogen and a C5-olefin containing stream comprising linear pentenes, dienes, acetylenes, and a diluent compound to a catalytic distillation reactor system having a lower catalyst zone and an upper catalyst zone;

concurrently in the catalytic distillation reactor system:

hydrogenating the acetylenes and dienes; and

fractionating the C5-olefin containing stream;

recovering an overheads fraction comprising the pentenes;

recovering a bottoms fraction;

determining a concentration of the diluent compound at one or more column elevations; and

adjusting one or more column operating parameters to maintain a set point concentration or a concentration profile of the diluent compound at the one or more column elevations;

measuring a concentration of the diluent compound at an elevation below the lower catalyst zone;

measuring a concentration of the diluent compound at an elevation intermediate the upper and lower catalyst zones; or

measuring a concentration of the diluent compound at an elevation above the upper catalyst zone.

9. The process of claim 8, wherein the catalytic distillation reactor system includes the upper catalyst zone above a C5-olefin containing stream feed elevation and the lower catalyst zone below the C5-olefin containing stream feed elevation, the process comprising at least one of:

measuring a density of a liquid fraction at an elevation below the lower catalyst zone and determining the concentration of the diluent compound at the elevation below based upon the measured density;

measuring a density of a liquid fraction at an elevation intermediate the upper and lower catalyst zones and determining the concentration of the diluent compound at the elevation intermediate based upon the measured density; or

measuring a density of a liquid fraction at an elevation above the upper catalyst zone and determining the concentration of the diluent compound at the elevation above based upon the measured density.

10. The process of claim 8, wherein the diluent compound comprises cyclopentane, cyclopentene, or a combination thereof.

11. The process of claim 8, wherein the diluent compound comprises one or more hydrocarbons having a normal boiling point in the range from 100°F to 125°F.

12. The process of claim 8, wherein the diluent compound comprises one or more hydrocarbons having a specific gravity in the range from 0.7 to 0.8.

13. The process of claim 8, wherein a sample elevation used in the determining step is disposed proximate an elevation of maximum rate of change in concentration of the diluent compound within the catalytic distillation reactor system.

14. The process of claim 13, further comprising determining an elevation of maximum rate of change in concentration of the diluent compound within the catalytic distillation reactor system.

15. The process of claim 8, wherein the adjusting comprises at least one of:

decreasing an overhead flow and increasing a reflux flow when a diluent compound concentration profile starts to move up the column and the reflux flow is below a column flooding value;

increasing an overhead flow and decreasing reflux flow when a diluent compound concentration profile starts to move down the column and the reflux flow is above a minimum design value;

decreasing a reboiler duty and an overhead flow when the diluent compound concentration profile starts to move up the column; or

increasing a reboiler duty and an overhead flow when the diluent compound concentration profile starts to move down the column.

16. A system for producing C5 olefins from a mixed C5 hydrocarbon feedstock, comprising:

    a catalytic distillation reactor system, including one or more reaction zones, for concurrently converting C5 dienes to C5 olefins and separating the C5 hydrocarbon feedstock into an overheads olefin product and a bottoms product;

    a feed line configured to feed a diluent compound to the catalytic distillation reactor system;

    an analyzer for determining a density profile or a composition profile of the diluent compound within the catalytic distillation reactor system; and

    a controller configured to adjust one or more operating parameters to maintain a set point density profile or composition profile of the diluent compound within the catalytic distillation reactor system.

17. The system of claim 16, wherein the analyzer is a density measurement device, the controller further configured to convert a measured density to an estimated composition.