CLAIMS:

What is claimed is:

1. A process for upgrading a hydrocarbon, comprising:

(I) introducing a hydrocarbon-containing feed comprising one or more of C_2-C_{16} linear or branched alkanes, one or more of C_4-C_{16} cyclic alkanes, one or more of C_8-C_{16} alkyl aromatics, or a mixture thereof into a reaction zone;

(II) contacting the hydrocarbon-containing feed with a catalyst disposed within the reaction zone to effect at least one of dehydrogenation, dehydroaromatization, and dehydrocyclization of at least a portion of the hydrocarbon-containing feed to produce a coked catalyst and a first effluent comprising one or more upgraded hydrocarbons and molecular hydrogen, wherein the hydrocarbon-containing feed and the catalyst are contacted at a temperature in a range from 300°C to 900°C, for a time period of 1 minute to 90 minutes, under a hydrocarbon partial pressure of at least 20 kPa-absolute, wherein the hydrocarbon partial pressure is the total partial pressure of any C_2-C_{16} alkanes and any C_8-C_{16} alkyl aromatics in the hydrocarbon-containing feed, wherein the catalyst comprises a Group 8-10 element or a compound thereof disposed on a support that comprises a mixed oxide of magnesium and aluminium;

(III) halting introduction of the hydrocarbon-containing feed into the reaction zone;

(IV) introducing an oxidant into the reaction zone;

(V) contacting the oxidant with the coked catalyst to effect combustion of at least a portion of the coke to produce a regenerated catalyst lean in coke and a second effluent comprising a combustion gas, wherein the oxidant and the coked catalyst are contacted for a time period of 1 minute to 90 minutes;

(VI) halting introduction of the oxidant into the reaction zone;

(VII) introducing a reducing gas into the reaction zone;

(VIII) contacting the reducing gas with the regenerated catalyst to produce a regenerated and reduced catalyst and a third effluent, wherein the reducing gas and the regenerated catalyst are contacted for a time period of 0.1 seconds to 90 minutes;

(IX) halting introduction of the reducing gas into the reaction zone;

(X) introducing an additional quantity of the hydrocarbon-containing feed into the reaction zone; and

(XI) contacting the additional quantity of the hydrocarbon-containing feed with the regenerated and reduced catalyst to produce a re-coked catalyst and additional first effluent, wherein the additional quantity of the hydrocarbon-containing feed and the regenerated and reduced catalyst are contacted at a temperature in a range from 300°C to 900°C, for a time period of 1 minute to 90 minutes, under a hydrocarbon partial pressure of at least 20 kPa-absolute, wherein the hydrocarbon partial pressure is the total partial pressure of any C_2-C_{16} alkanes and any C_8-C_{16} alkyl aromatics in the hydrocarbon-containing feed.

2. The process of claim 1, wherein an inverse temperature profile or an isothermal temperature profile is maintained within the reaction zone during step (II).

3. The process of claim 1 or claim 2, wherein the catalyst is disposed in a fixed bed within the reaction zone.

4. The process of claim 1 or claim 2, wherein the catalyst is in the form of a plurality of discrete particles within the reaction zone.

5. The process of any of claims 1 to 3, wherein:

the hydrocarbon-containing feed comprises propane,

the hydrocarbon-containing feed is at a temperature in a range from 300°C to 700°C when introduced into the reaction zone,

the hydrocarbon-containing feed has a hydrocarbon partial pressure of 20 kPa-absolute to 1,000 kPa-absolute, and

the first effluent is at a temperature in a range from 500°C to 800°C upon exiting the reaction zone.

6. The process of any of claims 1 to 5, wherein, upon exiting the reaction zone, the first effluent is at a temperature of ≥ 580°C, more preferably ≥ 630°C, or more preferably ≥ 670°C.

7. The process of any of claims 1 to 6, wherein:

the hydrocarbon-containing feed comprises propane,

the upgraded hydrocarbon comprises propylene, and

step (III) is initiated when the temperature of the first effluent upon exiting the reaction zone falls below 710°C, 680°C, 650°C, 620°C, 610°C, 600°C, 590°C, 580°C, 570°C, 560°C, or 550°C.

8. The process of any of claims 1 to 7, wherein:

the hydrocarbon-containing feed comprises propane,

the upgraded hydrocarbon comprises propylene,

contacting the hydrocarbon-containing feed with the catalyst in step (II) has a propylene selectivity of ≥ 75%, and

step (III) is initiated when a propylene yield falls below 65%, 50%, 55%, 50%, 47%, 45%, 43%, 40%, 37%, or 35%.

9. The process of any of claims 1 to 8, wherein:

steps (I) to (XI) are repeated for at least 15 cycles,

the catalyst produces a first yield when initially contacted with the hydrocarbon-containing feed, and

upon completion of the fifteenth cycle, the catalyst produces a fifteenth yield that is at least 98% of the first yield.

10. The process of any of claims 1 to 9, wherein:

the hydrocarbon-containing feed comprises propane,

the upgraded hydrocarbon comprises propylene, and

contacting the hydrocarbon-containing feed with the catalyst in step (II) has a propylene yield of at least 52 %, or at least 62 %, or at least 72 % at a propylene selectivity of ≥ 75%, ≥ 80%, ≥ 85%, or ≥ 90%, ≥ 95%.

11. The process of any of claims 1 to 10, wherein the hydrocarbon-containing feed introduced into the reaction zone comprises steam in an amount from 0.1 vol% to 50 vol%, preferably from 0.5 vol% to 20 vol%, more preferably from 1 vol% to 15 vol%, or more preferably from 5 vol% to 10 vol%, based on a total volume of any C_2-C_{16} alkanes and any C_8-C_{16} alkyl aromatics in the hydrocarbon-containing feed.

12. The process of any of claims 1 to 11, further comprising, after step (III) and before step (IV), the following step:

(III_{a1}) introducing a stripping gas into the reaction zone to remove at least a portion of any residual hydrocarbon-containing feed, first effluent, or both from the reaction zone;

(III_{a2}) removing at least a portion of any residual hydrocarbon containing feed, effluent, or both from the reaction zone by subjecting the reaction zone to a pressure of less than atmospheric pressure; or

a combination of steps (III_{a1}) and (III_{a2}).

13. The process of any of claims 1 to 12, further comprising, after step (VI) and before step (VII), the following step:

(VI_{a1}) introducing a stripping gas into the reaction zone to remove at least a portion of any residual oxidant, second effluent, or both from the reaction zone;

(VI_{a2}) removing at least a portion of any residual oxidant, second effluent, or both from the reaction zone by subjecting the reaction zone to a pressure of less than atmospheric pressure; or

a combination of steps (VI_{a1}) and (VI_{a2}).

14. The process of any of claims 1 to 13, further comprising, after step (IX) and before step (X), the following step:

(IX_{a1}) introducing a stripping gas into the reaction zone to remove at least a portion of any residual reducing gas, third effluent, or both from the reaction zone;

(IX_{a2}) removing at least a portion of any residual reducing gas, third effluent, or both from the reaction zone by subjecting the reaction zone to a pressure of less than atmospheric pressure; or

a combination of steps (IX_{a1}) and (IX_{a2}).

15. The process of any of claims 1 to 14, wherein step (IV) further comprises:

introducing a fuel with the oxidant into the reaction zone; and

combusting at least a portion of the fuel within the reaction zone to produce heat that heats the reaction zone to a temperature of ≥ 580°C, ≥ 620°C, ≥ 650°C, ≥ 680°C, ≥ 710°C, ≥ 740°C, ≥ 770°C, ≥ 800°C, ≥ 850°C, ≥ 900°C, or ≥ 1,000°C.

16. The process of any of claims 1 to 15, wherein the oxidant is at a temperature in a range from 580°C to 1,100°C, preferably from 600°C to 1,000°C, more preferably from 700°C to 900°C, or

more preferably from 750°C to 850°C and at a pressure in a range from 20 kPa-absolute to 1,000 kPa-absolute when contacted with the coked catalyst.

17. The process of any of claims 1 to 16, wherein the reducing gas is at a temperature in a range from 450°C to 900°C, preferably from 600°C to 900°C, more preferably from 620°C to 900°C, more preferably from 650°C to 850°C, or more preferably from 670°C to 800°C when contacted with the regenerated catalyst.

18. The process of any of claims 1 to 17, wherein the catalyst further comprises a promoter at an amount of up to 10 wt% of the total weight of the support, and the promoter comprises one or more of the following elements: Sn, Ga, Zn, Ge, In, Re, Ag, Au, Cu, a combination thereof, or a mixture thereof, .

19. The process of any of claims 1 to 18, wherein the Group 8-10 element comprises Pt.

20. The process of any of claims 1 to 19, wherein, during normal operation, the oxidant contacts the coked catalyst in step (V) at a normal temperature, a normal pressure, and for a normal period of time, the process further comprising every 12 hours to 90 days modifying step (V) by increasing the normal temperature, increasing the normal pressure, increasing the normal period of time, or a combination thereof to effect a re-activation of the coked catalyst.

21. The process of any of claims 1 to 20, wherein the reaction zone is a first reaction zone and the catalyst is a first catalyst, the process further comprising:

carrying out steps (I)-(XI) within a second reaction zone comprising a second catalyst; and

carrying out steps (I)-(XI) within a third reaction zone comprising a third catalyst, wherein the first reaction zone, the second reaction zone, and the third reaction zone are operated in parallel, and wherein a timing of the steps (I)-(XI) between the first, second, and third reaction zones is such that there is a continuous production of the one or more upgraded hydrocarbons and molecular hydrogen across the first, second, and third reaction zones.

22. The process of claim 21, wherein the first catalyst, the second catalyst, and the third catalyst have the same composition.

23. A cyclic process for upgrading a hydrocarbon in a reactor system, comprising:

(I) a reaction interval comprising introducing and halting introduction of a hydrocarbon-containing feed into a reaction zone, wherein the hydrocarbon-containing feed comprises one or more of C_2-C_{16} linear or branched alkanes, one or more of C_4-C_{16} cyclic alkanes, one or more of C_8-C_{16} alkyl aromatics, or a mixture thereof;

(II) a regeneration interval following the reaction interval, the regeneration interval comprising introducing and halting introduction of an oxidant into the reaction zone; and

(III) a reduction interval following the regeneration interval, the reduction interval comprising introducing and halting introduction of a reducing gas into the reaction zone; wherein:

the reaction interval is restarted after the reduction interval;

during introduction of the hydrocarbon-containing feed into the reaction zone, the hydrocarbon-containing feed contacts a catalyst disposed within the reaction zone to effect at least one of dehydrogenation, dehydroaromatization, and dehydrocyclization of at least a portion of the hydrocarbon-containing feed to produce a coked catalyst and a first effluent comprising one or more upgraded hydrocarbons and molecular hydrogen, wherein the hydrocarbon-containing feed and the catalyst are contacted at a temperature in a range from 300°C to 900°C, for a time period of 1 minute to 90 minutes, under a hydrocarbon partial pressure of at least 20 kPa-absolute, wherein the hydrocarbon partial pressure is the total partial pressure of any C_2-C_{16} alkanes and any C_8-C_{16} alkyl aromatics in the hydrocarbon-containing feed;

during introduction of the oxidant into the reaction zone, the oxidant contacts the coked catalyst to effect combustion of at least a portion of the coke to produce a regenerated catalyst lean in coke and a second effluent comprising a combustion gas, wherein the oxidant and the coked catalyst are contacted for a time period of 1 minute to 90 minutes;

during introduction of the reducing gas into the reaction zone, the reducing gas contacts the regenerated catalyst to produce a regenerated and reduced catalyst;

the catalyst comprises a Group 8-10 element or a compound thereof disposed on a support that comprises a mixed oxide of magnesium and aluminium.