CLAIMS:

What is claimed is:

1. A process for regenerating and reducing an at least partially deactivated catalyst comprising a contaminant and a Group 10 element disposed on an inorganic support, wherein the Group 10 element is present in an amount of from 0.001 wt% to 6 wt%, based on the weight of the inorganic support, the process comprising:

(I) heating the at least partially deactivated catalyst by contacting the at least partially deactivated catalyst with a combustion product to produce a precursor catalyst, wherein:

the combustion product is produced by combusting a combustion mixture comprising a fuel and an oxidant,

the combustion product, prior to, during, or after contact with the at least partially deactivated catalyst, comprises H_2O at a concentration of greater than 2 mol% and, optionally, O_2 at a concentration of less than 2 mol%, based on the total moles in the combustion product, and

the amount of O_2 in the combustion product, prior to, during, or after contact with the at least partially deactivated catalyst, is maintained at the concentration of less than 2 mol% by controlling a molar ratio of the oxidant to the fuel in the combustion mixture;

(II) providing an oxidative gas comprising no greater than 2 mol% of H_2O, based on the total moles in the oxidative gas;

(III) contacting the precursor catalyst with the oxidative gas at an oxidizing temperature in a range of from 620°C to 1,000°C for a duration of at least 30 seconds to produce a regenerated catalyst; and

(IV) contacting the regenerated catalyst with a H_2-containing gas at a reducing temperature in a range of from 620°C to 1,000°C for a duration of at least 0.1 seconds to produce a regenerated and reduced catalyst.

2. The process of claim 1, wherein the combustion product is produced by combusting the combustion mixture in the presence of the at least partially deactivated catalyst.

3. The process of claim 1, wherein the combustion product is produced by combusting the combustion mixture prior to contacting the at least partially deactivated catalyst with the combustion product such that the combustion product prior to contacting the at least partially

deactivated catalyst comprises the H_2O at the concentration of greater than 2 mol% and, optionally, the O_2 at a concentration of less than 2 mol%, based on the total moles in the combustion product.

4. The process of claim 1, wherein the combustion product comprises residual fuel and is free of any O_2.

5. The process of claim 1, wherein the fuel comprises at least one of H_2, CO, a hydrocarbon, and the contaminant disposed on the inorganic support, and wherein the oxidant comprises O_2.

6. The process of claim 1, wherein the combustion product comprises the H_2O, the optional O_2, and one or more of residual fuel, N_2, CO, and CO_2.

7. The process of claim 1, wherein step (II) comprises:

(IIa) providing the oxidative gas at a temperature below the oxidizing temperature; and

(IIb) pre-heating the oxidative gas to a temperature greater than the temperature of the precursor catalyst before the contacting in step (III).

8. The process of claim 1, wherein step (III) further comprises, heating the oxidative gas, heating the precursor catalyst, or heating both the oxidative gas and the precursor catalyst during contact of the precursor catalyst with the oxidative gas by using a radiant/conductive heat source, a heat exchanger, or a combination thereof.

9. The process of claim 1, wherein step (III) further comprises contacting the regenerated catalyst with a first stripping gas free of O_2 to produce a stripped regenerated catalyst, and wherein step (IV) comprises contacting the stripped regenerated catalyst with the H_2-containing gas to produce the regenerated and reduced catalyst.

10. The process of claim 1, wherein the Group 10 element comprises Pt, and wherein the inorganic support comprises at least 0.5 wt% of a Group 2 element, based on the weight of the inorganic support, the Group 2 element comprising Mg, and at least a portion of the Group 2 element is in the form of MgO or a mixed metal oxide comprising MgO.

11. A dehydrogenation process using the regenerated and reduced catalyst produced by a process of claim 1, the dehydrogenation process comprising:

(V) contacting a hydrocarbon-containing feed with the regenerated and reduced catalyst to effect one or more of dehydrogenation, dehydroaromatization, and dehydrocyclization of at least a portion of the hydrocarbon-containing feed to produce additional at least partially deactivated catalyst and an effluent comprising one or more upgraded hydrocarbons and molecular hydrogen, 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 aromatic hydrocarbons, or a mixture thereof;

(VI) repeating steps (I) through (IV), wherein, in step (III) additional regenerated catalyst is produced, and wherein, in step (IV), additional regenerated and reduced catalyst is produced from the additional regenerated catalyst; and

(VII) contacting an additional quantity of the hydrocarbon-containing feed with at least a portion of the additional regenerated and reduced catalyst to produce additional at least partially deactivated catalyst and additional effluent, wherein a cycle time from the contacting the hydrocarbon-containing feed with the regenerated and reduced catalyst in step (V) to the contacting the additional quantity of the hydrocarbon-containing feed with the additional regenerated and reduced catalyst in step (VII) is $\leqslant$ 5 hour.

12. A process for upgrading a hydrocarbon, comprising:

(I) contacting a hydrocarbon-containing feed with a catalyst comprising a Group 10 element disposed on an inorganic support to effect one or more of dehydrogenation, dehydroaromatization, and dehydrocyclization of at least a portion of the hydrocarbon-containing feed to produce an at least partially deactivated catalyst comprising a contaminant and the Group 10 element disposed on the inorganic support and an effluent comprising one or more upgraded hydrocarbons and molecular hydrogen, wherein:

the hydrocarbon-containing feed comprises one or more of C_2-C_{16} linear or branched alkanes, or one or more of C_4-C_{16} cyclic alkanes, one or more C_8-C_{16} alkyl aromatics, or a mixture thereof;

the Group 10 element has a concentration in the range of from 0.001 wt% to 6 wt%, based on the weight of the inorganic support;

the hydrocarbon-containing feed and the catalyst are contacted at a temperature in a range of from 300°C to 900°C; and

the one or more upgraded hydrocarbons comprise at least one of a dehydrogenated hydrocarbon, a dehydroaromatized hydrocarbon, and a dehydrocyclized hydrocarbon;

(II) heating the at least partially deactivated catalyst by contacting the at least partially deactivated catalyst with a combustion product comprising H_2O at a concentration of greater than 2 mol% and, optionally, O_2 at a concentration of less than 2 mol%, based on the total moles in the combustion product to produce a precursor catalyst, wherein the combustion product is produced by combusting a combustion mixture comprising a fuel and an oxidant, and wherein the amount of O_2 in the combustion product is maintained at the concentration of less than 2 mol% by controlling a molar ratio of the oxidant to the fuel in the combustion mixture;

(III) providing an oxidative gas comprising no greater than 2 mol% of H_2O, based on the total moles in the oxidative gas;

(IV) contacting the precursor catalyst at an oxidizing temperature in a range of from 620°C to 1,000°C with the oxidative gas for a duration of at least 30 seconds to produce a regenerated catalyst;

(V) contacting the regenerated catalyst with a H_2-containing gas at a reducing temperature in a range of from 620°C to 1,000°C for a duration of at least 0.1 seconds to produce a regenerated and reduced catalyst; and

(VI) contacting an additional quantity of the hydrocarbon-containing feed with at least a portion of the regenerated and reduced catalyst to produce additional at least partially deactivated catalyst and additional effluent.

13. The process of claim 12, wherein the combustion product is produced in the presence of the at least partially deactivated catalyst.

14. The process of claim 12, wherein the combustion product is produced prior to contacting the at least partially deactivated catalyst with the combustion product.

15. The process of claim 12, wherein the Group 10 element comprises Pt, and wherein the inorganic support comprises at least 0.5 wt% of a Group 2 element, based on the weight of the inorganic support, the Group 2 element comprising Mg, and

at least a portion of the Group 2 element is in the form of MgO or a mixed metal oxide comprising MgO.