

CLAIMS:

1. A method for operating a reverse flow reactor, comprising: exposing at least a portion of a fuel mixture comprising fuel and 0.1 vol% or more of O₂ to at least one heated surface in a recuperation zone of a reverse flow reactor to heat the at least a portion of the fuel mixture; reacting the fuel mixture under combustion conditions in the recuperation zone to form a flue gas and to heat one or more regeneration surfaces in a reaction zone of the reverse flow reactor to a regenerated surface temperature, the reaction zone comprising a catalyst composition for an endothermic reaction, the recuperation zone comprising a catalyst composition for a supplemental exothermic reaction; exposing a reactant stream to the one or more regeneration surfaces in the reaction zone to increase a temperature of the reactant stream; exposing, in the reaction zone, the reactant stream to the catalyst composition for the endothermic reaction under endothermic reaction conditions to form a product stream, a direction of flow for the reactant stream within the reaction zone being reversed relative to a direction of flow for the fuel mixture; exposing, in the recuperation zone, the product stream to the catalyst composition for the supplemental exothermic reaction under supplemental exothermic reaction conditions to form a reacted product stream and to heat the at least one heated surface in the recuperation zone.
2. The method of claim 1, wherein the catalyst composition for the endothermic reaction comprises a reforming catalyst.
3. The method of claim 2, wherein the reactant stream comprises a reformable hydrocarbon and steam, and wherein the product stream comprises hydrogen, the reformable hydrocarbon optionally comprising methane.
4. The method of any of the above claims, wherein the catalyst composition for the supplemental exothermic reaction comprises a water gas shift catalyst.
5. The method of claim 4, wherein the water gas shift catalyst comprises a high temperature water gas shift catalyst, a second reforming catalyst that is optionally different from the reforming catalyst in the reaction zone, or a combination thereof.
6. The method of any of claims 1 – 3, wherein the catalyst composition for the supplemental exothermic reaction comprises a methanol synthesis catalyst, a methanol conversion catalyst, or a combination thereof.
7. The method of any of claims 1 – 3, wherein the catalyst composition for the supplemental exothermic reaction comprises an olefin oligomerization catalyst.
8. The method of any of claims 1 – 3, wherein the catalyst composition for the supplemental exothermic reaction comprises a Fischer-Tropsch catalyst for olefin production.
9. The method of any of the above claims, wherein the fuel mixture is combusted

downstream from the catalyst composition for the supplemental exothermic reaction relative to the direction of flow for the fuel mixture.

10. The method of any of the above claims, wherein at least one of the fuel and the O₂ is not exposed to the catalyst composition for the supplemental exothermic reaction.

11. The method of any of the above claims, wherein the product stream is exposed to the catalyst composition for the supplemental exothermic reaction prior to being passed into an external heat exchange stage.

12. The method of any of the above claims, wherein the flue gas comprises a temperature of 420°C or more.

13. The method of any of the above claims, wherein the endothermic reaction conditions comprise a temperature of 600°C or more.