is disposed such that, during operation, flow from the combustion chamber outlet flows into the combustion preheat section

wherein the combustion channel has a height of 10 mm or less and wherein the combustion comprises a combustion catalyst staggered over the width of the combustion chamber, such that, at the beginning of the combustion chamber's length, catalyst is present in no more than 70% of the combustion chamber's width.

7. The compact steam reformer of claim **1** wherein the steam reforming reaction chamber comprises a catalyst comprising CuZnAl, Pd/ZnO, Ru, Pt, Rh, or combinations of these.

8. The compact steam reformer of claim **2** wherein a preheat layer is disposed between the steam reforming reaction chamber and a methanation layer that comprises the methanation catalyst.

9. The compact steam reformer of claim **8** wherein the methanation catalyst comprises Ru on an alumina support.

10. The compact steam reformer of claim **9** wherein the steam reforming reaction chamber comprises a catalyst having a porosity of at least 80%.

11. A prebonded assembly having the structure of the compact steam reformer of claim **1**.

12. A compact steam reformer system, comprising

the compact steam reformer of claim **1** comprising alcohol and steam flowing through the reactant preheat section and hydrogen flowing through the reactant preheat section.

13. The compact steam reformer system of claim **12** comprising alcohol and steam flowing through the reactant preheat section and hydrogen flowing through the reactant preheat section.

14. A method of producing H2 comprising passing CO and H2O into the compact steam reformer of claim **1**.

15. The method of claim **14** wherein the combustion chamber has a volume/power ratio of 0.017 ml/We or less.

16. The method of claim **14** wherein the integrated steam reformer has a volume/power ratio of 0.82 ml/We or less.

17. The method of claim **14**, comprising:

passing a reactant stream comprising a hydrogen source and water into the reactant preheat section and through a preheat layer in the reactant preheat section and then into the steam reforming reaction section where the hydrogen source and water react to form a product stream comprising H2;

passing the product stream comprising H2 through a layer parallel to the preheat layer and transferring heat through a wall from the product stream to the reactant stream;

passing a combustant stream comprising a fuel and an oxidant into the combustion preheat section and through a preheat layer in the combustion preheat section and then into the combustion chamber where the fuel and oxidant combust to form an exhaust stream;

wherein heat from the combustion passes through a wall into the steam reforming reaction section; and

passing the exhaust stream through a layer parallel to the preheat layer and transferring heat through a wall from the exhaust stream to the combustant stream.

18. Laminated apparatus for integrated thermal reaction, comprising the following layers in stacked in sequential order:

an endothermic preheat layer;

an endothermic reaction chamber;

an exothermic reaction chamber; and

an exothermic preheat layer;

wherein a reaction chamber wall separates the endothermic reaction chamber and the exothermic reaction chamber;

wherein a first fluid flow path connects the endothermic preheat layer with the endothermic reaction chamber; and

wherein a second fluid flow path connects the exothermic preheat layer with the exothermic reaction chamber

wherein the endothermic reaction chamber comprises a steam reformer and includes a steam reforming catalyst, and

wherein the exothermic reaction chamber comprises a combustion chamber and includes a combustion catalyst.

19. The laminated apparatus of claim **18** further comprising a methanator connected to the first fluid path.

20. The laminated apparatus of claim **18** further comprising a preferential oxidation chamber connected to the first fluid path.

21. A method of conducting thermal chemical reactions in the apparatus of claim **18**, comprising:

passing a first reactant stream into and through the endothermic preheat layer and then into the endothermic reaction chamber wherein the reactant reacts endothermically to form an endothermic product stream;

passing the endothermic product stream into a heat transfer layer that is adjacent to the endothermic preheat layer and passing heat from the endothermic product stream into the reactant stream through a wall that separates the heat transfer layer from the endothermic preheat layer; and simultaneously,

passing a second reactant stream into and through the exothermic preheat layer and then into the exothermic reaction chamber wherein the reactant reacts exothermically to form an exothermic product stream;

passing the exothermic product stream into a heat transfer layer that is adjacent to the exothermic preheat layer and passing heat from the exothermic product stream into the second reactant stream through a wall that separates the heat transfer layer from the endothermic preheat layer; and

wherein heat from the exothermic reaction is conducted into the endothermic reaction chamber through a reaction chamber wall that separates the enothermic reaction chamber and the exothermic reaction chamber.

22. The method of claim **21** wherein the endothermic reaction comprises steam reforming; wherein the exothermic reaction comprises combustion; wherein the laminated apparatus comprises a preferential reaction chamber in the first fluid flow path; wherein the endothermic product stream comprises CO and flows into the preferential reaction chamber wherein at least a portion of the CO is converted to CO_2.

23. The method of claim **17** wherein the product stream comprising H2 has an H2:CO ratio of at least 70.

24. The method of claim **17** wherein the product stream comprising H2 has an H2:CO ratio in the range of 100 to 100,000.

25. The method of claim **14** wherein the combustion chamber has a volume/power ratio of 0.011 ml/We or less.

26. The method of claim **14** wherein the combustion chamber has a volume/power ratio in the range of 0.007 and 0.004 ml/We.

27. The method of claim **14** wherein the integrated steam reformer has a volume/power ratio of 0.55 ml/We or less.

28. The method of claim **17** wherein the reforming chamber has a volume/power ratio of 0.03 ml/We or less.

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