

- 23 -

C L A I M S

1. A process for converting carbon dioxide and hydrogen by performing a reverse water gas shift reaction at elevated temperature, the process comprising introducing carbon dioxide, hydrogen and oxygen into a reaction vessel having an inlet and an outlet, and, wherein the reverse water gas shift reaction takes place in two different zones of the reaction vessel, being a top zone (z1) adjacent to a bottom zone (z2), wherein
- (a) no catalyst is present in the top zone (z1) of the reaction vessel, and
- (b) at least a gas stream comprising carbon dioxide, a hydrogen rich gas stream and an oxygen rich gas stream are introduced into the inlet at the top zone (z1) of the reaction vessel in separate feed streams, wherein the hydrogen rich gas stream is introduced into the reaction vessel at a temperature between 15 and 450°C,
- (c) the hydrogen rich gas stream and oxygen rich gas stream being introduced in close vicinity of each other, wherein at least the hydrogen rich gas stream and the oxygen rich gas stream are introduced into the reaction vessel via a burner comprising coaxial channels for the separate introduction of the different gas streams, the burner being located at the top of the reaction vessel, wherein the hydrogen and oxygen in the hydrogen rich gas stream and oxygen rich gas stream undergo a combustion reaction upon entering the reaction vessel, thereby providing the heating energy required for the reverse water-gas shift reaction; and
- (d) the temperature in the top zone (z1) of the reaction vessel is maintained in the range of 700 to 1200°C by varying the flow of any of the gas streams which are

- 24 -

introduced into the reaction vessel; and

(e) the bottom zone (z2) of the reaction vessel is provided with a catalyst bed comprising a reverse water gas shift catalyst, the top of the catalyst bed being

5 placed at a distance from the burner in the top zone (z1) sufficient to prevent damage from flame impingement on the catalyst bed;

(f) wherein in the bottom zone (z2) of the reaction vessel a catalytic reverse water gas shift reaction takes place  
10 at elevated temperatures, thereby converting unconverted carbon dioxide and hydrogen;

to produce a product stream comprising mainly carbon monoxide, hydrogen and water;

wherein in step (c) the hydrogen rich gas stream and  
15 oxygen rich gas stream are introduced into the reaction vessel in close vicinity of but not next to each other; and

wherein part of the gas stream containing carbon dioxide is introduced via a channel in between the hydrogen rich  
20 gas stream and the oxygen rich gas stream.

2. A process according to claim 1, wherein the catalyst bed is placed above the reactor outlet, which is located at the bottom of the reaction vessel, minimizing the free space between the catalyst bed and the reactor outlet.

25 3. A process according to claim 1 or 2, wherein a solids bed comprising refractory oxide material capable of retaining soot particles is positioned on top of the catalyst bed.

4. A process according to any one of claims 1 to 3,  
30 wherein the product stream leaving the hot reaction vessel is cooled in a heat exchanger with water to provide a cooled product mixture comprising mainly carbon monoxide and hydrogen and steam.

- 25 -

5. A process according to claim 4, wherein the product stream or steam produced after cooling the product stream is used to preheat one or more of the feed gas streams selected from the gas stream comprising carbon dioxide, the hydrogen rich gas stream, the oxygen rich gas stream, and optionally additional gas streams introduced into the reaction vessel as co-feed or pre-mixed gas streams.
6. A process according to any one of claims 1 to 5, wherein at least part of the hydrogen rich gas stream and/or at least part of the oxygen rich gas stream in the feed is obtained from a water splitter.
7. A process according to any one of claims 1 to 6, wherein one or more gas streams selected from a gas stream comprising carbon dioxide, a hydrogen rich gas stream and an oxygen rich gas stream, are preheated before being introduced into the reaction vessel.