CLAIMS

1. A process for producing one or more reaction products, the process comprising:

(i) providing ammonia and carbon dioxide to a reactor comprising a transition metal catalyst; and

(ii) reacting the ammonia and carbon dioxide in the presence of the transition metal catalyst to form one or more reaction products selected from the group consisting of carbon monoxide, one or more C_{1-3} hydrocarbons, and hydrogen,

wherein step (ii) is conducted in a single reactor.

2. The process according to Claim 1, wherein one or both of the following apply:

(a) the transition metal catalyst comprises a transition metal from one or more of Groups 8 to 11 of the periodic table; and

(b) the transition metal catalyst comprises one or more transition metals selected from the group consisting of Co, Fe, Cu, Ni, Ru and Pt,

optionally wherein the transition metal catalyst comprises Co.

3. The process according to any one of the preceding claims, wherein the transition metal catalyst is in the form of a solid metal catalyst.

4. The process according to any one of the preceding claims, wherein the transition metal catalyst is in the form of a solid metal catalyst provided on a solid support, optionally wherein the solid support comprises one or more of the group consisting of silica, alumina, carbon, ceria, zirconia, gallium oxide, indium oxide, and magnesium oxide,

optionally wherein the solid support comprises silica.

5. The process according to any one of the preceding claims, wherein the transition metal catalyst is obtainable by a process comprising:

(a) co-precipitation of a transition metal salt and a solid support precursor; and

(b) calcining or reducing the resulting product,

optionally wherein the solid support comprises silica and the solid support precursor comprises tetraethylorthosilicate.

6. The process according to Claim 4, or according to Claim 5 as dependent on Claim 4, wherein the transition metal catalyst comprises from 1 wt. % to 70 wt. % transition metal.

7. The process according to any one of the preceding claims, wherein the molar ratio of ammonia:carbon dioxide is from about 0.67:1 to about 10:1, optionally from about 1:1 to about 4:1.

8. The process according to any one of the preceding claims, wherein step (ii) is conducted at a temperature of from about 250°C to about 1000°C, optionally from about 300°C to about 700°C, more optionally from about 400°C to about 650°C, such as about 500°C to about 600°C, optionally wherein step (ii) is conducted at pressure of from atmospheric pressure to about 3,000 kPa,
optionally from about atmospheric pressure to about 500 kPa.

9. The process according to any one of the preceding claims, the process further comprising:

(iii) cooling the output products from step (ii) in a gas-liquid separator to provide a gaseous stream comprising one or more of carbon monoxide, one or more C_{1-3} hydrocarbons, and hydrogen,

and optionally subjecting the gaseous stream to a separation process to remove at least a portion of any gaseous nitrogen present in the gaseous stream, optionally wherein one or both of the following apply:

(a) step (iii) is conducted at a temperature of from about 1°C to about 40°C, optionally from about 10°C to about 30°C, such as about 25°C; and
(b) wherein step (iii) also provides a liquid stream comprising one or more of ammonium carbonate, ammonium bicarbonate and ammonium carbamate, and where the process further comprises:

(iv) passing the liquid stream comprising one or more of ammonium carbonate, ammonium bicarbonate and ammonium carbamate through an evaporator to regenerate ammonia and carbon dioxide, optionally wherein step (iv) is conducted at a temperature of from about 40°C to about 80°C, such as about 60°C.

10. The process according to any one of the preceding claims, wherein one or both of the following apply:

(a) step (ii) is conducted in an atmosphere comprising less than 1 vol. % O_2, optionally less than 0.1 vol. % O_2, more optionally less than 0.01 vol. % O_2; and

(b) step (ii) is conducted in a reactor that is heated by a source selected from a fuel (e.g. natural gas or ammonia), electrical heating or waste heat.

11. The process according to any one of the preceding claims, comprising one or both of the following precursor steps:

(A) obtaining a gaseous stream comprising carbon dioxide from a carbon capture process or from a stock of liquid carbon dioxide; and

(B) obtaining a gaseous stream comprising ammonia from a stock of liquid ammonia.

12. The process according to any one of the preceding claims, wherein the one or more C_{1-3} hydrocarbons comprises one or more of the group consisting of methane, ethane, ethene, and propane,

optionally wherein the one or more C_{1-3} hydrocarbons comprises methane.

13. The process according to any one of the preceding claims, wherein:

the one or more C_{1-3} hydrocarbons comprises methane;

the transition metal catalyst comprises one or more transition metals selected from the group consisting of Co, Fe, Cu, Ni, Ru and Pt in the form of a solid metal catalyst provided on a solid support; and

step (ii) is conducted at a temperature of from about 300°C to about 700°C, optionally wherein the process further comprising:

(iii) cooling the output products from step (ii) in a gas-liquid separator to provide a gaseous stream comprising one or more of carbon monoxide, one or more C_{1-3} hydrocarbons, and hydrogen, and a liquid stream comprising one or more of ammonium carbonate, ammonium bicarbonate and ammonium carbamate; and

(iv) passing the liquid stream comprising one or more of ammonium carbonate, ammonium bicarbonate and ammonium carbamate through an evaporator to regenerate ammonia and carbon dioxide,

optionally wherein step (iii) comprises subjecting the gaseous stream to a separation process to remove at least a portion of any gaseous nitrogen present in the gaseous stream.

14. The process according to any one of the preceding claims, wherein the transition metal catalyst comprises from 0.1 wt. % to 20 wt. % of an alkali metal,

optionally wherein the alkali metal is selected from one or more of the group consisting of lithium, sodium, potassium and rubidium,

more optionally wherein the alkali metal is selected from one or more of the group consisting of sodium and potassium.

15. An apparatus for conducting the process according to any one of Claims 1 to 14, wherein the apparatus comprises:

(a) a carbon dioxide storage tank for storing carbon dioxide in liquid form;

(b) an ammonia storage tank for storing ammonia in liquid form;

(c) a packed bed catalytic reactor comprising a transition metal catalyst in the form of a solid metal provided on a solid support, said packed bed catalytic reactor being suitable for converting carbon dioxide and ammonia into one or more of carbon monoxide and methane;

(d) a thermal energy source for heating the packed bed catalytic reactor;

(e) a gas-liquid separator; and

(f) an evaporator.