CLAIMS

1. A process for increasing production of carbon monoxide (CO) and recycling carbon dioxide when treating synthesis gas comprising the steps of:

passing a first synthesis gas stream comprising hydrogen, carbon monoxide and carbon dioxide through a first separation zone, thereby separating said first synthesis gas stream into a second stream comprising hydrogen and carbon monoxide, and a third stream comprising carbon dioxide;

feeding said third stream to a carbon dioxide-to-carbon monoxide conversion unit, producing a fourth stream comprising carbon monoxide, and a fifth stream comprising oxygen;

mixing said second stream and the fourth stream producing a syngas product stream; and

feeding the syngas product stream into a product synthesis unit.

2. A process for increasing production of carbon monoxide (CO) and recycling carbon dioxide when treating synthesis gas comprising the steps of:

passing a first synthesis gas stream, said first synthesis gas stream comprising hydrogen, carbon monoxide and carbon dioxide through a first separation zone, thereby separating said first synthesis gas stream into a second stream comprising hydrogen and carbon monoxide, and a third stream comprising carbon dioxide;

combining said third stream with a hydrogen stream generating a fourth stream comprising carbon dioxide and hydrogen;

feeding said fourth stream into a carbon dioxide-to-carbon monoxide conversion unit consisting of a Reverse Water Gas Shift (RWGS) reactor to produce a fifth stream comprising carbon monoxide, hydrogen and unreacted carbon dioxide;

passing said fifth stream to a second separation zone for removing the unreacted carbon dioxide and producing a CO_2 depleted syngas stream, wherein the unreacted carbon dioxide is recycled back into the third stream for combining with the hydrogen stream and feeding into the RWGS reactor;

combining the H_2 and CO from the second stream and H_2 and CO from the CO_2 depleted syngas stream producing a syngas product stream; and

feeding the syngas product stream into a product synthesis unit.

3. The process of claim 2, where the second separation zone is combined with the first separation zone, wherein the fifth stream RWGS reactor product is recycled back into the first separation zone, recovering in-situ the CO_2 from the fifth and first streams and producing the third stream comprising carbon dioxide from both streams.

4. The process of claim 3, wherein the H_2 and CO from the fifth stream is combined within the first separation zone with the H_2 and CO from the first stream, producing the second stream comprising hydrogen and carbon monoxide producing the syngas product stream which is fed into the product synthesis unit.

5. The process of any one of claims 2-4, further comprising mixing the syngas product stream with additional hydrogen for adjusting the stochiometric ratio requirement of the product synthesis unit.

6. The process of any one of claims 2-5, where said first and second separation zone comprises a CO_2 selective solvent, a CO_2 adsorption step and a solvent regeneration step to produce the desired carbon dioxide streams; preferably wherein the CO_2 selective solvent is methanol, ethanol, N-Methyl-2-pyrrolidone (NMP), amine, propylene carbonate, dimethyl ether of polyethylene glycol (DMPEG), methyl isopropyl ether of polyethylene glycol (MPEG), tributyl phosphate, or sulfolane.

7. The process of any one of claims 2-6, wherein all or a portion of said hydrogen stream is used as a stripping gas to extract CO_2 from the CO_2 selective solvent in the first separation zone including hydrogen in the third stream, comprising carbon dioxide, and reducing the amount of said hydrogen to generate the fourth stream.

8. The process of any one of claims 2-7, wherein all or a portion of said hydrogen stream is used as a stripping gas to extract CO_2 from the CO_2 selective solvent in the second separation zone thus generating unreacted carbon dioxide RWGS stream and additional hydrogen.

9. The process of any one of claims 2-8, wherein an effluent comprising water is produced from the RWGS reactor; preferably wherein the RWGS reactor effluent is cooled to condense and separate the water generated by the RWGS reaction.

10. The process of any one of claims 2-9, wherein the RWGS reactor is a heated catalytic multitube reactor design, an autothermal catalytic reactor, a fixed bed adiabatic catalytic reactor, or a combination thereof; preferably wherein the RWGS reactor comprises a nickel catalyst or an iron based catalyst; more preferably wherein the RWGS reactor is a high temperature autothermal POX type reactor, with no catalyst.

11. The process of any one of claims 1-10, where said first synthesis gas stream is produced from partial oxidation, gasification and/or reforming of a carbonaceous feedstocks; preferably wherein the carbonaceous material comprises a plastic, a metal, an inorganic salt, an organic compound, industrial wastes, recycling facilities rejects, automobile fluff, municipal solid waste, ICI waste, C&D waste, refuse derived fuel (RDF), solid recovered fuel, sewage sludge, used electrical transmission pole, railroad ties, wood, tire, synthetic textile, carpet, synthetic rubber, materials of fossil fuel origin, expended polystyrene, poly-film floc, construction wood material, or any combination thereof.

12. The process of any one of claims 2-11, where the source of hydrogen is from a renewable source and/or a source of low carbon intensity; more preferably the source of hydrogen is from a water electrolysis with renewable power or low carbon intensity power, a biogas reforming, a steam reforming, a low carbon intensity (CI) hydrogen source, or a low carbon intensity waste H_2 source.

13. The process of any one of claims 1-12, further comprising admixing to the third stream an external input of CO_2 or CO_2 input obtained from a process effluent, increasing the CO_2 flow rate upstream of the CO_2 to CO conversion unit thereby, increasing the flow rate of CO in the syngas product stream; or further comprising admixing to the third stream a reformed low carbon intensity (CI) carbon rich stream , increasing the carbon content upstream of the CO_2 to CO conversion unit thereby, increasing the flow rate of CO in the syngas product stream.

14. The process of claim 13, where the carbon rich stream is a waste gas or liquid from the product synthesis unit; or the carbon rich stream is a gas or liquid from an external source.

15. A process for increasing production of carbon monoxide (CO) and recycling carbon dioxide when treating synthesis gas comprising the steps of:

a. gasifying a carbonaceous material in a fluidized bed, producing a classified crude syngas;

b. reforming said classified crude syngas at a temperature above mineral melting point, producing reformed synthesis gas comprising hydrogen, carbon monoxide and carbon dioxide;

c. passing said reformed synthesis gas through a first separation zone, thereby separating said first synthesis gas stream into a second stream comprising hydrogen and carbon monoxide, and a third stream comprising carbon dioxide; and

d. recycling said third stream comprising carbon dioxide to said fluidized bed gasifier, with or without steam and/or O_2 to reduce said reformed synthesis gas H_2/CO ratio, and increasing the total CO yield and production.