CLAIMS

1. A system for thermochemical recycling of plastic materials, the system comprising

a first vessel (reactor) configured and operable for receiving a metal-rich plastic waste and thermally treating the metal-rich plastic waste in the presence of water to produce hydrogen gas, a heated decomposed plastic mass and gaseous materials;

a second vessel (reactor) configured and operable for receiving a plastic waste and at least an amount of said hydrogen gas, and optionally the heated decomposed plastic mass and gaseous materials from the first vessel; and thermally decomposing the plastic waste in the presence of the hydrogen gas, and optionally the heated decomposed plastic mass and gaseous materials, to produce distillates; and

means to direct the hydrogen gas, and optionally the heated decomposed plastic mass and gaseous materials from the first vessel to the second vessel, wherein the system does not comprise or involve external addition of hydrogen gas, all hydrogen gas utilized in the second vessel being generated in situ in the first vessel.

2. The system according to claim 1, wherein the first vessel (reactor) is provided as two or more reactors, each configured to receive a different component of the metal-rich plastic waste.

3. The system according to claim 2, wherein one of the two or more reactors is configured to receive and thermally convert plastic waste to a molten plastic and gaseous products; and another of the two or more reactors is configured to receive metal waste and water and configured to generate hydrogen gas.

4. The system according to claim 1, the system being associated with a metal-rich plastic waste stream configured to deliver a metal-rich plastic waste feedstock into the first vessel and with a plastic waste stream configured to deliver a plastic waste feedstock into the second vessel.

5. The system according to any one of the preceding claims, being configured for a continuous thermochemical conversion of a plastic waste into distillates.

6. The system according to any one of the preceding claims, further equipped with a heat transfer unit and a downstream system for fractional separation of vapors.

7. The system according to any one of the preceding claims, wherein the plastic to metal loading ratio (plastic:metal) is between 3:1 and 15:1.

8. The system according to any one of the preceding claims, wherein the metal in metal-rich plastic waste is aluminum.

9. The system according to any one of the preceding claims, comprising

-a heat exchange unit configured to receive heat from the first vessel and transfer the heat to the second vessel in order to recover within the process heat produced in the thermal treating stage.

10. The system according to any one of the preceding claims, wherein the metal-rich plastic waste comprises a zero valent form of a metal capable of reacting with water to evolve metal hydroxides or metal oxides as well as hydrogen gas, and wherein the plastic waste received in the second vessel comprises no more than 10wt% of zero-valent metal.

11. A process for thermochemical recycling of plastic materials, the process comprising

-thermally reacting a metal-rich plastic waste stream and water to produce hydrogen gas, steam, a heated molten plastic mass and gaseous products; and

-thermal decomposition of a plastic waste free of metals in the presence of an amount of the hydrogen gas and optionally the steam, heated molten plastic mass and gaseous products;

wherein said thermally reacting and thermal decomposition are carried out in separate vessels within a thermochemical system, to thereby generate fuels and petrochemicals, and wherein the process does not comprise or involve external addition of hydrogen gas, all hydrogen gas utilized being generated in situ in said thermally reacting.

12. The process according to claim 11, wherein the hydrogen gas production is achievable separately from the generation of molten plastic mass and gaseous products.

13. A process for thermochemical recycling of plastic materials, the process comprising:

-thermally reacting a metal-rich plastic waste and water to generate a metal-poor or metal-free molten plastic mass, gaseous products and hydrogen gas;

-transferring at least a portion of the hydrogen gas and optionally of the metal-poor or metal-free plastic mass and gaseous products to a thermochemical decomposition reactor containing metal-free plastic waste; and

-reacting the metal-free plastic waste at least in the presence of the hydrogen gas to produce fuels and petrochemicals, and wherein the process does not comprise or involve external addition of hydrogen gas, all hydrogen gas utilized being generated in situ in said thermally reacting.

14. The process according to any one of claims 11 to 13, wherein the water is sewage waters, tap water, sea water, or salt-rich water, and wherein a weight ratio of metal:water is between 1:1 and 1:10.

15. The process according to any one of claims 11 to 14, wherein hydrogen gas is generated at a temperature between 270 and 450 °C, and optionally under a pressure between 60 and 200 atm, and wherein generation of the fuels and petrochemicals is at a temperature between 200 and 400 °C and a pressure between 10 and 70 atm.