It is a further object of the present disclosure to re-use the energy obtained in the method for the method to be self-sufficient in terms of energy, for the method only to use a limited amount of extracted petroleum products thereby reducing potential human-produced CO_2 emissions.

These objects are achieved according to the aspects, embodiments and examples of the present disclosure as described herein.

The disclosure provides a method for producing fuel and additional hydrocarbons from waste plastic, comprising the steps of

- providing at least one plastic material;
- exposing said at least one plastic material to a primary cracking to obtain a first hydrocarbon fluid; said first hydrocarbon fluid being a gas;
- exposing said first hydrocarbon gas to a catalytic hydrogenation to obtain a second hydrocarbon fluid;
- fractional separation of said second hydrocarbon fluid to obtain at least one final product.

In one aspect of the disclosure, a method for producing fuel and additional hydrocarbons from waste plastic is provided, comprising the steps of

- providing at least one plastic material;
- exposing said at least one plastic material to anaerobic thermal cracking to obtain a first hydrocarbon fluid; said first hydrocarbon fluid being a gas;
- exposing said first hydrocarbon gas to a catalytic hydrogenation and condensation to obtain a multi-phase hydrocarbon fluid;
- separation of said multi-phase hydrocarbon fluid to obtain a second hydrocarbon fluid, wherein said second hydrocarbon fluid is a first hydrocarbon liquid obtained from said multi-phase hydrocarbon fluid during separation; and
- fractional separation of said second hydrocarbon fluid to obtain three final products, these products being a light fraction; a medium fraction and a heavy fraction, wherein said medium fraction is present in an amount of 55 to 80 wt% of the total end product~~at least one final product~~.

- a primary cracking reactor capable of receiving at least one plastic material and producing a first hydrocarbon fluid from said at least one plastic material by a primary cracking, said first hydrocarbon fluid being a gas;
- a catalytic hydrogenation reactor capable of receiving said first hydrocarbon fluid and producing a second hydrocarbon fluid by catalytic hydrogenation,
- and a fractional separator capable of fractional separation of said second hydrocarbon fluid to obtain at least one final product,

where said primary cracking reactor is in fluid connection with said catalytic hydrogenation reactor and said catalytic hydrogenation reactor is in fluid connection with said fractional separator.

In a further aspect according to the disclosure, a waste recycling system for recycling waste plastic into fluid hydrocarbon compounds is provided, comprising

- an anaerobic thermal cracking reactor capable of receiving at least one plastic material and producing a first hydrocarbon fluid from said at least one plastic material by an anaerobic thermal cracking, said first hydrocarbon fluid being a gas;
- a catalytic hydrogenation reactor capable of receiving said first hydrocarbon fluid and producing a second hydrocarbon fluid by catalytic hydrogenation,
- and a fractional separator capable of fractional separation of said second hydrocarbon fluid to obtain three final products, these products being a light fraction; a medium fraction and a heavy fraction~~at least one final product~~,

where said anaerobic thermal cracking reactor is in fluid connection with said catalytic hydrogenation reactor and said catalytic hydrogenation reactor is in fluid connection with said fractional separator;

wherein said system further comprises

- a condenser for producing said second hydrocarbon fluid together with said catalytic hydrogenation reactor and resulting in said second hydrocarbon fluid being a multi-phase hydrocarbon fluid, wherein said catalytic hydrogenation reactor is further fluidly connected with said fractional separator through said condenser; and

Claims

1. A method for producing fuel and additional hydrocarbons from waste plastic comprising the steps of

- providing at least one plastic material;
- exposing said at least one plastic material to anaerobic thermal cracking to obtain a first hydrocarbon fluid; said first hydrocarbon fluid being a gas;
- exposing said first hydrocarbon gas to a catalytic hydrogenation and condensation to obtain a multi-phase hydrocarbon fluid;
- separation of said multi-phase hydrocarbon fluid to obtain a second hydrocarbon fluid, wherein said second hydrocarbon fluid is a first hydrocarbon liquid obtained from said multi-phase hydrocarbon fluid during separation; and
- fractional separation of said second hydrocarbon fluid to obtain three final products, these products being a light fraction; a medium fraction and a heavy fraction, wherein said medium fraction is present in an amount of 55 to 80 wt% of the total end product~~at least one final product~~.

2. The method according to any of the preceding claims further comprising a step of pre-hydrogenation catalytic cracking performed prior to the step of catalytic hydrogenation, and wherein said first hydrocarbon fluid is obtained at least via said steps of anaerobic thermal cracking and pre-hydrogenation catalytic cracking.

3. The method according to any of the preceding claims further comprising a step of post-hydrogenation catalytic cracking performed after the step of catalytic hydrogenation and wherein said second hydrocarbon fluid is obtained at least via said steps of catalytic hydrogenation and post-hydrogenation catalytic cracking.

4. The method according to claim 1 wherein said separation further results in the formation of a first non-condensable hydrocarbon gas and wherein at least a part of said first non-condensable hydrocarbon gas is recirculated to and burnt in a gas burner to provide heat to said anaerobic thermal cracking.

~~5. The method according to any of the preceding claims, wherein three final products are obtained from said fractional separation step, these products being a light fraction such as mainly C6 to C10; a medium fraction such as mainly C11 to C20 and a heavy fraction such as mainly C21 and above.~~

~~6~~5. The method according to any of the preceding claims, wherein said catalytic hydrogenation is performed at operating temperatures between 150-280°C, preferably between 190-230°C, such as around 200°C.

~~7~~6. The method according to any of the preceding claims, wherein said catalytic hydrogenation is performed at a pressure range of 0.1 to 10 bar, preferably a range of 0.5 to 5 bar, like in the range of 0.7 to 2 bar, such as in the range of 0.9 to 1.1 bar, preferably around 1 bar.

~~8~~7. The method according to any one of the claims ~~5-7~~1-6, wherein said heavy fraction is recycled to the step of anaerobic thermal cracking, pre-hydrogenation catalytic cracking, post-hydrogenation catalytic cracking and/or catalytic hydrogenation or to said holding tank.

~~9~~8. The method according to claim ~~8~~7, wherein said heavy fraction is exposed to a step of heavy fraction cracking before being recycled to the step of anaerobic thermal cracking, pre-hydrogenation catalytic cracking, post-hydrogenation catalytic cracking and/or catalytic hydrogenation or to said holding tank.

~~10~~9. A waste recycling system for recycling waste plastic into fluid hydrocarbon compounds comprising

- an anaerobic thermal cracking reactor capable of receiving at least one plastic material and producing a first hydrocarbon fluid from said at least one plastic material by an anaerobic thermal cracking, said first hydrocarbon fluid being a gas;
- a catalytic hydrogenation reactor capable of receiving said first hydrocarbon fluid and producing a second hydrocarbon fluid by catalytic hydrogenation,
- and a fractional separator capable of fractional separation of said second hydrocarbon fluid to obtain three final products, these products being a

light fraction; a medium fraction and a heavy fraction~~at least one final product~~,

where said anaerobic thermal cracking reactor is in fluid connection with said catalytic hydrogenation reactor and said catalytic hydrogenation reactor is in fluid connection with said fractional separator; wherein said system further comprises

- a condenser for producing said second hydrocarbon fluid together with said catalytic hydrogenation reactor and resulting in said second hydrocarbon fluid being a multi-phase hydrocarbon fluid, wherein said catalytic hydrogenation reactor is further fluidly connected with said fractional separator through said condenser; and
- a post-condensation separator for separating said multi-phase hydrocarbon fluid to provide a first hydrocarbon liquid and a first non-condensable hydrocarbon gas, and wherein said condenser is further fluidly connected with said fractional separator through said post-condensation separator.

~~11~~10. The system according to claim ~~10~~9, wherein said system further comprises a pre-hydrogenation catalytic cracking reactor, wherein said anaerobic thermal cracking reactor is further fluidly connected with said catalytic hydrogenation reactor through said pre-hydrogenation catalytic cracking reactor.

~~12~~11. The system according to any of the claims ~~10-11~~9-10, wherein said system further comprises a post-hydrogenation catalytic cracking reactor, wherein said catalytic hydrogenation reactor is further fluidly connected with said fractional separator through said post-hydrogenation catalytic cracking reactor.

~~13~~12. The system according to any one of the claims ~~10-12~~9-11, wherein said system further comprises a gas burner for providing heat to said anaerobic thermal cracking reactor, said gas burner is fluidly connected with said post-condensation separator.

~~14~~13. The system according to any one of the claims ~~10-13~~9-12, wherein the system further comprises a heavy fraction cracking reactor, said heavy fraction cracking reactor being in fluidly connection with said fractional separator for receiving a heavy fraction obtained from the fractional separation process and

wherein said heavy fraction cracking reactor is further fluidly connected with said anaerobic thermal cracking reactor, said pre-hydrogenation catalytic cracking reactor, said post-hydrogenation catalytic cracking reactor and/or said catalytic hydrogenation reactor.

~~15~~14. Use of a system as described in any of the claims ~~10 14~~9-13 or a method as described in any of the claims 1-~~9~~ 8 for producing fuel and additional hydrocarbons from waste plastic.

~~16~~15. Use according to claim ~~15~~14, wherein said fuel is Diesel.