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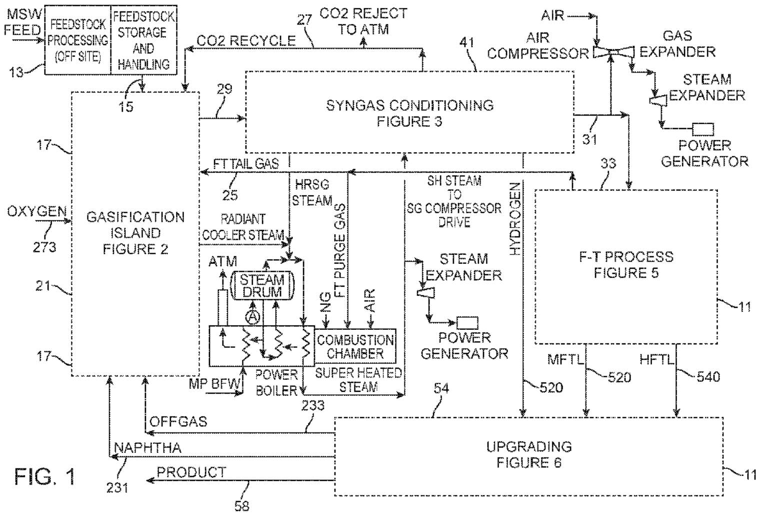

FIG. 1

(57) Abstract: Fuel and fuel additives can be produced by processes that provide Fischer-Tropsch liquids having high biogenic carbon concentrations of up to about 100% biogenic carbon. The fuels and fuel additive have essentially the same high biogenic concentration as the Fischer-Tropsch liquids which, in turn, contain the same concentration of biogenic carbon as the feedstock.

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FUELS AND FUEL ADDITIVES THAT HAVE HIGH BIOGENIC CONTENT DERIVED FROM RENEWABLE ORGANIC FEEDSTOCK

TECHNICAL FIELD

The subject matter relates generally to fuels and fuel additives that have high biogenic content and are derived from renewable organic feedstock.

BACKGROUND

[0001[With numerous detrimental effects of greenhouse gases having been increasingly documented, there is a clear need to reduce energy production from fossil fuels, particularly from petroleum and coal-derived fuel sources. To encourage the reduction of fossil fuel usage, governments are promoting the usage of fuels derived from renewable organic sources rather than fossil-based sources.

[0002[In the United States, the Environmental Protection Agency (EPA) has mandated a Renewable Fuel Standard ("RFS") under which cellulosic-based fuels generate Cellulosic RINs (renewable identification numbers). The RIN's are a form of compliance credits for Obligated Parties (e.g., refineries). According to the RFS, the Obligated Parties are required to blend an increasing amount of cellulosic fuel into fossil-derived fuels.

[0003[To determine the biogenic percentage content of fuels, the EPA requires tests that use radiocarbon dating methods. More particularly, the current USEPA regulations, at Section 8.1426(f)(9), require parties to use Method B or Method C of ASTM D 6866 to perform radiocarbon dating to determine the renewable fraction of the fuel.

[0004[One known method for recovering energy from Renewable organic material is gasification. This involves converting at least a fraction of the renewable organic material into a synthesis gas ("syngas') composed mainly of carbon monoxide, carbon dioxide, and hydrogen. In the nineteenth century, coal and peat were often gasified into "town gas" that provided a flammable mix of carbon monoxide (CO), methane (CH_4) and hydrogen (H_2) that was used for cooking, heating and lighting. During World Wars I and II, biomass and coal gasifiers were used to produce CO and H_2 to meet transportation needs. Also during the period of World War II, it was known that some syngas could be converted into liquid transportation fuels using the Fisher-Tropsch (F-T) process.

SUMMARY OF THE INVENTION

[0005[The present disclosure, most generally, relates to fuel and fuel additives that have high biogenic content derived from renewable organic feedstock such as, but not limited to MSW, woody biomass, corn, sugarcane, grass, plants and seed oil. Generally speaking, the feedstocks contain relatively high concentrations of biogenic carbon (i.e., carbon derived from plants) and relatively low concentrations of non-biogenic carbon (i.e., carbon derived from fossil sources).

[0006[More particularly, the present disclosure teaches that fuel and fuel additives can be produced by processes that provide Fischer-Tropsch liquids having high biogenic concentration and that provide the respective upgraded fuel products. In practice, the relatively high concentration of biogenic carbon is up to about 100% biogenic carbon. The fuels and fuel additive have essentially the same high biogenic concentration as the Fischer-Tropsch liquids which, in turn, contain the same concentration of biogenic carbon as the feedstock.

[0007[Various additional embodiments, including additions and modifications to the above embodiment, are described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008[The accompanying drawings illustrate one or more exemplary embodiments and, together with the detailed description, serve to explain the principles and exemplary implementations of the present inventions. One of skill in the art will understand that the drawings are provided for purposes of example only.

In the Drawings:

[0009[FIG. **1** shows one embodiment of an overall system for producing fuels and fuel additives that have high biogenic content and that are derived from Fischer-Tropsch liquids that contains a relatively high concentration of biogenic carbons and a relatively low concentration of non-biogenic carbons;

[0010[FIG. 2 shows an example of one embodiment of a gasification island;

[0011[FIG. 3 shows an example of one embodiment of a syngas conditioning system;

[0012[FIG. 4A shows an example of one embodiment of a CO2/H2S removal system;

[0013[FIG. 4B shows an example of another embodiment of a CO2/H2S removal system;

[0014[FIG. 5 shows an example of one embodiment of a system for generating Fischer-Tropsch liquids;

[0015[FIG. 6 shows an example of one embodiment of a system for producing refined Fischer-Tropsch liquids from the system of FIG. 5.

DETAILED DESCRIPTION

[0016[Various exemplary embodiments of the present inventions are described herein in the context of converting feedstock high biogenic content into fuels and fuel additives that have high biogenic content.

[0017[Those of ordinary skill in the art will understand that the following detailed description is illustrative only and is not intended to be limiting. Other embodiments will readily suggest themselves to such skilled persons having the benefit of this disclosure, in light of what is known in the relevant arts.

[0018[In the interest of clarity, not all of the routine features of the exemplary implementations are shown and described. It will be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions must be made in order to achieve the specific goals of the developer.

[0019[Throughout the present disclosure, relevant terms are to be understood consistently with their typical meanings established in the relevant art. However, without limiting the scope of the present disclosure, further clarifications and descriptions are provided for relevant terms and concepts as set forth below:

[0020[The term municipal solid waste (MSW) means, for example, the solid waste that is obtained from the collection of commercial and household trash. In its raw form, MSW need not be entirely solid, as it may contain entrained or absorbed liquids, or liquids in containers or other enclosed spaces. One of skill in the art will understand that MSW will have a broad range of compositions, and that the source of MSW need not necessarily be from a municipality. For purposes of this disclosure, other organic waste materials and various biomass materials such as vegetative matter may be equivalent to MSW.

[0021[The term stream as used herein means any fluid or solid moving or en route, directly or indirectly, from one location to another. A stream is still a stream even if it is temporarily stationary for any length of time.

[0022[Reference to a portion of a stream or material refers to any portion of the stream or material, including the stream or material in its entirety. A portion of a stream or material may be mixed with other compositions of matter and the mixture will be considered to comprise the portion of the original stream or material.

[0023[The term in fluid communication with as used herein includes without limitation both direct and indirect fluid communication, such as, for example, through an intermediate process unit.

[0024[The term unit as used herein means part of a system, and may for example comprise a unit operation, a system or group of unit operations, a plant, and so forth.

[0025[The term syngas (synthesis gas) as used herein has the same meaning as the term is used by one of skill in the art. For example, syngas may comprise a combination of carbon monoxide, hydrogen, carbon dioxide and possibly other components such as, without limitation, water vapor, sulfur- or nitrogen-containing compounds, methane and other alkanes, hydrocarbons, acid gases, halogens and particulates.

[0026[The term separator as used herein refers to any process unit known in the art for performing a separation process and, depending upon context, can include distillation columns, membrane separation systems, ion exchange adsorption systems, thermal adsorption, pressure swing adsorption, molecular sieves, flash drums, absorption or adsorption columns, wet scrubbers, Venturi scrubbers, centrifuges, chromatographs, or crystallizers. For example, separators may separate vapors from liquids, liquids from liquids, vapors from liquids from solids, fluids or solids from solids, or fluids from solids.

[0027[The term heat exchanger as used herein includes without limitation any heat exchanger or heat exchange device known in the art, and more broadly, any device which raises the enthalpy or internal energy of a first composition of matter, decreases the enthalpy or internal energy of a second composition of matter, and transfers heat from the second composition of matter to the first composition of matter. Various heat exchange means are disclosed herein, all of which are encompassed within this term. The term also includes combinations or series of multiple heat exchange means. It includes, without limitation, shell and tube heat exchangers, air or “fin-fan” coolers, refrigeration units, chillers, cooling towers, steam generators, boilers, plate heat exchangers, adiabatic wheel heat exchangers, plate fin heat exchangers, fluid heat exchangers, waste heat recovery units of any kind, or phase change heat exchangers of any kind. They may operate in a countercurrent, parallel, crosscurrent configuration, or any other flow configuration, and may involve separation of two fluids or direct contact between two fluids, or the use of an intermediate fluid (such as water, hot oil, molten salt, etc.) to transfer heat from one fluid to another.

[0028[The term compressor as used herein includes anything that is understood as a compressor in the normal sense of that term. In general, however, the term includes any device that raises a fluid from a first pressure to a second, higher pressure, either adiabatically or non-adiabatically. It may include any kind of compressor or pump, including without limitation, centrifugal or axial, or positive displacement (such as reciprocating, diaphragm, or rotary gear). The term may also include one or more stages of a multi-stage compressor. The term compressor used in the singular may also refer to multiple compressors arranged in series and/or parallel.

[0029[In Fig.1, a bio-refinery, generally designated by the numeral 17, is fed with a stream 15 containing relatively high concentration of biogenic carbons and the relatively low concentration of non-biogenic carbons along with other non-carbonaceous materials. In the preferred practice, the relatively high concentration of biogenic carbons is up to about 80% biogenic carbons. Among other products, the bio-refinery produces high biogenic concentration Fischer-Tropsch liquids derived from the feedstock that contain a relatively high concentration of biogenic carbons.

[0030[In the illustrated embodiment, as one example, the feedstock is provided by a facility, generally designated by the numeral 13 which provides a renewable organic feedstock. The facility 13 can be, for instance, a MSW processing facility in which non-biogenic derived carbon materials and non-carbonaceous materials are separated from the feed stock to the bio-refinery. The objective is to produce a segregated feedstock that contains a relatively high concentration of biogenic carbons and a relatively low concentration of non-biogenic carbons along with other non-carbonaceous materials found in the MSW.

[0031[As an example, the Facility 13 may process inbound MSW and separate materials into the following categories:

- Feedstock Material, sorted from MSW stream to be used for conversion into fuel;

- Recoverable Material, including but not limited to ferrous and nonferrous metals, cardboard, plastics, paper, and other recyclable materials that can be sorted and shipped to the commodities markets; and
- Residual Material, which is the remainder of the material not recycled or used as feedstock, which can be sent to landfill.

[0032[Some wet materials such as food waste or agricultural products which are high in biogenic content could be dried and added back to the feed stream along with other materials. Further, by recovering plastics such as High Density Polyethylene (HDPE) and Polyethylene Terephthalate (PET) among others, the percentage of non-biogenic carbons in the feedstock is reduced because the percentage of fossil-based plastics is reduced. The biogenic percentage content of the feedstock can significantly affect the economic value of the cellulosic fuel additives.

[0033[It should be understood that the Facility **13** can be physically separate facility from the other portions of the system shown in Fig. 1. Also, it should be understood that the Facility **13** can be as described in co-pending United States patent application Serial No: 14/842,729.

[0034[As mentioned above, the bio-refinery **17** depicted in **Fig. 1** is for converting the stream **15** of processed feedstock into a streams **520 and 540** of Fischer-Tropsch liquids. Particularly noteworthy is that the high biogenic concentration Fischer-Tropsch liquids contain the same relatively high concentration of biogenic carbons as the input stream **15**. In other words, percentage-wise, no non-biogenic carbons are added to the Fischer-Tropsch liquids in the production system and, indeed, some may be eliminated.

[0035[In the illustrated embodiment, the bio-refinery **17** includes a gasification system, generally designated by the numeral **21** and sometimes referred to herein as the Gasification Island (GI), for converting feedstock derived from renewable organic feedstock into syngas and, furthermore, for processing that syngas through a hydrocarbon reformer (HR), as will described below, to generate a high biogenic content syngas. It should be noted that the gasification system **21** receives streams **231** and **233** that carry recycled hydrocarbon products and intermediate products, respectively, to the HR. Also, it should be noted that the GI **21** receives stream **27** that carries recycled CO2 to stage 1 and stage 2 in the GI **21**. As will be explained below, the recycled CO2 is used for moderating the water-gas-shift reaction within the steam reformer in the GI **21** and as a purge gas for instruments and instrument systems and the feeder systems.

[0036[Also, the GI **21** receives stream **273** of oxygen and stream **25** of F-T tail gas.

[0037[In the gasification island **21**, generally speaking, the biogenic carbons is converted into biogenic syngas by a combination of steam reforming, sub-stoichiometric carbon oxidation and hydrocarbon reformation while producing syngas, including CO, H2 and CO2. The syngas product is carried by stream **29** in the illustrated embodiment.

[0038[Gasification reactions occurring in the GI **21** will be further described below and, also, are described in co-pending United States patent application Serial No: 14/138,635, the disclosure of which has been incorporated herein by reference. It should be understood that the unit operations in the GI **21** can differ depending upon the feedstock.

[0039[The syngas stream **29** is processed in a syngas conditioning system **41**, as will be described in more detail below, to provide a syngas feed stream **31** to an F-T reactor system **33.** It should be noted that the syngas conditioning system **41** provides the CO2 recycle stream **27** for recycling CO2 back to the GI **21.**

[0040[The output from the F-T reactor system **33** comprises F-T fluids, including a Heavy Fischer Tropsch liquid (HFTL) stream **540** and a Medium Fischer Tropsch Liquid (MFTL) stream **520**, both of which are F-T hydrocarbons. Any unreacted syngas can be recycled in the F-T reactor **33** as will be described below. Further, the output of the F-T reactor system **33** includes the afore-mentioned stream **25** of F-T tail gas.

[0041[The bio-refinery includes a hydrogen recovery system to remove hydrogen that is needed for upgrading from the conditioned syngas. A portion of the conditioned syngas flows through a combination membrane/PSA unit to yield a high purity hydrogen stream for the upgrading unit. The recovered hydrogen (permeate) from the membrane is fed to a PSA unit and the retentate is combined with bypass syngas and fed forward to the FT reactor. The recovered hydrogen is fed to the PSA unit where a relatively pure hydrogen stream is produced (>99.5% H2) and the PSA reject stream is routed to the suction of the syngas compressor for recovery of the reject syngas.

[0042[The bio-refinery **17** in **Fig. 1** further includes an upgrading system **54** for receiving the F-T fluids from the F-T system **33.** That is, the Heavy Fischer Tropsch liquid (HFTL) stream **540** and the Medium Fischer Tropsch Liquid (MFTL) stream **520** are fed to the upgrading system **54.** The output liquid from the upgrading system **54** is carried by the stream **58** in the illustrated embodiment. In practice, the F-T liquids can include naphtha, diesel, Synthetic Paraffinic Kerosene (SPK), heavier alkanes along with iso-alkanes, oxygenates, and olefins or combinations of all these components.

[0043[The gasification island system **21**, as shown in detail in **Fig. 2**, implements a 3-stage gasification process. In the preferred embodiment, the 3-stage gasification process includes:

a. Stage 1 - steam reforming;

b. Stage 2 – sub-stoichiometric carbon oxidation process to gasify unreacted carbons from the steam reforming; and

c. Stage 3 - hydrocarbon reforming.

[0044[In the illustrated embodiment of the gasification island system **21** in **Fig. 2**, stage 1 gasification is provided in the steam reformer unit, generally designated by the numeral **251.** Unreacted carbons from the stage 1 gasification are converted into syngas in the sub-stoichiometric carbon oxidation unit, generally designated by the numeral **271**. Also in this system, hydrocarbon reforming is provided in the third stage of gasification by a hydrocarbon reforming unit generally designated by the numeral **215.**

[0045[In the illustrated embodiment, the stage 1 gasification unit 251 selectively receives the stream 15 of processed feedstock and produces a stream 254 of syngas. Gasification unit 271 receives unreacted carbon from gasification unit 251 and produces a stream 277 of syngas. Syngas steams 254 and 277 are combined to form syngas stream 219. And, the gasification unit 211 receives the stream 27 of recycled CO2. In the gasification unit 211, the recovered high biogenic CO2 in stream 27 can be used to assist in fluidizing the bed materials, moderating the water-gas-shift reaction and purging instruments in a steam reformer, in a sub-stoichiometric carbon oxidation unit and in the hydrocarbon reformer. Also, the recovered high biogenic CO2 in stream 27 can be added to stream 15 of processed feedstock.

[0046[The gasification unit 211 in the embodiment of Fig. 2 includes a steam reformer, generally designated by the numeral 251, and the sub-stoichiometric carbon oxidation unit 271. It is the steam reformer 251 that initially receives the stream 15 of processed feedstock. Also, it is the steam reformer 251 that initially receives the stream 273 of oxygen.

[0047[As shown, the steam reformer 251 preferably includes an indirect heat source 253. The output streams from the steam reformer 251 include a stream 254 of syngas and a stream 256 of solids. The syngas stream 254 is carried to the hydrocarbon reforming unit 215. The solids stream 256, primarily comprised of ash and fine char, is carried to the sub-stoichiometric carbon oxidation unit 271.

[0048[In the preferred embodiment, the steam reformer 211 is a fluidized bed design, utilizing superheated steam, CO2, and O2 as the bed-fluidizing medium. In another embodiment only steam and O2 are used as a bed-fluidizing medium. Preferably, externally-fired indirect heaters 253 maintain the reformer bed temperature and provide much of the energy to support the endothermic reactions required in the gasification process. The process gas stream can exit the steam reformer 211 through a series of cyclones. Preferably, an internal cyclone separates and returns the majority of any entrained bed media to the reformer fluidized bed while a second external cyclone collects unreacted char for further conversion to syngas in the sub-stoichiometric carbon oxidation unit 271. In practice, flue gas from the steam reformer's indirect heaters is used in a fire tube boiler to generate steam for plant use.

[0049[The illustrated hydrocarbon reformer unit 215 receives the syngas stream 219 and produces the afore-mentioned primary stream 29 of syngas containing CO, H2 and CO2 along with other trace constituents. Further, the hydrocarbon reformer unit 215 receives stream 273 of oxygen and stream 25 of F-T tail gas. Finally, the hydrocarbon reformer unit 215 receives stream 231 of naphtha and stream 233 of off gas.

[0050[The hydrocarbon reformer unit 215 operates to recover the biogenic carbons by thermally dissociating hydrocarbons at temperatures greater than 2200 degrees F. Heat for the hydrocarbon reformer is provided by sub-stoichiometric oxidation of carbon monoxide and, hydrogen and hydrocarbons which are all exothermic reactions.

[0051[The hydrocarbon reformer unit 215, in the embodiment of Fig. 2, includes a syngas cooling section 225. The syngas cooling section can comprise either a radiant slagging cooler design or a recycle syngas slagging quench design.

[0052[In preferred practice, the hydrocarbon reforming unit 215 is a refractory-lined vessel with oxygen gas burner/mixer which operates in the range of 1800°F to 3000°F to assure all hydrocarbon compounds in the gas stream, including tars are converted to syngas, sulfur compounds are converted to H2S, and the water gas shift reactions approach equilibrium. The FT Tail Gas purged from the FT reaction loop, the purification system off gas, and stream 231 of vaporized naphtha are converted back to CO and H2 .in the hydrocarbon reforming unit 215.

[0053[The sub-stoichiometric carbon oxidation unit 271, in addition to receiving the solids stream 256, receives the stream 27 of recycled CO2 stream and a stream 273 of oxygen. Heating in the carbon sub-stoichiometric oxidation unit 271 is provided by sub-stoichiometric oxidation of the unreacted carbons. A stream 275 of low pressure steam, is superheated in the carbon sub-stoichiometric oxidation unit and used as fluidization steam for both stage 1 and stage 2 gasification. The output of the carbon sub-stoichiometric oxidation unit 271 is syngas stream 277 which, in the illustrated embodiment, joins with the syngas stream 254 from steam reformer 251 to form syngas stream 219 which is fed to the hydrocarbon reformer unit 215.

[0054[In the preferred embodiment, the sub-stoichiometric carbon oxidation unit 271 utilizes a fluidized bed in which oxygen is added with the fluidization steam and CO2 to further convert the fine char to syngas. The gasses generated in and passing through the carbon sub-stoichiometric oxidation unit 271 pass through an external cyclone and re-enter the main syngas stream 219 which is fed to the hydrocarbon reformer unit 215. The ash removed in the cyclone is cooled and transported to the collection silo for offsite disposal. Heat exchangers, submerged in the fluid bed of the sub-stoichiometric carbon oxidation unit 271 remove some heat by superheating low-pressure steam to 1100°F for use in the fluidization bed steam reformer 251 and the fluidization bed of the sub-stoichiometric carbon oxidation unit 271.

[0055[In operation of the system of Fig. 2, within the fluidized bed of the Steam Reformer 251, externally fired heaters rapidly heat the circulating bed media and the feedstock entering the vessel. The feedstock almost immediately undergoes drying and pyrolysis creating gaseous and solid (char) products. The gaseous pyrolysis products undergo water-gas shift reactions and together with simultaneous steam reforming of the solid char material, produce a syngas primarily made up of H2, CO, CO2, and some hydrocarbons. Most remaining char then reacts with superheated steam and oxygen to produce syngas. Char that escapes the Steam Reformer is separated via a cyclone and dropped into the sub-stoichiometric carbon oxidation unit for additional gasification and conversion. The Steam Reformer and carbon sub-stoichiometric oxidation unit utilize internal and external cyclones to separate and retain bed media that becomes entrained in the process gas stream. From the Steam Reformer and carbon sub-stoichiometric oxidation unit the syngas flows to the hydrocarbon reformer Unit to convert any remaining char, hydrocarbons, and tars into syngas.

[0056[As mentioned above, the output of the hydrocarbon reformer unit 215 is the syngas stream 29 which is fed to the syngas conditioning system 41. The syngas conditioning system 41 will now be described in conjunction with Fig. 3.

[0057[As shown in FIG. 3, the exemplary syngas conditioning system, which has been generally designated by the numeral 41, receives the primary syngas stream 29 and conditions that stream to produce the gaseous feed stream 31 to F-T reactors. In the illustrated embodiment, the syngas conditioning system 41 includes, sequentially in fluid flow communication, a Syngas Heat Recovery Steam Generator (HRSG) unit 411 for waste heat recovery, a syngas scrubber unit 421, a syngas compressor 431, a primary guard bed 436, a water gas shift reactor 441, ammonia removal 446, secondary guard beds 451, and a CO2/H2S removal system 461. One output of the CO2/H2S removal system 461, in the illustrated embodiment, is a syngas feed stream 470. Another output of the CO2/H2S removal system 461 is the stream 27 of recycled CO2.

[0058[Steam is generated from several sources inside the process. A HRSG recovers steam from the flue gas generated in the indirect fired heater unit 253 in the steam reformer unit 251. Steam is also generated in the HRSG unit 411 that recovers heat from the syngas stream 29 leaving the gasification island and steam is generated in the power boiler. The steam from all three sources are combined and superheated to provide the medium pressure steam used as the motive fluid in either syngas compressor (unit 431) steam turbine or a steam turbine power generator (figure 1). The combined medium pressure steam can have a biogenic content equal to the feedstock depending on the quantity of natural gas used in firing the external heaters. In the preferred embodiment a portion of the generated syngas is fed to a gas turbine / steam turbine (combined cycle power plant) to generate a high biogenic content power that is used to supply the electrical demand of the plant. Another embodiment would be to use all the syngas generated steam to generate biogenic power and drive the syngas compressor unit 431 by means of a steam turbine drive.

[0059[The HRSG unit 411 functions to provide waste heat recovery. The output of the HRSG unit 411 is a stream 420 of the syngas and a stream of high pressure steam. In the preferred embodiment, a portion of the generated steam from the HSRG and other sources is used to drive a steam turbine that generates power which, in aggregate, is about 40% biogenic. . In other embodiments, the syngas generated steam would be used to generate biogenic thermal power or to use the generated syngas directly in a gas turbine generator to generate biogenic power. In these two embodiments, the biogenic content of the generated power would be the same as the biogenic content of the syngas and, thus, the same as the feedstock.

[0060[The syngas scrubber unit 421 is a conventional gas scrubbing device that receives the syngas stream 420 and a stream 424 of caustic or other suitable alkaline solution. The liquids removed from the scrubber unit 421 comprise sour water stream 426 which can be conveyed to a wastewater treatment system. The sour water may contain undesirable contaminants such as, for example, ash particles, acids, mercury, and acidic compounds such as hydrochloric acid (HCl) and hydrogen sulfide (H2S) that are removed from the syngas. Syngas scrubbing is further described in co-pending United States patent application Serial No: 14/138,635, the disclosure of which has been incorporated herein by reference. The scrubbed syngas is conveyed in stream 428.

[0061[The syngas scrubber unit 421 is provided to remove contaminants that can potentially damage downstream equipment and affect the F-T synthesis catalyst performance. Preferably, the syngas scrubber unit has three primary sections: a Venturi scrubber, a packed tower section, and a direct contact cooler section. If a syngas quench cooler is utilized then approximately half of the cleaned syngas leaving the syngas scrubber unit will be circulated back to the hydrocarbon reformer quench cooler via the quench blowers while the remaining half will be compressed in the syngas compressor 431 to meet the requirements of the F-T synthesis process. If a radiant slagging cooler is employed the recycle gas blower will not be required and the flow from into the scrubber will equal the flow leaving the gasification island 21.

[0062[In the illustrated embodiment, a syngas compressor stage 431 comprising one or more conventional compressor stages 433 arranged in series to raise the pressure of a compressor inlet stream comprising at least a portion of the syngas stream to a predefined level, thereby outputting a compressed syngas stream 434. In practice, the final pressure of the syngas stream may range between about 400 psig to about 600 psig to meet the process requirements of the F-T synthesis process. Preferably, the heat of compression is removed with intercoolers after all but the final stage each of compression; all condensed water can be collected and sent to the waste water treatment plant for recovery. The outlet of the compressor is sent hot to primary guard bed 436 where any COS and HCN is hydrolyzed to H2S and NH3 and then to the shift reactor 441.

[0063[In one embodiment, the syngas compressor drive is an extraction/condensing turbine that is driven by superheated high pressure steam with a portion of the steam extracted at low pressure for process requirements. Also, the F-T recycle compressor can be on the syngas compressor shaft and driven by the syngas compressor steam turbine drive. In another embodiment the syngas compressor is driven by an electric motor which is energized from the power generated in a combined cycle power plant using syngas as a fuel to produce high biogenic power.

[0064[The water gas shift reactor 441 receives a portion of the pressurized primary syngas stream 440. The water gas shift reactor 441 operates to shift some of the steam and CO into H2 and CO2, via the water gas shift reaction, until the required H2/CO ratio in the outlet stream 450 is met. Subsequently, a side stream 442 of the pressurized primary syngas may bypass the water gas shift reactor 441 and may be recombined with an outlet stream 450 from the water gas shift reactor 441. High pressure steam is generated in the water gas shift unit to remove the heat of the shift reaction. The generated steam is fed back into the syngas stream 440 feeding the reactor to provide the hydrogen source for the shift reaction. Any additional steam requirements come from the plant steam system.

[0065[In the embodiment of Fig. 3, the outlet stream 450 of syngas from the water gas shift reactor 441 is conveyed to a conventional ammonia removal unit 446. In the ammonia removal unit 446, the syngas is cooled until the excess water condenses out with scrubbed absorbed ammonia. Then, the syngas leaves the condenser 446 as stream 448. The sour water from the condenser 446 can be conveyed to a wastewater treatment system. The stream 448 is conveyed to the inlet of the second guard bed 451 where any volatilized Hg is removed.

[0066[The pressurized primary syngas from the second guard beds 451 is conveyed as a stream 460 to the CO2/H2S removal system 461. The CO2/H2S removal system 461 will be further described in conjunction with Figs. 4A and 4B. One output of the CO2/H2S removal system 461is a stream 464 of sulfur. Another output is a stream 470 of syngas from which sulfur has been removed. The third output is the CO2 recycle stream 27.

[0067[In the illustrated embodiment, the syngas feed stream 470 is conveyed to H2S and Arsine guard beds 471 and, then, to an H2 recovery unit 481.

[0068[Syngas from the H2S/Arsine guard beds flows into the hydrogen recovery unit 481. The hydrogen recovery unit 481 extracts a steam 482 of high purity H2 which is required for the Hydrocracking Upgrading process, as described below. The output of the H2 recovery unit 481 is the syngas feed stream 31 to the F-T reactor 33. A third output from the hydrogen recovery unit 481 is a stream 483 of rejected syngas. The stream 483 can be recycled to join the stream 428.

[0069[In the preferred embodiment, the hydrogen recovery unit (HRU) 481 extracts H2 using a combination membrane and pressure swing adsorption (“PSA”) system. The HRU membrane retentate gas is re-mixed with the bulk syngas stream and sent to the F-T Reactors. The HRU PSA purge gas is routed to the suction of the Syngas Compressor 431 and the purified H2 stream is sent to upgrading.

[0070[As illustrated in FIG. 5, a system for generating F-T liquids receives the syngas feed stream 31. The system includes one or more F-T reactors 533 and provides, as mentioned above, the fluids output stream 535 that comprises F-T liquids and F-T tail gas. The FT reactor output stream 535 is fed into a thermal separation system generally designated by the numeral 500 to separate the F-T liquid into its heavy F-T liquid (HFTL), medium FT liquid (MFTL), water and the F-T tailgas.

[0071[In the preferred embodiment as illustrated in FIG. 5, the thermal separation system 500 includes two condensers 501 and 531 and two separators 503 and 504. The HFTL separator 503 has outlets 518 and 520, respectively. In practice, the condenser 501 operates using a tempered hot water loop as cooling medium to condense and separate the HFTL liquid fraction from the F-T water and MFTL liquid fraction. Both the MFTL, Water and the FT Tailgas remain in a vapor phase. The HFTL stream is carried by the outlet 520 for storage in tank(s) 521 for further processing. In practice, the HFTL stream 520 is composed primarily of heavy hydrocarbon waxes which are solid at room temperature. These waxes are kept warm above 230°F to prevent solidification.

[0072[Also as illustrated in FIG. 5, the thermal separation system 500 includes a second condenser 531 that receives, via the stream 518 from the HFTL separator 503, the F-T water and MFTL. In practice, the second condenser 531 operates, using cooling water to condense and separate the F-T water and MFTL from unreacted syngas and non-condensable hydrocarbons (methane, etc.). The condensed F-T water and MFTL stream phase split in the second separator 504, with the MFTL stream being routed to storage unit 522, as via stream 540, and the F-T water to waste water treatment via stream 542.

[0073[As Fig. 5 further shows, the F-T tail gas can be recycled to the F-T reactors 533 via a stream 537. In the illustrated embodiment, the F-T tail gas is separated at the MFTL separator 504 and carried by stream 550 to a compressor 511 whose output is conveyed in the syngas recycle line 537. Prior to the recycle compressor 511 a purge stream 552 branches off of stream 550. The purge stream 552 is directed to both the hydrocarbon reformer 215 via stream 25 to control hydrocarbon content in the recycle syngas and to the power boiler to purge inerts from the recycle syngas.

[0074[FIG. 6 shows an example of one embodiment of the upgrading system 54 of Fig. 1. More particularly, Fig. 6 illustrates a system for producing refined F-T liquids from the system of FIG. 5. The system illustrated in FIG. 6 includes a hydrocracker reactor unit 643 which receives liquids from hydrocracking charge vessel 560 fed by tanks 521 and 522. In the preferred embodiment, the hydrocracker reactor unit 643 employs a high temperature, high pressure catalytic process that upgrades the HFTL and MFTL hydrocarbon streams into a transportation fuel (SPK or Diesel). Due to the low severity of the upgrading, the hydro-processing and hydrocracking occur in one reactor. The olefins and alcohols are first saturated and then the alkanes are cracked into the SPK range of products. The hydrocracking mechanism, which involves a protonated cyclopropane intermediate, forms an isomer product along with a straight chained product. In the hydrocracker reactor unit 643, the feed mixture passes through a series of catalyst beds for conversion into shorter chained hydrocarbons. However, another embodiment would pre-fractionate the MFTL and remove the light fraction overhead to the hydrocarbon reformer and send the heavy fraction along with the HFTL to the hydrocracker for upgrading. This embodiment removes most of the oxygenates from the stream flowing to the hydrocracker and lessens the hydro-treating load on the hydrocracker.

[0075[As further illustrated in FIG. 6, the hydrocracker reactor unit 643 provides the output stream 644 which is fed to a hydrocarbon thermal separation system generally designated by the numeral 701 wherein the crackate is cooled, condensed, and separated into two streams; heavy and light crackate, using a series of heat exchangers and separator vessels.

[0076[In the illustrated embodiment of the, hydrocarbon thermal separation system 701, the crackate is cooled in a feed/effluent heat exchanger 702 and the heavy crackate is separated from the light crackate in a heavy crackate separator 703. From the heavy crackate separator 703, the heavy crackate and light crackate is routed to a fractionator 853, as by streams 704 and 750. In addition, some of the heavy crackate can be recycled to the hydrocracker 643 to keep material flowing into the hydrocracker during startup and when the fractionation column is malfunctioning.

[0077[In the illustrated embodiment, a light crackate separator 705 is provided for separating the light crackate from generated water and hydrogen. The separated light crackate is routed to the fractionator 853 by stream 750. The water is sent, as by line 706, to the bio-refinery's waste water treatment plant for treatment. The separated hydrogen gas is routed to recycle as by stream 708. Fresh hydrogen is introduced into the system by stream 741.

[0078[The fractionation process will now be described in greater detail. As previously mentioned, the fractionator 853 receives a stream 704 of heavy crackate liquids and a stream 750 of light crackate liquids. The purpose of the fractionator 853 is to separate the SPK or Diesel cut from the heavy crackate fraction and the naphtha fraction. The side draw stream 856 is fed into a stripper column 857 to remove lights from the SPK/Diesel feed and provide final clean up and recovery of the SPK/Diesel products. In the fractionator 853, the incoming heavy and light crackate streams are combined and heated by natural gas fired heater for an initial separation in the fractionator column. Preferably, the fractionator 853 uses direct steam injection to strip the low boiling hydrocarbons from the high boiling hydrocarbons without utilizing a high temperature reboiler configuration.

[0079[The outputs from the fractionator 853 include overhead stream 231 that carries recyclable hydrocarbon products. Preferably, the overhead stream 823 which is provided into a condenser unit 860 where the stream is condensed and separated into three streams: main fractionator ("MF") water stream 862, and the afore-mentioned light phase (naphtha) stream 231 and off gas stream 233. In practice, a portion of the naphtha is refluxed back into the fractionator 53 and a portion is sent to a Naphtha Vaporizer for injection into the hydrocarbon reformer. The off gas stream 233 is recycled by the offgas Compressor to the hydrocarbon reformer for reprocessing. The bottoms from the fractionator column 853 are pumped to the hydrocracking charge vessel 524, as by stream 855, for additional hydrocracking. The water is sent to the bio-refinery's Waste Water Treatment plant for treatment.

[0080[Naphtha from the Fractionator OH Separator is pumped into the Naphtha Vaporizer where it is vaporized using low-pressure steam. The naphtha vapor then flow into the hydrocarbon reformer 215 of Fig. 2 for recovery. The fractionation column overhead pressure floats on the offgas Compressor discharge rate. The offgas Compressor provides motive force to move the Fractionator Overhead Separator offgas into the discharge of the Naphtha Vaporizer. The combined streams then flow into the hydrocarbon reformer.

[0081[The SPK product, withdrawn by the steam 856 from the upper part of the fractionator 853, is sent to the Product Stripper column 857 for final product separation. The heat to the product Stripper column 857 is provided, for example, by a natural gas fired Product Stripper

Reboiler. The Product Stripper overhead stream recycles back to the Fractionator 853. The bottoms stream 800 is cooled and sent, via the stream 58, to storage unit 803 as the SPK product.

[0082[As shown in FIG. 4A, one embodiment of an exemplary CO2/H2S removal system 461 includes a sulfur removal unit 463 that receives the stream 460. One output of the sulfur removal unit 463 is a stream 464 of sulfur. Another output of the removal unit 463 is a stream 466 of syngas from which sulfur has been removed.

[0083[The syngas stream 466 is fed to an amine solvent system, generally indicated by the numeral 491. In the illustrated embodiment, the amine solvent system 491A comprises an absorber unit 493 and a regenerator unit 495 connected in counter-current relationship. The output of the regenerator unit 493 is the aforementioned syngas feed stream 470. The output of the absorber unit 495 is the aforementioned stream 27 of recycled CO2.

[0084[In the preferred embodiment of Fig 4A, the absorber unit 493 is a column where CO2 is removed by contact with a circulating amine/water solution. In this embodiment the amine absorber can remove H2S from stream 466 in the event the sulfur removal unit under performs. The treated syngas is water washed to remove any entrained amine solution. In the preferred embodiment, the cleaned syngas leaving the solvent absorber 493 is heated using Medium Pressure (MP) saturated steam and routed, as stream 470, to the guard bed to removal trace H2S and arsenic catalyst poisons prior to introduction into the F-T synthesis process.

[0085[As shown in FIG. 4B, another exemplary CO2/H2S removal system 461 includes an amine unit where syngas stream 460 is fed to an amine solvent system, generally indicated by the numeral 491B. In the illustrated embodiment, the amine solvent system 491B comprises an absorber unit 493 and a regenerator unit 495 connected in counter-current relationship. The output of the regenerator unit 495 is fed to the sulfur removal unit 463. The output of the absorber unit 493 is the aforementioned syngas feed stream 470. In this embodiment, the absorber unit 493 is a column where CO2 and H2S is removed by contact with a circulating amine/water solution. The treated syngas is then water washed to remove any entrained amine solution and sent, as stream 470, to the final guard beds 471.

[0086[In embodiment of Fig. 4B, the regenerator overhead output stream 466 is fed to the sulfur removal unit 463 where the H2S is removed from the reject CO2 stream. One output of the sulfur removal unit 463 is the aforementioned stream 27 of recycled CO2 and a stream 464 of sulfur. A portion of the overhead CO2 reject stream from the Sulfur Removal unit is compressed and recycled back the gasification island and the excess is vented to the atmosphere.

[0087[In operation of CO2/H2S removal system in Figs. 4A and 4B, “rich” amine (i.e., amine after absorption of CO2) from the absorber column passes through a lean/rich exchanger and then flashes into the Rich Solvent Flash Drum. The flashed gas, rich in CO and H2, flows to the suction of the syngas compressor for reuse in the process. The flashed rich liquid stream flows to the Solvent Regenerator column. In the Solvent Regenerator, the rich solvent is heated in a steam reboiler, driving off the absorbed CO2/H2S. The “leaned” solvent flowing out the bottom of the Solvent Regenerator is recirculated back via the lean/rich exchanger and the solvent cooler to the Absorber for reuse. A portion of the overhead CO2 reject stream from the Solvent Regenerator is compressed and recycled back the gasification island and the excess is vented to the atmosphere. Preferably, the system is designed to reduce the CO2 content in the syngas stream to <1 mol% and the H2S content to less than 5 ppmv, while minimizing the loss of CO and H2.

[0088[In the overall operation of the above-described system, multiple reactions take place as the feedstock is gasified. The major reaction occurs at elevated temperatures when char (carbons) reacts with steam to produce syngas primarily made up of hydrogen (H2), carbon monoxide (CO), carbon dioxide (CO2), and some hydrocarbons:

$$\mathrm{C + H2O \rightarrow H2 + CO}$$

$$\mathrm{2C + O2 \rightarrow 2CO}$$

$$\mathrm{C + O2 \rightarrow CO2}$$

Simultaneously, the reversible “water gas shift” reaction

$$\mathrm{CO + H2O \leftrightarrow CO2 + H2,}$$

approaches equilibrium conditions with the CO/ H2O and the CO2/ H2 ratios based on the equilibrium constant at the gasifier operating temperature. The gasification system may be configured, and conditions provided, so that at least the following gasification reaction occurs:

$$\mathrm{C + H_2O \rightarrow H_2 + CO.}$$

Simultaneously, conditions may preferably be provided so that the following reversible “water shift” reaction reaches an equilibrium state determined mainly by the temperature of the gasifier, the pressure preferably being near atmospheric:

$$CO + H_2O \leftrightarrow CO_2 + H_2.$$

The primary FT reaction converts syngas to higher molecular weight hydrocarbons and water in the presence of a catalyst:

$$nCO + (2n + 1)H_2 \rightarrow C_nH_{2n+2} + nH_2O.$$

[0089[Further as to the overall operation of system, it should be noted that the syngas produced in the gasification island 21 has an insufficient quantity of hydrogen for the effective production and upgrading of F-T liquids. The Sour shift reactor 441 generates additional hydrogen to increase the H2:CO ratio in the syngas from about 0.8 to approximately 2.0. The water gas shift reaction converts a portion of the CO and H2O in the syngas to H2 and CO2. The reaction is exothermic and occurs over a sour shift catalyst. The reaction is a “sour shift” as H2S is still present in the syngas stream. Utility steam and steam generated by the Shift Reactor 441 are mixed with the syngas to provide the water for the water-gas shift reaction and to moderate the temperature rise in the reactor. Hydrogen production and the syngas H2:CO ratio are controlled by bypassing a portion of the syngas stream around the Shift Reactor. The Shift Reactor effluent heat is recovered by interchanging with the reactor influent syngas, generating shift reactor steam, and pre-heating boiler feed water.

[0090[In the preferred embodiment, typical liquids produced by the Fischer Tropsch system have the following characteristics:

Table 1: Fischer Tropsch derived liquids

FT Liquids				FT Liquids		Comments
		Total		MFTL	HFTL	Typical Carbon Distribution
Carbon Distribution				C4-C26	C7 - C102	
		Min	Max			
C4-C09		0.087486904	0.227235687			
C10-C19		0.187753506	0.363200073		0	
C20-C29		0.173346133	0.216928906			
C30-C39		0.091271701	0.113838535			
C40+		0.074314544	0.183203668			
+C10	>	0.702132452	0.701724616			
Acidity, Total mg KOH/g				0.95		
Freezing Point	F				163	
Boiling Point Range	F			96.4-797	311-1400	
Non-hydrogen Composition						
Water	mg/kg			<750		
Nitrogen	mg/kg			<2		
Sulfur	mg/kg			<2		
Metals (Al, Ca, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Pd, Pt, Sn, Sr, Ti, V, Zn)	mg/kg			<0.1	<0.1	per metal
Halogens	mg/kg			<1	<1	

[0091[The MFTL is a clear and bright liquid. The HFTL is a white wax at room temperature, but is normally stored and shipped in its molten state.

[0092[The creation of fuel from renewable organic feedstock by the above-described system has significant advantages. It provides an energy efficient system with a very low emissions profile and reduces, by displacement, greenhouse gases associated with the use of petroleum and coal derived fuel products.

[0093[The fuel additives that have high biogenic content can be used to increase the biogenic content of fossil-based fuels and, therefore, can substantially increases the value of such fuels. The additive percentage can vary widely from small fraction to substantial fractions. For example, for use as jet fuel, the .high biogenic content additive can be as much as 50%, with the remainder being fossil-based jet fuel. In the instance of diesel fuels, the fuel additives that have high biogenic content can be percentages that approach 100%.

[0094[Further, in the instances where the renewable organic feedstock is derived from MSW, the quantity of MSW entering landfills is reduced, thus dramatically reducing harmful methane gas emissions from landfills and mitigating the need for new or expanded landfills.

[0095[Exemplary embodiments have been described with reference to specific configurations. The foregoing description of specific embodiments and examples has been presented for the purpose of illustration and description only, and although the invention has been illustrated by certain of the preceding examples, it is not to be construed as being limited thereby.

CLAIMS

What is claimed is:

1. A high biogenic content fuel derived from renewable organic feedstock sources comprising:

at least one of Synthetic Paraffinic Kerosene (SPK) and diesel derived from Fischer-Tropsch liquids and having substantially the same high biogenic concentration as the Fischer-Tropsch liquids and having substantially the same high biogenic concentration as the renewable organic feedstock to the Fischer-Tropsch process that creates the Fischer-Tropsch liquids, wherein the high biogenic concentration is up to 100% biogenic carbons in both the feedstock and the FT liquids, as confirmable by radiocarbon dating and as opposed to non-biogenic carbons derived from fossil sources of carbon.

2. A high biogenic content fuel derived from renewable organic feedstock sources according to Claim 1 wherein the FT liquids have the following carbon characteristics:

Carbon Distribution: : MFTL:C4-C26
HFTL C7 - C102

Typical Carbon Distribution for Combined Material

		Min	**Max**
C4-C09		0.087	0.23
C10-C19		0.18	0.36
C20-C29		0.17	0.22
C30-C39		0.09	0.11
C40+		0.07	0.18
+C10	>	0.70.	

3. A high biogenic content fuel derived from renewable organic feedstock sources according to Claim 1, wherein the high biogenic concentration is the same percentage biogenic carbon in both the feedstock and the FT liquids.

4. A high biogenic content fuel derived from renewable organic feedstock, the high biogenic content fuel comprising:

at least one of naphtha, diesel fuel and Synthetic Paraffinic Kerosene (SPK) derived from Fischer-Tropsch liquids and having substantially the same high biogenic concentration as the Fischer-Tropsch liquids and having substantially the same high biogenic renewable organic concentration as the feedstock to the Fischer-Tropsch process that creates the Fischer-Tropsch liquids, wherein the high biogenic concentration is up to 100% biogenic carbons in both the feedstock and the FT liquids, as confirmable by radiocarbon dating and as opposed to non-biogenic carbons derived from fossil sources of carbons.

5. A high biogenic content fuel derived from renewable organic feedstock according to Claim 4, wherein the FT liquids have the following carbon characteristics:

Typical Carbon Distribution: MFTL:C4-C26
HFTL C7 - C102

Typical Carbon Distribution for Combined Material

		Min	Max
C4-C09		0.087	0.23
C10-C19		0.18	0.36
C20-C29		0.17	0.22
C30-C39		0.09	0.11
C40+		0.07	0.18
+C10	>	0.70.	

6. A high biogenic content fuel derived from renewable organic feedstock sources according to Claim 5, wherein the high biogenic concentration is the same percentage biogenic carbon in both the feedstock and the FT liquids.

7. A high biogenic content fuel additive derived from renewable organic feedstock, the fuel comprising:

a fuel additive that is at least one of a naphtha fuel, a diesel fuel or Synthetic Paraffinic Kerosene (SPK) derived from Fischer-Tropsch liquids and having substantially the same high biogenic renewable organic concentration as the Fischer-Tropsch liquids and having substantially the same high biogenic concentration as the feedstock to the process creating the Fischer-Tropsch liquids, wherein the high biogenic concentration is confirmable by radiocarbon dating and there is up to 100% biogenic carbon in both the feedstock and the FT liquids as opposed to non-biogenic carbon derived from fossil sources of carbon; and

wherein the Fischer-Tropsch liquids are produced in a process including the steps of :

a) in a feedstock processing step, removing non-biogenic derived carbon materials and non-carbonaceous materials from the feedstock source material to produce a feedstock that is contains a relatively high concentration of biogenic carbon and a relatively low concentration of non-biogenic carbon along with other non-carbonaceous materials from the source material; and

b) in a bio-refinery, converting the processed feedstock into Fischer-Tropsch liquids while maintaining the relatively high concentration of biogenic carbon and the relatively low concentration of non-biogenic carbon.

8. A high biogenic content fuel derived from renewable organic feedstock sources according to Claim 7, wherein the high biogenic concentration is the same percentage biogenic carbon in both the feedstock and the FT liquids.

9. A high biogenic content fuel derived from renewable organic feedstock, according to Claim 7, wherein the high biogenic content fuel comprises:

at least one of naphtha, diesel fuel and Synthetic Paraffinic Kerosene (SPK) derived from Fischer-Tropsch liquids and having substantially the same high biogenic concentration as the Fischer-Tropsch liquids and having substantially the same high biogenic renewable organic concentration as the feedstock to the Fischer-Tropsch process that creates the Fischer-Tropsch liquids, wherein the high biogenic concentration is up to 100% biogenic carbons in both the feedstock and the FT liquids, as confirmable by radiocarbon dating and as opposed to non-biogenic carbons derived from fossil sources of carbons.

10. A high biogenic content fuel additive derived from renewable organic feedstock according to Claim 9, wherein the renewable organic feedstock is processed by sub-stoichiometric carbon oxidation and hydrocarbon reformation while producing syngas, including CO, H2 and CO2.

11. A high biogenic content fuel additive derived from renewable organic feedstock according to Claim 10, wherein the Fischer-Tropsch reactor provides FT liquids including a heavy FT liquid fraction (HFTL), and a medium/lighter FT liquid fraction (MFTL).

12. A high biogenic content fuel additive derived from renewable organic feedstock according to Claim 8, wherein the Fischer Tropsch derived liquids have the following carbons characteristics:

Typical Carbon Distribution: MFTL:C4-C26
HFTL C7 - C102

Typical Carbon Distribution for Combined Material

		Min	**Max**
C4-C09		0.087	0.23
C10-C19		0.18	0.36
C20-C29		0.17	0.22
C30-C39		0.09	0.11
C40+		0.07	0.18
+C10	>	0.70.	

13. A system for producing high biogenic carbon concentration Fischer-Tropsch (F-T) liquids derived from municipal solid wastes (MSW) processed feedstock that contain a relatively high concentration of biogenic carbon (carbon derived from plants) and a relatively low concentration of non-biogenic carbon (from fossil sources of carbon) along with other non-carbonaceous materials, wherein the Fischer Tropsch derived liquids have the following carbons characteristics:

Typical Carbon Distribution: MFTL:C4-C26

HFTL C7 - C102

Typical Carbon Distribution for Combined Material:

		Min	**Max**
C4-C09		0.087	0.23
C10-C19		0.18	0.36
C20-C29		0.17	0.22
C30-C39		0.09	0.11
C40+		0.07	0.18
+C10	>	0.70.	

wherein the system comprises:

a) a bio-refinery for converting the processed feedstock into Fischer-Tropsch liquids while maintaining the relatively high concentration of biogenic carbon and the relatively low concentration of non-biogenic carbon from the renewable feedstock;

b) within the bio-refinery, a gasification island (GI) that provides at least gasification and sub-stoichiometric oxidation of the processed feedstock that contain a relatively high concentration of biogenic carbon , wherein the GI selectively receives:

the processed feedstock and produces syngas containing CO, H2, H2O and CO2:

selectively receives recycled hydrocarbon products and intermediate products to recover the biogenic carbon by the hydrocarbon reforming of the biogenic compounds; and

selectively receives recycled CO2.

14. A system according to Claim 13 further including a syngas conditioning system and an F-T reactor that receives syngas from the syngas conditioning system.

15. A system according to Claim 14, wherein the syngas conditioning system provides the CO2 recycle to the Gasification Island.

16. A system according to Claim 13, wherein the F-T reactor provides FT liquids, including a heavy FT liquid fraction (HFTL) and a medium liquid fraction MFTL, and F-T tailgas.

17. A system according to Claim 16, wherein the F-T tailgas is recycled to the F-T reactor.

18. A system according to Claim 16, further including a hydrocracker for receiving the F-T liquids.

19. A system according to Claim 18 further including a fractionator for receiving heavy crackate and light crackate from the hydrocracker.

20. A system according to Claim 19, wherein the fractionator provides the recycled high biogenic hydrocarbon products.

21. A system according to Claim 20, wherein the fractionator provides the high biogenic concentration of SPK or of Naphtha or of Diesel or of a combination of all three.

22. A system for producing high biogenic concentration Fischer-Tropsch liquids according to Claim 13, wherein said liquids includes fuels.

23. A system for producing high biogenic concentration Fischer-Tropsch liquids according to Claim 22, wherein said liquids includes diesel fuel.

24. A system for producing high biogenic concentration Fischer-Tropsch liquids according to Claim 22, wherein said liquids include synthetic paraffinic kerosene (SPK).

25. A system for producing high biogenic concentration Fischer-Tropsch liquids according to Claim 22, wherein said liquids include naphtha.

26. A system for producing high biogenic concentration Fischer-Tropsch liquids according to Claim 22, wherein in said liquids include at least naphtha, diesel fuel and synthetic paraffinic kerosene (SPK).

27. A system for producing high biogenic concentration Fischer-Tropsch liquids according to Claim 22, wherein CO, H2 and CO2 are recycled along with the recycled selected hydrocarbon products including naphtha and methane.

28. A system for producing high biogenic concentration Fischer-Tropsch liquids according to Claim 27, wherein the recycled selected hydrocarbon products and intermediate products include tail gas from the Fischer-Tropsch process.

29. A system for producing high biogenic concentration Fischer-Tropsch liquids according to Claim 22, wherein high biogenic carbon dioxide (CO2) produced in the process is removed from the gas streams and a portion of the CO2 is recycled to the gasification system.

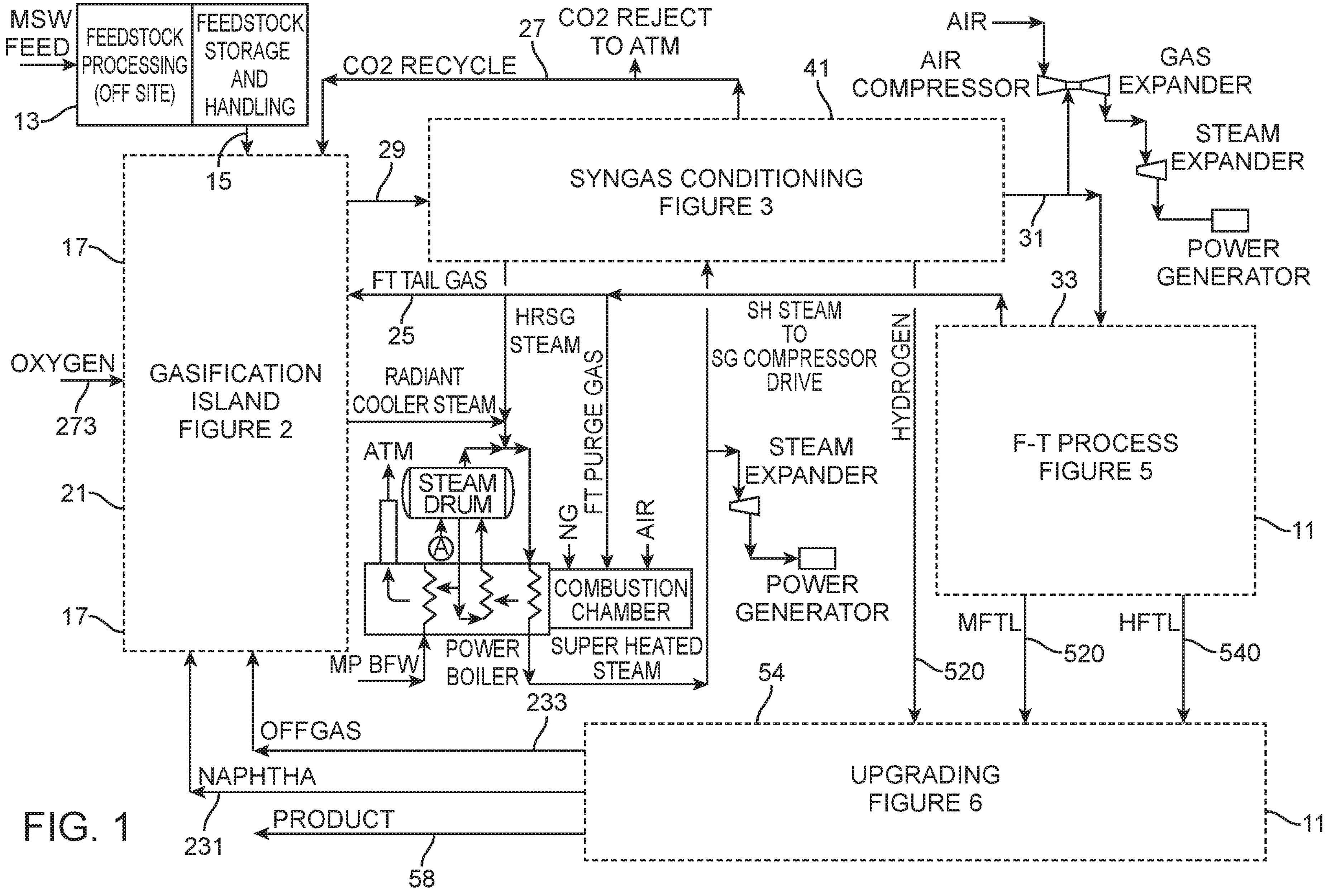

MSW FEED
FEEDSTOCK PROCESSING (OFF SITE)
FEEDSTOCK STORAGE AND HANDLING
13
15
CO2 RECYCLE
27
CO2 REJECT TO ATM
41
AIR
AIR COMPRESSOR
GAS EXPANDER
STEAM EXPANDER
POWER GENERATOR
29
SYNGAS CONDITIONING FIGURE 3
31
33
17
FT TAIL GAS
25
HRSG STEAM
RADIANT COOLER STEAM
FT PURGE GAS
SH STEAM TO SG COMPRESSOR DRIVE
HYDROGEN
OXYGEN
273
GASIFICATION ISLAND FIGURE 2
21
ATM
STEAM DRUM
A
NG
AIR
COMBUSTION CHAMBER
STEAM EXPANDER
POWER GENERATOR
F-T PROCESS FIGURE 5
11
17
MP BFW
POWER BOILER
SUPER HEATED STEAM
233
54
520
MFTL
520
HFTL
540
OFFGAS
NAPHTHA
231
PRODUCT
58
UPGRADING FIGURE 6
11

FIG. 1

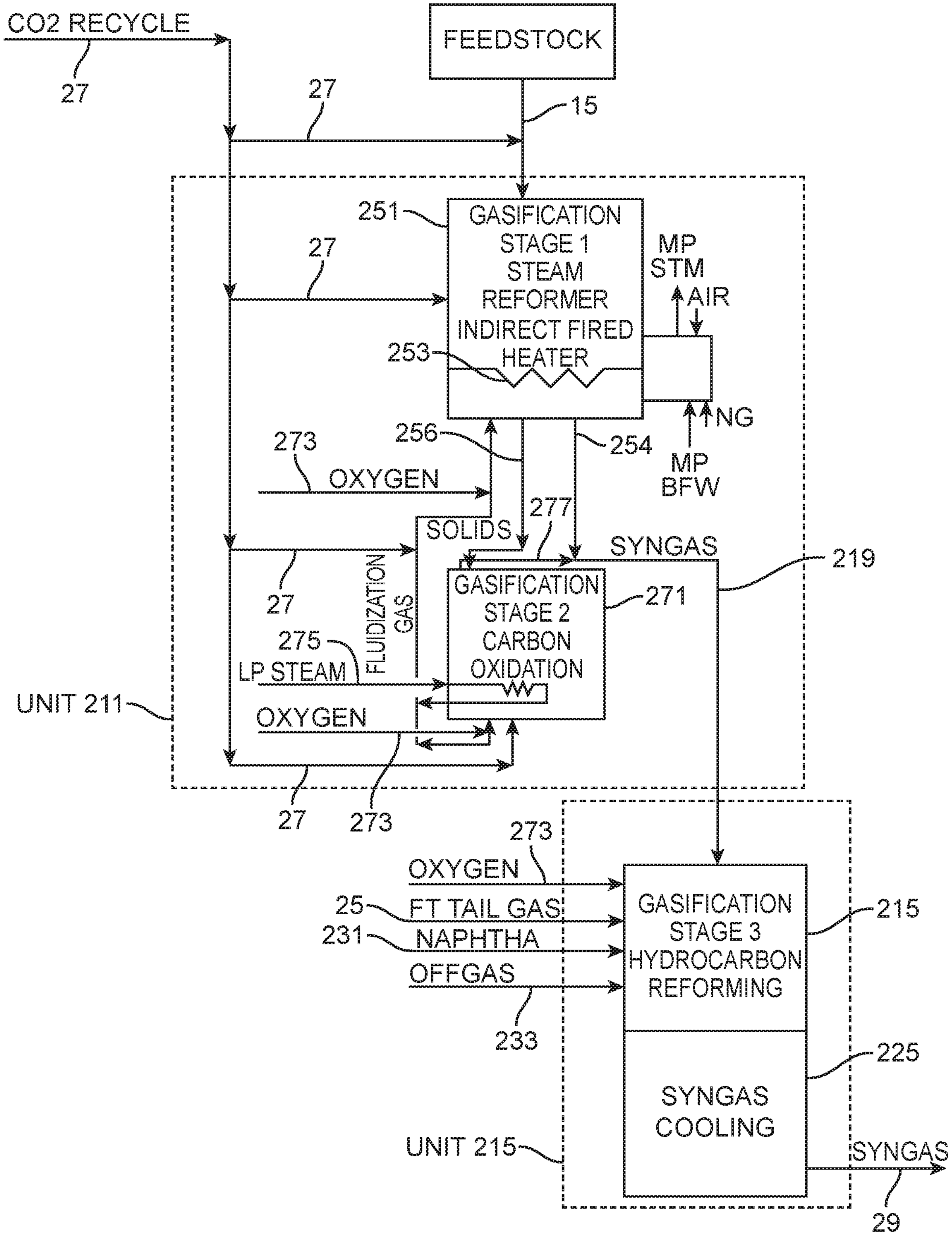

CO2 RECYCLE
27
FEEDSTOCK
15
27
251
GASIFICATION STAGE 1 STEAM REFORMER INDIRECT FIRED HEATER
MP STM
AIR
253
NG
MP BFW
256
254
273
OXYGEN
277
SOLIDS
SYNGAS
219
27
FLUIDIZATION GAS
GASIFICATION STAGE 2 CARBON OXIDATION
271
275
LP STEAM
UNIT 211
OXYGEN
27
273
273
OXYGEN
25
FT TAIL GAS
231
NAPHTHA
OFFGAS
233
GASIFICATION STAGE 3 HYDROCARBON REFORMING
215
SYNGAS COOLING
225
UNIT 215
SYNGAS
29

FIG. 2

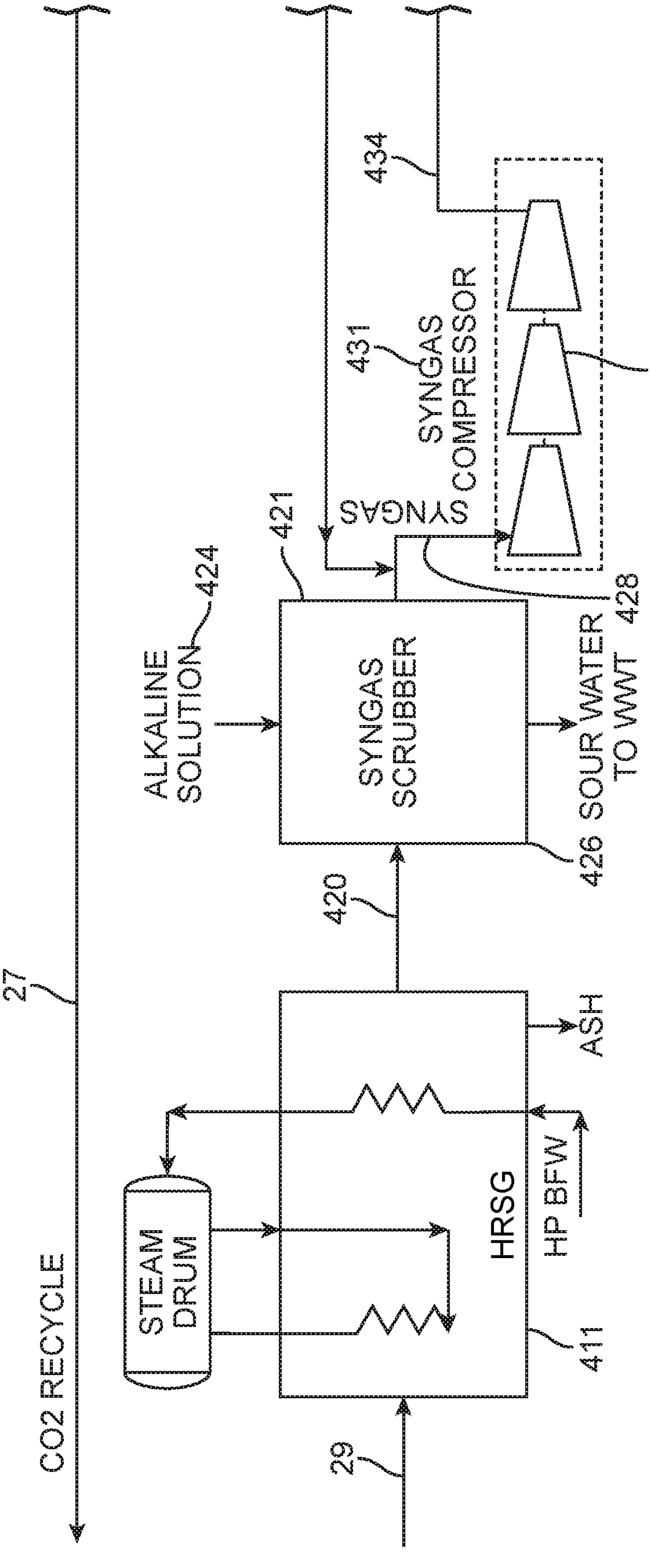

CO2 RECYCLE
27
29
STEAM DRUM
HRSG
HP BFW
411
ASH
420
ALKALINE SOLUTION
424
421
SYNGAS SCRUBBER
426
SOUR WATER TO WWT
428
SYNGAS
431
SYNGAS COMPRESSOR
433
434

FIG. 3

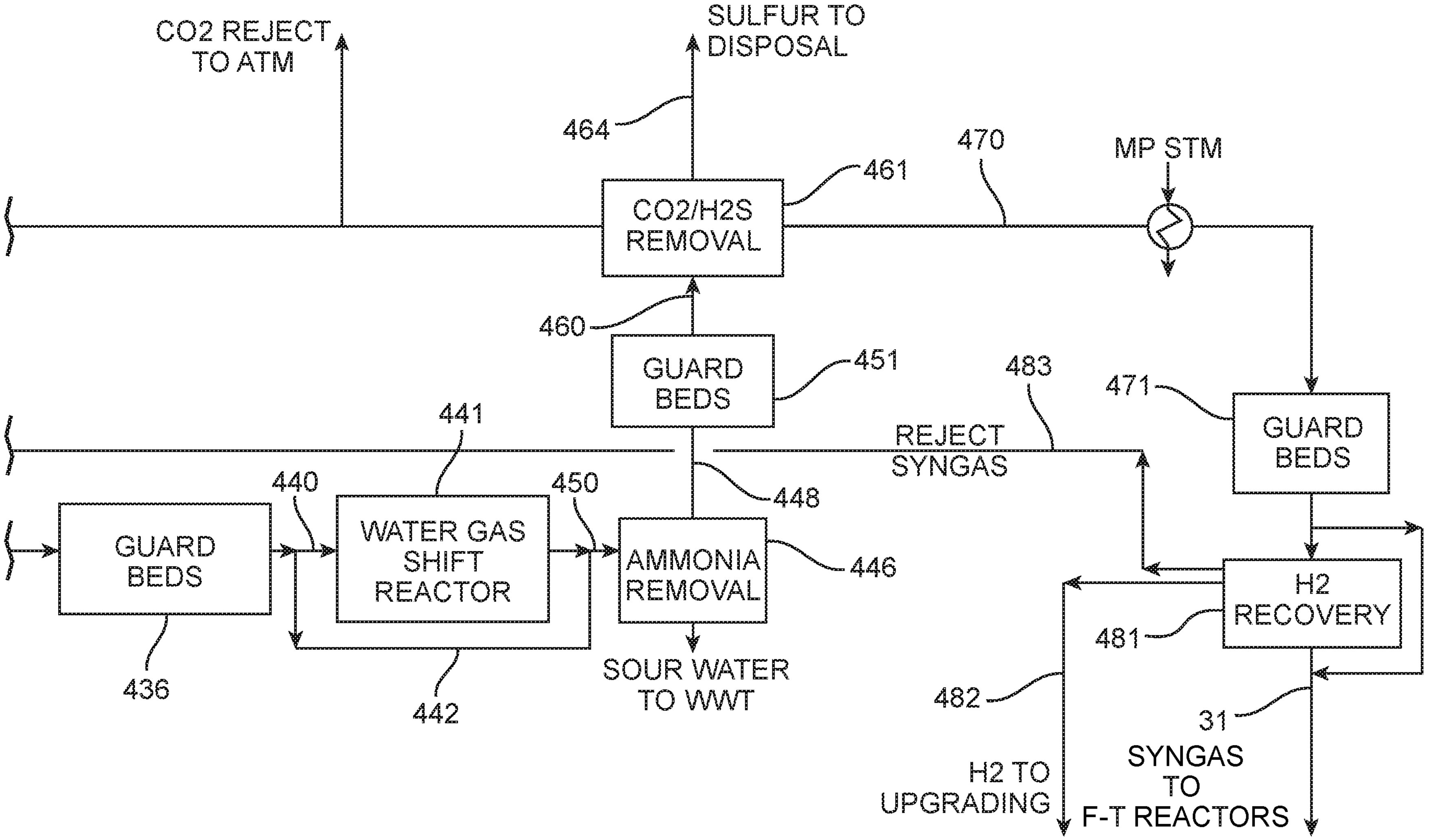

CO2 REJECT
TO ATM
SULFUR TO
DISPOSAL
464
470
MP STM
461
CO2/H2S
REMOVAL
460
GUARD
BEDS
451
483
471
GUARD
BEDS
441
REJECT
SYNGAS
440
450
448
WATER GAS
SHIFT
REACTOR
GUARD
BEDS
AMMONIA
REMOVAL
446
H2
RECOVERY
481
436
442
SOUR WATER
TO WWT
482
31
SYNGAS
TO
F-T REACTORS
H2 TO
UPGRADING

FIG. 3 (Cont.)

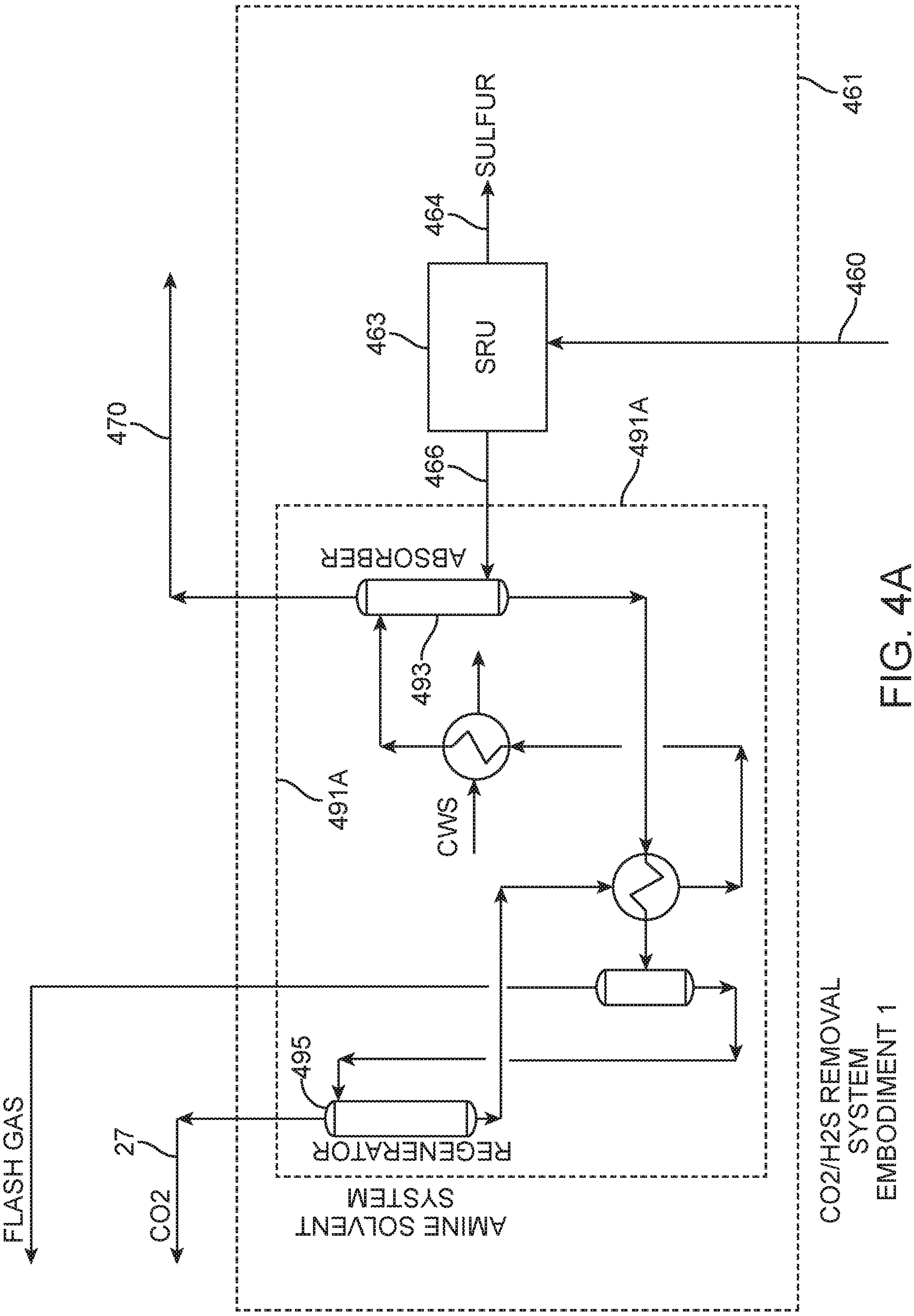
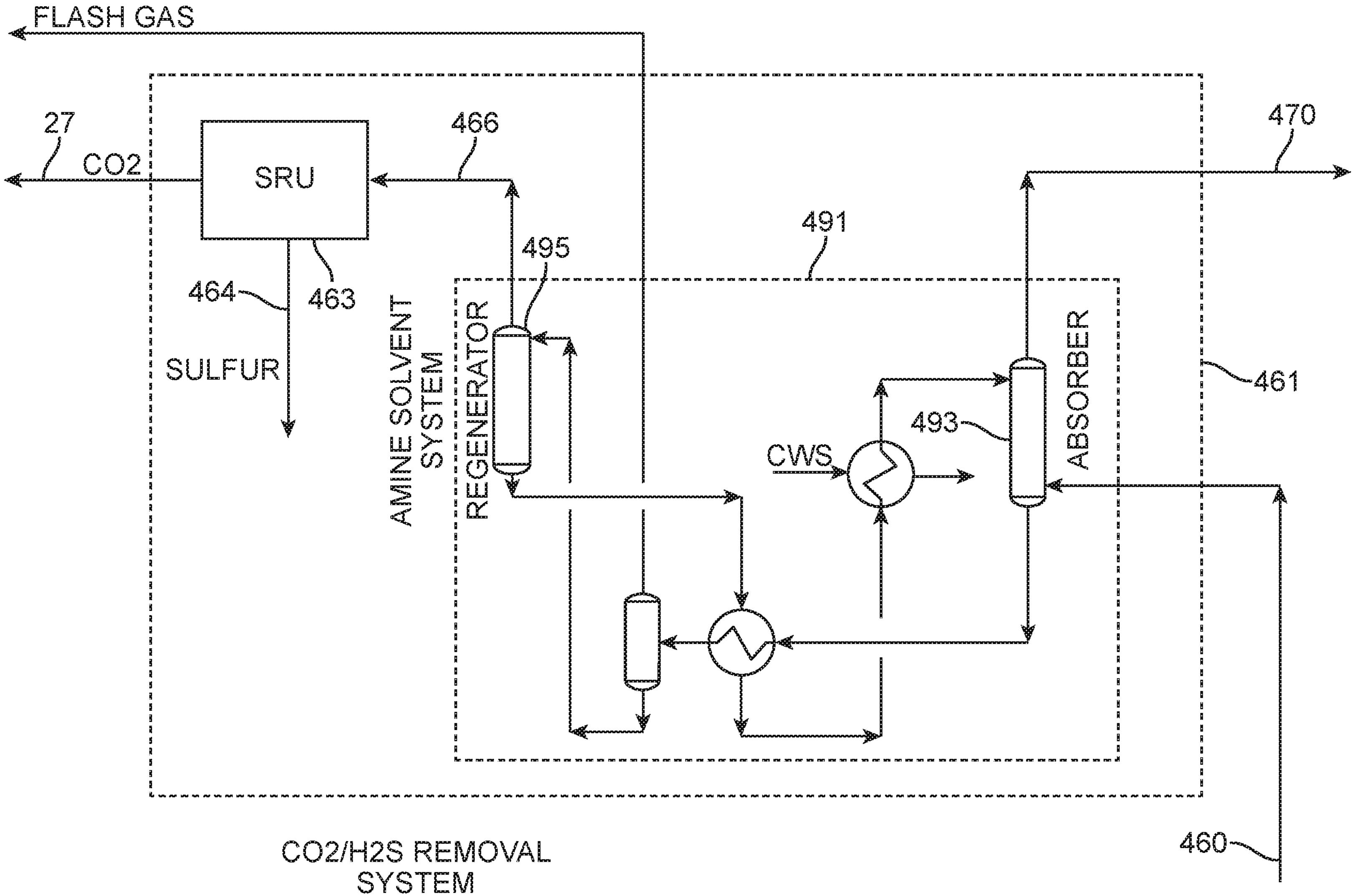

FLASH GAS
CO2
27
470
AMINE SOLVENT SYSTEM
REGENERATOR
495
491A
CWS
493
ABSORBER
466
491A
463
SRU
464
SULFUR
460
461
CO2/H2S REMOVAL SYSTEM EMBODIMENT 1

FIG. 4A



CO2/H2S REMOVAL
SYSTEM
EMBODIMENT 2

FIG. 4B

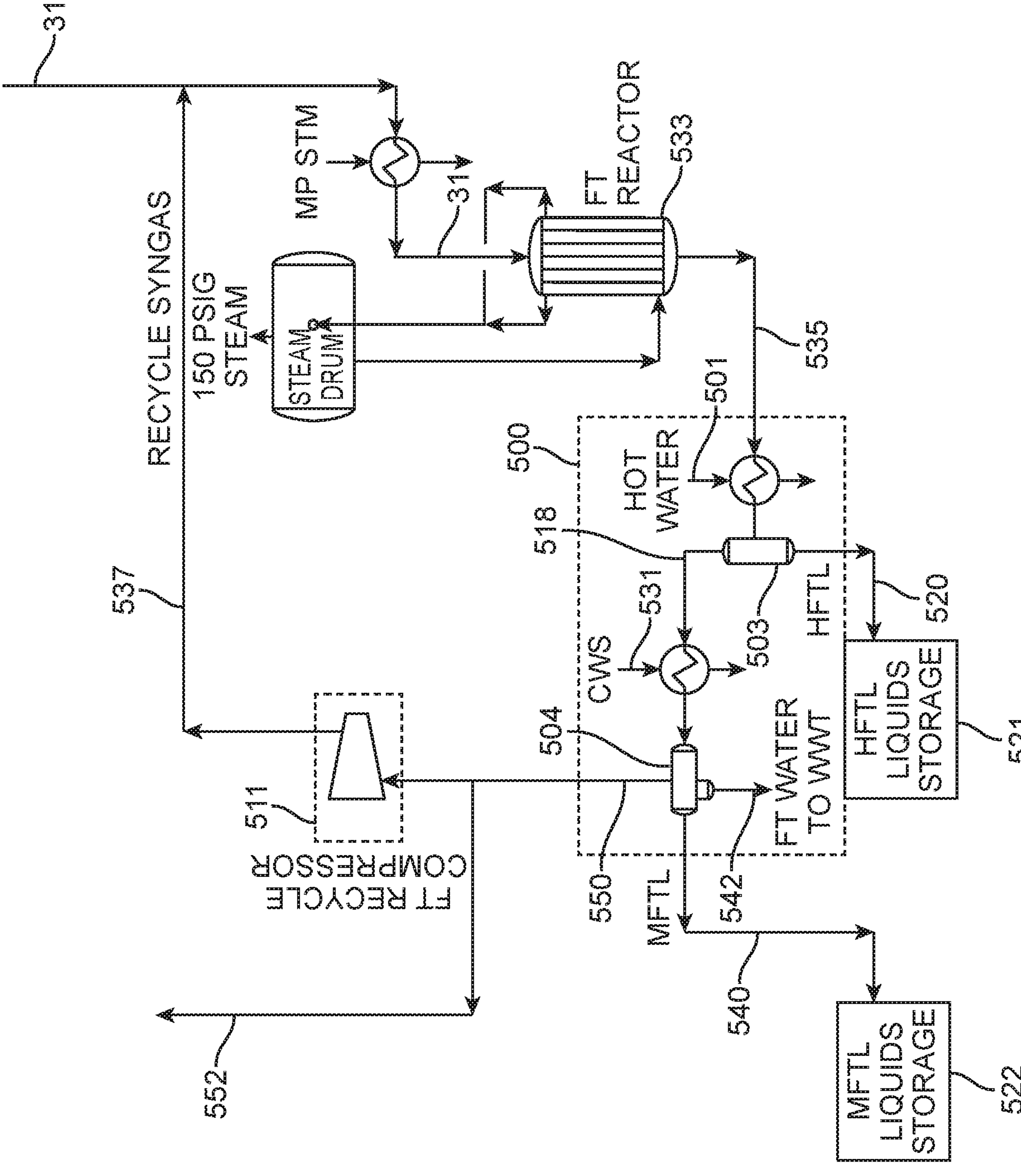

31
RECYCLE SYNGAS
MP STM
31
FT REACTOR
533
150 PSIG STEAM
STEAM DRUM
535
500
501
HOT WATER
518
531
CWS
503
HFTL
520
HFTL LIQUIDS STORAGE
521
537
504
511
FT RECYCLE COMPRESSOR
FT WATER TO WWT
550
542
MFTL
540
MFTL LIQUIDS STORAGE
522
552

FIG. 5

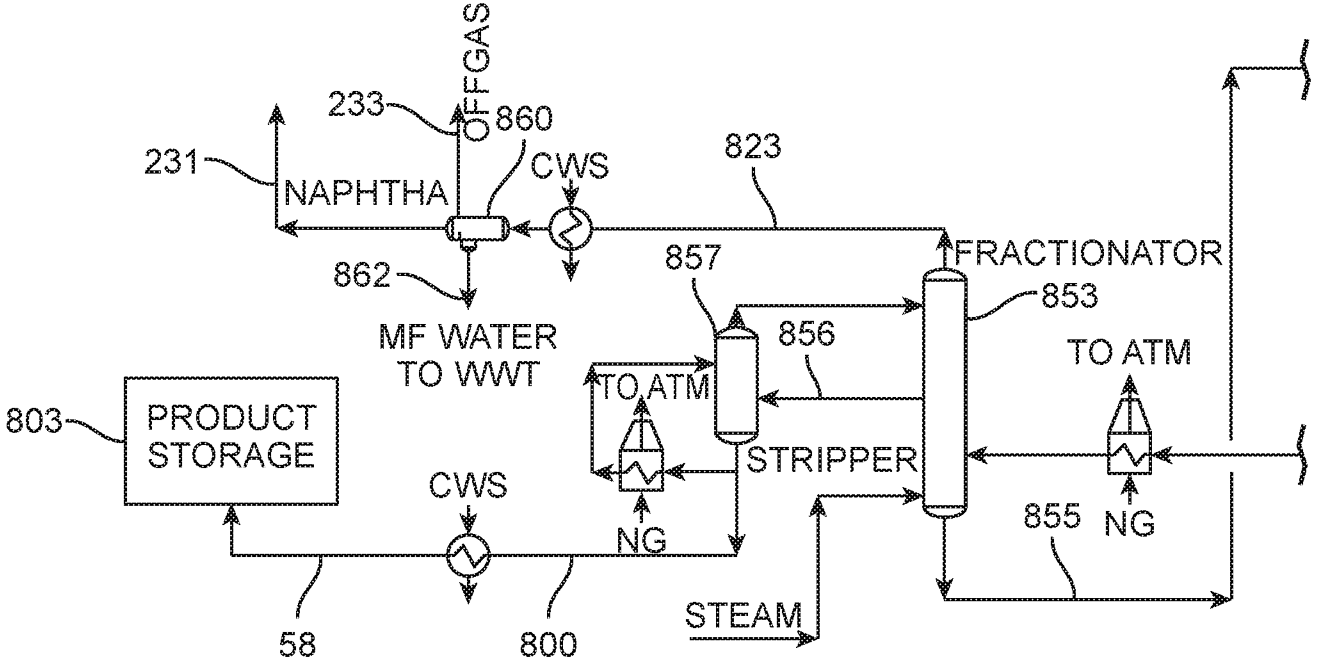

233
OFFGAS
860
231
CWS
823
NAPHTHA
FRACTIONATOR
857
862
853
856
MF WATER
TO WWT
TO ATM
TO ATM
803
PRODUCT
STORAGE
STRIPPER
CWS
855
NG
NG
STEAM
58
800

FIG. 6

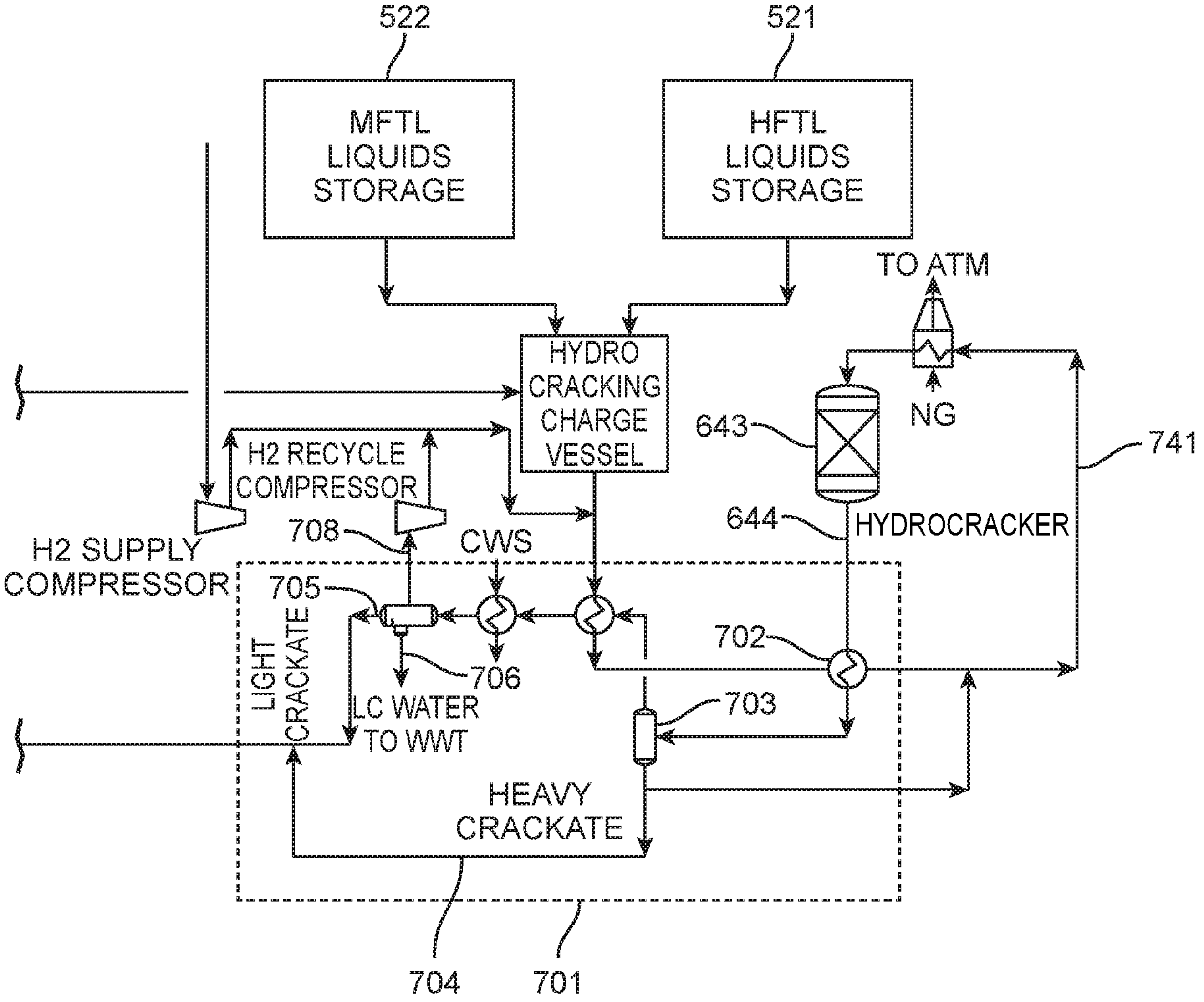

522
521
MFTL LIQUIDS STORAGE
HFTL LIQUIDS STORAGE
TO ATM
HYDRO CRACKING CHARGE VESSEL
NG
643
741
H2 RECYCLE COMPRESSOR
708
CWS
644
HYDROCRACKER
H2 SUPPLY COMPRESSOR
705
702
LIGHT CRACKATE
706
703
LC WATER TO WWT
HEAVY CRACKATE
704
701

FIG. 6 (Cont.)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 15/67950

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - C07C 5/13 (2016.01)
CPC - C07C 5/2789; C07C 5/2791; C07C 5/2721
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): C07C 5/13 (2016.01)
CPC: C07C 5/2789; C07C 5/2791; C07C 5/2721

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 585/737, 585/20, 585/24; 518/700, 518/728 (key word limited; see search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Patents, Google Scholar
Search terms used: biogenic content fuel renewable organic feedstock sources Synthetic Paraffinic Kerosene diesel Fischer-Tropsch liquids liquids non-biogenic carbons fossil sources

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014/0224706 A1 (DO et al.) 14 August 2014 (14.08.2014); para [0001], [0010], [0048]-[0049], [0062]-[0063], [0083], [0105], [0107]-[0109], [0111]-[0112], [0115], [0122]-[0123], [0139], [0200], [0242]-[0243]; Figs. 1-2	1-29
Y	US 2008/0168706 A1 (RUSEK et al.) 17 July 2008 (17.07.2008); para [0036]	1-29
Y	US 2011/0288352 A1 (PETERS et al.) 24 November 2011 (24.11.2011); para [0020], [0060]-[0061]	1-12
Y	US 2014/0088204 A1 (TANAKA) 27 March 2014 (27.03.2014); para [0021], [0023]-[0024], [0040], [0055], [0065], [0071], [0102], [0110]	2, 5, 11-29
A	US 2012/0208902 A1 (KRESNYAK et al.) 16 August 2012 (16.08.2012); entire document	1-29
A	US 2010/0036181 A1 (DIEBOLD et al.) 11 February 2010 (11.02.2010); entire document	1-29

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 03 March 2016 (03.03.2016)	Date of mailing of the international search report 17 MAR 2016
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

摘要

燃料和燃料添加剂可以通过提供具有高达约100%生物炭的高生物炭浓度的费-托液体的方法来生产。所述燃料和燃料添加剂具有与费-托液体基本相同的高生物源浓度，而所述费-托液体包含与原料相同浓度的生物源碳。