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(54) **Title**: APPARATUS, SYSTEM, AND METHOD FOR PROCESSING MATERIALS

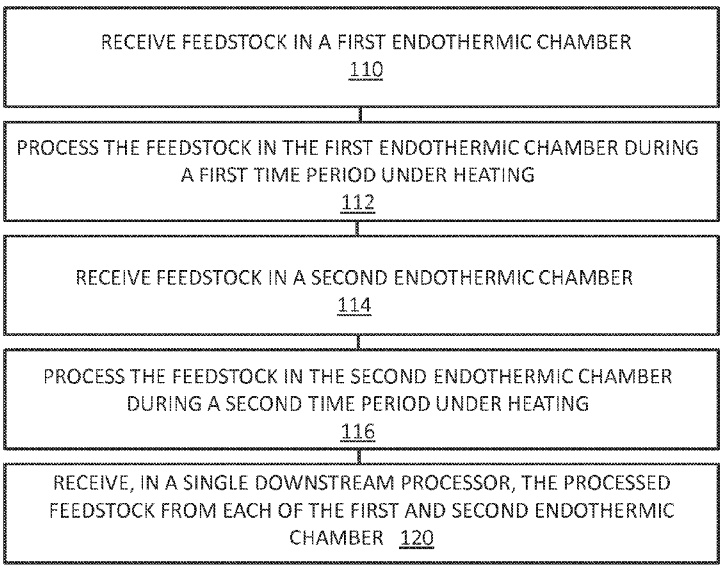

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FIG. 4

(57) Abstract: A refinery system is provided. The refinery system includes a feedstock supply line, a first endothermic chamber that receives feedstock from the feedstock supply and processes the feedstock under elevated heat during a first time period, a second endothermic chamber that receives feedstock from the feedstock supply under elevated heat during a second time period, and a refining processor downstream and in communication with each of the first chamber and the second chamber. A related method is also disclosed.

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APPARATUS, SYSTEM, AND METHOD FOR PROCESSING MATERIALS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to US Provisional Patent Application No. 61/785,220 filed on March 14, 2013 and entitled APPARATUS AND METHODS OF PROCESSING MATERIALS, the contents of which are incorporated by reference in their entirety herein.

TECHNICAL FIELD

[0002] The present disclosure relates to an apparatus, system, and method for processing materials.

BACKGROUND

[0003] Disposal of residential, commercial, and industrial waste in an environmentally friendly and cost-efficient manner continues to be a problem for which current solutions have one or more disadvantages associated therewith.

[0004] Disposal in a landfill creates a multiplicity of problems, such as, for example, selecting a site for disposal, transport of material to and from the site, potential pollutions problems in the nearby soil, groundwater, and air, and issues associated with the lack of recycling when materials are disposed of in a landfill.

[0005] Other methods for waste disposal include recycling materials such as plastics, but the same logistics problems associated with transport to and from a landfill are present, and current methods of recycling are not energy or cost efficient. In addition, many commercial and industrial providers are charged a service or tonnage charge for materials that they recycle, which creates an incentive to avoid recycling.

[0006] Pyrolysis may be used to dispose of certain plastic wastes, however, conventional pyrolysis methods are not energy or cost efficient.

[0007] Accordingly, a method, good, or product that is configured to address these disadvantages is needed.

SUMMARY

[0008] This Summary is provided to introduce in a simplified form concepts that are further described in the following detailed descriptions. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it to be construed as limiting the scope of the claimed subject matter.

[0009] According to one or more embodiments, a refinery system is provided. The system includes a feedstock supply line, a first endothermic chamber that receives feedstock from the feedstock supply line and processes the feedstock under elevated heat during a first time period, a second endothermic chamber that receives feedstock from the feedstock supply line under elevated heat during a second time period, and a refining processor downstream and in communication with each of the first chamber and the second chamber.

[00010] According to one or more embodiments, the feedstock is one of mostly polymers, contaminated soil, and animal processing byproducts.

[00011] According to one or more embodiments, the system includes respective first and second catalyst chambers downstream from the first and second endothermic chambers but upstream from the refining processor.

[00012] According to one or more embodiments, a common line is downstream of the first and second endothermic chambers and in communication with the refining processor downstream.

[00013] According to one or more embodiments, syngas is formed in the respective first and second catalyst chambers, and further wherein, syngas formed in the first and second catalyst chambers is used to heat one of the first and second endothermic chambers.

[00014] According to one or more embodiments, the catalyst chambers include a catalyst selected from the group consisting of Acidic catalysts, Silica-Alumina, PZMSM-5 Zeolite, HZSM-5 zeolite, Hy Zeolite, Mordenite ZSM-5 x-Zeolite, Faujasite Zeolite (y-Zeolite), Clinoptilolite, MCM-41, and SBA-15, ZnO, CaO, K2O, and combinations thereof.

[00015] According to one or more embodiments, the first and second time periods do not substantially overlap.

[00016] According to one or more embodiments, the first time period is between about two hours and about fifteen hours.

[00017] According to one or more embodiments, the feedstock is processed until the oxygen level is below about 10%.

[00018] According to one or more embodiments, the feedstock is processed until the oxygen level is below about 5%.

[00019] According to one or more embodiments, the system includes a third endothermic chamber that receives feedstock from the feedstock supply under elevated during a third time period.

[00020] According to one or more embodiments, the first endothermic chamber and the second endothermic chamber are configured to supply a continuous amount of processed feedstock to the refining processor.

[00021] According to one or more embodiments, the refining processor includes a crude oil refining system that includes an oil and water separator and one or more condensers for separating syngas.

[00022] According to one or more embodiments, the refining processor includes a crude oil refining system that includes a catalyst chamber and a condenser for separating syngas and leaving a biodiesel source.

[00023] According to one or more embodiments, each of the first and second endothermic chambers are sealed after feedstock is provided therein.

[00024] According to one or more embodiments, one of the first endothermic chamber and the second endothermic chamber is at a preferred operating temperature (POT) at all times during processing.

[00025] According to one or more embodiments, the feedstock is algae.

[00026] According to one or more embodiments, the feedstock includes a polymer.

[00027] According to one or more embodiments, the feedstock includes animal byproducts.

[00028] According to one or more embodiments, the refining processor processes syncrude and syngas.

[00029] According to one or more embodiments, processed feedstock is removed from the first endothermic chamber while feedstock is loaded into the second endothermic chamber.

[00030] According to one or more embodiments, a method of generating a resource is provided. The method includes receiving a feedstock in a first endothermic chamber, processing the feedstock in the first endothermic chamber during a first time period under heating, receiving a feedstock in a second endothermic chamber, processing the feedstock in the second endothermic chamber during a second time period under heating, and receiving, in a single downstream refining processor, the processed feedstock from each of the first endothermic chamber and the second endothermic chamber for further processing.

[00031] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock for a period of between about two hours and about 15 hours.

[00032] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock for a period of between about four hours and about 13 hours.

[00033] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock for a period of between about six hours and about 11 hours.

[00034] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock for a period of between about eight hours and about 9 hours.

[00035] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock from ambient temperature to about 900 degrees C during the first time period.

[00036] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock from ambient to about 50 degrees C.

[00037] According to one or more embodiments, the method includes processing the feedstock in a respective first and second catalyst chamber downstream from each of the first and second endothermic chambers and upstream of the single downstream refining processor.

[00038] According to one or more embodiments, processing the feedstock in a respective first and second catalyst chamber includes introducing a catalyst consisting of Acidic catalysts, Silica-Alumina, PZMSM-5 Zeolite, HZSM-5 zeolite, Hy Zeolite, Mordenite ZSM-5 x-Zeolite, Faujasite Zeolite (y-Zeolite), Clinoptilolite, MCM-41, and SBA-15, ZnO, CaO, K2O, and combinations thereof.

[00039] According to one or more embodiments, the first time period and the second

time period do not substantially overlap.

[00040] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock until the oxygen levels are below about 10%.

[00041] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock until the oxygen levels are below about 5%.

[00042] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock until the feedstock is reduced to primarily a light weight gas, a heavy weight gas, and carbon char.

[00043] According to one or more embodiments, the carbon char is removed from each of the first endothermic chamber and the second endothermic chamber.

[00044] According to one or more embodiments, the light weight gas is syngas, the method further comprising isolating the syngas and using the syngas to heat either of the first and second endothermic chambers during a subsequent processing step.

[00045] According to one or more embodiments, during receiving, in a single downstream refining processor, the processed feedstock from each of the first endothermic chamber and the second endothermic chamber for further processing includes receiving a continuous supply that is alternated from the first endothermic chamber and the second endothermic chamber.

[00046] According to one or more embodiments, during the processing of feedstock, one of the first endothermic chamber and the second endothermic chamber is maintained at a preferred operating temperature (“POT”) at all processing times.

[00047] According to one or more embodiments, a method of generating a resource includes at a first time, receiving a feedstock in a first endothermic chamber, processing the feedstock in the first endothermic chamber under heating to an elevated processing temperature in which light weight heating gas is produced, and at a second time, receiving a feedstock in a second endothermic chamber, and processing the feedstock in the second endothermic chamber under heating to an elevated processing temperature in which light weight heating gas is produced. One of the first and second endothermic chambers maintains the elevated processing temperature during a processing period of time, the processing period of time including at least one heating period for each of the first and second endothermic chambers.

[00048] According to one or more embodiments, a refinery system includes a feed stock supply line, a first endothermic chamber that receives feedstock from the feedstock supply and processes the feedstock under elevated heat during a first time period, a second endothermic chamber that receives feedstock from the feedstock supply under elevated heat during a second time period, a refining processor downstream and in communication with each of the first chamber and the second chamber, and a control module configured to direct a heating source to apply heat to the first endothermic chamber during the first time period, monitor the oxygen level in the first endothermic chamber to determine a desired oxygen level in the feedstock, upon determining a desired oxygen level in the feedstock of the first endothermic chamber, direct a heating source to apply heat to the second endothermic chambering during the second time period, monitor the oxygen level in the second endothermic chamber to determine a desired oxygen level in the feedstock, and upon determining a desired oxygen level in the feedstock of the second endothermic chamber,

direct a heating source to apply heat to one of the first endothermic chamber or a third endothermic chamber.

[00049] According to one or more embodiments, the first and second time periods are about the same.

[00050] According to one or more embodiments, a refinery system includes a feedstock supply line, a first endothermic chamber that receives feedstock from the feedstock supply and processes the feedstock under elevated heat during a first time period and a first catalyst chamber for interacting with syncrude from the first endothermic chamber, a second endothermic chamber that receives feedstock from the feedstock supply under elevated heat during a second time period and a second catalyst chamber for interacting with syncrude from the second endothermic chamber, and a refining processor downstream and in communication with each of the first chamber and the second chamber, the refining processor receiving a generally continuous supply of syncrude from one of the first catalyst chamber and the second catalyst chamber during a manufacturing process.

[00051] According to one or more embodiments, the refining processor processes syncrude and syngas.

[00052] According to one or more embodiments, a method of generating a resource is provided. The method includes at a first time, receiving a feedstock in a first endothermic chamber, processing the feedstock in the first endothermic chamber under heating to an elevated processing temperature to produce a product for downstream processing, at a second time, receiving a feedstock in a second endothermic chamber, processing the feedstock in the second endothermic chamber under heating to an elevated processing temperature to produce a product for downstream processing, and providing a product for downstream processing in

a generally continuous manner from one of the first endothermic chamber and the second endothermic chamber.

[00053] According to one or more embodiments, the method includes processing the product for downstream processing in a catalyst chamber.

[00054] According to one or more embodiments, a method of generating an oil byproduct is provided. The method includes providing a feedstock into a first endothermic chamber in communication with a first catalytic chamber, applying heat to the first endothermic chamber in order to process the feedstock into a processed syncrude, transporting the processed syncrude from the first endothermic chamber into the downstream processor, providing feedstock into the second endothermic chamber in communication with a second catalytic chamber, wherein each of the first and second endothermic chambers are in communication with a single downstream processor that processes the oil byproduct, applying heat to the second endothermic chamber from the second endothermic chamber in order to process the feedstock into a processed syncrude, and transporting the processed syncrude into the downstream processor.

BRIEF DESCRIPTION OF THE DRAWINGS

[00055] The previous summary and the following detailed descriptions are to be read in view of the drawings, which illustrate particular exemplary embodiments and features as briefly described below. The summary and detailed descriptions, however, are not limited to only those embodiments and features explicitly illustrated.

[00056] FIG. 1 illustrates a system diagram of a portion of a processing system according to one or more embodiments disclosed herein;

[00057] FIG. 2 illustrates a system diagram of a portion of a processing system according to one or more embodiments disclosed herein;

[00058] FIG. 3 illustrates a system diagram of a portion of a processing system according to one or more embodiments disclosed herein;

[00059] FIG. 4 illustrates one or more methods of processing waste materials according to one or more embodiments disclosed herein; and

[00060] FIG. 5 illustrates temperature versus time charts of respective first and second endothermic chambers according to one or more experiments according to the one or more methods disclosed herein.

DETAILED DESCRIPTIONS

[00061] These descriptions are presented with sufficient details to provide an understanding of one or more particular embodiments of broader inventive subject matters. These descriptions expound upon and exemplify particular features of those particular embodiments without limiting the inventive subject matters to the explicitly described embodiments and features. Considerations in view of these descriptions will likely give rise to additional and similar embodiments and features without departing from the scope of the inventive subject matters.

POLYMER AS A FEEDSTOCK

[00062] FIG. 1 illustrates a portion of a system, where the portion is generally designated 10A. Portion of system 10A works in conjunction with portion of system 10B illustrated in FIG. 2 and portion of system 10C illustrated in FIG. 3 to form an entire system that processes materials, such as, for example, plastics and the like. System 10A includes feedstock supplies 11A and 11B. While illustrated in the system diagram as being separate feedstocks, the feedstock supply may be one in the same for supplying feedstock to endothermic chambers 12A and 12B. The feedstock supplies 11A and 11B may include any waste material. In one or more embodiments, the waste material may include waste plastics

and other polymers from postindustrial manufacturing, municipal waste collections, or any other source of waste plastics. The waste plastics may include plastics 1 through 7 and 9. The plastics may be bailed, bundled, shredded, or otherwise processed or unprocessed.

[00063] The waste material is transferred from storage using any appropriate material handler, such as a tractor, to a staging or loading area. The waste material is then loaded onto a conveyor loader, hydraulic loader, or carried by hand, or other appropriate manner, and is then supplied to the endothermic chambers 12A and 12B. This is preferably done during alternating time periods, though may be done at the same time. The endothermic chambers 12A and 12B are loaded with the feedstock material. Downstream from the endothermic chambers 12A and 12B are respective catalytic chambers 14A and 14B. Catalytic chambers 14A and 14B each have a catalyst compound loaded therein.

[00064] The catalyst compound used herein may include, but is not limited to, Acidic catalysts, Silica-Alumina, PZMSM-5 Zeolite, HZSM-5 zeolite, Hy Zeolite, Mordenite ZSM-5 x-Zeolite, Faujasite Zeolite (y-Zeolite), Clinoptilolite, MCM-41, and SBA-15, and combinations thereof. The catalysts may also be alkaline catalysts such as ZnO, CaO, K2O, and combinations thereof.

[00065] The polymer feedstock may include, but is not limited to, #1 PET (Polyethylene terephthalate), #2 HDPE (High-density polyethylene); #3 PVC (Polyvinyl chloride); #4 LDPE (Low-density polyethylene); #5 PP (Polypropylene); #6 PS (Polystyrene); #7 Other; and #9 or ABS.

[00066] In one or more processes, endothermic chamber 12A is sealed after the feedstock is provided therein. Next, processing occurs of the feedstock in the endothermic chamber. This occurs by subjecting the feedstock to a heating process where the temperature of the feedstock is raised from ambient to about 50 degrees C in a first heating step. The

temperature of the feedstock is then raised from about 50 degrees C to about 900 degrees C over less than about a 12 hour period. In one or more embodiments, the elevated temperature may be higher or lower than about 900 degrees C. For example, in one or more embodiments, the elevated final temperature may be between about 450 and 550 degrees C. During the process of applying heat to the endothermic chamber 12A, the oxygen level therein is reduced during the heating process until it is at a suitably low level. In one or more embodiments, the oxygen level may be about 10 percent. In one or more embodiments, the oxygen level may be about 5 percent. In one or more embodiments, the oxygen level is below about 5 percent after final processing within the endothermic chamber 12A.

[00067] The endothermic chamber 12A is in fluid communication with catalyst chamber 14A. The catalyst chamber 14A includes a catalyst to aid in reacting with gases formed in the endothermic chamber 12A. The catalyst may include Acidic catalysts, Silica-Alumina, PZMSM-5 Zeolite, HZSM-5 zeolite, Hy Zeolite, Mordenite ZSM-5 x-Zeolite, Faujasite Zeolite (y-Zeolite), Clinoptilolite, MCM-41, and SBA-15, and combinations thereof. The catalysts may also be alkaline catalysts such as ZnO, CaO, K2O, and combinations thereof. Gases are formed in endothermic chamber 12A when a chemical reaction of the feedstock occurs. Specifically, the chemical reaction may be cracking where long chain molecules in the feedstock are broken down into shorter chain molecules that generally form into a light weight gas, which may be syngas, a heavy gas, which may be syncrude, and a carbon char.

[00068] During cracking, the gases are formed and they flow out of the endothermic chamber 12A into the catalyst chamber 14A. The gases, collectively the syngas and syncrude, may further react with a catalyst.

[00069] Towards the conclusion of processing of the feedstock in the endothermic

chamber 12A, feedstock 11A is loaded into endothermic chamber 12B in the same manner as it is loaded into endothermic chamber 12A. In this manner, during the time period P1 in which endothermic chamber 12A is processing, feedstock in endothermic chamber 12B is also being processed in the same manner. This has the advantage of maintaining a continuous supply of syngas, Syncrude, and carbon char from processed feedstock to be used for downstream processing. In this manner, inefficiencies associated with starting and stopping a pyrolysis system as new processed feedstock becomes available are eliminated. This has the advantage of increasing production uptime and it has been determined to yield higher efficiency in recycling feedstocks, and additionally only requires single downstream processing equipment. Endothermic chamber 12A may be loaded by about between 10 and 90 percent by volume with feedstock.

[00070] Feedstock is then processed in endothermic chamber 12B according to the same manner as that which is processed in endothermic chamber 12A while endothermic chamber 12A cools. During this cooling period, char is removed from the endothermic chamber 12A, as well as any other contaminants or materials such as metal. These materials may then be further processed or sold for industrial use.

[00071] During processing of feedstock in either of the endothermic chambers 12A and 12B, syngas travels into a flue 16. The syngas may then further go through a filtering process to remove any dust or other contaminants in a filter 44 or 46. A compressor 20 may then compress the syngas before it is stored in a storage tank 22 where it is later used for providing heat treatment to each of the endothermic chambers 12A and 12B. In this manner, the majority of the energy used in the portion 10A is from syngas made from recycled materials.

[00072] Char removed from either of endothermic chambers 12A and 12B may be subject to further processing FP, which may include any suitable processing for those

materials. Syncrude may be pumped or otherwise transferred into a portion 10B of the system for further processing. A separator 24 separates oil and water in the crude oil.

[00073] The crude oil then travels through one or more condensers 34, 36 in order to cool the crude oil down to less than about 350 degrees C. Syngas is separated from crude oil during this process, and may be stored in tank 22 for further use. A transition tank 42 may contain the processed crude oil which will later be processed in a further processing step. A backpressure module 40 may be provided in communication with condensers 34, 36 in order to reduce any backpressures in the system.

[00074] During the portion 10B, solids from air may be processed in filters 44 and 46. Steam from the refining process of 10A is processed through filter 44 and then into filter module 46 for capturing any remaining steam and contaminants. A buffer tank 30 and pressure module 26 may be provided for storing processed materials during any of the processes.

[00075] Portion 10C of the system may be further provided for additional processing. Specifically, an oil flow pump 44 may be provided for pumping the crude oil to a thermochemical distillation chamber 46. In this chamber, the crude oil is heated for further processing. The oil is then transferred to a catalyst chamber 50 for additional processing. A syngas filter 52 filters out any syngas, which is then filtered in filter 54 and filter 56. Steam from this portion of the refining process is processed through the dust filter 54 and then passed through the hydro filter module 56, capturing the remaining steam and contaminants. The collection of contaminants is then processed through the chamber 12A or 12B to convert from a liquid into a solid.

[00076] The remaining oil then goes through condenser 60 to form a diesel grade material that is collected within tank 62. Another condenser 64 condenses the remaining oil

into a distillates collection tank 66. A back pressure module 70 may be in communication therewith, with buffer tank 72 and negative pressure module 74.

[00077] Oil from the diesel collection tank 62 is transferred to a diesel measurement tank 76 that is in communication with a distillates measurement tank 80. An oil flow pump 82 provides pumping forces to pump oil to an acidic wash tank 84. An oil flow pump 86 further provides pumping forces to pump oil to an alkali wash tank 90 where sulfur is cleaned from the fuel, completing the refining process and resulting in transportation grade ultra-low biodiesel fuel D2. The biodiesel fuel is then transferred to a transition tank 92 where further testing may be completed before transport to a transfer fuel trailer or other storage tank.

[00078] Collectively, portions 10A, 10B, and 10C form a system 10 that is capable of converting plastic waste into a highly efficient recycling process producing syngas for heating during the processing step, biodiesel for use as a fuel source, and char for further processing as desired. A control module 94 may be in communication with one or more or all of the elements described herein for monitoring one or more aspects of the refining process. For example, the endothermic chambers 12A and 12B may have one or more sensors in communication therewith that monitor, for example, temperature, pressure, oxygen levels, and any other desired characteristic. The control module 94 may then be configured to monitor the one or more characteristics, and direct additional elements to carry out one or more portions of the process disclosed herein. As the control module 94 detects a release in negative pressure from system 10A, particularly the refining of oil of the first feedstock from the endothermic chamber 12A, the control module directs the oil pump 44 to pump oil from endothermic chamber 12B to thereby cause a continuous flow of oil in the refining process. In this manner, system uptime is maximized and the system 10 is almost always running at operating temperatures and pressures, thereby increasing efficiency in the recycling process

by eliminating the inefficiencies associated with startup when temperatures and pressures are not at operating ranges. The control module 94 is configured to monitor a decrease in gas flow into the catalyst chamber 14A in order to direct heating of endothermic chamber 12B.

EXPERIMENTAL RESULTS FOR PROCESSING OF POLYMER MATERIALS

[00079] In one or more experiments, the system 10 utilized the processes disclosed herein to produce syngas, biodiesel, and char. In the one or more experiments, each of the first endothermic chamber 12A and the second endothermic chamber 12B had about the same amount of feedstock having about the same characteristics applied therein. The first endothermic chamber 12A was sealed and heat was applied according to the following schedule shown in TABLE I.

TABLE I

TIME	TEMP.	OXYGEN LEVEL	GASIFICATION
0:00	21 C	21%	0%
0:30	150 C	16%	0%
1:00	250 C	10%	0%
1:30	350 C	5%	40%
2:00	450 C	2%	76%
2:30	450 C	2%	76%
3:00	500 C	2%	69%
3:30	500 C	2%	69%
4:00	520 C	2%	60%
4:30	520 C	2%	60%
5:00	550 C	2%	47%
5:30	520 C	2%	60%
6:00	500 C	2%	69%
6:30	350 C	5%	40%
7:00	250 C	10%	0%
7:30	150 C	16%	0%
8:00	32 C	21%	0%
8:30	21 C	21%	0%

[00080] At about time 4:30 during the heating and processing of the first endothermic chambers 12A, the second endothermic chamber 12B was loaded with feedstock and the heating process began. In this manner, at about 7:00, the feedstock in the second endothermic chamber 12B starts a gasification flow. At about 7:00, heat is no longer applied to endothermic chamber 12A and ambient air is introduced to decrease pressure and increase the cooling rate. At about 8:30, the endothermic chamber 12A is rotated to increase the cooling rate. At about 9:30, a chamber door is opened on the endothermic chamber 12A, thereby allowing an increased cooling rate. The heating process for the second endothermic chamber 12B was carried out to have consistent time measurements as the heating process for the first endothermic chamber 12A. At about 10:30, the char is removed from the endothermic chamber 12A. Feedstock may then be loaded into chamber 12A for heating and processing at a later date. Maximum pressure was found to be about 500 pounds per square inch.

[00081] After the first endothermic chamber 12A has cooled, the syngas, crude oil, and char material are then processed according to the one or more processes disclosed herein.

[00082] FIG. 5 illustrates graphs plotting temperature of each endothermic chamber 12A, 12B relative to processing time. As illustrated, by having alternating endothermic chambers 12A, 12B provides for a continuous supply of processed feedstock at a preferred operating temperature (“POT”) of about at least 425 degrees C, which has been shown to create optimum processing conditions for increased efficiency and improved processed stock. In one or more embodiments,

CONTAMINATED SOIL AS A FEEDSTOCK

[00083] In one or more embodiments, feedstocks 11A and 11B may be petroleum contaminated soils from, but not limited to, fuel spills, fuel tank leakage, petroleum beach wash, refining spills, fuel line spills, petroleum laden spills, and sands residue from separation washing.

[00084] The petroleum contaminated soils are transferred into the endothermic chambers 12A and 12B for processing. After the soil has been processed in the endothermic chambers 12A and 12B, the separated syngas and oil is sent for further processing as described herein with reference to other materials, and the soil and char is removed from the endothermic chambers 12A and 12B. A vacuum or similar apparatus may be used to remove the soils.

POULTRY, SWINE, BOVINE, AND FISH PROCESSING OFFAL AS A FEEDSTOCK

[00085] In one or more embodiments, feedstocks 11A and 11B may be poultry, swine, bovine, fish, or other animal processing byproducts. The animal processing byproducts are transferred into the endothermic chambers 12A and 12B for processing. Before being placed into endothermic chambers, the processing byproducts are preferably dewatered or dried to a moisture content of less than about 50%. After the byproducts have been processed in the endothermic chambers 12A and 12B, the separated syngas and oil is sent for further processing as described herein with reference to other materials, and the char is removed from the endothermic chambers 12A and 12B. A vacuum or similar apparatus may be used to remove the char and other materials. These materials have particular applicability as a fertilizer grade material.

[00086] One or more methods are illustrated in the flowchart of FIG. 4 and generally

designated 100. The one or more methods may include a method of generating a resource. The method may include receiving a feedstock \ in a first endothermic chamber 110, processing the feedstock in a first endothermic chamber during a first time period under heating 112, receiving a feedstock in a second endothermic chamber 114, processing the feedstock in a second endothermic chamber during a second time period under heating 116, and receiving, in a single downstream refining processor, the processed feedstock from each of the first endothermic chamber and the second endothermic chamber for further processing 120.

[00087] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock for a period of between about two hours and about 15 hours.

[00088] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock for a period of between about four hours and about 13 hours.

[00089] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock for a period of between about six hours and about 11 hours.

[00090] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock for a period of between about eight hours and about 9 hours.

[00091] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock from ambient temperature to about 900 degrees C during the first time period.

[00092] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock from ambient to about 50 degrees C in a first portion of the heating process.

[00093] According to one or more embodiments, the method includes processing the feedstock in a respective first and second catalyst chamber downstream from each of the first and second endothermic chambers and upstream of the single downstream refining processor.

[00094] According to one or more embodiments, processing the feedstock in a respective first and second catalyst chamber comprises introducing a catalyst comprising one of Acidic catalysts, Silica-Alumina, PZMSM-5 Zeolite, HZSM-5 zeolite, Hy Zeolite, Mordenite ZSM-5 x-Zeolite, Faujasite Zeolite (y-Zeolite), Clinoptilolite, MCM-41, and SBA-15, and combinations thereof. The catalysts may also be alkaline catalysts such as ZnO, CaO, K2O, and combinations thereof.

[00095] According to one or more embodiments, the first time period and the second time period do not substantially overlap. In this manner, only a portion of the first and second time period overlaps, yet the endothermic chambers continually provide processed feedstock for further downstream processing.

[00096] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock until the oxygen levels are below about 10%.

[00097] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the feedstock until the oxygen levels are below about 5%.

[00098] According to one or more embodiments, processing the feedstock in either of the first endothermic chamber or the second endothermic chamber includes heating the

feedstock until the feedstock is reduced to primarily a light weight gas, a heavy weight gas, and carbon char.

[00099] According to one or more embodiments, the carbon char is removed from each of the first endothermic chamber and the second endothermic chamber.

[000100] According to one or more embodiments, the light weight gas is syngas and the method further includes isolating the syngas and using the syngas to heat either of the first and second endothermic chambers during a subsequent processing step.

[000101] Particular embodiments and features have been described with reference to the drawings. It is to be understood that these descriptions are not limited to any single embodiment or any particular set of features, and that similar embodiments and features may arise or modifications and additions may be made without departing from the scope of these descriptions and the spirit of the appended claims.

CLAIMS

What is claimed is:

1. A refinery system comprising:

a feedstock supply line;

a first endothermic chamber that receives feedstock from the feedstock supply line and processes the feedstock under elevated heat during a first time period;

a second endothermic chamber that receives feedstock from the feedstock supply line under elevated heat during a second time period; and

a refining processor downstream and in communication with each of the first chamber and the second chamber.

2. The system of claim 1, wherein the feedstock is one of mostly polymers, contaminated soil, and animal processing byproducts.

3. The system of claim 1, further including respective first and second catalyst chambers downstream from the first and second endothermic chambers but upstream from the refining processor.

4. The system of claim 3, wherein a common line is downstream of the first and second endothermic chambers and in communication with the refining processor downstream.

5. The system of claim 3, wherein syngas is formed in the respective first and second catalyst chambers, and further wherein, syngas formed in the first and second catalyst chambers is used to heat one of the first and second endothermic chambers.

6. The system of claim 1, wherein the catalyst chambers include a catalyst selected from the group consisting of Acidic catalysts, Silica-Alumina, PZMSM-5 Zeolite, HZSM-5 zeolite, Hy Zeolite, Mordenite ZSM-5 x-Zeolite, Faujasite Zeolite (y-Zeolite), Clinoptilolite, MCM-41, and SBA-15, ZnO, CaO, K2O, and combinations thereof.

7. The system of claim 1, wherein the first and second time periods do not substantially overlap.

8. The system of claim 1, wherein the first time period is between about two hours and about fifteen hours.

9. The system of claim 1, wherein the feedstock is processed until the oxygen level is below about 10%.

10. The system of claim 9, wherein the feedstock is processed until the oxygen level is below about 5%.

11. The system of claim 1, further including a third endothermic chamber that receives feedstock from the feedstock supply under elevated during a third time period.

12. The system of claim 1, wherein the first endothermic chamber and the second endothermic chamber are configured to supply a continuous amount of processed feedstock to the refining processor.

13. The system of claim 1, wherein the refining processor comprises a crude oil refining system that includes:

an oil and water separator; and

one or more condensers for separating syngas.

14. The system of claim 1, wherein the refining processor comprises a crude oil refining system that includes:

a catalyst chamber; and

a condenser for separating syngas and leaving a biodiesel source.

15. The system of claim 1, wherein each of the first and second endothermic chambers are sealed after feedstock is provided therein.

16. The system of claim 1, wherein one of the first endothermic chamber and the second endothermic chamber is at a preferred operating temperature (POT) at all times during processing.

17. The system of claim 1, wherein the feedstock comprises algae.

18. The system of claim 1, wherein the feedstock comprises a polymer.

19. The system of claim 1, wherein the feedstock comprises animal byproducts.

20. The system of claim 1, wherein the refining processor processes syncrude and syngas.

21. The system of claim 1, wherein processed feedstock is removed from the first endothermic chamber while feedstock is loaded into the second endothermic chamber.

22. A method of generating a resource, comprising:

receiving a feedstock in a first endothermic chamber;

processing the feedstock in the first endothermic chamber during a first time period under heating;

receiving a feedstock in a second endothermic chamber;

processing the feedstock in the second endothermic chamber during a second time period under heating; and

receiving, in a single downstream refining processor, the processed feedstock from each of the first endothermic chamber and the second endothermic chamber for further processing.

23. The method of claim 22, wherein processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock for a period of between about two hours and about 15 hours.

24. The method of claim 23, wherein processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock for a period of between about four hours and about 13 hours.

25. The method of claim 24, wherein processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock for a period of between about six hours and about 11 hours.

26. The method of claim 25, wherein processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock for a period of between about eight hours and about 9 hours.

27. The method of claim 26, wherein processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock from ambient temperature to about 900 degrees C during the first time period.

28. The method of claim 27, wherein processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock from ambient to about 50 degrees C.

29. The method of claim 22, further including processing the feedstock in a respective first and second catalyst chamber downstream from each of the first and second endothermic chambers and upstream of the single downstream refining processor.

30. The method of claim 29, wherein processing the feedstock in a respective first and second catalyst chamber comprises introducing a catalyst consisting of Acidic catalysts, Silica-Alumina, PZMSM-5 Zeolite, HZSM-5 zeolite, Hy Zeolite, Mordenite ZSM-5 x-

Zeolite, Faujasite Zeolite (y-Zeolite), Clinoptilolite, MCM-41, and SBA-15, ZnO, CaO, K2O, and combinations thereof.

31. The method of claim 22, wherein the first time period and the second time period do not substantially overlap.

32. The method of claim 22, wherein processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock until the oxygen levels are below about 10%.

33. The method of claim 22, wherein processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock until the oxygen levels are below about 5%.

34. The method of claim 22, wherein processing the feedstock in either of the first endothermic chamber or the second endothermic chamber comprises heating the feedstock until the feedstock is reduced to primarily a light weight gas, a heavy weight gas, and carbon char.

35. The method of claim 34, wherein the carbon char is removed from each of the first endothermic chamber and the second endothermic chamber.

36. The method of claim 34, wherein the light weight gas is syngas, the method further comprising isolating the syngas and using the syngas to heat either of the first and second endothermic chambers during a subsequent processing step.

37. The method of claim 22, wherein, receiving, in a single downstream refining processor, the processed feedstock from each of the first endothermic chamber and the second endothermic chamber for further processing comprises receiving a continuous supply that is alternated from the first endothermic chamber and the second endothermic chamber.

38. The method of claim 22, wherein, during the processing of feedstock, one of the first endothermic chamber and the second endothermic chamber is maintained at a preferred operating temperature ("POT") at all processing times.

39. A method of generating a resource comprising:

at a first time, receiving a feedstock in a first endothermic chamber;

processing the feedstock in the first endothermic chamber under heating to an elevated processing temperature in which light weight heating gas is produced;

at a second time, receiving a feedstock in a second endothermic chamber; and

processing the feedstock in the second endothermic chamber under heating to an elevated processing temperature in which light weight heating gas is produced,

wherein one of the first and second endothermic chambers maintains the elevated processing temperature during a processing period of time, the processing period of time including at least one heating period for each of the first and second endothermic chambers.

40. A refinery system comprising:

a feed stock supply line;

a first endothermic chamber that receives feedstock from the feedstock supply and processes the feedstock under elevated heat during a first time period;

a second endothermic chamber that receives feedstock from the feedstock supply under elevated heat during a second time period;

a refining processor downstream and in communication with each of the first chamber and the second chamber; and

a control module configured to:

direct a heating source to apply heat to the first endothermic chamber during the first time period;

monitor the oxygen level in the first endothermic chamber to determine a desired oxygen level in the feedstock;

upon determining a desired oxygen level in the feedstock of the first endothermic chamber, direct a heating source to apply heat to the second endothermic chambering during the second time period;

monitor the oxygen level in the second endothermic chamber to determine a desired oxygen level in the feedstock; and

upon determining a desired oxygen level in the feedstock of the second endothermic chamber, direct a heating source to apply heat to one of the first endothermic chamber or a third endothermic chamber.

41. The system of claim 40, wherein the first and second time periods are about the same.

42. A refinery system comprising:

a feed stock supply line;

a first endothermic chamber that receives feedstock from the feedstock supply and processes the feedstock under elevated heat during a first time period and a first catalyst chamber for interacting with syncrude from the first endothermic chamber;

a second endothermic chamber that receives feedstock from the feedstock supply under elevated heat during a second time period and a second catalyst chamber for interacting with syncrude from the second endothermic chamber; and

a refining processor downstream and in communication with each of the first chamber and the second chamber, the refining processor receiving a generally continuous supply of syncrude from one of the first catalyst chamber and the second catalyst chamber during a manufacturing process.

43. The system of claim 42, wherein the refining processor processes syncrude and syngas.

44. A method of generating a resource comprising:

at a first time, receiving a feedstock in a first endothermic chamber;

processing the feedstock in the first endothermic chamber under heating to an elevated processing temperature to produce a product for downstream processing;

at a second time, receiving a feedstock in a second endothermic chamber;

processing the feedstock in the second endothermic chamber under heating to an elevated processing temperature to produce a product for downstream processing; and providing a product for downstream processing in a generally continuous manner from one of the first endothermic chamber and the second endothermic chamber.

45. The method of claim 44, further including processing the product for downstream processing in a catalyst chamber.

46. A method of generating an oil byproduct, comprising:

providing a feedstock into a first endothermic chamber in communication with a first catalytic chamber;

applying heat to the first endothermic chamber in order to process the feedstock into a processed syncrude;

transporting the processed syncrude from the first endothermic chamber into the downstream processor.

providing feedstock into the second endothermic chamber in communication with a second catalytic chamber, wherein each of the first and second endothermic chambers are in communication with a single downstream processor that processes the oil byproduct;

applying heat to the second endothermic chamber from the second endothermic chamber in order to process the feedstock into a processed syncrude; and

transporting the processed syncrude into the downstream processor.

47. A method of generating an oil byproduct, consisting of:

providing a feedstock into a first endothermic chamber in communication with a first catalytic chamber;

applying heat to the first endothermic chamber in order to process the feedstock into a processed syncrude;

transporting the processed syncrude from the first endothermic chamber into the downstream processor;

providing feedstock into the second endothermic chamber in communication with a second catalytic chamber, wherein each of the first and second endothermic chambers are in communication with a single downstream processor that processes the oil byproduct;

applying heat to the second endothermic chamber from the second endothermic chamber in order to process the feedstock into a processed syncrude; and

transporting the processed syncrude into the downstream processor.

48. A system comprising:

a first feedstock processing module that includes a first endothermic chamber and a first catalytic chamber in communication therewith; and

a second feedstock processing module that includes a second endothermic chamber a second catalytic chamber in communication therewith;

wherein the first feedstock processing module processes feedstock to form syncrude during a first time period and the second feedstock processing module proceeses feedstock to form syncrude during a second time period, wherein the first time period and the second time period alternate to form a continuous output of syncrude.

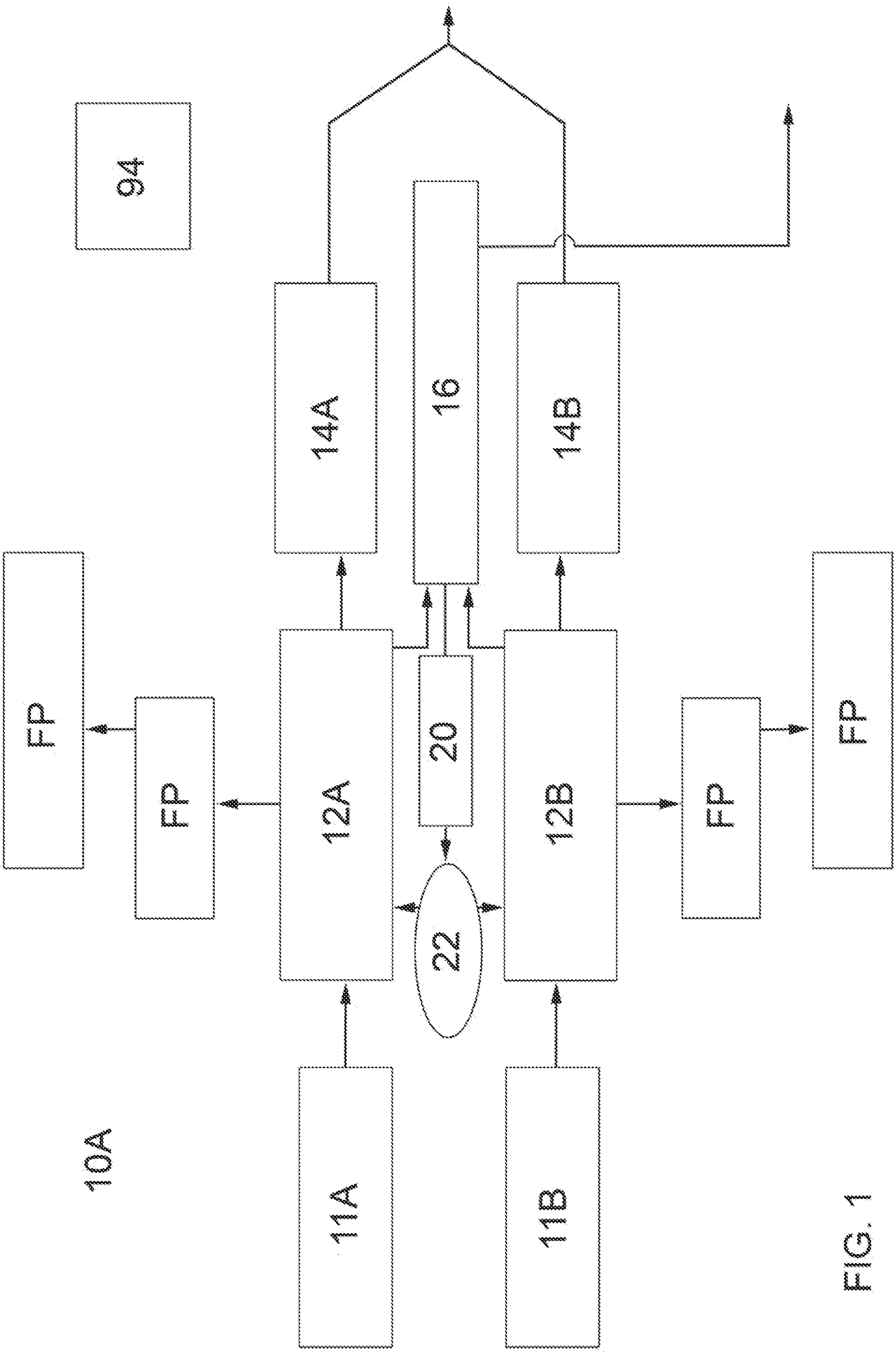


FIG. 1

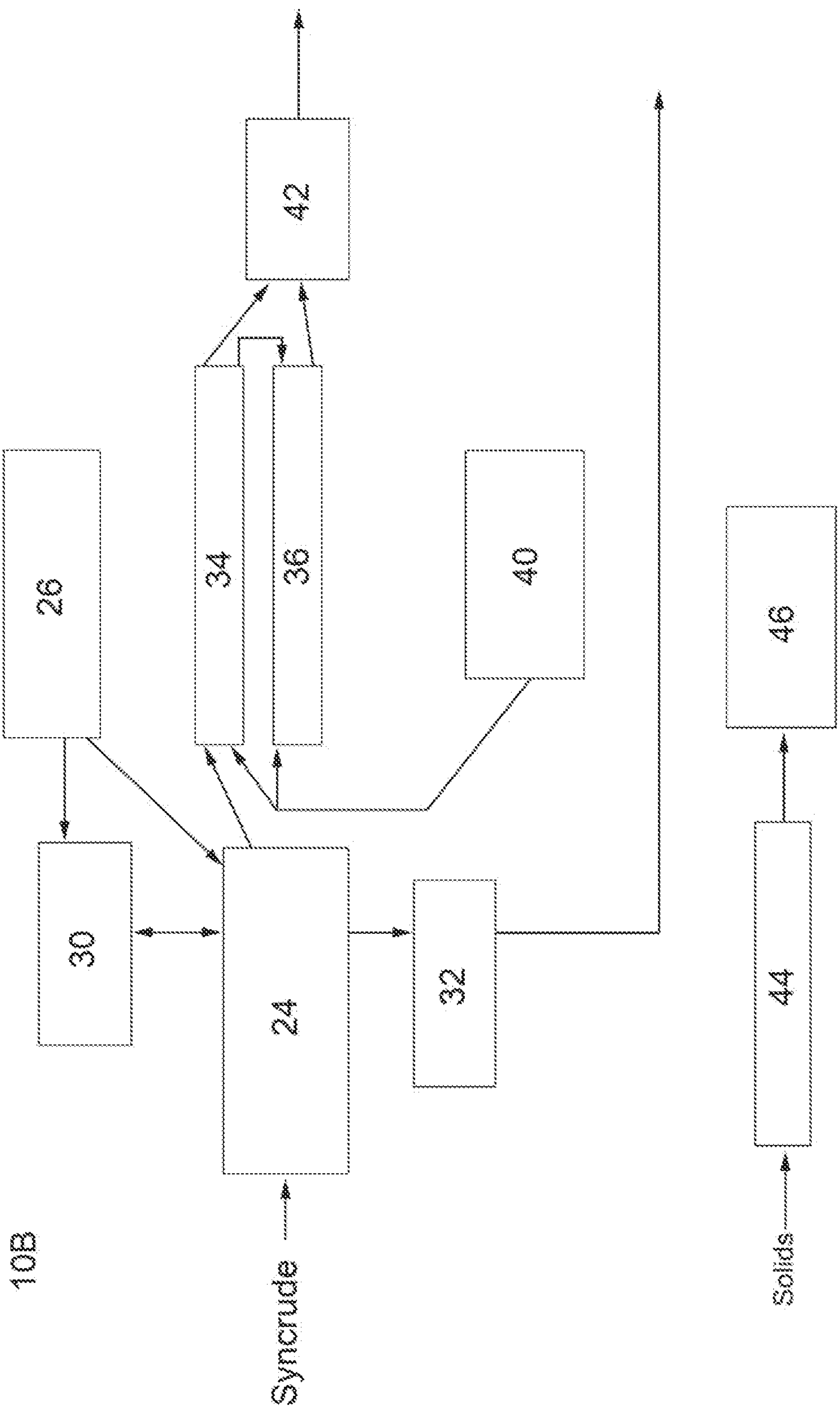


FIG. 2

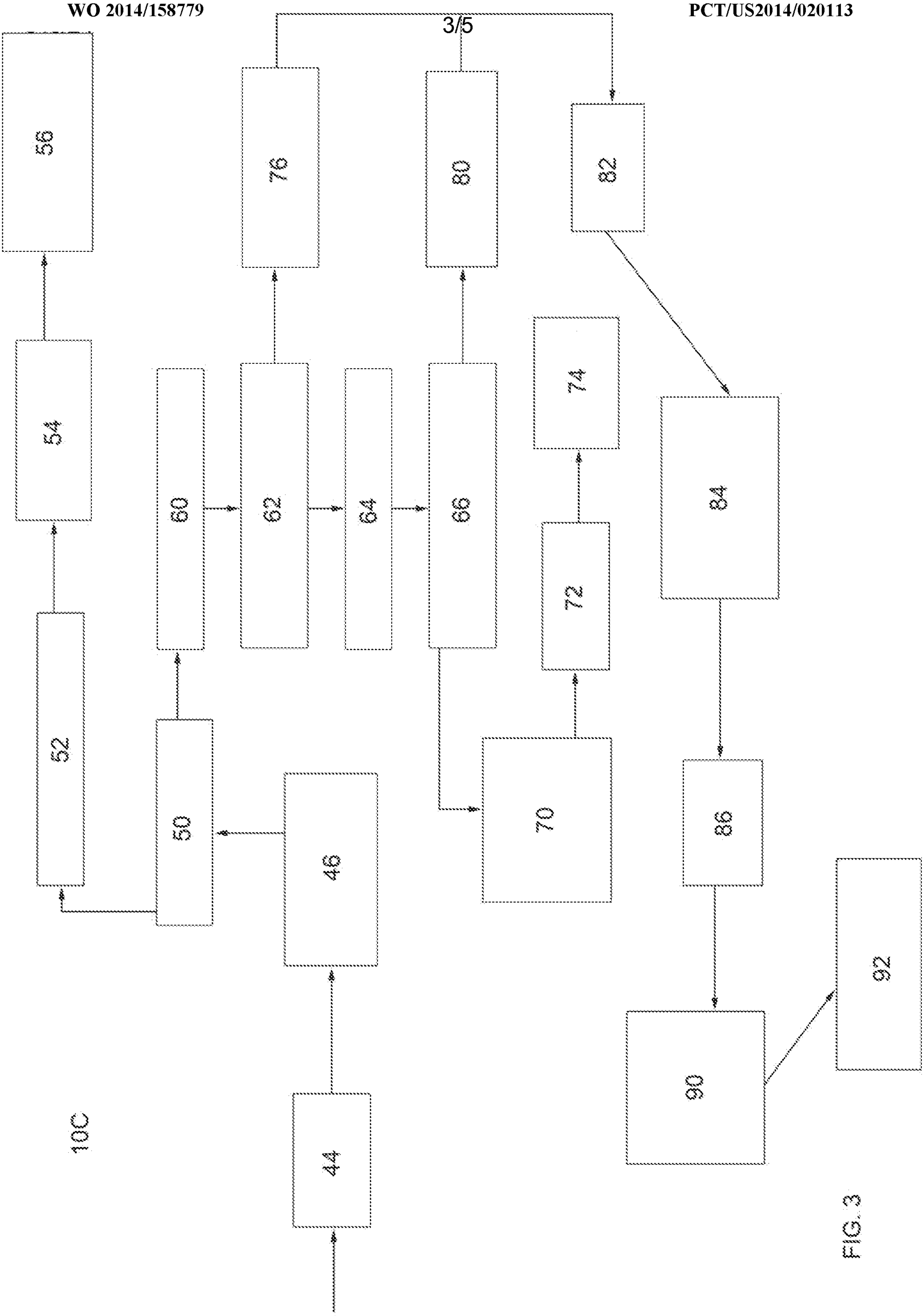
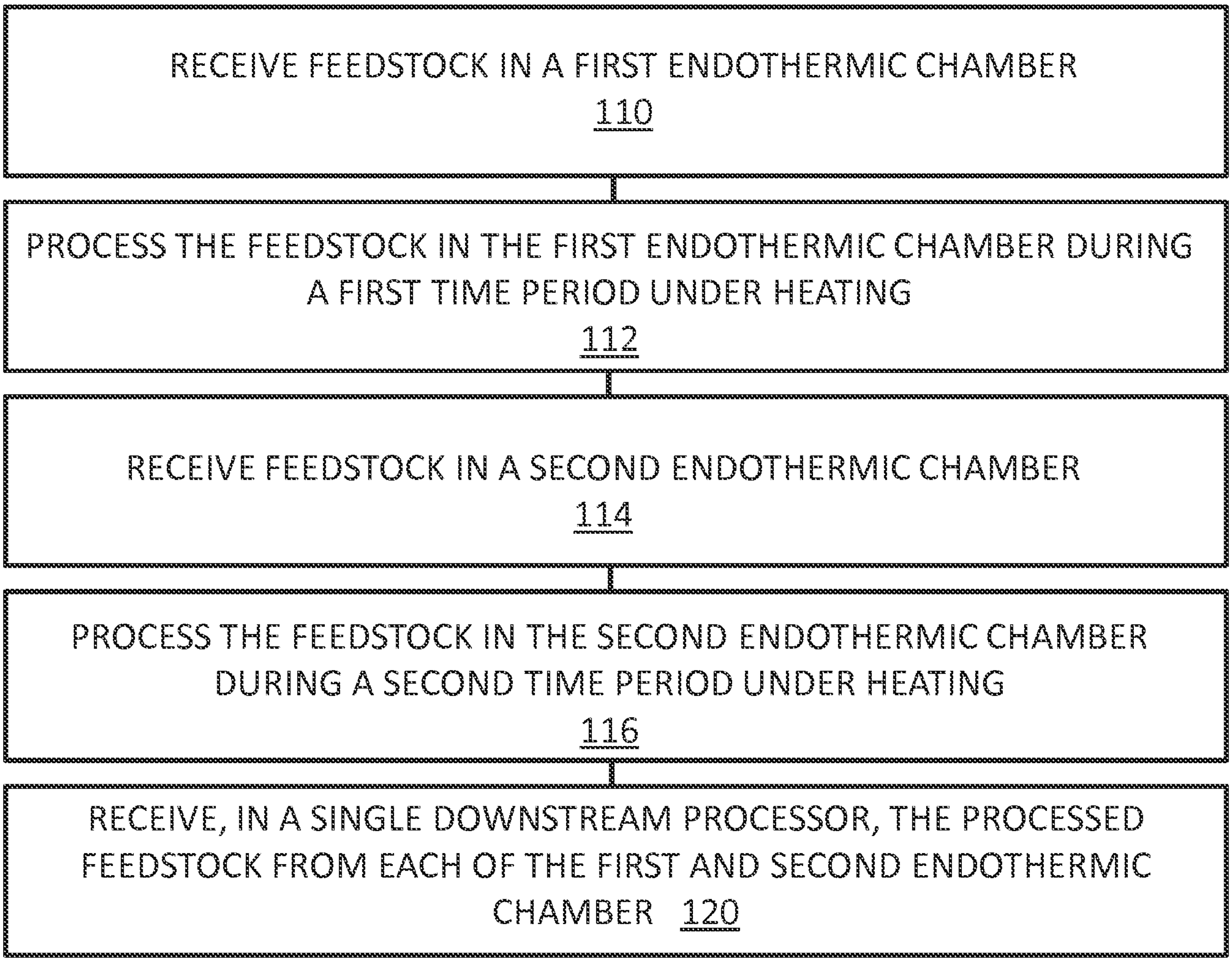
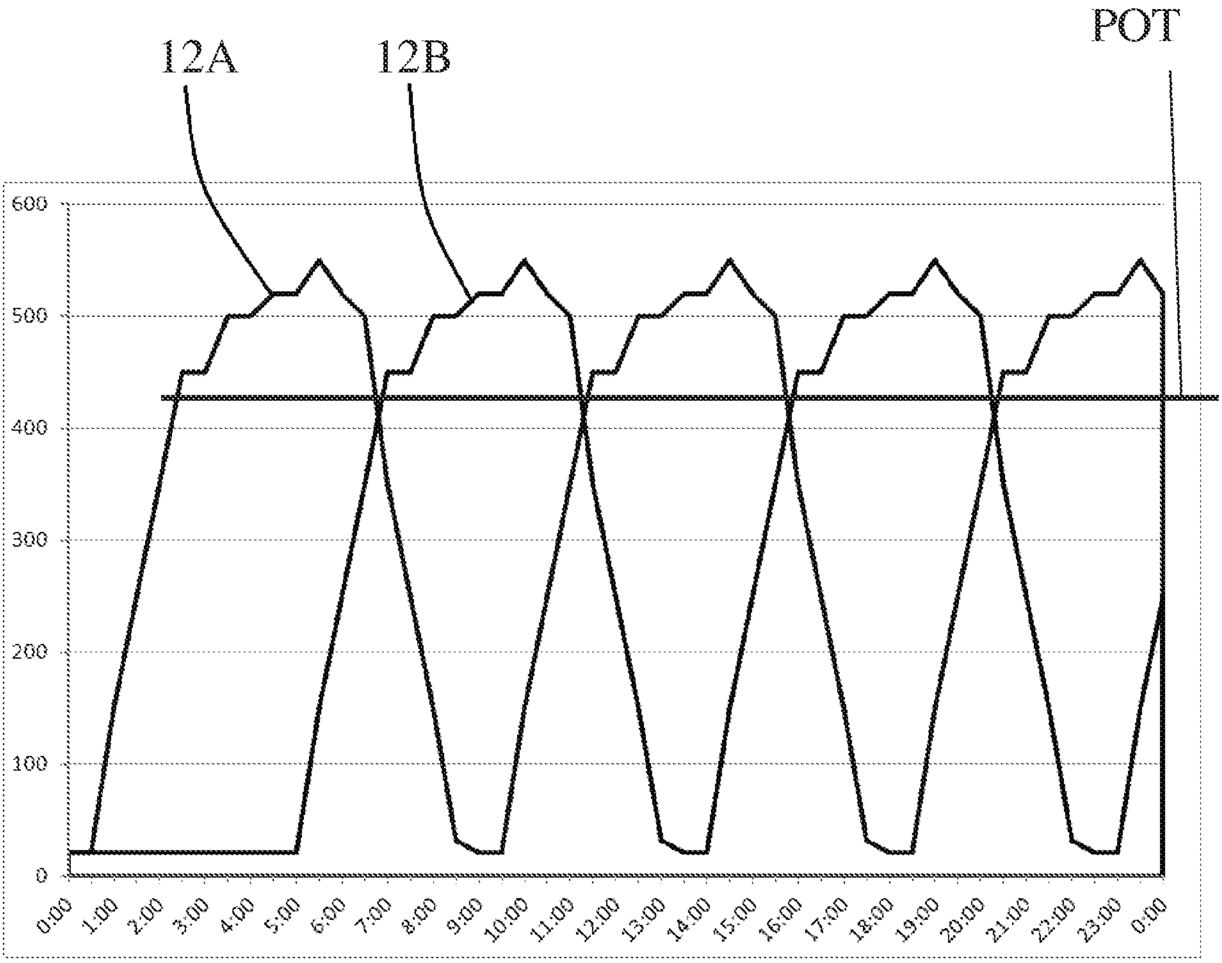


FIG. 3


RECEIVE FEEDSTOCK IN A FIRST ENDOTHERMIC CHAMBER
110
PROCESS THE FEEDSTOCK IN THE FIRST ENDOTHERMIC CHAMBER DURING A FIRST TIME PERIOD UNDER HEATING
112
RECEIVE FEEDSTOCK IN A SECOND ENDOTHERMIC CHAMBER
114
PROCESS THE FEEDSTOCK IN THE SECOND ENDOTHERMIC CHAMBER DURING A SECOND TIME PERIOD UNDER HEATING
116
RECEIVE, IN A SINGLE DOWNSTREAM PROCESSOR, THE PROCESSED FEEDSTOCK FROM EACH OF THE FIRST AND SECOND ENDOTHERMIC CHAMBER 120

100

FIG. 4


12A
12B
POT
600
500
400
300
200
100
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
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20:00
21:00
22:00
23:00
0:00

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/020113

A. CLASSIFICATION OF SUBJECT MATTER

B09B 5/00(2006.01)i, B09B 3/00(2006.01)i

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)
B09B 5/00; F23G 5/12; G05D 7/00; F23G 5/027; C10B 55/00; F23G 5/40; B09B 3/00; B01J 8/06; C10B 53/00; F23G 7/00; B01J 8/00; F23B 7/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: refinery, endothermic chamber, feedstock, catalyst, control module

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 2002-0040864 A1 (SERIO, M. A. et al.) 11 April 2002 See abstract; claims 1, 10; and paragraphs [0006], [0007].	1-48
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"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
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"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
24 June 2014 (24.06.2014)

Date of mailing of the international search report
25 June 2014 (25.06.2014)

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Information on patent family members

International application No.
PCT/US2014/020113

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