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(54) **Title**: APPARATUS FOR FLARE GAS PROCESSING AND USE

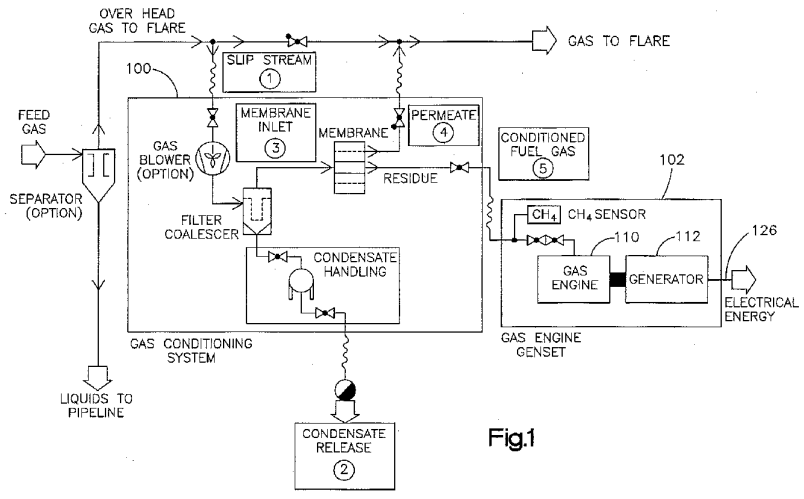


Fig.1

(57) **Abstract**: A mobile apparatus may include a mobile platform or container equipped with at least one membrane separation unit for separating useful fuel gas from raw natural gas produced at an oil or gas production facility, a gas engine that uses the fuel gas to generate electricity that is returned to the facility, and a control panel for operating the apparatus. A method may include the steps of delivering the apparatus to an oil or gas production facility, connecting and operating the apparatus while the facility is generating raw natural gas, and disconnecting and removing the apparatus from the site when raw natural gas is no longer being generated.

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CRUSOE-1005

Apparatus for Flare Gas Processing and Use

RELATED APPLICATIONS

[0001] This application claims the benefit of provisional U.S. Patent Application No. 61/938,485, filed 02/11/2014, and provisional U.S. Patent Application No. 62/007,648, filed 06/04/2014, both of which are incorporated by reference.

TECHNICAL FIELD

[0002] The present disclosure relates generally to a mobile apparatus, system, and method for processing and using raw natural gas that is normally flared at the site of oil and gas field operation facilities.

BACKGROUND

[0003] Across the United States, Canada, and elsewhere large amounts of raw natural gas are flared because of the lack of gas pipeline takeaway capacity. In the Bakkan Shale Gas Field of North Dakota alone, over 30% of the gas being recovered from oil and gas field operations is being burned off into the atmosphere. Gas flared as a byproduct of oil drilling in the Bakken Field releases millions of tons of carbon dioxide into the atmosphere every year, causing considerable environmental concerns.

[0004] At the same time, a number of oil and gas field facilities where gas is being flared rely on diesel-powered electrical generating units for electricity needed to run the facilities. The diesel-powered electrical generating units and diesel fuel must be transported to the remote sites, and the fuel costs and costs of transporting and storing the fuel must be added to the cost of operating the facility. Because of contaminants and uneven qualities, the raw natural gas is often unsuitable for use in electric power generators.

[0005] Membrane-based separation of components of raw natural gas, such as the separation of methane from heavier hydrocarbons such as propane and butane, is well-known in the art. In this way, components of a natural gas stream, in particular methane gas, can be isolated and used as a fuel, as taught for example in U.S. Patents 6,161,386 and 4,370,150. Notwithstanding the availability of membranes to create useful fuel from raw natural gas, oil and gas production facility operators have not taken advantage of the technology due to technological, logistical, and economic shortcomings related to the prior art.

SUMMARY OF THE INVENTION

[0006] A mobile apparatus may include a mobile platform or container equipped with at least one membrane separation unit for separating useful fuel gas from raw natural gas produced at an oil or gas production facility, a gas engine that uses the fuel gas to generate electricity that is returned to the facility, and a control panel for operating the apparatus.

[0007] A method may include the steps of delivering the apparatus to an oil or gas production facility, connecting and operating the apparatus while the facility is generating raw natural gas, and disconnecting and removing the apparatus from the site when raw natural gas is no longer being generated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Figure 1 is a schematic view of a combined gas conditioning and power generation system configured in accordance with the invention.

[0009] Figure 2 is a perspective view of an apparatus comprising an embodiment of the system shown schematically in Fig. 1.

DETAILED DESCRIPTION

[0010] The present invention seeks to reduce costs associated with diesel-powered electrical generating units, to eliminate undesirable emissions generated by flaring natural gas, and to reduce emissions from the generation of electricity used to operate oil and gas field facilities, since electricity produced by gas engines results in fewer harmful emissions than electricity produced by diesel-fuel engines.

[0011] The invention includes a mobile apparatus equipped to convert raw natural gas into a suitable fuel and to use the fuel to provide electricity to an oil or gas production facility that generated the raw natural gas. In one embodiment, the apparatus includes a mobile container equipped with a coalescer for removing certain unwanted contaminants from the raw gas, at least one membrane separation unit for isolating useful fuel gas, a heating system for heating the fuel gas, a gas compressor in case the raw gas pressure is too low, a gas engine that uses the fuel gas to generate electricity, a radiator for cooling the engine, and a control panel for operating the apparatus.

[0012] A second membrane is also available for removal of H2S where levels exceed 200 ppm. The invention also includes a system for processing raw natural gas to produce fuel gas that is used in a gas engine to produce electricity for the production facility that generated the raw natural gas.

[0013] The invention further includes a method comprising the steps of delivering the apparatus to the production facility, connecting and operating the apparatus while the facility is generating raw natural gas, and disconnecting and removing the apparatus when the facility is no longer generating the gas.

[0014] In one embodiment the mobile container is a 40-foot long ISO container that is capable of holding the heating system, coalescer, one or more membrane separation units, gas engine, and control panel. The heating system, coalescer, membrane separation units, and control panel are in one embodiment secured to a skid, which is then secured within the container. For larger capacity systems, two or more mobile containers will be required. In one embodiment, for example, in which a gas engine having a capacity of 570 kW is needed, a first container contains the heating system, coalescer, and membrane separation units, and a second container contains the gas engine and control panel. In a preferred embodiment, the invention includes a fleet of mobile containers and towing engines, or "tractors," where the various components of the invention are releasably attached within the containers and can be replaced and rearranged to accommodate different needs at different production facilities. In another preferred embodiment, the containers are modular and each one can be used as a single operating unit or can be separated and used independently as two or more operating units. In still other embodiments, the mobile containers are trucks or other vehicles capable of carrying the invention components.

[0015] In one embodiment incoming raw natural gas is introduced into a coalescer. Suitable coalescers include liquid-gas coalescers that remove water, some of the hydrocarbon liquids, and/or particulate matter from the raw natural gas, to thereby help protect the downstream membrane and gas engine. After passing through the coalescer, the natural gas is sent to the membrane separation unit. In situations where no coalescer is used, the incoming raw natural gas is introduced directly into the membrane separation unit.

[0016] A suitable membrane separation unit is secured to the mobile container and includes an inlet for natural gas and a membrane, where gas entering the unit flows across the feed side of the membrane. The permeate side of the membrane is maintained at lower pressure to provide a driving

force for transmembrane permeation. C3+ hydrocarbons (e.g. propane and butane), acid gases and water vapor all permeate the membrane preferentially, resulting in a contaminant-enriched permeate stream and a contaminant-depleted residue stream. In a preferred embodiment, the residue stream consists essentially of methane and is the conditioned fuel product. Membranes and the use of membrane processes to provide for the isolation of methane is taught, for example, in U.S. Patents 6,161,386 and 4,370,150, both of which are incorporated herein by reference in their entirety. In one embodiment, membrane skids are designed to house up to six membranes in the same pressure vessel, with any combination of methane recovery or H2S removal membranes, as required for flow rate and quality needed. In some embodiments where engines above 500kW are required or where a combination of engines are required at one site, a membrane-only container is provided with multiple pressure vessels, each capable of housing up to six membranes each in any combination.

[0017] In order to separate selectively for C3+ hydrocarbons over methane, the membrane is suitably made from an elastomeric or rubbery polymer such as nitrile rubber, neoprene, polydimethylsiloxane (silicone rubber), chlorosulfonated polyethylene, polysilicone-carbonate copolymers, fluoroelastomers, plasticized polyvinylchloride, polyurethane, cis-polybutadiene, cis-polyisoprene, poly(butene-1), polystyrene-butadiene copolymers, styrene/butadiene/styrene block copolymers, styrene/ethylene/butylene block copolymers, thermoplastic polyolefin elastomers, and block copolymers of polyethers, polyamides and polyesters. Silicone rubber is a preferred material for separating C3+ hydrocarbons from methane. When the contaminant of primary concern is hydrogen sulfide, a preferred membrane is one in which the selective layer is a polyamide-polyether block copolymer, such as commercially available Pebax® (Arkema, King of Prussia, PA). These materials exhibit selectivity in favor of C3+ hydrocarbons over methane, but are, in general, slightly less selective in that regard than silicone rubber.

[0018] Suitable membranes include composite structures, and they may be manufactured as flat sheets or as hollow fibers and housed in any convenient module form. In a preferred embodiment, flat-sheet membranes in spiral-wound modules are used. The membrane modules are typically housed end-to-end in one or more pressure tubes and the tubes are mounted on a skid. Other equipment, such as filters, compressors, pumps and monitoring or control equipment, may also be included on the skid as needed. Suitable membrane units as described herein are available commercially from Membrane Technology and Research (Newark, CA).

[0019] The membrane unit may contain a single membrane module, a bank of membrane modules, or an array of modules, depending on the amount of gas to be treated and the complexity of the separation. A single-stage membrane separation operation is suitable for many applications. When the residue stream requires further purification, it is passed to a second bank of membrane modules for a second processing step. When the permeate stream requires further concentration, it is passed to a second bank of membrane modules for a second-stage treatment. These alternative arrangements and modifications are known to those ordinarily skilled in the art.

[0020] A suitable heating system is employed to receive the residue stream from the membrane unit when the gas is too cold for use in the gas engine. Some gas engines require, for example, that the gas be at a temperature of at least 43 degrees Fahrenheit. When present, the effluent from the heating system is passed to the inlet of the gas engine. When no heating system is present, the residue stream from the membrane unit is passed directly to the gas engine.

[0021] A suitable gas engine is secured to the mobile container and ranges upward in capacity from 100 kW, depending on the power required. Examples of suitable gas engines are illustrated in U.S. Patent 6,161,386 (depicting a combustor, turbine, and electricity generator) and U.S. Patent

4,370,150. A suitable radiator, such as one sold by Gunter as Model 501092A121A, is included for engine cooling. Load cables connected to the gas engine transmit electricity generated by the gas engine to the production facility. In one embodiment, auxiliary means for providing electricity is provided when there will likely be periods when the production facility will require electricity but will be generating no or low levels of raw natural gas. In an alternative embodiment where the facility needs a source of heat, a combined heat and power (CHP) unit is employed as the gas engine, and a radiator system is used to cool the engine at times when the facility has no need for the heat source. In a similar way, a combined cooling, heating, and power (CCHP) unit is used when the facility needs sources of electricity, heating and cooling. In an application where the facility operator contemplates times when raw natural gas flow will be interrupted, a stand-by diesel generator is provided.

[0022] At some production facilities, only a relatively small portion of the raw natural gas generated by the facility is needed to power the facility, and it is desirable for environmental and sometimes economic reasons for the flaring of raw natural gas to be further reduced. In one embodiment, the invention achieves this objective with the addition of a chiller unit. All or some portion of the raw natural gas generated by the facility is passed through the chiller and the chiller removes natural gas liquids (NGLs) from the raw natural gas stream. The NGLs are collected in containers that can be transported offsite. In the practice of this embodiment the need to flare gas is thus further reduced or eliminated, and the NGLs can be used elsewhere or sold to generate revenue. As an additional advantage, the chiller is powered by electricity from the generator, and the chiller's consumption of electricity furthers the goal of reducing flaring, since the added electricity demand enables the generator to utilize more methane. The chiller is in one embodiment contained in a separate mobile unit but operated through the main control panel.

[0023] The control panel provides the necessary displays and systems for monitoring and operating the various components of the invention. In one embodiment, the apparatus will be equipped with sensing and computing equipment that detects and monitors operational characteristics and conditions, including gas leaks and the like, and forecasts needs for servicing and repair. The sensing and computing equipment is either part of the control panel or in communication with the control panel, and sometimes includes other audio-visual devices. In this way the apparatus provides visual and/or audible signals and information about characteristics, conditions, or needs for service or repair. In still another embodiment, the sensing and computing equipment is in communication with remote locations so that output from the equipment is available at the remote locations. In further embodiments, the apparatus is equipped with automatic adjustment and shut-off controls that are actuated either directly by the sensing and computing equipment, or actuated by human operators, located either remotely or on site, who receive output from the sensing and computing equipment.

[0024] Oil and gas production facilities require electricity and sometimes heating and cooling to operate, but production facilities are typically located in remote areas where no utility power is available. In accordance with the present method, the container and equipment is transportable and is delivered to and kept at a production facility only for as long as the facility is operating and generating raw natural gas. In this way, the invention can effectively accommodate numerous production facilities without the need for a capital investment in stationary and unnecessarily duplicative equipment, and without the added costs of installing and uninstalling stationary equipment at each production site. One or more containers can be moved as an operator expands or contracts its drilling sites to different or additional remote locations. The operator can lease or purchase containers and equipment and arrange for transportation to sites as needed, or the operator

can enter into a service contract with a provider of mobile containers and equipment, where the provider is responsible for transportation, connection, optionally operation and maintenance, disconnection, and removal.

[0025] Referring to the drawings, the illustrated apparatus has parts that are examples of the elements recited in the apparatus claims, and can be operated in steps that are examples of the steps recited in the method claims. The illustrated apparatus thus includes examples of how a person of ordinary skill in the art can make and use the claimed invention. These examples are described here to further provide enablement and best mode without imposing limitations that are not recited in the claims.

[0026] Figure 1 is a schematic view of a system configured to operate as described above. The illustrated example has subsystems including a gas conditioning system 100 and a gas engine genset 102. The gas conditioning system 100 may be configured as shown and described in U.S. Patent Publication No. 2013/0055897, which is incorporated by reference as part of this disclosure. The gas genset 102 includes a gas engine 110 and a generator 112 that is driven by the engine 110. These subsystems 100 and 102 may be operatively interconnected for transportation and use as parts of a unitary assembly as shown in Fig. 2. This particular example includes a container 120 in which the gas conditioning system 100 and the gas genset 102 are operatively interconnected with an air cooler 122 and electrical controls 124. The air cooler 122 is linked with the engine 110 through water lines as shown in the drawing, and thus serves as a radiator for the engine 110. The electrical controls 124 may be accessible to a user standing or reaching within the container 120, and include a control panel as described above. A cable 126 in communication with the engine 110 transmits electricity generated by the engine 110 to the production facility. Accordingly, the

container 120 and its contents together define a self-contained, mobile flare gas processing unit that provides a user with electrical power output but requires only feed gas input from the user.

[0027] The gas engine genset is compact, containerized/skid mounted, and mobile which makes the system particularly suitable for remote sites where high levels of heavy hydrocarbons and/or H2S present in the fuel gas are reduced significantly to allow reliable engine operation and remain within the emissions threshold limits.

[0028] The inlet to the membranes is taken as a slip-stream (#1) gas pipeline. The inlet gas enters the filter coalesce which removes any liquid condensates/aerosols (#2) formed and the overhead gas next enters the membrane vessels. The membrane vessels split the inlet (#3) into two streams:

1. The membranes preferentially permeate the heavy hydrocarbons, CO2, water and H2S, and the resulting permeate stream (#4) is flared (or flows back into the pipeline).

2. The residue gas stream will be the conditioned gas (#5) with a lower BTU (dry gas) value and with a lower H2S content The conditioned fuel gas will be routed to the gas engines after necessary pressure regulation.

3. The conditioned gas will be burned in a high efficient (low emission) gas engine and generates electricity.

4. The generated electricity powers either a local grid (island operation) or will be fed into the main grid.

[0029] Some of the major advantages of the packaged Fuel Conditioning and Power Generation Unit are as follows:

[0030] Mobile solution: The turn-key containerized design allows for easy shipping and little onsite work to hook up the system.

[0031] Easy accessibility: The membrane system as well as the generation system are easily accessible from inside and outside of the container. This allows for fast service and maintenance of the system.

[0032] Reliable process solution: The Membrane System is a passive solution with no mechanical or rotating parts. Maintenance and operating costs are reduced considerable compared to other gas treating solutions. The engine operates with a gas similar to natural gas which allows for extended service intervals and high uptime. Installation is ideal for remove locations.

[0033] Dehydration without Rotating Equipment: The proposed Membrane Fuel Gas Conditioning System dehydrates the conditioned gas without the expense of other maintenance-heavy, gas dehydration solutions.

[0034] Design Flexibility: The modular design approach of the containerized solution allows for future design flexibility. Through the addition of future engine and membrane units, additional gas can be processed and the generation capacity can be increased.

[0035] Less Unscheduled Downtime: The presence of heavy hydrocarbons, acid gases, and water vapour in the fuel gas can result in significant operating problems with gas engines. Rich fuel causes pre-detonation, incomplete combustion of fuel, and carbon deposit build-up, which can damage the internals of the firing chamber. With the incorporate membrane system, the expected time between scheduled engine maintenance is increased.

[0036] Fuel Generation: On-site generation for spec-quality fuel gas from field gas. This allows utilizing field gas directly and avoids to move the gas from a remote float/station to a processing field line before utilizing.

[0037] Environmental Impact: Using on-site flare gas for power generation will reduce the amount of gas which needs to be flared and thus lowers the "carbon footprint". In addition the impact of trucking, storing and combusting diesel for power generation will be reduced as well.

[0038] Reduction of Emissions from power generation: Combustion of acid gases and the incomplete combustion of hydrocarbons in the firing chamber result in dangerous pollutants in the exhaust gas. The package reduces the volume of VOC and acid gas emissions.

[0039] In some cases the amount of electrical power required on an oil field pumping site may be small compared to the amount of power that can be produced with the gas available. For example, the amount of gas going to flare might produce about 3 MW of power when only about 250 KW is needed to run the site. Therefore, the system can provide power for both local consumption and also for export to the grid at the same time if utility power lines are accessible from the site. Additionally, the gas may be of sufficient quality to burn directly out of the well without any membrane treatment. For this reason the system could be configured to bypass the membrane separation unit.

[0040] This written description sets for the best mode of carrying out the invention, and describes the invention so as to enable a person skilled in the art to make and use the invention, by presenting examples of elements recited in the claims. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples, which may be available either before or after the application filing date, are intended to be within

the scope of the claims if they have elements that do not differ from the literal language of the claims, or if they have equivalent elements with insubstantial differences from the literal language of the claims.

What is claimed is:

1. A mobile apparatus for processing raw natural gas and using fuel gas resulting from the processing to produce electricity for use in an oil or gas production facility that generated the raw natural gas, the apparatus comprising:

(a) a mobile platform;

(b) a membrane separation unit secured to said mobile platform, said unit comprising an inlet for receiving raw natural gas from the production facility, a membrane for separating usable fuel gas from the raw natural gas, an outlet for a residue stream consisting essentially of methane, and an outlet for a permeate stream consisting of other components of the raw natural gas;

(c) a gas engine for generating electricity and which comprises an inlet for receiving the residue stream from the membrane separation unit, the gas engine being secured to said mobile platform and operatively interconnected with the membrane separation unit; and

(d) a cable in communication with the gas engine for transmitting electricity generated by the gas engine to the production facility.

2. An apparatus as defined in claim 1 wherein the mobile platform is part of a container configured to enclose and contain the membrane separation unit and the gas engine for transportation with the container.

3. An apparatus as defined in claim 2 wherein the mobile platform is a part of a vehicle trailer.

4. A system for processing raw natural gas and using fuel gas resulting from the processing to produce electricity for use in an oil or gas production facility that generated the raw natural gas, the system comprising:

(a) a mobile platform;

(b) a membrane separation unit secured to said mobile platform, said unit comprising an inlet for receiving raw natural gas from the production facility, a membrane for separating usable fuel gas from the raw natural gas, an outlet for a residue stream consisting essentially of methane, and an outlet for a permeate stream consisting of other components of the raw natural gas;

(c) a gas engine secured to said mobile platform for generating electricity and which comprises an inlet for receiving the residue stream from the membrane separation unit;

(d) a cable in communication with the gas engine for transmitting electricity generated by the gas engine to the production facility; and

(e) a control panel and sensing and computing equipment that provide for operation of the membrane separation unit and gas engine, detection and monitoring of operational characteristics and conditions of the membrane separation unit and gas engine, and forecasting of needs for servicing and repair of the membrane separation unit and gas engine.

5. A system as defined in claim 4 wherein the mobile platform is part of a container configured to enclose and contain the membrane separation unit and the gas engine for transportation with the container.

6. A system as defined in claim 5 wherein the mobile platform is a part of a vehicle trailer.

7. A method for processing raw natural gas and using fuel gas resulting from the processing to produce electricity for use in an oil or gas production facility that generated the raw natural gas, the method comprising:

(a) providing a mobile apparatus comprising a mobile platform, a membrane separation unit secured to said mobile platform, a gas engine secured to said mobile platform for generating electricity and which comprises an inlet for receiving the residue stream from the reverse

osmosis unit, and a cable in communication with the gas engine for transmitting electricity generated by the gas engine to the production facility, wherein the membrane separation unit comprises an inlet for receiving raw natural gas from the production facility, a membrane for separating usable fuel gas from the raw natural gas, an outlet for a residue stream consisting essentially of methane, and an outlet for a permeate stream consisting of other components of the raw natural gas;

(b) transporting the mobile apparatus to the production facility;

(c) connecting and operating the mobile apparatus while the production facility is generating raw natural gas, and

(d) disconnecting and removing the mobile apparatus from the production facility when raw natural gas is no longer being generated by the facility.

8. A method as defined in claim 7 wherein the mobile platform is part of a container configured to enclose and contain the membrane separation unit and the gas engine for transportation with the container.

9. A method as defined in claim 8 wherein the mobile platform is a part of a vehicle trailer.

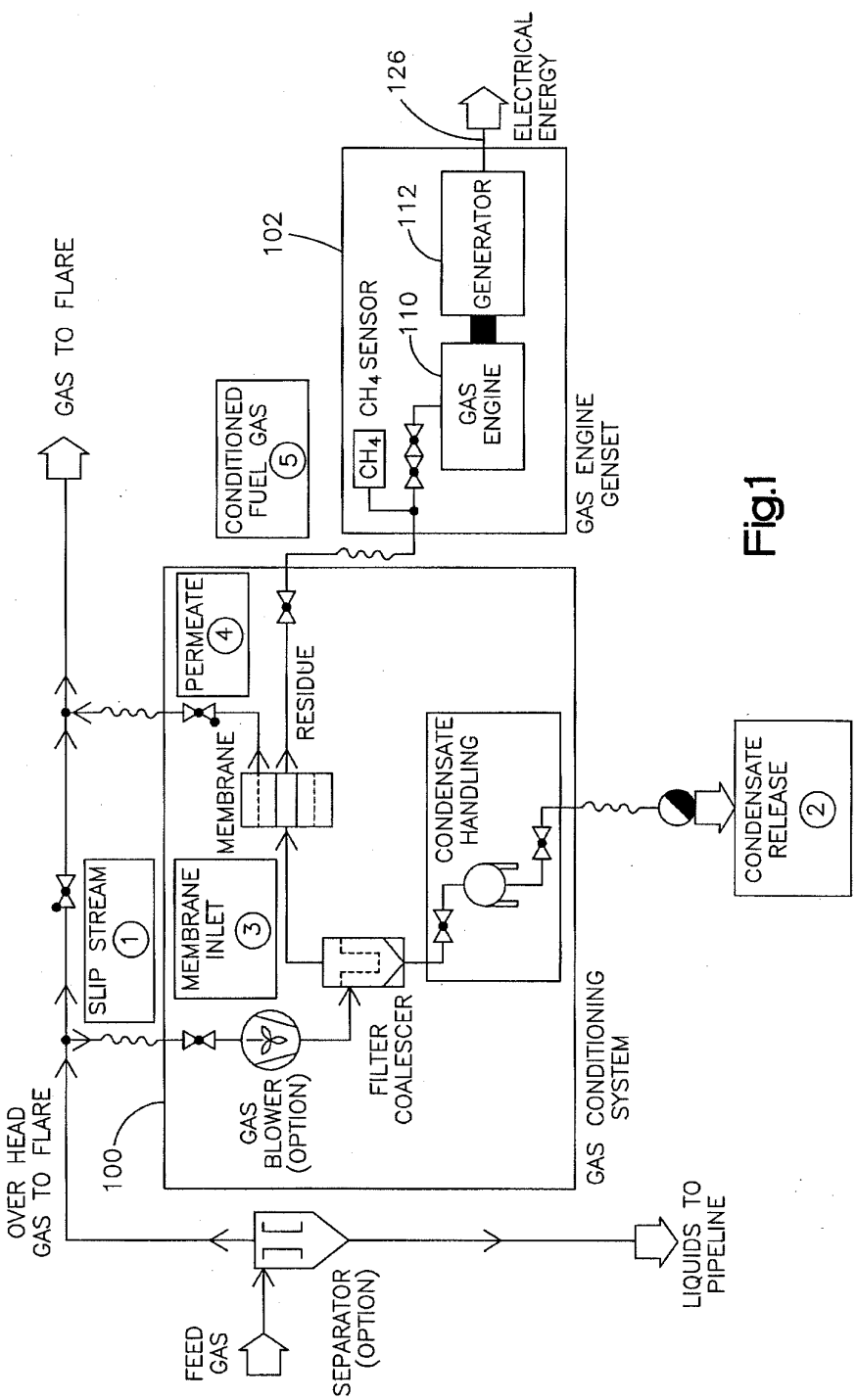

GAS TO FLARE
126
ELECTRICAL ENERGY
102
112
GENERATOR
110
CH_4 SENSOR
GAS ENGINE
CH_4
CONDITIONED FUEL GAS
5
GAS ENGINE GENSET
PERMEATE
4
RESIDUE
MEMBRANE
CONDENSATE HANDLING
CONDENSATE RELEASE
2
SLIP STREAM
1
MEMBRANE INLET
3
FILTER COALESCER
GAS BLOWER (OPTION)
100
GAS CONDITIONING SYSTEM
OVER HEAD GAS TO FLARE
FEED GAS
SEPARATOR (OPTION)
LIQUIDS TO PIPELINE

Fig.1

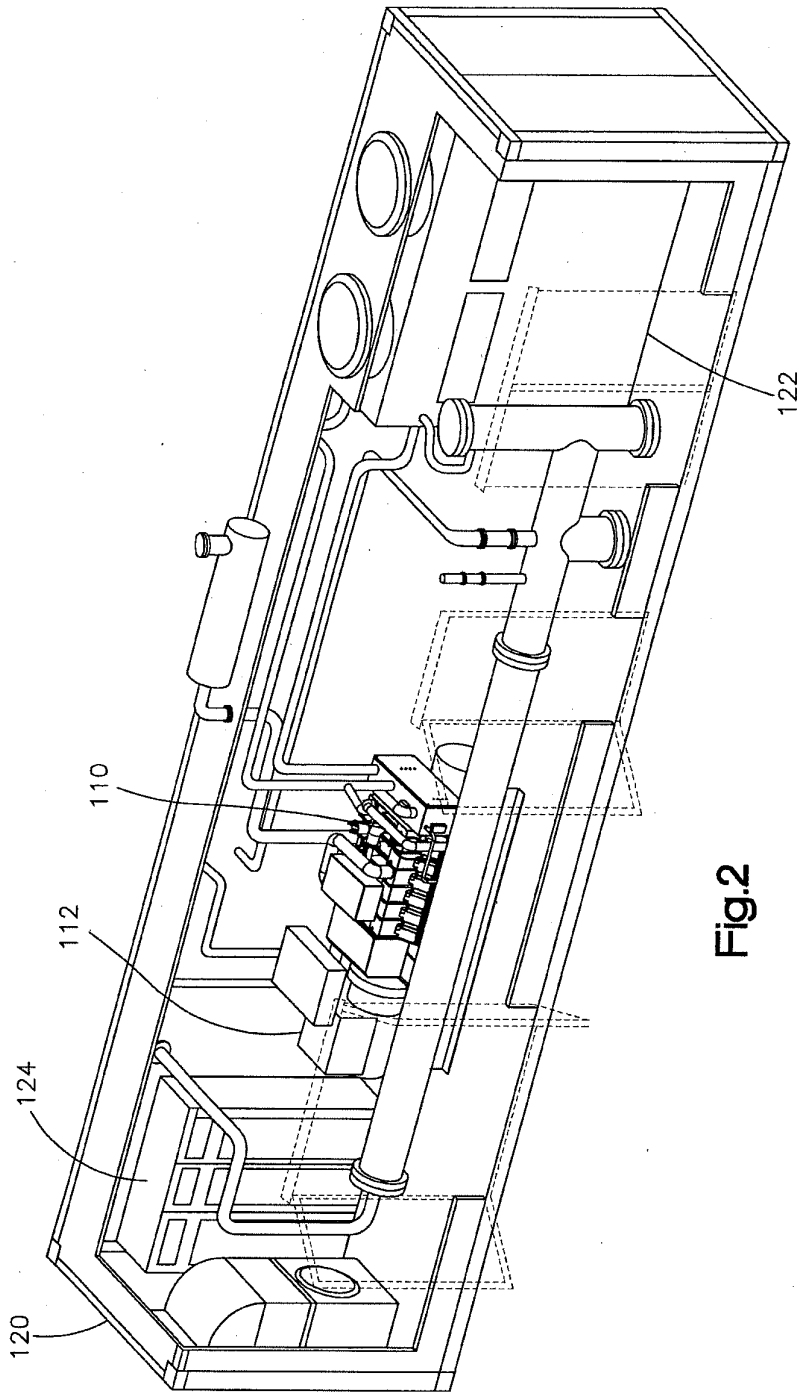


Fig.2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US15/15354

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B01D53/22; C10L3/10; E21B43/34 (2015.01)
CPC - B01D53/22; C10L3/10; E21B43/34
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): B01D53/22, 53/72, 61/06, 61/12; C10L3/10; E21B43/34 (2015.01)
CPC: B01D53/22, 53/72, 61/06, 61/12, 2257/7025, 2313/365; C10G2300/4068; C10L3/10; E21B43/34

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google Scholar; ProQuest; IP.com; Mobile, portable, trailer, transport, vehicle, platform, membrane, processing, apparatus, separation, raw, well, natural gas, clean, fuel, quality, purify, methane, electricity, engine, generate, production, sensor, repair, control, cable

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,955,704 B1 (STRAHAN, RL) 18 October 2005; figures 1-2; column 2, lines 3-66; column 3, lines 6-35; column 4, lines 27-67; column 5, lines 1-38	1-9
Y	US 4,597,777 A (GRAHAM, TE) 1 July 1986; abstract; column 1, lines 26-47; column 2, lines 50-65	1-9
Y	US 2008/0296018 A1 (ZUBRIN, RM et al.) 4 December 2008; paragraphs [0062], [0212], [0214], [0220]	4-6
A	US 2013/0186133 A1 (PLOEGER, JM et al.) 25 July 2013; entire document	1, 4, 7
A	US 2014/0038070 A1 (PAPILE, CJ) 6 February 2014; entire document	1, 4, 7
A	US 2012/0017639 A1 (PETERSON, ER et al.) 26 January 2012; entire document	1, 4, 7

☐ 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
"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	Date of mailing of the international search report
17 April 2015 (17.04.2015)	18 MAY 2015
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774