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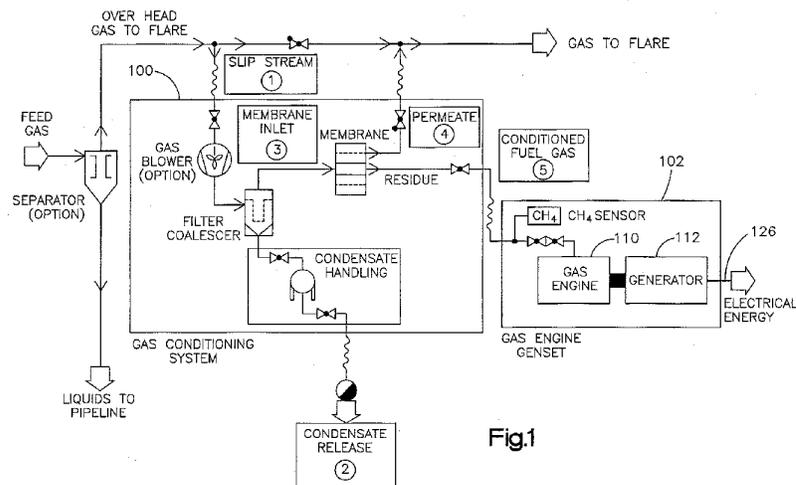


Fig.1

(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

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## 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 H<sub>2</sub>S 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

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