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(54) **SYSTEM AND PROCESS FOR EXTRACTING OIL AND GAS BY HYDRAULIC FRACTURING**

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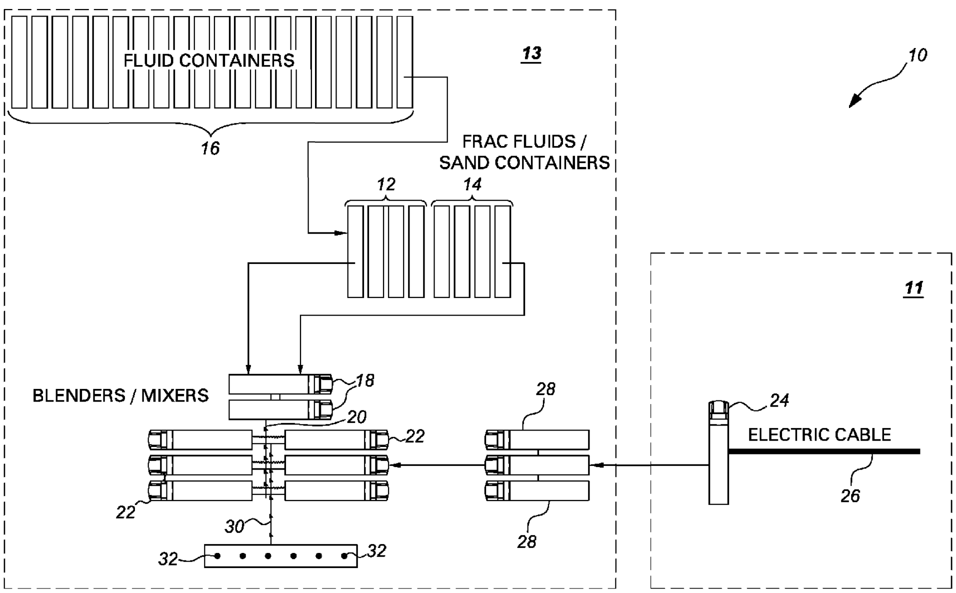
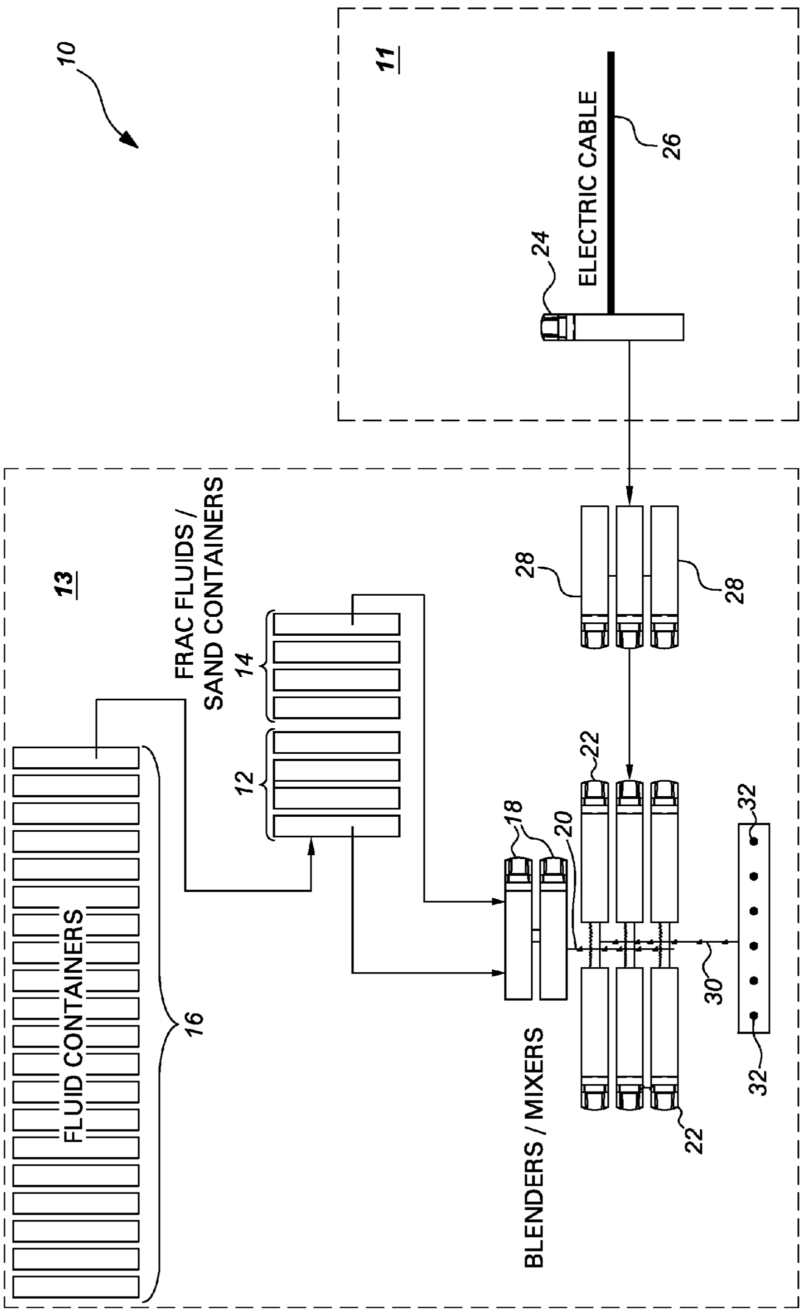
(57) **ABSTRACT**

A fracturing system is described. The system includes an electric motor-driven pumping sub-system, configured to pump a pressurized fracturing fluid into at least one wellbore, under high pressure conditions sufficient to increase the downhole pressure of the wellbore, to exceed that of the fracture gradient of the solid matter surrounding the wellbore. The system also includes an electric power generation sub-system that provides energy to the pumping sub-system. The electric power generation sub-system includes a multitude of electric motors that are powered by a single electrical feed source. A related process for extracting hydrocarbons from a reservoir rock formation by the fracturing operation is also described.

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BLENDERS / MIXERS

Fig. 1

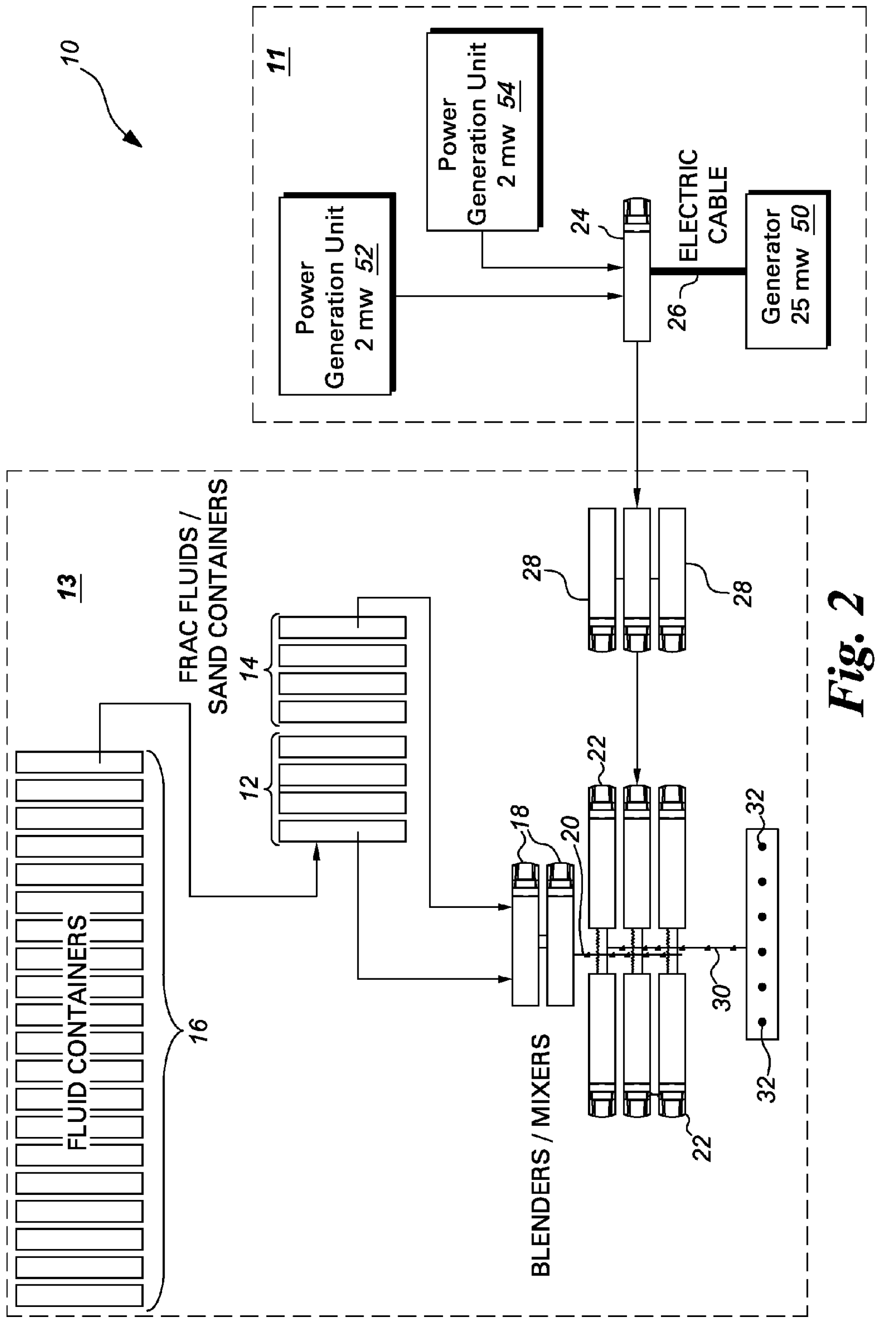
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Fig. 2

SYSTEM AND PROCESS FOR EXTRACTING OIL AND GAS BY HYDRAULIC FRACTURING

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This Application claims the benefit of U.S. Provisional Application No. 61/649,563, filed May 21, 2012, which is herein incorporated in its entirety by reference.

TECHNICAL FIELD

[0002] This invention relates generally to the extraction of hydrocarbons from reservoir rock formations. In some specific embodiments, the invention relates to a portable and modular system that can be transported to an oil or gas field, and used to stimulate production from an oil or gas well.

BACKGROUND OF THE INVENTION

[0003] Hydraulic fracturing or "fracing" is a process for increasing the flow of oil or gas from a well. It is usually carried out by pumping specific types of liquids into a well, under pressures that are high enough to fracture the rock. A network of interconnected fractures are formed, and they serve as pore spaces for the movement of oil and natural gas to the wellbore. When used in combination with techniques such as horizontal drilling, hydraulic fracturing is capable of converting previously-unproductive rock formations into large natural gas fields, for example.

[0004] A hydraulic fracture is typically formed by pumping the fracturing fluid into the wellbore at a rate sufficient to create a downhole pressure that exceeds the fracture gradient of the surrounding rock. The rock cracks, and the fracture fluid continues farther into the rock, extending the crack into the depth of the well. Often, a proppant (as discussed below) is added into the injected fluid, to prevent the fractures from closing when the injection is stopped. The fracture that remains open is permeable enough to allow the flow of the desired gas or oil to the well, and eventually, to the surface for collection. The fracturing technique can be especially productive in the case of wells formed by horizontal drilling. These types of wells are formed by drilling holes that are substantially lateral, i.e., parallel with the rock layer that contains the fuels to be extracted. The lateral wells can have tremendous lengths, e.g., up to about 10,000 feet, after an initial, vertical depth into the rock formation.

[0005] Hydraulic fracturing equipment that is used in oil and natural gas fields includes a large number of components. Blenders, high-volume fracturing pumps, monitoring units, material tanks, hoses, electronics systems, and power units are just some of the components required for these operations. In a typical fracturing operation currently practiced, a large number of tractor trailers are used to support individual sets of diesel engines and fracturing pumps, along with associated equipment, such as transmission systems. As one example, 16 tractor trailers may support 16 diesel-powered, 2000 hp fracturing pumps. (Two of the engine/pump sets are typically employed for back-up purposes). High-capacity, high-power hydraulic pumps (e.g., triplex or quintuplex types) are commercially available from a number of sources. Collectively, the pumps provide sufficient pressure into one or more wellbores, to allow for the injection and movement of the slurry (water, proppants, and chemical additives), through thousands of feet of earth and rock. Fracturing equipment needs to be designed to operate over a wide range of pressures and injection rates, and can operate at about 100 Mpa (15,000 psi) or higher; and 265 L/s (100 barrels per minute), or higher. The power needed for these operations can exceed 20-30 megawatts.

[0006] A number of drawbacks are associated with most of the current types of fracturing equipment and systems. For example, the mechanical collection of many diesel engines and many pumps can lead to high inefficiencies in the overall pumping operation. Part of this inefficiency is due to maintenance requirements for each of a multitude of engines, and the potential for engine break-downs.

[0007] The use of large amounts of diesel fuel can also require extra safeguards, to address potential safety, noise, and environmental problems. Moreover, the number of tractor trailers required for the conventional fracturing system represents a relatively large and undesirable "footprint" at the drilling/fracturing site. (Since the use of diesel engines mandates the use of diesel fuel, additional space is required for diesel fuel tankers). This potentially large truck fleet also has significant "community impact", in terms of traffic congestion and road-surface wear and tear.

[0008] In view of some of these concerns and challenges, new hydraulic fracturing systems would be welcome in the industry. The new systems should reduce the number of diesel engines required for the pumping sub-system in a fracturing operation. The new systems should also simplify the power-delivery mechanism for energizing all of the pumps required for the fracturing process. In some preferred embodiments, the new systems should also reduce the amount of large equipment required at a hydraulic fracturing site, thereby reducing the ecological footprint at the site.

BRIEF DESCRIPTION

[0009] One embodiment of the invention is directed to a fracturing system, comprising:

[0010] a) an electric motor-driven pumping sub-system, configured to pump a pressurized fracturing fluid into at least one wellbore, under high pressure conditions sufficient to increase the downhole pressure of the wellbore, to exceed that of the fracture gradient of the solid matter surrounding the wellbore; and

[0011] b) an electric power generation sub-system that provides energy to the pumping sub-system, comprising a multitude of electric motors that are powered by a single electrical feed source.

[0012] Another embodiment of the invention is directed to a process for extracting hydrocarbons from a reservoir rock formation by a hydraulic fracturing operation, comprising the step of introducing a hydraulic fracturing treatment fluid into a subterranean formation at a pressure sufficient to form or to enhance at least one fracture within the subterranean formation. In this method, the fracturing treatment fluid is pumped into at least one wellbore in the subterranean formation by an electric motor-driven pumping sub-system, configured to pump the fluid into the wellbore under high pressure conditions sufficient to increase the downhole pressure of the wellbore, to exceed that of the fracture gradient of the solid matter surrounding the wellbore. The pumping sub-system is energized by an electric power generation sub-system that provides energy to the pumping sub-system, and the power generation sub-system comprises a multitude of electric motors that are powered by a single electrical feed source.

DRAWINGS

[0013] FIG. **1** is a schematic representation of a hydraulic fracturing system according to some embodiments of this invention.

[0014] FIG. **2** is a schematic representation of a hydraulic fracturing system according to other embodiments of the invention.

DESCRIPTION OF THE INVENTION

[0015] Approximating language, as used herein throughout the specification and claims, may be applied to modify any quantitative representation that could permissibly vary, without resulting in a change in the basic function to which it is related. Accordingly, a value modified by a term or terms, such as "about", is not limited to the precise value specified. In some instances, the approximating language may correspond to the precision of an instrument for measuring the value. The terms "first," "second," and the like, herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another.

[0016] As used herein, the terms "may" and "may be" indicate a possibility of an occurrence within a set of circumstances; a possession of a specified property, characteristic or function; and/or qualify another verb by expressing one or more of an ability, capability, or possibility associated with the qualified verb. Accordingly, usage of "may" and "may be" indicates that a modified term is apparently appropriate, capable, or suitable for an indicated capacity, function, or usage, while taking into account that in some circumstances, the modified term may sometimes not be appropriate, capable, or suitable. For example, in some circumstances, an event or capacity can be expected, while in other circumstances, the event or capacity cannot occur. This distinction is captured by the terms "may" and "may be", or "can" or "can be".

[0017] A hydraulic fracturing system is described herein. The system can be used as a drilling and stimulation technique, e.g., as a procedure that can increase the flow of oil or gas (e.g., natural gas) from a well within subsurface rock. The system comprises an electric motor-driven pumping sub-system. The sub-system is configured to pump a pressurized fracturing fluid into at least one wellbore, under high pressure conditions sufficient to increase the downhole pressure to exceed that of the fracture gradient of the rock surrounding the wellbore. The system further comprises an electric power generation sub-system that provides energy to the pumping sub-system. (For simplicity, the pumping sub-system and power sub-system may be referred to herein as the "pumping system" and the "power system", respectively).

[0018] In some preferred embodiments, the pumping system comprises a multitude of electric motors that are powered by a single electrical feed source, e.g., an electrical feeder. The source of the electrical feeder (directly or indirectly) may be a transmission line, sub-station, power generation facility, or a dedicated power generation sub-system, for example. (As exemplified herein, the power generation system or sub-system may be located on-site or off-site).

[0019] Moreover, in some specific cases, the electrical feed source may comprise at least one gas turbine engine. The gas turbine engine could be situated in a location remote from the pumping system. Alternatively, the gas turbine could be located on the same site (sometimes referred to as a "well-pad") as the pumping system. In some embodiments, the gas turbine can be fueled by natural gas, oil, or other carbon-based fuels that are obtained at the site, e.g., after drilling and stimulation of some of the well(s). (In other embodiments, the fuel can be piped to the site, or transported there via truck, and the like).

[0020] The pumping system may be arranged in many different ways, depending in part on various factors. They include: the size of the hydraulic fracturing operation, and any associated drilling operations. The size of the operations depends, in turn, on other factors as well, such as the vertical depth and horizontal length of the drilling and fracturing operations; the type and composition of earth and rock through which the drilling/fracturing operations will proceed; as well as the general drilling/fracturing system design. As briefly described herein, hydraulic fracturing operations often require a great deal of power for the pumping operation.

[0021] In one embodiment, the pumping system comprises one or more platforms, which can be mobile. Each platform can support one or more pumps, and one or more electrical motors, which together are sometimes referred to as pumping units or "pumpers". An electrical motor could power multiple pumps. However, in some specific embodiments (though not all embodiments), each electrical motor provides power for one pump. Techniques for providing the physical and electrical connections between the pumps and the motors are known in the art.

[0022] Many different types of pumps may be used; and they are commercially available from well-fracturing companies, or other drilling and drilling-support companies. Examples of pump suppliers include Baker Hughes, Halliburton, Weatherford, Weir Oil & Gas, and Bosch Rexroth. The size of each pump will depend on various factors, such as the overall pumping requirements at the well site (in terms of pumping pressure and pumping rate, for example); and the size of the platform on which the pump will be located. In some embodiments, each pump has a capacity in the range of about 2,000 hp to about 3,000 hp, although this range can vary considerably.

[0023] As one non-limiting illustration, each mobile platform can be the bed of a truck, e.g., the bed of a tractor-trailer rig, or a trailer attached to such a rig. Heavy-duty tractor-trailers are often quite suitable for carrying pumps, motors, and drilling equipment. Their ability to travel on the highway and over many other roads is a distinct advantage for transport of the necessary equipment and materials to many drilling and fracturing sites.

[0024] Each tractor-trailer can accommodate at least one pump, and a motor to drive the pump. In some embodiments, each tractor-trailer supports two pumps and two electric motors, each associated with one of the pumps. As described briefly below, the ability to energize each motor from a single electrical feed source is a distinct advantage over prior art systems, e.g., those that rely on dedicated, direct-drive engines on each tractor-trailer.

[0025] Hydraulic fracturing operations include a number of different types of equipment and operational units, and substantially all of the equipment and materials must be located at the site of the fracturing operation. In general, the fracturing operations can include:

[0026] 1) supply containers for fracturing fluid components (including large water supplies), sand and/or other proppants, and various fracturing chemicals/additives;

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