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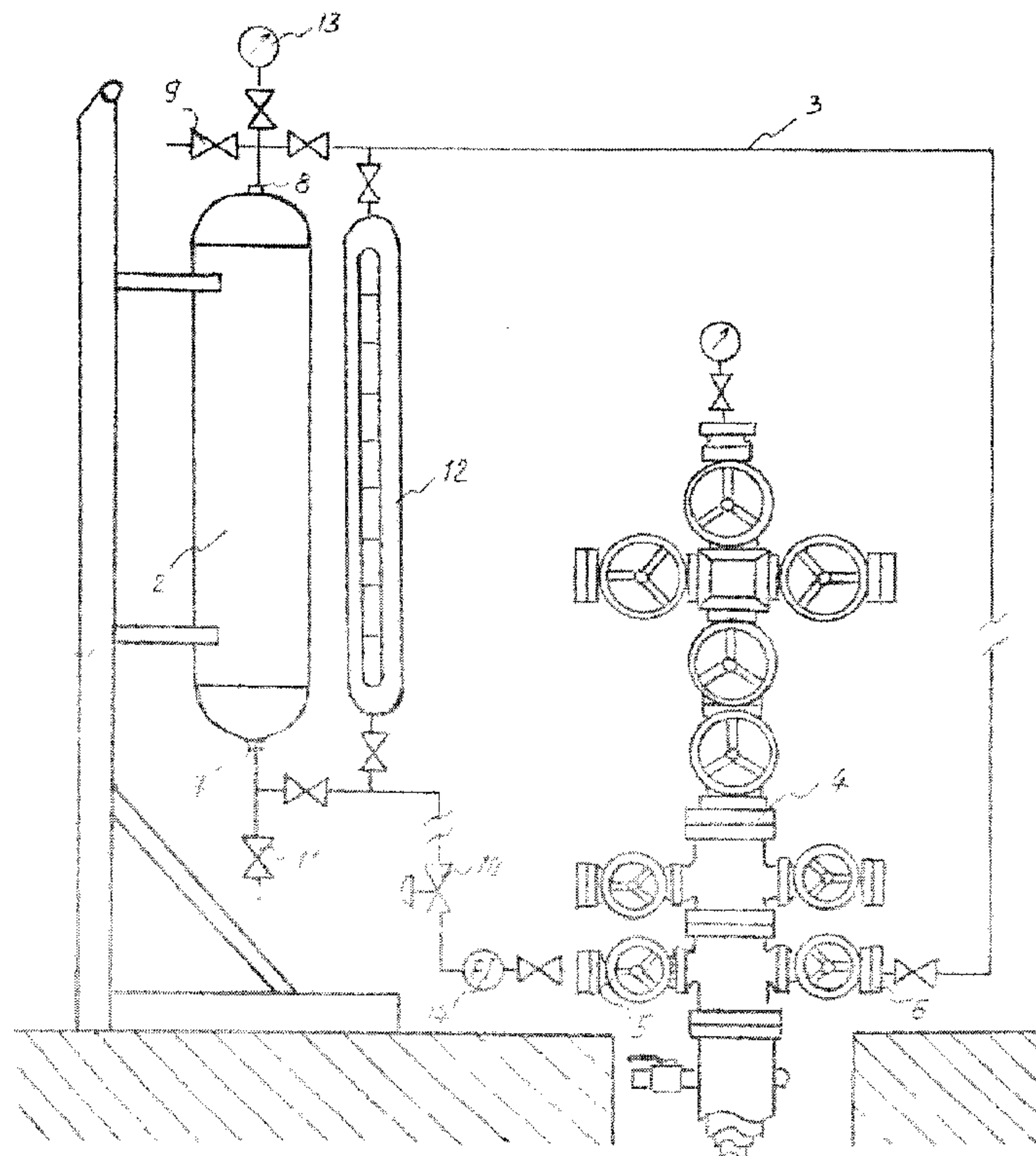
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(54) Title: GRAVITATIONAL DISPLACEMENT APPARATUS (GDA)



(57) **Abrégé/Abstract:**

An apparatus and method for treating sustained casing annulus pressure (SCP) and surface casing vent flow (SCVF) by continually and consistently injecting higher density fluid into the annulus of a petroleum well via the connected apparatus. As the higher density fluid is drip fed into the annulus, it slowly migrates downwards and displaces lower density fluids and gasses due to the pull of gravity, thus helping to control or eliminate SCP by creating the hydrostatic column in the annulus.

ABSTRACT

An apparatus and method for treating sustained casing annulus pressure (SCP) and surface casing vent flow (SCVF) by continually and consistently injecting higher density fluid into the annulus of a petroleum well via the connected apparatus. As the higher density fluid is drip fed into the annulus, it slowly migrates downwards and displaces lower density fluids and gasses due to the pull of gravity, thus helping to control or eliminate SCP by creating the hydrostatic column in the annulus.

PROVISIONAL PATENT APPLICATION

TITLE

Gravitational Displacement Apparatus (GDA)

ABSTRACT

This invention relates to the Oil & Gas industry and can be used to remediate gas migration behind the casing, sustained casing pressure and surface casing vent flow on any type of oil and gas well. GDA is a device that uses gravitational force to apply the “lube and bleed” method to gradually fill micro channels in cement sheath between inner and outer casings with heavy fluid, and displace hydrocarbon gas and other lightweight fluid as it migrates downward.

BACKGROUND

Field of the Invention:

This invention relates to the Oil & Gas industry and can be used to remediate gas migration behind the casing, sustained casing pressure and surface casing vent flow on oil and gas (petroleum) wells using the “lube and bleed” remediation method. The apparatus creates a simple, low cost and low maintenance solution compared to what is currently being used in the industry.

Description of the Related Art:

The existing application of the “lube and bleed” method in the industry typically requires frequent use (daily, weekly etc) of pumping equipment at the well site, in order to inject small amounts of fluid into the annulus of a well. Not only is this method time consuming, labor intensive and costly, it also can be difficult to perform on wells in remote locations and wells with limited access.

There are other systems on the market that attempt to remediate these issues. For example, Casing Annulus Remediation System (CARS), US patent US 6186239 B1 (U.S. Pat. No. 5,927,405). CARS is a system for remediation of casing pressure by pumping heavy brine between casing strings. The system uses a hose, which is inserted between the casings through a casing spool outlet to required depth, then heavy brine is pumped to displace lighter fluid with heavy one. This system is not very practical and not widely used in the industry due to its limitations, which include difficulty inserting the hose into the very narrow space between casings. Additionally, for wells with the casing cemented to surface, it would be impossible to insert the hose using the CARS method.

FIELD OF THE INVENTION

This invention relates in general to well remediation systems in the oil and gas industry, and in particular to the apparatus and methods used for filling an annulus in a well with high density brine, or other similar media, to control or eliminate sustained casing pressure.

BACKGROUND

Sustained casing pressure (SCP) and surface casing vent flow (SCVF) is exhibited by many wells and is a large-scale problem in the oil and gas industry worldwide. It presents safety hazards, regulatory concerns and environmental impacts. A failure to manage casing annulus pressures may result in well blowouts or other events that may cause significant damage to property, the environment, and personnel.

In the petroleum industry, oil and gas wells have multiple casings of different sizes that are suspended from a wellhead. SCP is often caused by persistent gas and liquid migration through the leaking cement sheath in a well's casing annuli, but can also be caused due to, but not limited to, leaks in casing wellhead seals or poor primary cement job.

In some jurisdictions, wells are operated with a surface casing vent in the open position. A well that has a leak or exhibits SCP, may also exhibit surface casing vent flow (SCVF) if the fluid or gas entering the annulus is allowed to escape through the surface casing vent and released into the atmosphere, causing environmental damage.

To control the annular pressure, the "bleed-and-lube" method is often used in the industry. This typically involves rigging up to a well and pumping high-density fluid, typically brine, into the annulus through one vent at the upper end of the well, then bleeding off lighter fluid and gas using a second well valve, which gets displaced when heavy brine migrates downward. This technique is time consuming, expensive, and may not get the pressure under control if incorrectly administered by a field engineer or a service company.

DESCRIPTION OF RELATED ART

Another method of SCP remediation utilizes a CARS unit (Casing Annulus Remediation System, **US6186239B1**), which pumps high-density fluid into the annulus using a pressurized tube through an access port in the wellhead. However, in addition to multiple steps and equipment required, this system is relatively impractical because the delivery tube typically encounters various obstacles, making it difficult to insert deep into the annulus. Further, if the casing itself is cemented to the surface, the tube cannot be inserted to the annulus at all, limiting its use.

Other SCP remediation methods focus on the composition of high-density fluids by adding various additives to prevent the fluid from dissipating or mixing with the lighter density fluid.

BRIEF SUMMARY OF THE INVENTION

This apparatus and method addresses the ongoing industry need for an effective, cost efficient and low maintenance remediation process to manage SCP and SCVF within an annulus.

This apparatus, placed on the ground slightly above the well with equipped support stands, attaches to two well valves using standard industry piping and connectors. Once the pressure vessel is filled with high-density brine or other similar media, the equipped needle valve is opened, allowing pressure to equalize between the well annulus and the vessel. The brine will then start to drip feed into the casing annulus by gravitation, without the need for a pump. The drip rate can be adjusted by the needle valve. As the brine slowly migrates downward, it displaces lighter fluids and gases, which rise up the annulus column and eventually through the second valve back into the vessel, to be bled off upon refill with more high density brine.

In the preferred method, the high-density brine is drip fed into the casing annulus using the equipped needle valve with sight. By decreasing the flow, the brine is allowed to slowly absorb and migrate downwards without dispersing out of the second valve. This method allows for the use of any type of high-density brine, without the need for any specific type of formulation.

The pressure vessel can be of any shape (ex. sphere, cylinder, cube) and any size. The size of the vessel would determine the amount of brine it can store, thereby requiring fewer refills and/or faster drip rate. The apparatus may further optionally

have a digital fluid level sensor with wireless connection to notify an operator when a refill is required.

These and other features of the present invention are more fully set forth in the detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawing illustrates an example of the apparatus, in the shape of a cylinder, coupled to a wellhead assembly.

DETAILED DESCRIPTION

The apparatus and method of the present invention will now be described more fully hereinafter with reference to the accompanying drawings in which some, but not all, embodiments of the invention are shown. Indeed, various embodiments of the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout. For the convenience in referring to the accompanying figures, directional terms are used for reference and illustration only. For example, the directional terms such as "upper", "lower", "above", "below", and the like are being used to illustrate a relational location.

Referring to the accompanying drawing, the pressure vessel in the shape of a cylinder **2** is placed on the ground next to a well **4** with the equipped support stands **1**, such that it sits

slightly higher than the wellhead valves **5** and **6**. Using standard industry piping and fittings **3**, the cylinder connects to a well through two outlet wellhead valves, into one of which the higher density fluid is injected **5** and from the other **6** where the lower density fluid and gasses are returned back into the cylinder through displacement, to be bled and withdrawn upon refill. The cylinder has a minimum of two connections, one lower **7**, from which the higher density fluid flows through the piping **3** and into the wellhead valve **5**, and one higher **8**, into which lower density fluid and gasses are returned back into the cylinder from the second wellhead valve **6**.

The larger the cylinder, the greater the volume of brine it can store, which allows for less frequent refills and bleed offs.

Once filled with high-density brine or other similar media through fill valve **9**, the equipped needle valve with sight **10** is opened and adjusted to allow the brine to drip feed into the casing annulus by gravitation through the well valve **5**. The rate of drip feed is can be adjusted depending on the type of well and its immediate requirements.

As the brine slowly migrates downward and deep into the casing annulus, it fills up micro channels and cracks along the way, displacing lighter fluids and gases. By raising the density and hydrostatic pressure in the fluid column, the casing annulus pressure is brought under control or into regulatory compliance. The displaced lower density gasses and fluids rise to the top of the wellhead, then exit from the second well valve **6** and back into the cylinder through the higher connection **8**. Once in the cylinder, the lighter density fluid

will be bled off upon refilling with more high-density brine. Using a lower bleed valve **11** at the lower connection on the cylinder, the lower density fluid is drained. Once the bleed process is complete, the cylinder is refilled with high-density brine using the fill valve **9**. A fluid level indicator **12** is used to visually determine when the cylinder needs to be refilled. Optionally, the fluid indicator can be digital with information transmission capability. The apparatus also includes industry standard pressure gauge **13** and an optional flow indicator **14**, which can measure and record volume of fluid injected.

It should be noted that a well may have more than two wellhead valves, depending on the number of casings a well contains. Therefore the apparatus should be connected to the valves where SPC is exhibited.

Generally it should be appreciated by one of skill in the art that many industry standard high-density fluids could be used with this apparatus, therefore not limited to any specific formulation. These fluids are generally comprised of liquid brine, including halide brines, formate brines, and acetate brines and may include additional additives and modifiers to meet specific needs and requirements.

This invention has significant advantages to current systems and methods. Once initially set up on site next to a well, the remediation process can be continual and consistent without the need for periodic manual 'bleed-and-lube' process from a field operator, thereby reducing cost, time and without production interruption. Depending on size, the apparatus is relatively mobile and can be placed on any well site, including wells in remote locations and can be left on site as

long as needed. Additionally, the apparatus can be placed on non-producing abandoned wells, which typically get overlooked because of high costs involved in the traditional process, thereby reducing environmental impact and meeting regulatory requirements at minimal cost, with the added benefit of powerless operation due to gravity.

It is to be understood that the subject of the present disclosure is intended to demonstrate a preferred embodiment of the invention and is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to those skilled in the art. As such, the techniques disclosed in the description represent techniques discovered by the inventors to function well in the practice of the invention, and thus can be considered to constitute preferred modes for its practice. However, those of skill in the art should, in light of the present disclosure, appreciate that many changes can be made in the specific embodiments which are disclosed and still obtain a like or similar result without departing from the scope of the invention. For example, in an alternative embodiment, a pump can be used to assist the injection of high-density fluid into the well valve, without needing the apparatus to be lifted higher such that the fluid will flow due to gravity alone. Accordingly, the subject disclosure is therefore to be limited only by the scope set out in the following claims.

Claims (8)

What is claimed is:

1. An apparatus for treating sustained casing annulus pressure (SCP) and surface casing vent flow (SCVF) by delivering high density fluid through gravitation, said apparatus comprising:
a pressure vessel capable of holding fluid, said vessel be pressure rated to meet wellhead requirements, and said vessel have a minimum of one connection port at the bottom and one connection port at the top;
adjustable stands to mount the vessel;
standard piping and fittings to connect the vessel to two wellhead valves;
needle valves;
secondary valves attached to both connection ports on the vessel;
pressure gauge;
fluid level indicator.
2. An apparatus according to claim 1 wherein:
the apparatus contains an optional pump to assist with pumping the high density fluid if gravitational setup is not possible due to well design and location.
3. An apparatus according to claim 1 wherein:
the needle valve contains an optional sight glass for visual drip feed control.
4. An apparatus according to claim 1 wherein:
the pressure vessel can be of any shape or size.
5. An apparatus according to claim 1 wherein:
the fluid level indicator can include, but not limited to, a sight glass, magnetic, or digital with or without information transmission capability.
6. An apparatus according to claim 1 wherein:

the adjustable stands can include wheels for ease of mobility to another well site.

7. A method of using the apparatus in claim **1** to drip feed the high-density fluid into the wellhead valve and subsequently into the casing annulus.

8. A method of using the apparatus in claim **1** on various types of wells, including but not limited to currently producing oil and gas wells, abandoned wells, remote wells.

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