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PROCESS FOR INCREASING THE PRODUCTION OF OIL WELLS

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16 Claims. (Cl. 166—21)

This invention relates to a process for increasing the production of oil wells and the recovery of oil and gas from subterranean oil sands.

In general, the invention relates to processes for increasing oil and gas production from oil wells in which a gas is forced under pressure into certain wells of a group or oil field in order to force the oil and gas in the oil bearing strata into adjoining wells from which the oil is pumped or allowed to flow. In systems of this type the usual practise is to use air as the pressure medium although other gases such as natural gas have been used. The wells or oil fields to be treated by a gas process are usually depleted of natural gas and yield relatively small amounts of oil. Moreover, natural gas is not always available in sufficient quantities for the purpose of the process.

Air forced under pressure into certain wells of a group moves the oil in the oil sand strata toward surrounding wells by direct pressure, due to air going into solution in the oil near the air pressure wells and later expanding near the pumping wells and by the carrying of oil vapors. The mechanism is probably the same when gases other than air are used but the oil obtained when air is used in the process is saturated with oxygen. Likewise the gas obtained, while containing some combustible constituents is rarely of much value because it contains such large quantities of air. If the gas does contain sufficient combustible constituents to be ignitable it is a dangerous material to handle or use because of its explosive character.

When air is used as a medium for forcing the oil through the sands a comparatively small amount of air is absorbed or dissolved in the oil. When the air is dissolved in the oil the physical nature of the oil is not materially changed. On the other hand, oil will absorb or dissolve a comparatively large amount of gas (some kinds of oil under pressure will absorb 100 vol. of gas for one vol. of oil) and the gas dissolved in the oil will have a very marked effect to lower the viscosity of the oil. The dissolved gas also decreases the surface tension of the oil and thus the oil with the decrease of viscosity and surface tension will migrate much more easily through the sands than the oil which does not have the dissolved gas.

In connection with the actual operation of such processes one of the most outstanding disadvantages resulting from the use of air is the increased trouble and expense caused by the excessive corrosion of the tubing and pumping equipment by aerated water and oil in the wells. For example,

a sediment interfering with pumping apparatus at a particular oil property where such a process was in use analyzed over 63 percent iron rust. Aside from the necessity of more frequently replacing corroded equipment the trouble caused by sediment getting into pumps and cutting the cups is considerable.

An important object of the present invention is to provide a process which will be effective in increasing the production of oil wells and at the same time prevent the excessive corrosion of equipment caused by the use of air.

A further object is to produce a combustible gas of relatively high and constant B. t. u. value which is adapted for use as a domestic and commercial fuel.

Other objects and advantages will be apparent from the following detailed description of the invention.

As indicated above the oil fields or oil bearing sands to which processes for increasing oil and gas production are usually applied are those which have been worked as long as possible by pumping methods and which are therefore on a poor paying basis. In many cases a vacuum may be applied to the wells in an effort to increase production, but it has been found that the gas obtained in this manner generally contains air or oxygen in amounts up to 40 per cent of the gas, due to the fact that the gathering lines connected between the wells and the vacuum pump leak and allow air to be drawn into the lines. The usual gas obtained by the use of vacuum pumps contains about one to five per cent oxygen, and this gas is very corrosive in all pipe lines. Furthermore, it is very corrosive in the oil equipment and is not desirable for this purpose.

In accordance with the present invention the gas obtained from pumping oil or gas wells in the manner referred to or natural gas obtained from any source, is treated in the usual manner for the removal of its gasoline content, after which the resulting gas under pressures of from 30 to 300 pounds per square inch is mixed with air under like pressures and passed through a heated catalytic chamber where all the free oxygen in the air-gas mixture is removed or fixed by the reaction with the combustible constituents of the gas. The temperature in the reaction chamber is preferably raised to about 700° F. to start the reaction after which no outside heat is necessary since the reaction is self-sustaining after once initiated. The catalytic or reaction chamber may be any of the well known types

in which gases are passed in contact with a heated catalyst, and under some conditions it is desirable to use a heat exchanger in connection therewith so that the heated gases leaving the catalytic chamber may be used to preheat the incoming gas mixture. Catalysts such as platinum, palladium, chromium, manganese, nickel or copper deposited on pumice or "Alundum" may be used in the chamber.

The gas leaving the reaction chamber or the heat exchanger as the case may be is distributed in high pressure mains and introduced into certain wells of a group or lease in the same manner in which air has been used heretofore, so that the gas will be employed to force or carry oil into adjoining wells which are being pumped. This gas is entirely devoid of free oxygen and therefore non-corrosive to the well casings and other equipment, since as generally appreciated oxygen is essential under ordinary conditions in order for corrosion to occur. Furthermore the oxidation of the unsaturated constituents of the oil does not occur in practicing the present invention as is undoubtedly the case when air is used, since large quantities of oxygen are absorbed in the operation, as may be indicated by the following analysis of an air-gas mixture obtained from a pumping well where air was used as a pressure medium in the oil sand strata:

Constituent	Percent
Carbon dioxide (CO ₂)	1.20
Oxygen (O ₂)	4.30
Nitrogen (N ₂)	73.70
Propane (C ₃ H ₈)	16.40
Butane (C ₄ H ₁₀)	4.40

Instead of carrying out the gas treatment in the catalytic chamber under the excessively high pressures often required on the wells, pressures from 30 to 60 pounds per sq. in. may be used and the resulting gas put under the desired pressure after leaving the catalytic chamber.

The invention also contemplates the regulation of the percentages of gas and air in the air-gas mixture in accordance with certain variable conditions which may exist in the different fields to which the invention may be applied, in order to obtain from the pumping wells a gas (after removal of gasoline), which will have a relatively high and constant heating value. Where the sand stratum being treated is comparatively porous the gas will pass more rapidly from the gas pressure wells to the pumping wells and therefore undergo less change in composition. Accordingly under such conditions the percentage of air in the gas-air mixture passed into the reaction chamber and the pressure of the gas passed into the wells should be less or a back pressure should be maintained at the pumping wells until the gas recovered from these wells reaches the desired composition. However, where the stratum is rather compact a more diluted gas and higher pressures may be employed with no back-pressure at the pumping wells. Since the natural gas used to make up the air-gas mixture has a heating value of approximately 1150 to 1300 B. t. u. the percentages of air may vary widely or from 25% to 80% of the mixture, which, after passing through the reaction chamber will have a heating value of from 1000 to 200 B. t. u. Under ordinary conditions a low heating value gas or a gas having practically no heating value is preferably used, especially where a heating gas

of only moderate B. t. u. is required from the pumping wells.

Obviously the combustible gas used in the process may come from any convenient source, and may comprise, for example, natural gas, coal gas, producer gas, water gas, or gas from the pumping wells in the oil field being treated, but in any case sufficient combustible gas must be used to fix the free oxygen in the air-gas mixture.

A very important advantage of the process, aside from preventing corrosion of the equipment by using a non-corrosive pressure medium, that is, a pressure medium devoid of free oxygen, results from the fact that a large increase in the volume of gas leaving the reaction is obtained over that entering. This increase in gas volume is especially important when it is remembered that in some instances natural gas cannot be obtained in sufficient quantities, is too expensive, or the use of manufactured gas must be resorted to. According to the present invention a small volume of one of these combustible or semi-combustible gases may be increased, have their B. t. u. value lowered and rendered non-corrosive where by the stimulation of oil and gas, production is carried on much more efficiently than heretofore.

In the art of increasing the production of oil wells various operating methods have been proposed for utilizing air under pressure in the oil sand strata, such for example, as applying the pressure medium to certain wells and a reduced pressure on others. It is to be understood, however, that the present process is not limited to any particular procedure except as may be defined in the claims, but it may be applied in any desirable manner, for example the non-corrosive (oxygen free) gas may be introduced into any or all wells of a group for any period of time sufficient to charge the oil and oil bearing strata with the gas, after which the pressure is released on any or all wells and the oil recovered in any convenient manner the same as if the field were new.

After the system is once in operation the combustible gas taken from the producing wells may be stored in abandoned or even in other wells which are being or which have been worked or which are to be worked by the process. Or in case a back pressure is used on the pumping wells they may be used to a certain extent for storage and the gas withdrawn as required for the process or domestic and commercial purposes. Where a back pressure is used as suggested it is apparent that the combustible gas obtained will contain no free oxygen as does gas from gas pumping wells or oil fields in which air is used as a pressure medium.

When high percentages of air are used in the gas mixture entering the reaction chamber steam may be admitted in order to prevent the temperature from rising too high and at the same time to increase the volume and heating value of the gas, since at the temperatures attained (1200°-1800° F.) the steam is converted into water gas by the interaction with the carbon constituent in the gas mixture.

In the application of the above described process the use of back pressure on the oil pumping wells particularly after the flow of oil has increased is very desirable because the more gas that can be dissolved in the oil the more fluid it becomes and in the end a better yield will be obtained.

The present process is very advantageous where there is a small volume of natural gas

available because if the B. t. u. value of the gas is 1000 to 1300 and this B. t. u. value is reduced from 200-500 the volume will be increased several times. Thus a good non-corrosive gas can be produced at a low cost. Further, when this low B. t. u. gas is introduced into the oil sands it will absorb hydrocarbons which will substantially increase its B. t. u. value and thus make it suitable as a fuel for domestic and industrial purposes when it is recovered from the wells along with the oil. The gas formed by the above treatment is a hydrocarbon gas containing some carbon monoxide and this gas is readily soluble in petroleum oil. Therefore this gas is very advantageous in reducing viscosity and the surface tension of the oil, and thus assists in moving the oil through the sands to the outlet wells. Some of the hydrocarbons of the oil will be retained by the gas and this hydrocarbon gas mixture will have a higher B. t. u. value than the gas which is originally forced into the oil sands.

While the process has been described mainly in connection with oil fields or wells which must be pumped or wells in which the yield of oil is small, it is nevertheless to be understood that the invention is not limited thereto since it has equal advantage and may be used to increase production of flowing wells or wells already producing large quantities of oil.

The preferred form of the invention having been thus described, what is claimed as new is:

1. In the process of increasing the production of oil wells, in which a gas under high pressure is forced into selected wells of a group to move the oil into the other wells of the group the improvement which comprises, mixing natural gas with a small proportion of air, passing the mixture through a heated catalytic chamber whereby free oxygen in said mixture is fixed, and passing the resulting gas under high pressure into said selected wells to move said oil.

2. The process of increasing the production of oil wells, which comprises mixing an oxygen containing natural gas with a small proportion of air, passing said mixture through a heated catalytic chamber whereby the free oxygen in said mixture is fixed and passing the resulting gas under superatmospheric pressure into selected wells of a group whereby oil contained in the oil bearing strata is moved into the other wells of the group.

3. The process of obtaining oil and gas from oil bearing strata, which comprises preparing a non-corrosive combustible gas substantially devoid of free oxygen and containing a substantial proportion of combustible constituents, introducing said gas under high pressure into said strata whereby oil and gas are moved outward from the point of introduction of said combustible gas and collecting said oil and gas in wells removed from and surrounding said point of introduction.

4. In the process of increasing the production of oil wells, in which a gas under high pressure is forced into selected wells of a group to move the oil into the other wells of the group the improvement which comprises, passing a non-corrosive combustible gas substantially devoid of free oxygen and containing a substantial proportion of combustible constituents into said selected wells, maintaining a back pressure on said other wells while removing oil therefrom and withdrawing gas from said other wells as its heating value approaches a desired maximum.

5. The process of stimulating the production of oil and gas from oil sand strata, which comprises simultaneously increasing the volume of, decreasing the B. t. u. value of and rendering a corrosive combustible gas mixture non-corrosive, and introducing the resulting gas substantially devoid of free oxygen and containing a substantial proportion of combustible constituents into an oil sand stratum to stimulate production of oil and gas therefrom.

6. The process of treating oil bearing strata, which comprises passing a gas mixture containing uncombined oxygen and a substantial proportion of combustible constituents into contact with a highly heated catalyst whereby the free oxygen content thereof is fixed and the volume thereof increased, and introducing the resulting gas into the oil bearing strata to stimulate production of oil therefrom.

7. In the process for stimulating the production of oil and gas from oil-bearing strata in which a gaseous pressure medium is introduced into said strata through oil well casings, the improvement which comprises preparing a non-corrosive gaseous pressure medium from an oxygen containing combustible gas, and thereafter introducing the resulting gaseous medium substantially devoid of free oxygen and containing a substantial proportion of combustible constituents into the oil-bearing strata through said casings, whereby corrosion of said casings is substantially prevented.

8. In the process for increasing the production of oil wells in which a gaseous pressure medium is forced into the oil-bearing strata drained by said wells, the improvement which comprises passing a combustible gas through a heating zone to fix its free oxygen content, and thereafter passing the resulting gas containing a substantial proportion of combustible constituents into said strata.

9. The process of stimulating oil production from oil bearing strata, which comprises passing a natural combustible gas containing free oxygen over a heated catalyst in a reaction zone to fix said free oxygen and thereby render said gas substantially non-corrosive to oil well casing, cooling the resulting gas containing a substantial proportion of combustible constituents and introducing it under a superatmospheric pressure into the oil bearing strata.

10. The method of recovering hydrocarbons from hydrocarbon containing rock and sand which consists in introducing therein a gas comprising carbon monoxide and hydrogen, substantially as set forth.

11. The method of recovering hydrocarbons from natural hydrocarbon containing rock and sand which consists in introducing water gas into the wells, substantially as set forth.

12. In the process of increasing the production of hydrocarbons from oil wells in which a pressure medium is forced into the oil bearing strata penetrated by said wells, the improvement which comprises fixing the free oxygen content of a mixture of natural gas and a small proportion of air, and thereafter forcing the resulting mixture into the said oil bearing strata.

13. In the process of increasing the production of hydrocarbons from oil wells in which a gaseous pressure medium is forced into the oil bearing strata penetrated by said wells, the improvement which comprises catalytically fixing the free oxygen content of a mixture of com-

bustible gas containing a small proportion of air, and thereafter forcing the resulting gaseous mixture into the oil bearing strata.

14. In the process of increasing the production of hydrocarbons from oil wells in which a gaseous pressure medium is forced into the oil bearing strata penetrated by said wells, the improvement which comprises forcing into said oil bearing strata a gaseous pressure medium comprising a non-corrosive combustible gas substantially devoid of free oxygen and containing a substantial proportion of combustible constituents.

15. In the process of increasing the production of hydrocarbons from oil wells in which a

gaseous pressure medium is forced into the hydrocarbon bearing strata penetrated by said wells, the improvement which comprises forcing into said strata a gaseous pressure medium comprising carbon monoxide and hydrogen.

16. In the process of increasing the production of hydrocarbons from oil wells in which a gaseous pressure medium is forced into the oil bearing strata penetrated by said wells, the improvement which comprises forcing into the said strata a gaseous pressure medium devoid of free oxygen and comprising natural gas, carbon monoxide and hydrogen.

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