

UNITED STATES PATENT OFFICE

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METHOD OF DEVELOPING OIL FIELDS

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This invention relates to the development of oil fields and more particularly to a method of extracting oil from the oil sand in such a manner that the gas occurring with the oil may be utilized to the best advantage in forcing the oil from the sand and carrying it to the surface.

In developing oil fields, some operators hurriedly bring the property to full development, each well as it is brought in being allowed to flow oil and gas without any particular control being exercised over the individual wells or a group of wells. The nearest approach to control that is sometimes practised is the maintaining of a back-pressure on the wells. This plan of development gives a rapidly increasing daily production which reaches a peak rather early in the life of the property and thereafter rapidly declines as the gas pressure falls. It has the disadvantage that the early production of oil is usually greatly in excess of the facilities which will properly handle subsequent production, thus necessitating equipment far in excess of what is required for a later production.

Most operators prefer to bring production rapidly up to a point where it can be readily handled by normal equipment and then discontinue further drilling until such time as the wells begin to decline after which new wells will be drilled as in the preceding plan. However, no particular control over the wells except possibly, back-pressure, is practised. Moreover, as the wells are brought in they are allowed to flow oil and gas without any particular attention being paid to the ratio of oil to gas being produced.

The present invention aims to provide a method of operating oil wells which will enable the energy or pressure of the natural gas to be utilized to the best advantage in the recovery of oil from its oil sands. According to my method, the field will be developed in a gradual manner. Plans will, however, be made for projecting wells over the entire oil area, the wells being arranged across the property according to some approved geometric pattern. After a well has been drilled to completion it will ordinarily

not be allowed to flow freely because of the excessive quantity of gas which would flow compared with the oil produced. Oil under pressure contains a comparatively large volume of dissolved gas. When the pressure is released as by opening a well, the gas will come out of solution and in coming out of solution will tend to carry the oil through the sand toward the point of low pressure. However, as gas will travel faster than oil through any given sand or formation it is necessary to slow down the movement of the gas and this is accomplished by maintaining a back-pressure on the wells.

The ideal production ratio of gas to oil is such that the volume of gas produced per barrel of oil would be equivalent to the gas dissolved in the oil under naturally occurring conditions. By keeping a controlled back-pressure on the well this ideal condition can be approximated more or less closely. In time, however, the oil in the immediate vicinity of the well will be drained more or less completely from the sand and the gas will migrate comparatively long distances without carrying very much oil with it; the well will therefore produce an excessive amount of gas. When this condition occurs, the well is shut-in and another well in the immediate vicinity is opened and operated under a controlled back-pressure. When the second well is opened it will ordinarily be found advisable to operate it under a reduced back-pressure as compared with the first well; first, because there may have been some drop in pressure following the opening of the first well and, second, because there will probably not be so much free gas in the vicinity of the second well as there was at the first, much of the free gas having found its way into the region of the first well. However, this free gas in the vicinity of the first well is still capable of doing useful work inasmuch as it is still under pressure, and when the second well is opened such gas will tend to flow toward the new region of low pressure.

In the sands between the two wells will be a body of oil and in the region of the first well will be a body of free gas. This gas is, therefore, so to speak, behind the oil body

with respect to the second well and in its efforts to move toward the second well will tend to push the oil body toward the second well. Also since some of the free gas in the sands has moved into the region of the first well there will be less free gas in the vicinity of the second well than there was originally. Consequently when the second well is opened, there will be less free gas ready to pass out through the well with the result that the ratio of oil to gas will approximate more or less closely the ideal ratio. Eventually, however, the free gas from the first well and from the sands surrounding the second well will reach the second well which will as a consequence begin to produce an excessive amount of gas. When this condition occurs it is generally best to again open the first well in order to permit the free gas now in the vicinity of the second well to force the oil back through the sands toward the first well. By alternating the direction of flow of oil and gas between the two wells under suitably regulated back-pressure, an unusually complete drainage of the oil from the sand may be obtained. When the first well again begins to produce an excessive amount of gas, it is closed and a third well opened and the process continued as before. After the third well begins to produce an excessive amount of gas it is closed in and the procedure then carried on as before in connection with the first and second wells until the entire field has been covered.

For simplicity of description I have referred to the treatment of single wells. However, in order to obtain increased production it will ordinarily be found desirable to operate the wells in groups so as to have one-half of the wells producing all the time. For example, alternate rows or groups of wells will be opened over the entire field to the flow of oil and gas. When any row or group of wells produces an excessive amount of gas such wells will be shut in and the adjacent row or group of wells opened.

By operating the wells in the manner indicated the operator will also be enabled to determine if gas is channelling from one well to another. Channelling would be indicated when any two wells or groups of wells tend constantly to flow proportionately more gas and oil or more gas than adjacent wells or groups of wells. Such wells as persistently produce more gas than the other wells would be shut-in to prevent a wastage of the gas.

It will be apparent that the wells may be operated in various combination of groups without departing from the spirit of the invention. For example, it may be found advisable to depart from a straight-line row of wells and to operate wells in more or less irregular rows as data becomes available from observing the manner in which the wells are producing. It may be found, for example, that the oil sand between any two straight-

line row of wells is of varying degrees of porosity, such condition being indicated by a more copious flow of oil or gas between any two wells. When this condition is indicated the relation of one row of open wells to another row of subsequently opened wells will be such that all of the wells in any given row will flow oil and gas in substantially the same ratio of oil to gas.

What is claimed is:—

1. The method of operating a group of oil wells which flow oil due to natural rock pressure which consists in alternately opening and shutting-in certain of the wells to thereby alternate the direction of flow of gas and oil between the wells, the wells being shut-in when the ratio of the gas to the oil produced exceeds a predetermined ratio and opened again after the volume of gas in the shut-in wells has dropped to a point permitting production at substantially the ideal gas-oil ratio.

2. The method of operating a group of oil wells which flow oil due to natural rock pressure which consists in flowing oil and gas from a row of wells until the ratio of the gas to the oil produced exceeds a predetermined ratio, thereafter shutting-in the wells, opening another row in proximity to the first and allowing the newly opened wells to produce gas and oil until the ratio of the gas to the oil produced exceeds a predetermined ratio and thereafter shutting them in and reopening the first row.

3. The method of operating oil wells which flow oil due to natural rock pressure, which consists in flowing oil and gas from a well under a back-pressure, shutting-in the well when the ratio of the gas to the oil produced exceeds a predetermined ratio, opening an adjacent well to the flow of oil and gas under a back-pressure, shutting in the well when the ratio of gas to oil production exceeds a predetermined ratio, and reopening the first well and permitting it to flow oil and gas as long as the production of gas does not exceed the said predetermined ratio.

4. The method of operating a group of oil wells, which flow oil due to natural rock pressure, which consists in flowing oil and gas from a row of wells under a back-pressure, shutting-in the wells when the ratio of gas to oil production exceeds a predetermined ratio, opening a second row of wells and flowing oil and gas from them under a controllable back-pressure, shutting-in the wells when the ratio of gas to oil production exceeds a predetermined ratio, and continuing with other wells across the oil field in the same manner as indicated.

5. The method of extracting oil from an oil sand while the oil is under the pressure of the natural gas occurring with the oil, which consists in projecting a plurality of rows or groups of wells in the oil sand and alternately

opening and shutting-in spaced rows or groups of wells whereby the oil will be forced by the gas to travel from one region of low pressure to another and extracting the oil from the wells which are open.

5 6. The method of extracting oil from an oil sand while the oil is under the pressure of natural gas, which consists in projecting a plurality of wells into the oil sand, flowing
10 oil and gas from a row of wells while maintaining them under a controllable back-pressure, shutting in the wells when the ratio of gas to oil production exceeds a predetermined ratio and proceeding across the oil
15 field in the manner indicated by successively opening and shutting-in rows of oil wells.

7. The method of developing an oil field which consists in projecting oil wells into the oil sands according to a predetermined geometric pattern and after the wells are completed alternately opening and shutting-in
20 one half of the wells in predetermined groups over the field.

8. The method of developing an oil field
25 which consists in projecting oil wells into the oil sands according to a predetermined geometric pattern, preventing free flow of oil from completed wells until all the wells in the group to be operated are completed, and
30 thereafter alternately opening and shutting-in one half of the wells in predetermined groups over the field, all of the wells of a group being shut-in when the majority of the wells of the groups produce an excessive
35 amount of gas measured by a predetermined ratio of oil to gas.

9. A method of draining oil from oil sands comprising opening two or more wells to the flow of oil and gas, shutting-in the wells
40 when the ratio of gas to oil produced exceeds a predetermined ratio, and opening two or more adjacent wells which will flow oil and gas in a ratio lower than said predetermined ratio.

45 In testimony whereof I affix my signature.
HENRY L. DOHERTY.

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