METHOD FOR THE DEVELOPMENT OF OIL FIELDS HAVING ZONALLY NON-UNIFORM COLLECTOR PROPERTIES

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Abstract

A method for the development of oil fields, having zonally non-uniform collector properties, which method consists in that after the industrial drilling of the field, some individual sections comprising at least one injection well surrounded by production wells are selected for the independent development of the oil field, the injection well or wells passing through the maximum number of productive formations completed by said production wells.

3 Claims, 3 Drawing Figures
METHOD FOR THE DEVELOPMENT OF OIL FIELDS HAVING ZONALLY NON-UNIFORM COLLECTOR PROPERTIES

The present invention relates to methods for the development of oil fields having zonally non-uniform oil sand properties (thickness, permeability). Widely used in the prior art of oil recovery is a process based on the application of contour or external injection of a flooding agent.

Contour flooding or its combination with flooding injection is frequently resorted to for development of large oil fields as well as of the fields having oil sands of poor productive capacity.

In the first case, the oil field is subdivided by rows of injection wells into a few independent producing areas. Such a development allows the entire field to be put into production in a short time, and the output rate to be rapidly increased.

In the second case, i.e. in the case of an oil field of poor productive capacity, the most efficient method of contour flooding is used, which is known in the prior art as pattern flooding. Various systems of the contour area injection are known, which differ from one another by the rate of action of the injection medium upon the productive horizon. In the case of oil sands having poor productive capacity, this method is often the only effective one to act upon the oil bearing sands for insuring the profitability of such oil fields.

However, the productive horizon of the oil field under development, as a rule, are characterized by rather non-uniform oil sand properties. Very often the productive horizon of an oil field, recovered as a single body, is composed of several productive subterranean formations separated by isolating streaks. Such sands are usually rather non-uniform, both in plane and in their thickness, and often they are blocked by practically impermeable rocks. The productive and non-productive sections of these sands are randomly distributed in a plane, without any definite regularity.

However, on using the basic methods for oil recovery with the help of the contour injection, the input wells are arranged in a strictly definite order (all wells of one row are located in succession, over one well, etc.). In connection with this contradiction, the known methods of contour flooding suffer from the following disadvantages:

1. In the case where the flooding agent is forced into oil sands, at the very beginning of the exploitation, the location of injection wells among production wells has been predetermined according to strictly geometrical systems but without regard to existing geological features of productive sands. A considerable number of injection wells open only a low productive zone of the oil sand, and, hence, they cannot be effectively used.

2. In case of a complex geology of the productive sands, the injection wells and production wells fed thereby often complete sands of different types, i.e. in some sections of the injection wells some sands contain impermeable rocks, while the same sands can be represented in the surrounding wells by permeable rocks; whereas in the other section the contrary is the case. Naturally, in these cases wells cannot interact through said types of sands.

To recover oil from such sands, it is necessary either to drill additional wells or to change the injection system. From experience, it is known that due to a disagreement between the types of the sections in the injection and production wells the volume of the non-recovered oil reserves amounts to as much as 20–30 percent.

3. When arranging the injection wells in rows, each such well diminishes the injection rate of the adjacent wells due to the phenomenon of interference.

4. The row of injection wells is used for supplying the production wells located at both sides of this row. This makes it difficult to control the recovery of oil from separate oil bearing sands by means of applying different injections pressures to said sands as in this case the same differentiation of the injection pressure on both sides is not always needed.

When using the known methods of the pattern flooding from the very beginning of the process of oil recovery, the above-stated disadvantages of the contour injection of a flooding agent remain except for that mentioned in paragraph 3.

A principal object of the present invention is to provide a system for development of oil fields, having non-uniform oil sand properties, which makes it possible to use contour flooding from the very beginning of the process of the oil recovery, by means of providing a necessary amount of injection and productive wells, most advantageously arranged in the injection wells determined by taking into consideration the geological features of the field, in order to improve all the characteristics of the process of oil recovery and to insure large production of oil due to efficient development of all oil reserves thus cutting down the production cost and increasing the output of the oil field under development.

This object is achieved by providing a method for development of oil fields with zonally non-uniform productive oil sands having varying thickness and permeability by drilling injection wells into said sands, injecting a flooding agent through some of these wells and production of oil through the surrounding production wells and according to the invention after the industrial flooding of the oil field by selecting at least one well for injection, the said well completing the largest number of productive oil sands completed by the surrounding production wells characterized by a high productivity index.

In keeping with this method of development, the location of injection wells among the production wells will not correspond to a strictly geometrical system, as is the case with the known systems of flooding. Application of the system thus developed to any zonally non-uniform oil sands results in a higher production rate, fuller commitment of all oil reserves to the development process, achievement of a higher recovery factor, and reduction of production costs.

Further objects and advantages of the present invention will become more fully apparent and the invention will be better understood from the following description of its exemplary embodiments, taken in conjunction with the accompanying drawings, in which:

FIG. 1 shows a diagram of an oil field with the wells and pipelines connecting the wells to common oil gathering stations and group pumping plants (the wells are not yet drilled and the injection wells are not yet selected therefrom); FIG. 2 is a view similar to that of FIG. 1 after the development of the oil field and selection of the injection wells (indicated by two circles); and FIG. 3 is a block diagram of one section of oil field drilling by the method according to the invention.

The development of an oil field according to the proposed method is carried into effect in the following order.

The oil field or a separate portion thereof is drilled so as to provide a uniform system of wells. The density of the network of wells, and the relationship between the numbers of the production and injection sections as well as the corresponding design characteristics of the system intended for development of this field.

Then, based on the technological design of the oil field development, a project is worked out referring to the whole production system, i.e. power requirements, oil gathering systems, water supply systems, etc. In this case, the group plant 1 of the oil gathering system and the group pumping plant 2 of the water supply system are arranged in the form of a common station (FIG. 1), the pipelines 4 (one line per well) being laid therefrom. Each individual well can be connected through a gate system either to the oil gathering system or to the water supply system, if required. At the considered time period, the wells 3 are not yet drilled, and their location is determined by the oil field development design. The pipelines and the common oil gathering systems should be constructed prior to the drilling of the wells. Their construction may be effected on some selected sections of the oil field in turns.
After drilling a section (comprising approximately 20-30 wells), geological and hydrodynamical tests of the oil field are carried out in order to determine the productivity of the horizon. These tests are used as a basis (on observing the conditions stated hereinafter) for selecting the injection (FIG. 2) wells 6 (indicated by two circles) and the production wells 7 (indicated by a single circle). The injection wells are connected to the water supply systems, the production wells being connected to the oil gathering system.

When selecting the injection and production wells, the following conditions should be adhered to.

The injection wells must be distributed over the production area and surrounded at all sides by production wells. Investigations have shown that the injection wells uniformly distributed over the production area feature minimum mutual interference, so that their intake capacity, is increased by as much as 20 percent.

The injection wells and the production wells surrounding the former are grouped in such a manner that the same productive oil bearing formations could be thereby completed.

The efficiency of the proposed method is clearly illustrated by a block diagram in FIG. 3 which makes it apparent that all productive formations (D1a, D1b, D1c, D1d, and D1e), completed by the production wells, are also available in the injection well, and this fact provides for effective exploitation of all the reserves of oil in the field and helps to effectively organize the control of the oil resources from the productive oil bearing sands, combined into a common oil recovery field by differentiating the injection pressure.

The injection well selected from the section, chosen in accordance with the above-mentioned distinguishing feature, should have the best intake properties and be located as nearly as possible to the center thereof. The condition for selection of the well having the best intake properties is dictated by the test results indicating that during the contour flooding the injection wells play a decisive part (except for the systems of pattern and linear flooding, when the number of the production wells equals that of the injection wells). The calculations have shown that due regard to this factor makes it possible to increase the recovery factor of the oil field up to 30 percent.

Application of the proposed method for development of an oil field will provide for a much higher producing rate in comparison with the existing methods, under otherwise equal conditions, as well as a reduction in the oil cost and an increase in the oil production.

What we claim is:

1. A method for the development of an oil field having productive formations and zonally non-uniform collecting properties, said method comprising drilling at least part of the field and dividing the drilling part into individual sections wherein are arranged injection wells surrounded by production wells, the sections being selected for the independent development of the oil field, the selected injection wells being selected and arranged for passing through a maximum number of the productive formations completed in the surrounding production wells located within the supply zone and having the highest oil recovery factor.

2. A method for the development of oil fields having productive formations and zonally non-uniform collector properties comprising the following operations: industrial drilling of the field or its separate parts; arranging therein injection wells surrounded by production wells; selection of some individual sections including at least one injection well surrounded by production wells for the independent development of the oil field; and selecting and arranging injection wells in these sections to pass through all the productive formations completed in the surrounding production wells, located within the supply zone and having the highest oil recovery factor.

3. A method for development of an oil field having oil sands with thickness and permeability varying from well to well, said method comprising: production drilling said oil field to form wells, selecting at least one well for injection, the selected wells completing the largest possible number of productive oil sands completed by the surrounding production wells characterized by the highest possible productivity index, injecting a flooding agent through the selected wells, and producing oil through the surrounding production wells.