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ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

Институт Природных ресурсов
Направление подготовки Нефтегазовое дело
Кафедра Геологии и разработки нефтяных месторождений

МАГИСТЕРСКАЯ ДИССЕРТАЦИЯ

Тема работы
ОПТИМИЗАЦИЯ МЕТОДОВ ПОВЫШЕНИЯ НЕФТЕОТДАЧИ НА Х. НЕФТЕГАЗОВОМ МЕСТОРОЖДЕНИИ (ХМАО)

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Студент

Группа	ФИО	Подпись	Дата
2БМ5Г	Хиджакадзе Георгий Николаевич		

Руководитель

Должность	ФИО	Ученая степень, звание	Подпись	Дата
Ст. препод.	Дозморов П.С.	к.т.н.		

КОНСУЛЬТАНТЫ:

По разделу «Финансовый менеджмент, ресурсоэффективность и ресурсосбережение»

Должность	ФИО	Ученая степень, звание	Подпись	Дата
доцент каф. ЭПР	Шарф И.В.	к. э. н		

По разделу «Социальная ответственность»

Должность	ФИО	Ученая степень, звание	Подпись	Дата
ассистент каф. ЭБЖ	Немцова О.А.			

Консультант-лингвист

Должность	ФИО	Ученая степень, звание	Подпись	Дата
доцент каф. ИЯ	Уткина А.Н.	к.ф.н.		

ДОПУСТИТЬ К ЗАЩИТЕ:

Зав. кафедрой	ФИО	Ученая степень, звание	Подпись	Дата
доцент каф. ГРНМ	Чернова О.С.	к.г-м.н.		

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Введение

В условиях, когда бюджет страны формируется в результате добычи и продажи нефтяной и газовой продукции, огромное значение обретает добыча углеводородов.

В связи с большим значением углеводородов происходит интенсификация добычи нефти, что приводит к увеличению объема добытой нефти. В таких условиях очень важным является оптимальное и безопасное использование методов интенсификации, для предотвращения осложнений и выходу из строя оборудования.

В настоящее время многие методы повышения нефтяной отдачи используются необоснованно, вследствие чего предприятие терпит убытки. Анализ эффективности выявит проблемы на предприятии в использовании методов, доказать или опровергнуть их обоснованности, и впоследствии, оптимизировать уже используемые методы.

Актуальность данной темы заключается в корректном проведении мероприятий по интенсификации, которые позволят снизить дальнейшие затраты на ремонт скважинного оборудования и агенты, увеличит прирост добычи нефти при сокращении затрат рабочих агентов и ремонтов.

Целью работы являлась оптимизация системы заводнения на данном месторождении.

Задачи:

— изучить геолого-техническую модель;

— провести анализ эффективности используемых методов;

— предложить варианты развития системы заводнения;

— рассчитать стоимость внедрения технологии;

— выявить вредных факторов при работе по внедрению и эксплуатации.

Аннотация

В первой главе рассмотрены основные данные о месторождении. Промышленная нефтеносность связана с терригенными отложениями надугольной толщи васюганской свиты – пласт $Ю_1^{1-2}$. Количество геологических запасов составляет 230% по отношению к извлекаемым. Рассмотрены физико-химические свойства, дающие представление о системе вода-нефть, нефть-вода. В конце главы представлены модели коллектора, пористости, которые будут исследованы и использованы для дальнейшего моделирования системы заводнения.

Во второй главе рассмотрены все существующие методы повышения нефтяной отдачи: тепловые, химические, заводнение пластов, физические, газовые. В конце каждого вида методов приведено заключение, обосновывающее или опровергающее использование такого воздействия на данном месторождении. Обоснованными методами воздействия на пласт являются заводнение, гидравлический разрыв пласта, и очистка призабойной зоны методом солянокислотной обработки ввиду геолого-технической характеристики месторождения. Требуется провести анализ эффективности.

В третьей главе проведен анализ эффективности используемых методов повышения нефтяной отдачи на данном месторождении. Сделан вывод, что гидравлический разрыв пласта используется эффективно и оптимизации не требует, а также что система заводнения на данном месторождении используется не корректно, вследствие неэффективной закачки воды в районе 40–60%. Предложено два варианта развития системы заводнения, из которых один связан с рисками техногенной трещиноватости посредством превышения производительности скважин по объему закачиваемой воды. Смоделированы текущая система заводнения и система заводнения с внедренной технологией, в результате которой прирост добычи нефти увеличивается в сутки на 20%.

В четвертой главе представлены расчеты выручки от реализации, затрат на внедрения, затрат на дополнительную добычу, налог на прибыль,

накопленный поток денежной наличности, дисконтированный поток денежной наличности, чистая текущая стоимость. По результатам расчетов представлен график чистой текущей стоимости и накопленного потока денежной наличности, показывающий окупаемость проекта, которому соответствует переход линии чистой текущей стоимости от потока денежной наличности в положительную область. Переход начинается в периоде первого квартала, что показывает срок окупаемости. Последующий год принесет прибыль в 2 раза.

В пятой главе рассмотрены все возможные вредные и опасные факторы, с которыми могут столкнуться работники во время внедрения и эксплуатации технологии. К выявленным вредным факторам, влияющим на безопасность и производительность труда относятся: вредные вещества, метеоусловия, повышенный уровень шума. К выявленным опасным факторам относятся: электрический ток, пожарная безопасность, электрическая дуга и металлические искры при сварке. Проведен анализ воздействия на экологию, выявляющий возможное воздействие технологии на атмосферу и литосферу. Рассмотрены чрезвычайные ситуации и план действий при них, а также правовые вопросы обеспечения безопасности.

Consider all existing intensification methods of using them to X field

There are several types of stimulation:

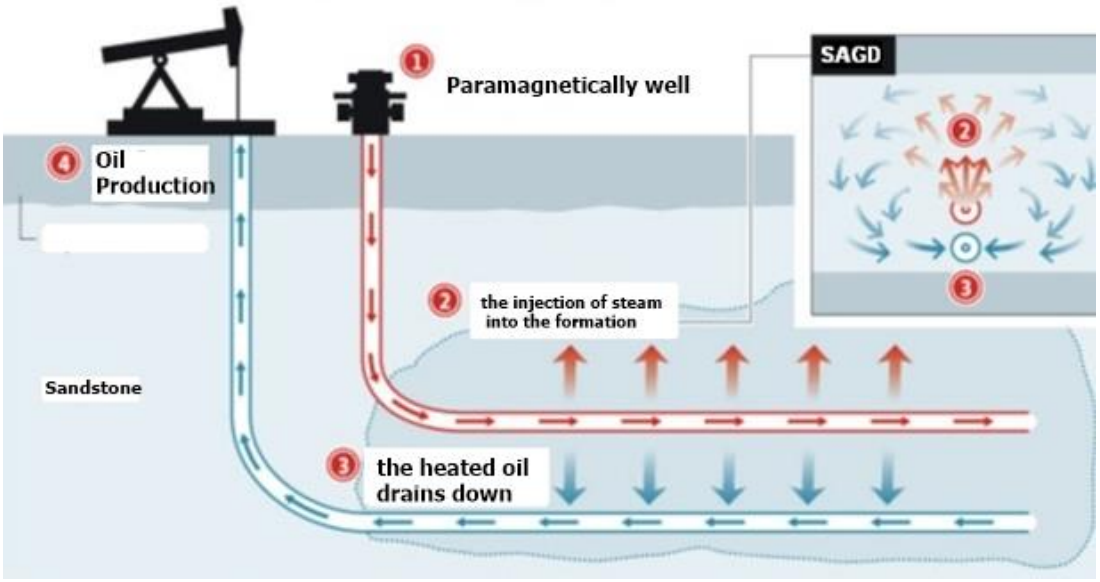
- Thermal
- Chemical
- Water flooding reservoirs
- Physical
- Gas

Thermal methods

These methods are based on the artificial temperature increase in the bottom area or on the trunk. Such methods are mainly used for heavy oil deposits or a high content of paraffins and resins. Increased temperature leads to the dilution of the oil, and waxes and so resins start to melt.

Steam injection

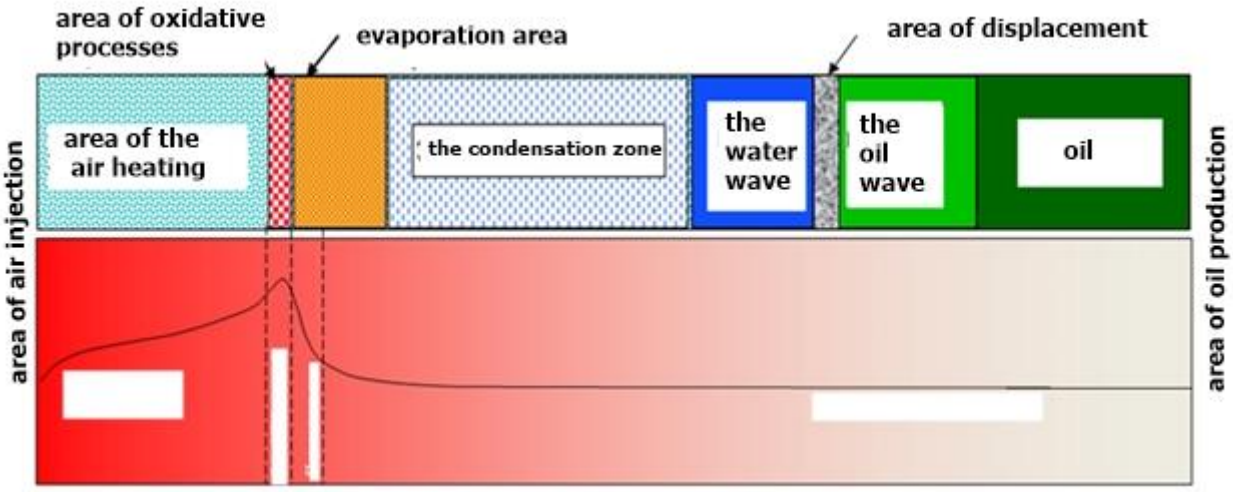
In this method, steam is supplied from the surface into the formation by special equipment or through paramagnetically wells. Steam with high heat capacity makes a significant change in the area of the reservoir, heating it and reducing the relative permeability, viscosity, and causing the distillation of oil. Picture 1 shows a diagram programaciones impact, in this case, the steam is injected through a special paramagnetically well, where the vapor warmed sheet of oil, giving some flow to the wellbore.



Picture 1 – Scheme of steam injection

In situ combustion

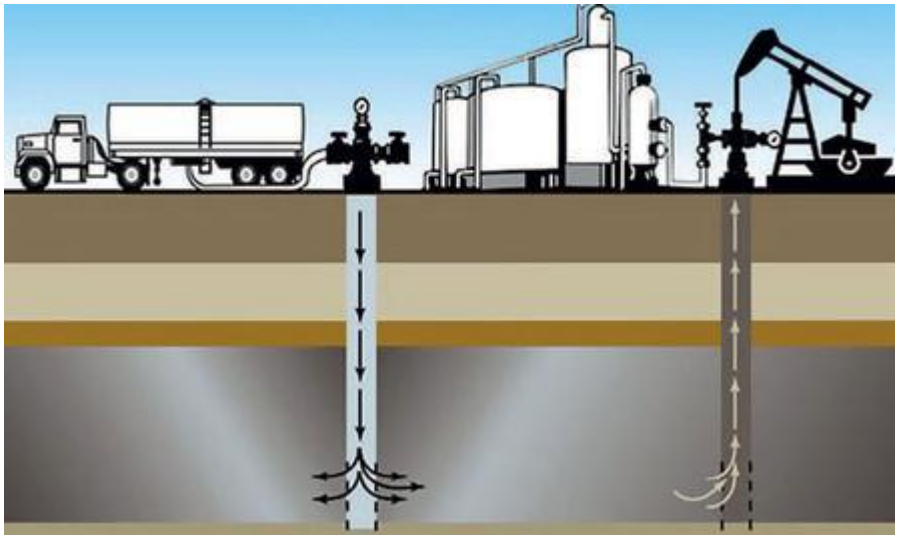
Based on the oxidative reaction of oil and oxygen, resulting in the release of large amounts of heat. The main advantage of this method is that heat is generated in the reservoir. It is generated using a submersible downhole electric heater or oxidation reactions. In the combustion process, fuel is part of the oil that remained in the reservoir after the process of displacing gases.



Picture 2 – Scheme of in situ combustion

A fix hot water

Wet in situ combustion is a fix in certain quantities of water, together with air, which is subsequently evaporated. The steam from the water is transferred further of the combustion front, where it expands the heating zone, increasing the efficiency.



Picture 3 – Scheme of a fix hot water

Conclusion

On X field, the use of thermal methods is not appropriate due to insufficient high–viscosity oil and the lack of sulfur. Thus the costs that are necessary for the constant heating of the steam or water and their subsequent injection are unfounded.

Chemical methods

These methods are applied in the case of flooding severely depleted reservoirs with low viscosity and salt content.

The solutions of surfactants

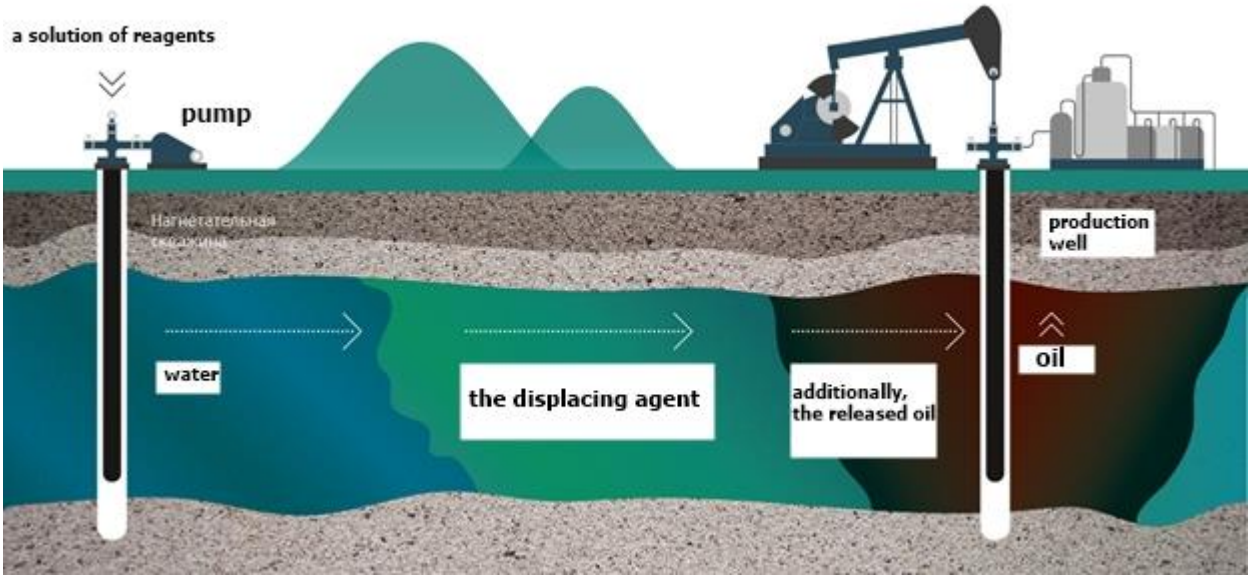
Surface–active substances aimed at reducing the surface tension of the boundary water–oil, thereby increasing the mobility and bytesneeded of oil by water. These include also methods of injection of the alkaline solution, which in consequence of interaction with the oil, the formation of surface–active substances.

Polymer solutions

The method consists of injection of polyacrylamide, which has the ability to sagemath water, increasing its viscosity, and then increased coverage of the reservoir flooding, and germanised the ratio of viscosities of water and oil.

Injection acids

The injection of sulfuric, hydrochloric acids have found wide application, solving the problem of waste disposal. Used 10–15% solution of hydrochloric acid in the formations composed of terrigenous or carbonate rocks, for the purpose of cleaning the bottom zone due to dissolution of rocks.



Picture 4 – Scheme of a chemical methods

Conclusion

The injection of hydrochloric acid at X field is the most optimum method with the use of performing the SCR, because the formation is clastic rocks. The solutions of surfactants and polymers to use is not advisable due to high salinity and low water content. Effective will the implementation of the injection of the scale inhibitors in wells with high water cut.

To maintain potential production wells, stimulation of oil and injectivity of the reservoir may be recommended fix various acid solutions and solutions of surfactants or compositions based on them.

Most often used of fix acid compositions and injection of solvents. In addition, when processing the PZ wells include the use of a reagent for inhibiting the swelling of clays and cleaning of bottom–hole zone. Download acid compositions allows to increase the permeability of 2–10 times, lower residual oil saturation by 10–20 %.

To determine the coefficients of the working thickness of the producing wells it is necessary to conduct photoamerica research. In the future, program of the HMO field based on the Geophysics will be updated.

Water flooding

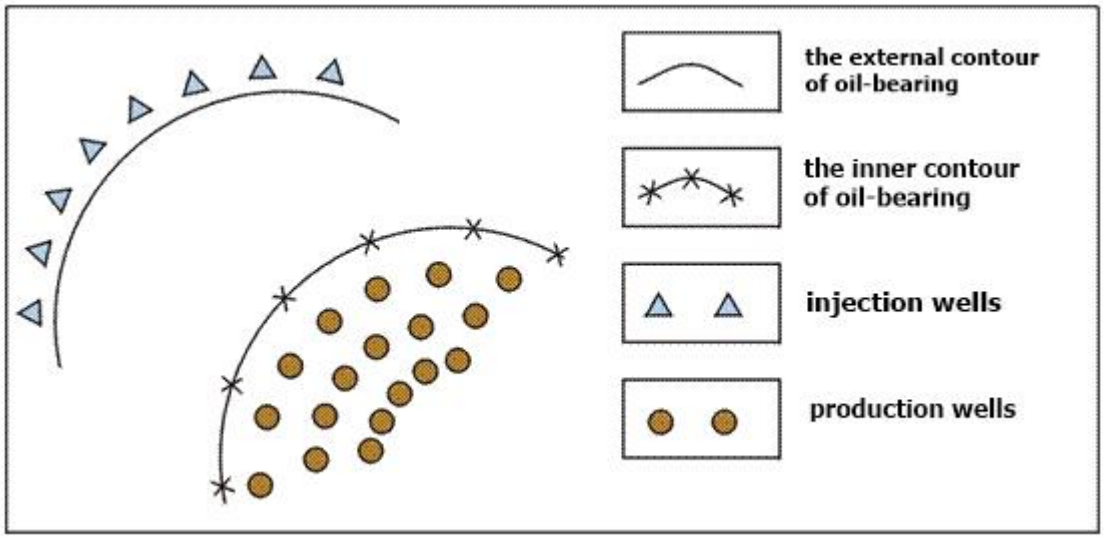
The most effective and widespread method of reservoir stimulation with the aim of maintaining energy balance and enhanced oil recovery is water flooding

oil reservoirs. The advantages of the method are relative simplicity of implementation, availability of the agent and its high displacing ability.

Depending on the relative location of injection and production wells, there are three schemes of flooding: the peripheral, the marginal, contour. Also, perhaps a combination of these methods.

Peripheral water flooding

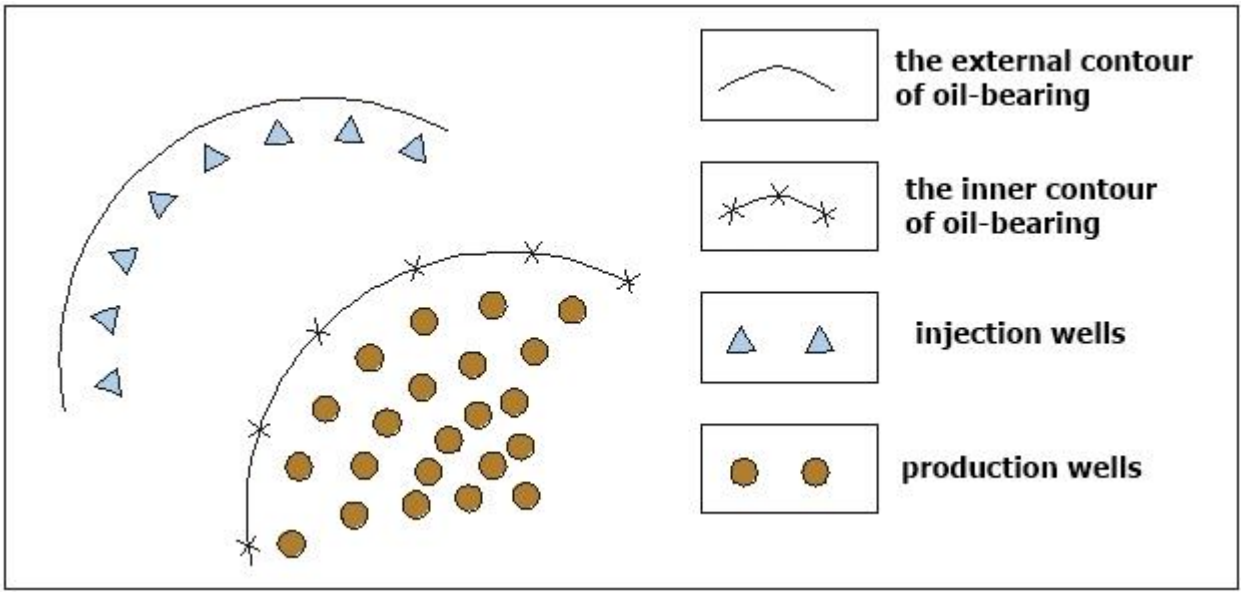
Water injection is made through injection wells located beyond the outer contour of oil-bearing at a certain distance, depending on the degree of exploration of deposits, the distance between injection wells. Favorable conditions for this type of flooding are: homogeneous structure of the layer, low viscosity oil. In this type of flooding, the natural process is not disturbed and an area intensifitsiruetsa and closer to the deposits.



Picture 5 – Peripheral water flooding

Marginal flooding

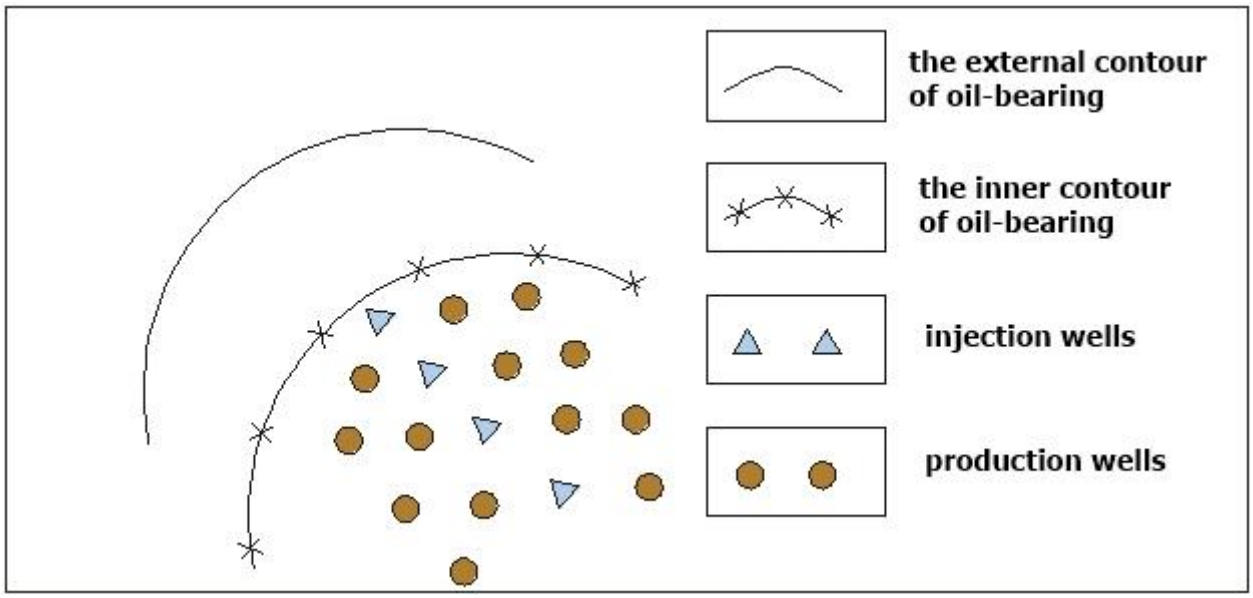
Injection wells are placed between the outer and inner contours of the oil. Applies when the development of reservoirs with low permeability aquifer part. With this arrangement, the zone of low permeability is excluded, as the impact on Deposit is the part of edge zones, where the reduced outflow of water in the invaded region. This method of flooding does not provide the maximum level of production in the short term, but allows you to keep stable production for a long period of time.



Picture 6 – Marginal flooding

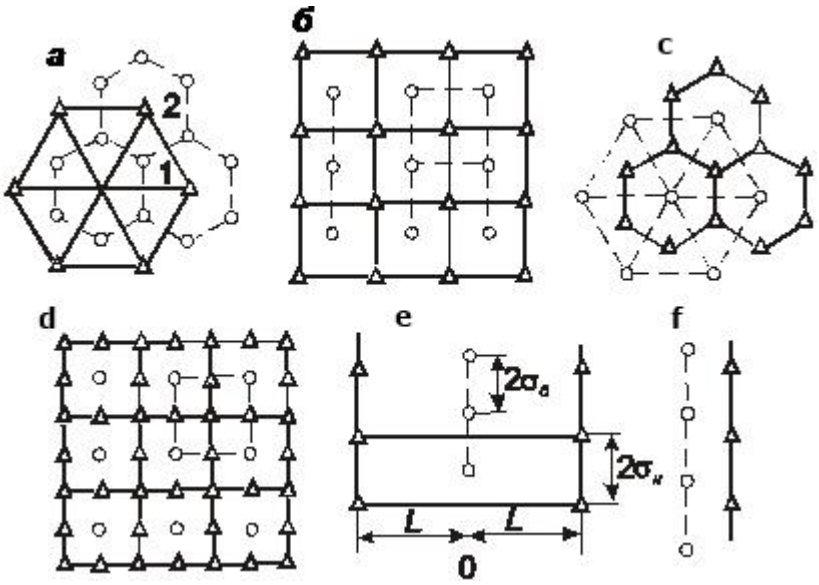
Contour flooding

The injection of water and the maintenance of reservoir energy occurs directly in the oil–bearing part of the reservoir. The most productive and optimal scheme of intra–contour flooding areal is a system which is dispersed by water injection over the entire area of the oil–bearing part of the reservoir.



Picture 7 – Contour waterflooding

There are four(a) five(b) seven(C), nine dot(g) and linear(d,e) (Fig. 2.4) types of wells.



Picture 8 – Types of areal system flooding

Linear system involves the placement of wells as injection and mining, in line with the ratio of 1:1 as five-point system. Five-point system is symmetric and it is possible to choose the opposite location of the wells, where the injection well will be located in the center. In the seven-point system the location of wells triangle and the ratio of wells is 2:1. In nine–dot system for one production borehole have three magnetoline 3:1.

Areal flooding effectively in the development of reservoirs with low permeability. The effectiveness increases with the homogeneity of the reservoir and reduce oil viscosity.

Conclusion

On X field contour implemented system flooding with areal seven-point location of wells with distance between them of 500 – 700 m, the same is implemented in combination with the marginal flooding to displace oil from a homogeneous Sandstone reservoir with low permeability and water cut.

To influence the object U_1^{1-2} selected artificial water flooding of the reservoir, as the base operating agent for the impact - water Aptian-Albian-Cenomanian complex. Technological effect is due to the best degree of washing off formation water from oil reservoirs and its stability in relation to the breed and cement.

As of 01.01.2010 On X the field drilled and there are six injection three wells. It is necessary to note the presence of inefficient pumping, which is confirmed by the PIP (profile acceleration). The studies found that of the four injection wells, which carried out research in 2011, three are leaking (the injected water takes the design interval of the cut in three of them). To estimate the number of ineffective injection studies is not possible. By material balance, water injection exceeds the fluid withdrawal since March 2010, and as of 01.01.2010 Ineffective injection is about 31 %.

Physical methods

Physical methods include: hydraulic fracturing, horizontal drilling, electromagnetic effects on the formation and wave action on the reservoir.

Hydraulic fracturing

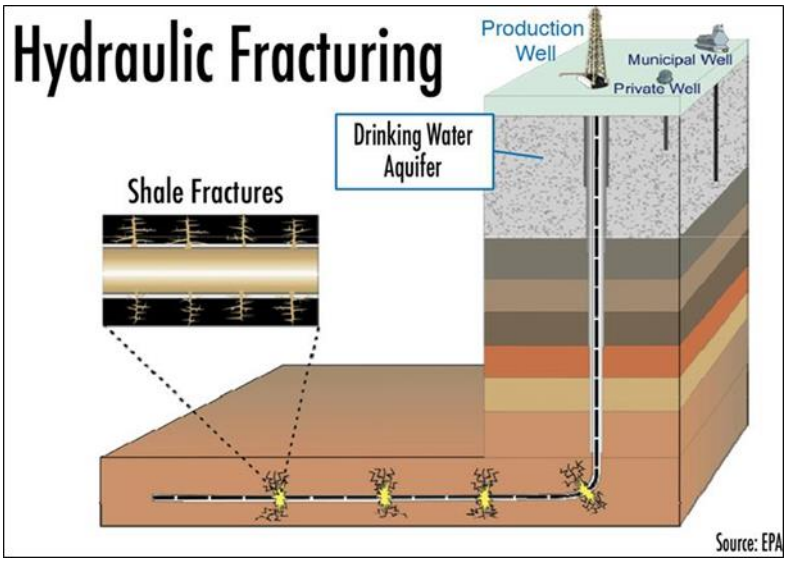
This method involves the pumping downhole viscous liquid under pressure, is able to create cracks in the rocks. Cracks can be vertical and horizontal rotation, their length depends on the injection parameters. After the formation of cracks in them pumped a viscous fluid to prevent closure of cracks, the liquid filler. Reasonable use of hydraulic fracturing in reservoirs with low permeability, and where the individual streaks are not involved in the design, which reduces oil recovery facility.

Hydraulic fracturing (HF) is one of the most effective methods of intensification of oil production and increase reserves recovery. There are many modifications of hydraulic fracturing, varying volumes, concentrations and rates of injection of fluids and proppant. The choice of modification depends on the geological and physical characteristics of the reservoir and goals.

On X field the highest efficiency among physical methods of intensification of production, has a method of hydraulic fracturing (HF). Forces", n well Service" frac on the field conducted in 13 oil wells. The entire scope of work performed from January 2007 to March 2008. Almost the entire volume hydraulic fracturing carried out in wells located in pure oil zone, with the exception of well No. 344, which is located on the line of the inner contour of oil

In wells hydraulic fracturing U_1^{1-2} completed prior to their commissioning. In the remaining 8 wells EMG was performed after 1–7 months after beginning their operation. Test results of exploratory and production wells have shown oil flow with a flow rate of 5,6 m^3/day 55 m^3/day. Given the low proportion of water in the testing and operation of wells and the presence of CNS the use of hydraulic fracturing (HF) in the present conditions is the most effective way of development.

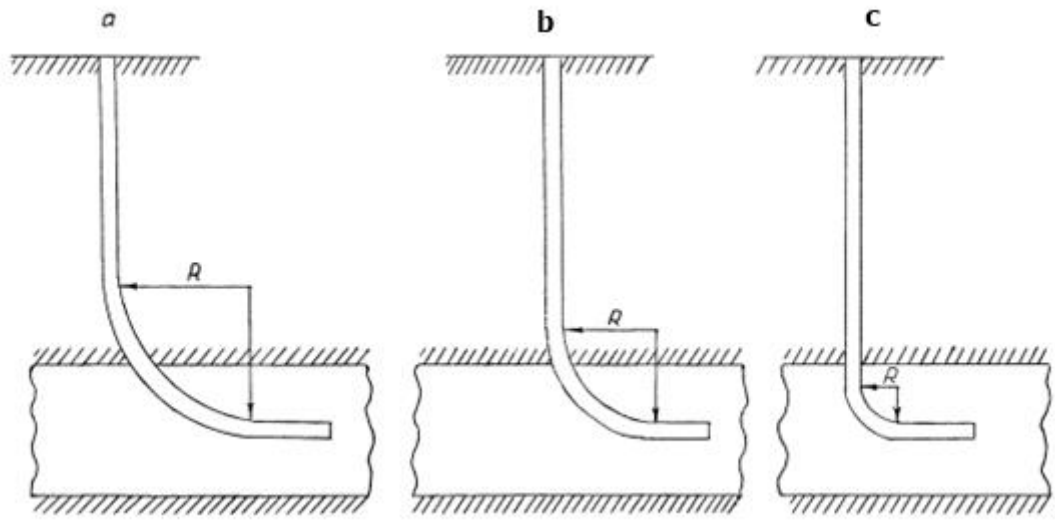
Work on OPZ wells, hydraulic fracturing should be carried out with the involvement of service firms specializing in the application of a technology. Such organizations are obliged to have TEKSERT certificates, sanitary and epidemiological Surveillance of the Russian Federation, allowing the use of reagents used in the oil industry. However, before carrying out fishing operations should be required from implementing organizations conduct special studies to determine compatibility of reagents with the reservoir fluids X field.



Picture 9 – Hydraulic fracturing

Horizontal wells

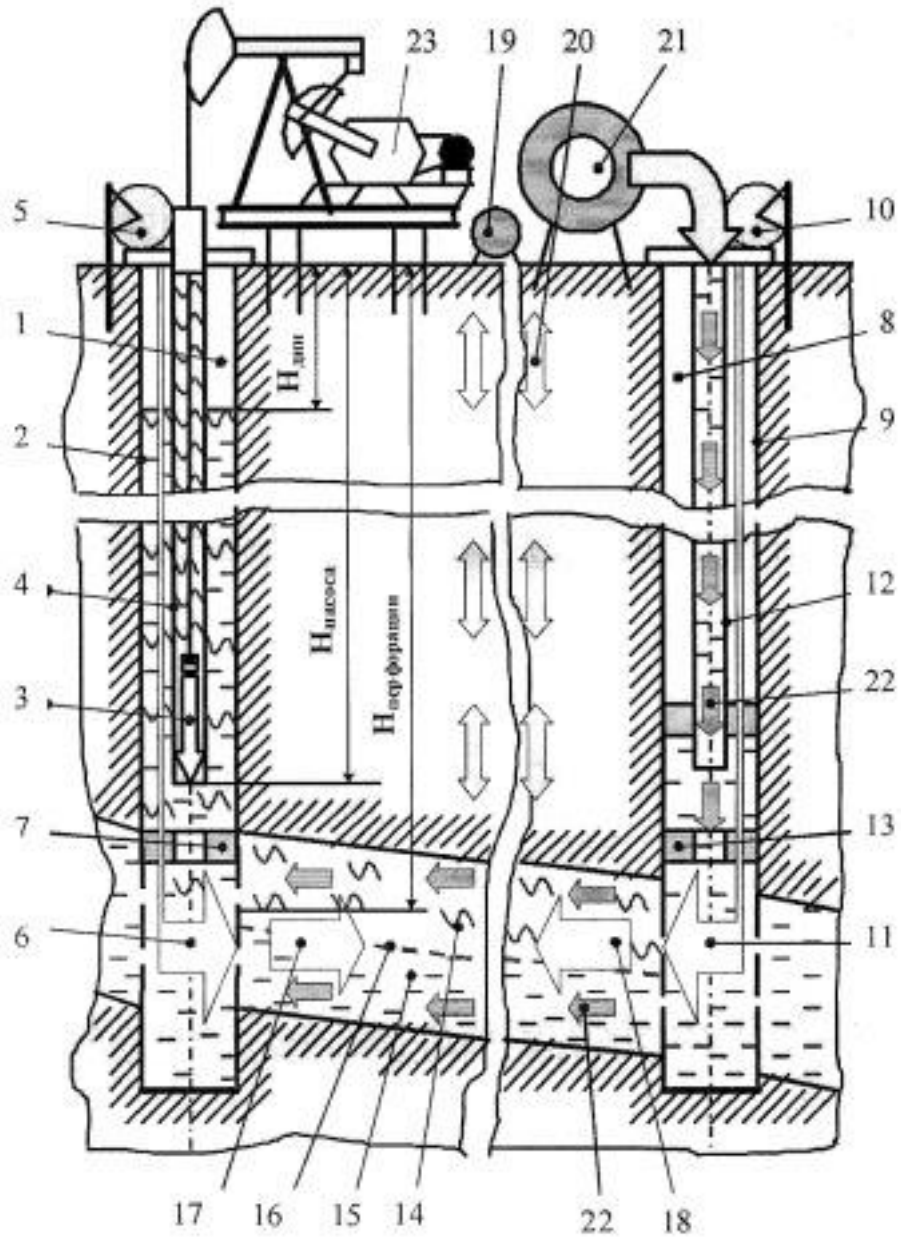
This method has proven itself in the later stages of development when the number of idle and unprofitable wells increases, along with increasing water cut and drop in reservoir pressure. The increase in production is due to increased contact area of the borehole from the productive formation.



Picture 10 – Scheme of horizontal wells (a, b, c – respectively with large, medium and small radius of curvature)

Electromagnetic interference

The method is based on the technology of stimulation of high–frequency of electromagnetic field, giving an internal heat source. Along with heat effect, the electromagnetic field leads to a decrease in the onset temperature of crystallization of paraffin's and oil demolition.

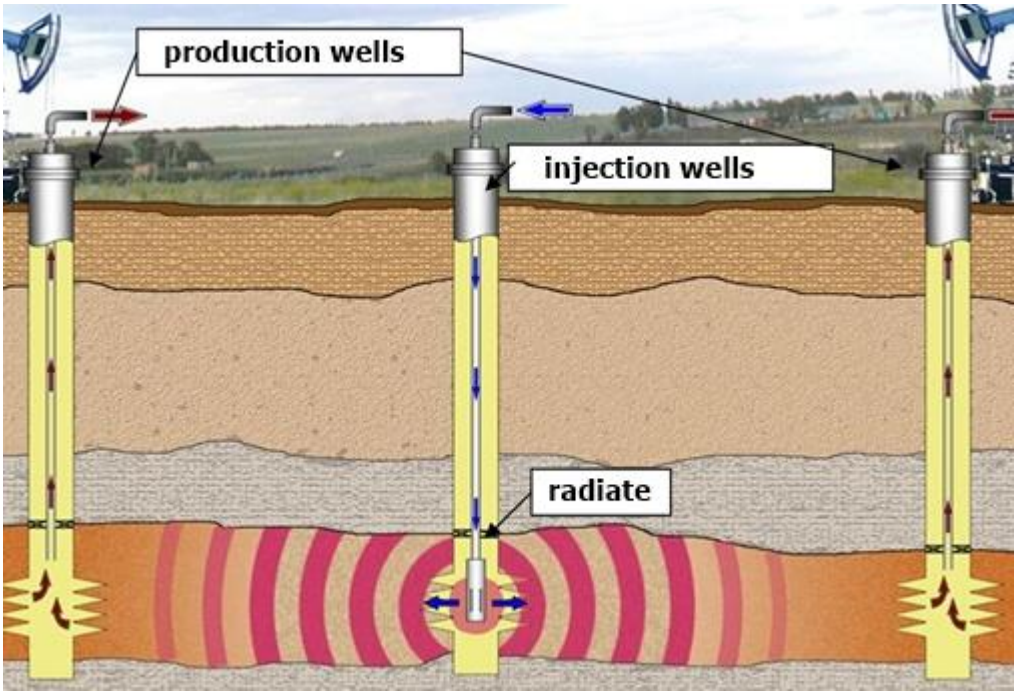


Picture 11 – the Circuit of electromagnetic stimulation:
5 – generator of EM oscillations to the waveguide(6); 7 – anchor; 8 – injection well and its column(9); 10 – generator of electromagnetic oscillations with a waveguide(11); a 12 – column tubing; 13 – anchor at the depth of the perforation; 14 is a hydrocarbon fluid; 15,16 – the water in the trap; 17 – flow from the production well; 18 – flow from injection wells; 19 – pulser–receiver scanning vibrations(20); 21 pump; 22 – the flow of the working fluid

Wave action

The known methods of wave action, such as: vibration, shock, impulse. The method consists in the impact of waves on the low–permeability areas of the reservoir where the waves are damped in highly permeable areas, but spread to large distance in low–permeability zones of the formation. Using this method, you

can achieve great intensification of the inflow due to the wide range of amplitude–frequency parameter effects.



Picture 12 – Diagram of wave stimulation

Conclusion

For intensification of oil production at the field X, EMG is recommended for production and injection wells before commissioning.

Almost the entire volume hydraulic fracturing carried out in wells located in pure oil zone, with the exception of well No. 344, which is located on the line of the inner contour of oil. Effective oil–saturated thickness at wells with hydraulic fracturing ranges from 3.3 m.

When conducting hydraulic fracturing in the wells of the injected volume of proppant varies from 10 t to 30 t, which indicates the difference of the arguments of the resulting cracks. At the moment the lack of special studies to determine the filtration characteristics of the wells (before and after fracturing) does not allow for a valid comparison of the dynamics of the hydrodynamic parameters. Therefore, the assessment of the effectiveness of the fracture made on the basis of changes of fluid rate and water cut of wells.

In 5 wells of 13 hydraulic fracturing U_1^{1-2} completed prior to their commissioning. In the remaining 8 wells EMG was performed after 1–7 months after beginning their operation.

It is recommended to begin drilling horizontal wells in connection with still not a large number of wells that can pay off in the future.

Electromagnetic and wave action is not recommended due to lack of cash resources to purchase equipment and implement activities in the absence of staff.

Gas methods

Air injection into the formation

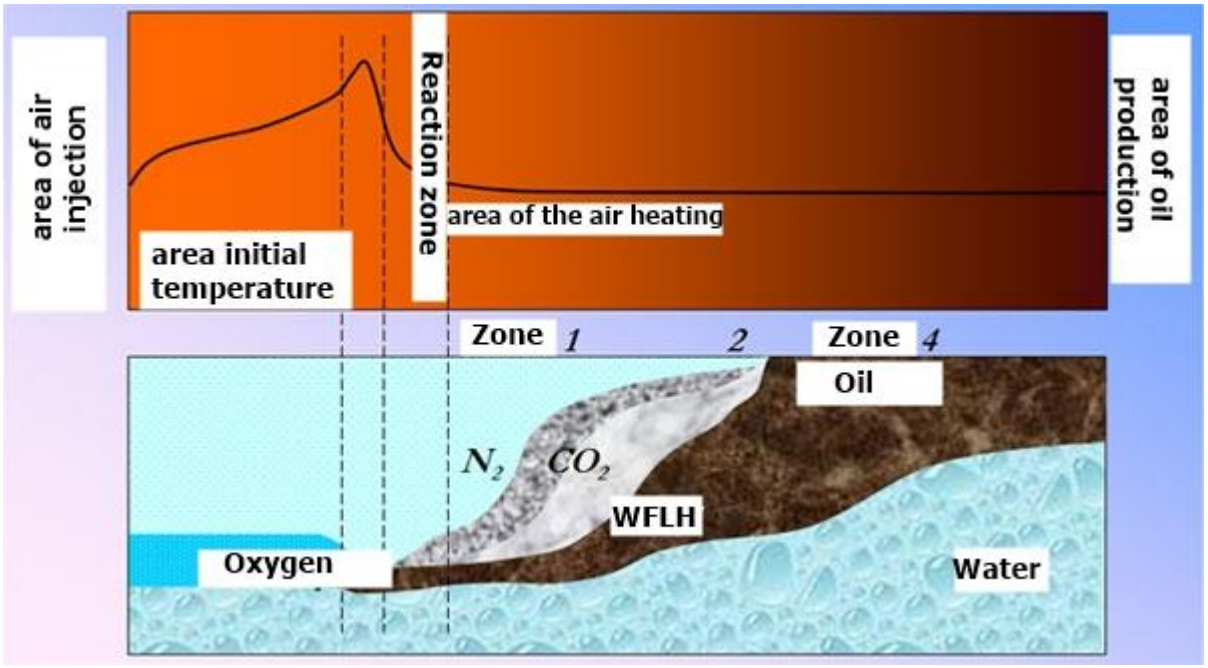
The method is based on pumping air into the reservoir, after which there is a low temperature oxidation process, transforming the air into an effective displacement agent that contains carbon dioxide gas, wide fraction of light hydrocarbons and nitrogen. The advantage of this method is the use of air, as an inexpensive agent, in combination with the natural energy of the reservoir is formed by the displacing agent. Initiating in–situ oxidation process is the most important consequence of energy use stratum. The intensity of oxidation reactions increases with increasing temperature

Injection of carbon dioxide

Dioxide, when dissolved in water, increases its viscosity, when dissolved to form carbonic acid H2CO3. Carbonic acid can dissolve some cement and reservoir rock, increasing permeability. Dioxide is able to dissolve better in oil than in water, so it can move from the water phase in the oil. Dioxide reduces the viscosity of oil and increases the density, and the volume greatly increases. Thus, the dioxide is contributing in the development of a low–viscosity oil, increasing its volume, and high–viscosity oils by reducing their viscosity when dissolved in it dioxide.

Nitrogen, flue gases

The method is based on the delivery of solid propellants for slaughter and subsequent burning without any protective shell. The exhaust gases are able to displace fluid from the barrel into the reservoir that can expand cracks and create new. Powder gases are also ways to melt the asphaltenes, resins and paraffin.



Picture 2.12 – Scheme of the impact of gas methods

Conclusion

No gas method is not fully satisfy the conditions for the justified use. Shallow depth, the presence of a large number of salts in water–cut wells make the use of these methods scrupulous and demanding monitoring.

The key conclusion

Flooding, hydraulic fracturing and bottom–hole cleaning method by means of hydrochloric acid processing have proved to be the effective methods. But for further research is necessary to analyze the efficiency to identify possible improper use of these methods.

Заключение

В диссертации была рассмотрена геолого-технологическая модель, взяты параметры пласта, расположение скважин, по которым производилось моделирование системы заводнения. Во второй главе рассмотрены все методы увеличения нефтяной отдачи, при которых на данном месторождении лучшим являются гидравлический разрыв пласта и заводнение ввиду наличия низкопроницаемых пропластков и маловязкой нефти. В третьей главе проведен анализ эффективности гидравлического разрыва пласта и заводнения, по результатам которых выявлена необходимость в оптимизации системы заводнения по причине неэффективной закачки в объеме 40–60 %. Представлено две модели системы заводнения и их сравнение, по результатам которых выбрана вторая, с введением под нагнетание двух новых скважин, т.к. первый вариант связан с рисками техногенной трещиноватости посредством превышения производительности скважин по объему закачиваемой воды.

Предлагаемая модель системы заводнения наряду с ремонтно-изоляционными работами позволит оптимизировать систему разработки как с технологических позиций, восстановить пластовое давление, так и с экономических, снижение себестоимости продукции. Ввод дополнительно двух нагнетательных скважин позволит сформировать полноценную систему поддержания пластового давления и достичь оптимальных режимов закачки 100–150 $м^3$/сут. Текущее внедрение позволит за текущий год получить дополнительно добычу нефти, относительно предыдущего года на 8,5%, что увеличит прибыль в 2 раза.