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ON THE ISSUES OF PERSPECTIVES FOR THE DEVELOPMENT OF THE SIYAZAN MONOCLINAL OIL FIELD OF THE REPUBLIC OF AZERBAIJAN

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A B S T R A C T

The article considers complications associated with abnormal conditions during the development of the Siazan monoclinic oil field. In complex geological, geophysical and operational conditions, the application and continuation in the development of new innovative methods based on the existing system was considered an urgent issue. To solve the problem, new nanostructured composites of class BAF-1 and BAF-2 were created, as well as a method of acting on a bottomhole field. Using the reagent, 391.1 tons of oil were additionally produced from well No. 111 from the South-East Saadan field, from well No. 198 from the South-West Saadan field, and from well No. 1463 operating at the Amirkhanly fields during the operation of the pilot stage. The nanostructured composite BAF-1 and BAF-2 eliminates the stiffness of 3.0% of the produced water, destroys sulfate reducing bacteria.

K E Y W O R D S

Asphaltene;
Resin;
Paraffin;
Nanostructured composite;
Slaughter area.

Introduction

Siyazan monocilinal oil fields (SMOF) are one of the fields of the Republic of Azerbaijan distinguishing for unique, specific features and having anomalous geological and physical properties. Layers at the bed - crossing of the deposits (Chandahar-Zarat, Siyazan-Nardaran, Sedan, Amirkhanli and Zagli-Zeyva), differ from other oil and gas regions due to a unique complex lithofacy and tectonic elements in [1].

The field is 55 km long and 0.4-1.0 km wide, the layers lie under 75-85o angle, sometimes vertically and inverted, the thickness of the productive strata in the section is measured in millimeters, the ancient sediments (Cretaceous) cover relatively new sediments and contact the presence of oil spills on the line has created a unique geological condition, which also has a serious impact on oil facilities. The main development objects, Maykop, Koun, Sumgayit, Upper-Cretaceous and partially Chokrak horizons, are widespread in the monocline. The section is composed of fine sand particles, sandstone, clays, siltstones, conglomerates, cracked marls, and Upper Cretaceous mainly contains limestones. The collectors are mainly porous, with some cracks at the top of the section. The granulometric composition is composed of a large number of plate fraction siltstones. The average porosity is 17.7%, the permeability is 41.2×10^{-3} mkm^2. The field pressure is 2-3 times lower than the initial pressure.

Materials and methods

Unlike other oil fields in the USA, Canada, the Middle East, Western Europe, Southeast Asia, Africa, and the Republic of Azerbaijan, one of the key features of development in the Siyazan monocline oil field (SMOF) is the long range of production well filters of 200÷1500 m. At the end of drilling, prefabricated long filters covering oil layers are usually run into the wells, and then, if necessary, these filters are expanded by perforation. Simultaneous operation of an object with several different geological and hydrodynamic properties at SMOF with the use of long filters worsens the performance of wells, and as a result, despite the high initial oil production, due to technological, geological and environmental issues in the later stages oil production sharply falls down. The analysis shows that in these conditions, starting from the period of development in oil-producing wells, irrigation and the formation of high-altitude sand plugs are formed [2-7]

Violation of the process of natural isolation of layers in production wells at SMOF, connection of layers of different regimes and pressures as a result of intramigration and emigration, mixing of different characters and genetic types of water, significant increase of aggression as a result of contact with foreign contaminants, including corrosive bacteria, carbonates, radioactive contamination with substances poses a serious risks to the normal operation of the field.

In order to clarify the situation, samples have been taken from the produced waters and oils of the mentioned areas.

Water physico-chemical analysis was carried on according to standards QOST 4011-72, QOST P52407-2005, QOST 4192-82, QOST 4245-72, QOST 4388-72, QOST 4389-72, QOST 18164-72, QOST 18876-73, QOST P 51211-98, ISO 6060:1989, Standard Methods 5210B. Radioactive elements of water samples were determined using guidelines МУ 2.6.1.1981-05.

Density and kinematic viscosity of oil samples was determined using Anton Paar SVM 1001. Dynamic viscosity of oil was measured using Anton Paar MCR 302. Mechanical

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impurities were determined according to standard ASTM D473. The resin content was determined according to ASTM D381 standard. Water content was determined using ASTM D4006-16E1 standard.

Results and discussion

The results of physical-chemical analysis of water taken from the Ghil-Gilchay water injection site at SMOF are given in table 1, the amount of radioactive elements determined in samples of water taken from different depths are given in table 2, and the results of microbiological analysis of water samples taken from water reservoirs are given in table 3.

As it can be seen from table 1, in water samples, indicators such as BDO and CDO are more than 100 times the allowable limit, SASs are more than 10 times, petroleum products are more than 10 times, dependent substances are more than 100 times, minerals are more than 2 times, and various ions are sharp over.

As it can be seen from table 2, the amount of radioactive elements in water samples varies widely depending on the depth at which they are taken.

The amounts of various harmful bacteria are also very high in the water samples, as shown in table 3.

In the process of development, in the horizons of oil and gas fields and in separate structures of horizons, in addition to oil and water droplets, gas bubbles, paraffins, asphaltenes, resins, mechanical mixtures (sand, clay, salt microcrystals, etc.) are also formed. They turn into complex colloidal

Table 1
Results of physical and chemical analysis of produced water samples taken from «Gil-Gilchay» water supply and disposal service area

Ions	Acceptable limit, mg /l	Actual value, mg/l	Actual value, mg. ekv/l	Actual value, % ekv
BDO (Biological Demand for Oxygen)	3.0	318.0	-	-
COD (Chemical Oxygen Demand)	4.0-6.0	690.0	-	-
SAS (Surfactants)	0.1	0.3	-	-
Petroleum products	0.05	0.42	-	-
Dependent items	-	420.0	-	-
Minerality	1000.0	23131	-	-
HCO_3	30.0	1952.0	32.0	8.47
SO_4^{2-}	500.0	1710.0	35.63	9.43
Cl^-	350.0	11005	310.0	82.09
Ca^{2+}	180.0	300.0	15.0	3.97
Mg^{2+}	40.0	192.0	16.0	4.24
Na^++K^+	170.0	7972.38	346.63	91.79
NO^{2-}	0.08	0.36	-	-
NO^{3-}	4510	9.8	-	-
NH^{4-}	0.5	4.6	-	-
Fe^{+3}	0.5	0.520	-	-
Cu^{+2}	0.001	0.090	-	-
Al^{+3}	0.5	0.120	-	-
Zn^{+2}	0.01	0.089	-	-

Table 2
The amount of radioactive elements detected in samples taken from produced water at different depths in SMOF

Radioactive elements	Quantity, g/l
U.107	4.0-8.0
Ra.107	1.75-7.0
Rn.107	5.13-7.1
Th.107	1.7-4.1

Table 3
Results of microbiological analysis of water samples taken from reservoirs

Sampling site	SRB, attack / ml	IB, attack / ml	HB, attack / ml
Gil-gilchay area	10^3	10^6	10^7
Ata-chay area	10^3	10^7	10^7
Sedan area	10^3	10^6	10^7
SRB - Sulfate reducing bacteria; IB - iron bacteria; HB - hydrocarbon bacteria			

systems - oil emulsions, change their rheological properties and, as a result, become non-Newtonian (anomalous) liquids.

The results of physical and chemical analysis of oil samples taken from individual wells of the Siyazan field are given in table 4. For example, the results of the analysis of oil samples taken from wells № 1702, 1704, 1761 operated in the field in different years differ significantly from each other (table 4).

Thus, according to the results of laboratory analysis of oil samples taken from wells, the increment in specific gravity of oil on wells in the period from 2007 to 2013 was 51.6; 16.86 and 1.3 kg/m^3, in resin content was – 8%; 12% and 8%, in kinematic viscosity values - 11.7; 9.3 and 26.2 sSt, mechanical mixtures increased by 22.97; 23.95 and 71%, the amount of separated water increased by - 7.3; 8.33; 39.5%, and the oil cut was decreased by 39.27; 11.17 and 30.5%.

The results of the relevant analysis of oil samples taken from many other wells operating in the field have changed similarly.

Thus, the completion technology applied in the field (ready-made long filters) has a negative impact on the colloidal structure and rheological properties of the oil, as it increases oil viscosity and makes it difficult to extract.

The changes in physic-chemical parameters of produced oil is demonstrated in figures 1, 2 and 3.

As it can be seen from the graphs, between 2007 and 2013 (6 years), the deterioration of rheological properties of oils on all samples, regardless of the well, naturally led to a decline in oil production. The reason for the oil rheological properties deterioration is the imbalance of heavy components in the oil phase, i.e. ratio between the soluble components (asphaltene, resin, paraffin) and solvents (light components of oil), which eventually results in the formation of ARPS (Asphaltene, resin, paraffin sediments).

Table 4

Changes in oil samples taken from oil wells at different times

Well №	Date of analysis	Oil cut, %	Density, kg/m^3	Separated water, %	Oil kinematic viscosity, sSt	Amount of resin, %	Amount of mechanical impurities in oil , %
1704	15.05.2007	99.5	847.1	0.4	1.3	16	0.1
	27.08.2013	60.23	898.7	7.7	13	24	23.07
1702	14.02.2007	88.5	876.06	11	9.7	18	0.05
	27.08.2013	77.33	892.92	2.67	19	30	24.0
1761	06.06.2008	43.5	897.8	55.5	11.3	12	1.0
	26.08.2013	12	899.1	16	37.5	20	72.0

Under current conditions, paraffin, resin and other hydrocarbon compounds are separated from oil and deposited in the wellbore zone, around the filter, on the inner surface of the risers due to various reasons, including decrease of the temperature). One of the main reasons for this is the influence of the structural and mechanical properties of oil on the flow process. Thus, paraffin and resin crystallize in the oil phase, precipitates in the areas close to the well bottomhole, and then gradually spreads into the formation at a distance from the well bottomhole.

As a result, there are serious problems in the operation of production wells and oil transportation. In order to prevent this, a number of researches have been conducted to restore the initial permeability of the wellbore zone. In order to reduce the freezing point of high-viscosity oil and improve its rheological characteristics, a number of physicochemical

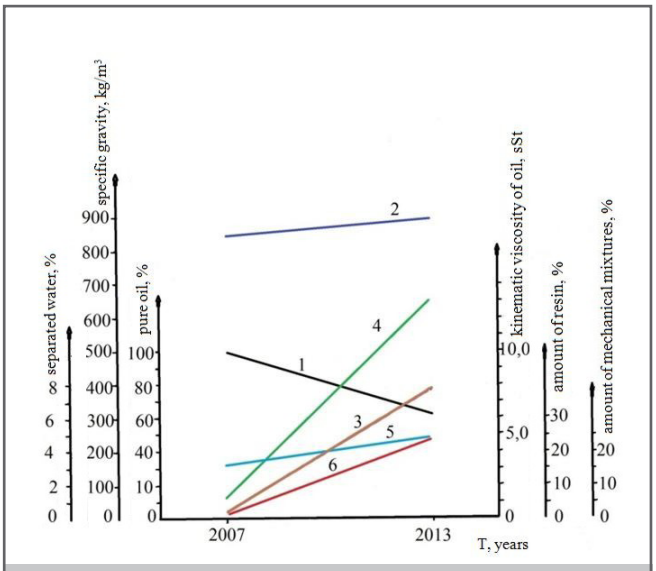

Fig. 2. Dynamics of change of physical and chemical properties of oil extracted from well № 1702, depending on time: 1 - pure oil; 2 - specific gravity of oil; 3 - separated water; 4 - kinematic viscosity of oil; 5 - the amount of resin; 6 - mechanical mixtures

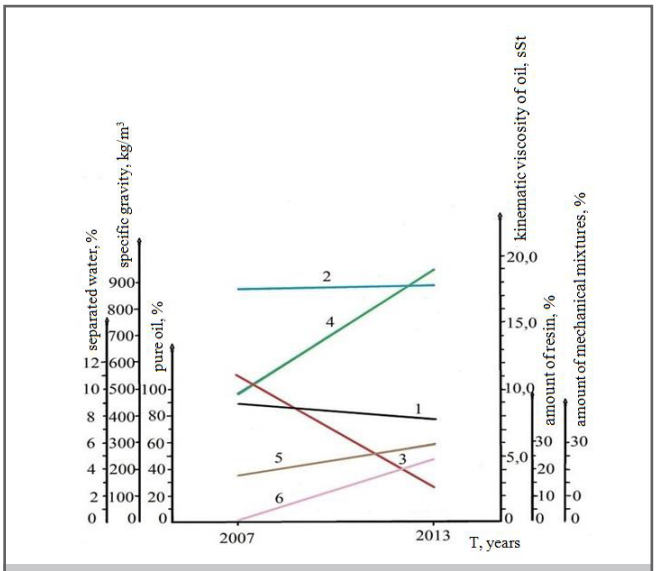

Fig. 3. Dynamics of change of physical and chemical properties of oil extracted from well № 1761 depending on time: 1 - pure oil; 2 - specific gravity of oil; 3 - separated water; 4 - kinematic viscosity of oil; 5 - the amount of resin; 6 - mechanical mixtures.

methods are used, including thermal, light fractions and various solvents and additives that regulate the viscosity-plastic properties of oil. At present, various types of polymers are widely used in the world. However, it should be noted that the additives used to regulate the rheological properties of oil do not always give the expected results. Therefore, research is underway to find highly effective regulators of the rheological properties of oil. Researches show that composites based on nanostructured polymers of some transition metals with porous and channel structure have the properties of regulating the rheological properties of petroleum colloids. They prevent the formation of non-valent bonds with resin, one of the main associative components of the mechanism of self-construction and self-formation, or regulate the rheological properties of oil by ensuring the disintegration of those already formed.

The use of beforementioned nanocomposites as additives has been tested in the Siyazan monoclinal oil fields [6-8].

In order to ensure the extraction of residual oil from production wells in order to develop difficult-to-extract oil reserves, an economically efficient and high-quality content composition has been developed using diesel-alkaline waste from the refinery as raw material. For this purpose, diesel-alkaline waste acedol (TTS-38. Az.R 2013-80) and nanostructured polycrystalline powders BAF-1 and BAF-2 (technical names of reagents of Oil Refinery named after H. Aliyev) have been used in oil production wells. Well impact technology has been developed. During a year 380 tons of additional oil was produced by taking measures influencing the wellbore field in oil production well № 111 operating in the Sedan area of the Siyazan field [9, 10].

It should be noted that the composite based on nanostructured coordination polymers also eliminates the hardness of produced water, destroys sulfate-reducing bacteria. The results of the analysis of produced water under normal conditions and after the addition of the composite are given in table 5.

Thus, the results of research and industrial application show that the developed nanotechnology significantly increases the prospects for the development of the Siyazan monoclinic oil field and creates the basis for more efficient exploitation of world oil fields of this nature [11, 12].

Table 5

Results of analysis of formation water under normal conditions and mixtures of equal amounts of BAF-1 and BAF-2 in ADFW (Alkalized diesel fraction waste) with the addition of 1.0% composite

Parameter	Unit of measurement	Formation water, without additives	After addition of 1.0% composite of BAF-1 and BAF-2 in ADFW	Normative document
Sulfate-reducing bacteria (SRB)	cell/1ml	10^2	Not detected	Act 39-15-1-13

Conclusion

The results of laboratory scientific and experimental research in the Siyazan field, one of the oldest onshore oil fields in the Azerbaijan, show that the technology created on the basis of newly obtained nanostructured reagents can be successfully applied not only in Azerbaijan, but in all oil fields around the world. The results of preliminary studies on oil samples taken from oil fields in Turkmenistan, Kazakhstan, Tatarstan and Siberia give us reason to say this.

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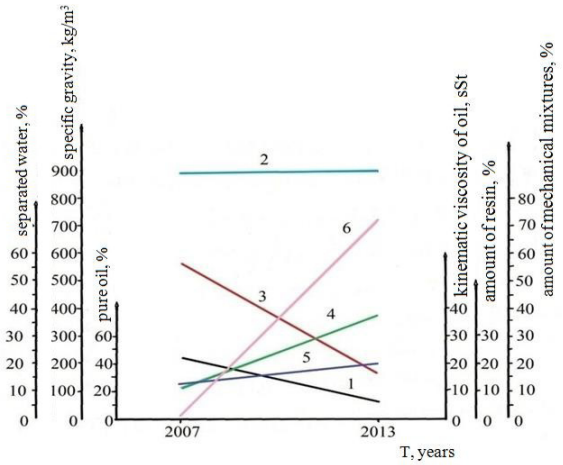

Fig. 3. Dynamics of change of physical and chemical properties of oil extracted from well № 1761 depending on time: 1 - pure oil; 2 - specific gravity of oil; 3 - separated water; 4 - kinematic viscosity of oil; 5 - the amount of resin; 6 - mechanical mixtures.

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К вопросу о перспективах освоения Сиязанского моноклинального нефтяного месторождения Азербайджанской Республики

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Реферат

В статье рассмотрены осложнения, связанные с аномальными условиями при разработке Сиазаньского моноклинного нефтяного месторождения. В сложных геолого-геофизических и эксплуатационных условиях актуальным вопросом считалось применение и продолжение при разработке новых инновационных методов на основе существующей системы. Для решения проблемы были созданы новые наноструктурные композиты класса БАФ-1 и БАФ-2, а также разработан метод воздействия на призабойное поле. С применением реагента дополнительно добыто 391.1 тонны нефти из скважины №111 на месторождении Юго-Восточный Саадан, со скважины №198 на месторождении Юго-Западный Саадан, и со скважины №1463, работающей на месторождении Амирханлы за период эксплуатации на пилотной этапе. Наноструктурированный композит БАФ-1 и БАФ-2 устраняет жесткость 3.0% пластовой воды, уничтожает сульфатредуцирующие бактерии.

Ключевые слова: асфальтены; смолы; парафин; наноструктурный композит; площадь забоя скважины.

Azərbaycan Respublikası Siyəzən monoklinal neft yatağının işlənilməsinin perspektivlilik məsələlərinin təhlili

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Xülasə

Məqalədə, Siyəzən monoklinal neft yatağının anomal işlənmə şəraiti ilə əlaqədar olaraq baş verən mürəkkəbləşmələrə baxılmışdır. Çətin geoloji-geofiziki və istismar şəraitində, mövcud işlənmə sisteminə yeni innovativ üsulların, tətbiqi və işlənilmənin davam etdirilməsi aktual məsələlərdən hesab edilmişdir. Problemin həlli məqsədi ilə yeni sinif BAF-1 və BAF-2 nanoquruluşa malik kompozitlər yaradılmış, quyudibi sahəyə təsir üsulu işlənilmişdi. Reagentin tətbiqi ilə Cənub-şərqi Səadan sahəsində istismarda olan 111 №-li, Cənub-qərbi Səadan sahəsində istismarda olan 198 №-li, Əmirxanlı sahəsində istismarda olan 1463 №-li neft hasiledici quyulardan təcrübə sınaq mərhələsində əlavə olaraq 391.1 ton neft hasil olunmuşdur. BAF-1 və BAF-2 nanoquruluşlu kompozit, 3.0%-li lay suyunun codluğunu aradan qaldırır, tərkibindəki sulfatreduksiyaedici bakteriyaları məhv edir.

Açar sözlər: qatran; parafin; nanoquruluşlu kompozit; quyudibi sahə.