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On the Degree of Influence of the Formation Washing Ratio on the Oil Recovery Coefficient of the Deposits of the Ferghana Oil and Gas Region Represented by Terrigenous Rocks

Agzamov A.Kh., Ermatov N.Kh., Normatov B.R., Ashirov V.R., Rahmonqulov M.T.

Doctor of Technical Sciences, Professor, Academician of the Russian Academy of Natural Sciences, Tashkent, Uzbekistan.
Professor, Chair of the department “Development and operation oil and gas deposits”, Candidate of technical sciences, Associate professor, Karshi engineering-economics institute, Karshi city, Uzbekistan.
Head of Upstream Department, Ministry of Energy, Tashkent, Uzbekistan.Engineer of the Andijanneft JSC, Andijanneft JSC, Andijan city, Uzbekistan.
Deputy Dean of the Faculty of Oil and Gas, Karshi engineering-economics institute, Karshi city, Uzbekistan.

ABSTRACT: Information is given on the geological structure and development of oil fields in the Ferghana oil and gas region, represented by carbonate rocks. Based on the processing of indicators, the dependences of the oil recovery coefficient on the degree of washing of the reservoir are established. it is shown that with an increase in the activity of the water-pressure system, the increase in the oil recovery coefficient due to water flooding decreases.

KEY WORDS: field, deposit, object, reservoir, development, system, pressure, waterflooding, stage, reserve, coefficient, extraction, displacement, dependence, growth, effect, flushing.

I. INTRODUCTION

Currently, the main technologies for developing oil deposits are based on the displacement of oil by water. The effectiveness of these technologies depends on the geological and physical properties of oil-saturated formations, on the properties of oil and water and extraction conditions. As experience in the development of oil fields shows, the coefficient of oil recovery (COR) from reservoirs during flooding is most strongly affected by: oil / water viscosity ratio; permeability heterogeneity of formations; average permeability and dissection, reservoir temperature; relative sizes of oil-water zones; micro homogeneity of the porous medium; oil saturation and capillary forces; well grid density and water flooding system [10-15 and others].

The results of the degree of influence of factors on the oil recovery factor based on multivariate analysis of 50 objects of the Ural-Volga region are studied. The analyzed objects confined to terrigenous reservoirs were at a late stage of development. Of the 50 objects studied, 18 were developed during in-situ flooding, 15 in outflow waterflooding and 17 under natural water pressure conditions. The values of geological factors at the analyzed objects varied in rather large ranges: the ratio of viscosity of oil and water from 1 to 25; average permeability from 0.15 to 2.5 microns ^{2}; formation temperature from 25 to 75°C; effective oil saturated thickness from 3 to 20 m; sandiness coefficient from 0.55 to 0.95; relative reserves of the oil-water zone from 25 to 100%; oil saturation from 0.75 to 0.95; well grid density from 10 to 60 ha / well.; the rate of fluid production from geological reserves from 2.5 to 7.5%.

In these ranges, changes in geological and production factors and their relative impact on oil recovery factor amounted to (%): the ratio of viscosity of oil and water is 21.1; average permeability +15.4; reservoir temperature +7; effective oil saturated thickness +6; sand factor +6; relative reserves of the oil-water zone -5,6; oil saturation +3,6; well grid density -3; water flooding systems +2,2; the rate of fluid production from geological reserves +0,6 («+» and «-» - positive and negative influence of the factor, respectively) [12].

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II. METHODOLOGY

When developing the studied oil deposits, regardless of the type of reservoir, due to their small depth with comparable sizes (oil reserves), almost the same development systems were implemented.

The following features of implemented systems are highlighted: [5,7,8,9]:

- drilling of deposits with a relatively dense grid of wells placed along a triangular grid;
- joint exploitation of deposits of horizons of KKS, Ia, Ib, III of some fields;
- the exploitation of deposits in the initial period under natural conditions, followed by the use of various water flooding systems (deposits with relatively small reserves are developed without maintaining reservoir pressure).

Due to the close values of the initial reservoir pressure of oil deposits and the pressure of oil saturation with gas, as well as the late use of water flooding, the low activity of the contour waters, which most often did not significantly affect the development process, the vast majority of the oil deposits were drained in the initial stage of development in the dissolved mode gas (table 1).

Maintaining reservoir pressure by injecting water began with overflow flooding. Exploratory and flooded oil wells were usually used to realize near-water flooding for water injection. In previous studies evaluating the effectiveness of bypass flooding, it is noted that despite a number of factors conducive to its successful application (small size of deposits, a small ratio of oil and water viscosities), it turned out to be relatively low due to [1-5]:

- poor hydrodynamic connection of the deposits with the marginal zone, due to a sharp deterioration in the reservoir properties of the reservoir in the area of the initial oil-water contact. The indicated factor made it difficult to develop the design fund of injection wells, as a result of which the latter covered only separate, small in length sections of the perimeter of the oil-bearing area, water flooding was focal in nature;

- significant heterogeneity of productive objects due to the presence of tectonic and lithological screens, extensive zones of erosion of wedging.

III. RESULTS

Under the influence of these factors, small sections of the reservoir experienced the injection effect, and most often only individual producing wells. Pressure redistribution occurred extremely slowly and unevenly, its growth was observed, mainly in the injection zones, while the central sections of the deposits continued to be developed under the depletion regime;

- there is a big difference in the permeability of cracks and matrices of carbonate reservoirs, which did not allow even by increasing the injection pressure to cover the entire reservoir with the influence of water flooding. With increasing injection pressure, most of the injected water went into the marginal region or penetrated deep into the reservoirs through systems of interconnected cracks, prematurely encircling the production of production wells. Having displaced a small amount of oil from more permeable fractured interlayers, the injected water subsequently moved along the same path, isolating sections of the low-permeability reservoir.

In the period 1960-1965 in order to intensify the waterflooding process in many deposits, the transfer of the injection line from the initial to the current oil content circuit and the development of various types of in-circuit flooding were widely used. As a result of the transition from overflow to various types of in-circuit flooding, reservoir pressure stabilized in the deposits, and annual oil production increased.

The implementation of in-circuit flooding made it possible to increase the efficiency of the injected water in many reservoirs by eliminating leakage into the outflow zone, to stabilize pressure in those areas of the reservoir that did not experience the effects of water injection during outflow water, and to cover the tectonic or lithological shielded areas of the reservoir by the injection effect.

Currently, all the facilities under consideration are in the fourth stage of development, which is characterized by low rates of oil extraction - less than 2.0% of the initial recoverable reserves, high water cut of produced products and depletion of reserves (more than 90%), a significant drop in reservoir pressure, despite implementation of measures to maintain it and relatively low values of the oil recovery coefficient (table. 2).

As you know, the effectiveness of modern oil field development systems is largely due to the use of artificial water flooding, which accounts for about 90% of the total world oil production [12].

However, the widespread use of this method of developing oil fields is unthinkable without its further improvement. In this regard, the study of the features of artificial flooding in various geological and physical conditions

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and finding ways to improve it has been given and is given considerable attention. Such studies, as is known, on the one hand, make it possible to use the accumulated experience in the exploitation of deposits during artificial flooding in the process of designing the development of new fields: on the other hand, they contribute to the effective further development of depleted facilities, in which huge material and technical resources have already been invested [13]. Evidence of this is the numerous works devoted to various issues of developing oil fields in Bashkortostan, Tatarstan, the Kuibyshev, Orenburg and Perm regions, Ukraine and Azerbaijan using water flooding [12,13,15].

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IV. ANALYSIS

The dependence of oil recovery on the completeness of flushing the reservoir during the development of deposits with flooding is the basis of the well-known expression [12,14]:

$$КИН = К_{в} \cdot К_{охв}, \qquad (1)$$

Where $К_{в}$ – the displacement coefficient, which is the ratio of the volume of displaced oil to its initial volume in the reservoir during prolonged and intensive washing of a homogeneous element of a porous medium; $К_{охв}$ - reservoir coverage factor by volume processes.

coefficients $К_{в}$ и $К_{охв}$ change in time, since the front of the water entering the reservoir as it moves captures more and more new sections of the reservoir, interlayers and, when the direction of the filtration flows changes, stagnant and deadlock zones.

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To assess the effectiveness of implemented development systems, many researchers recommend using the dependence of the recovery factor on the degree of washing of the formation [12,15].

Moreover, as a criterion for assessing the technological efficiency of development systems implemented at the field, the achieved oil recovery factor is taken with the same degree of washing of the pore volume occupied by oil,

$$КИН = f(\tau), \quad (2)$$

Where $\tau = \frac{\sum Q_ж}{НГЗ}$,- flushing ratio, $\sum Q_ж$- accumulated fluid withdrawal in reservoir conditions; НГЗ-initial geological oil reserves.

Unlike the numerous forms and types of displacement characteristics that have long been used in practice, this technique is convenient in that it allows the use of primary, and therefore to a lesser extent, distorted initial data, such as fluid withdrawal, which is taken into account in the field quite reliably, and the geological oil reserves at the late and the final stages of the development of category AB, conversion factors for the physical parameters of fluids in reservoir conditions and vice versa. The multiplicity of reservoir washing, being a relative value, is convenient when comparing, since it is equally applicable in the analysis of both small-sized deposits and large deposits [15].

Figure 1 shows the dependence of the oil recovery factor on the multiplicity of flushing the formation for the main facilities of the low-level non-volatile oil and gas industry represented by terrigenous reservoirs developed under natural conditions and using water flooding.

It can be seen from it that there is a close relationship between these parameters, described by a linear dependence with a fairly high correlation coefficient:

$$КИН = 0{,}1266 + 0{,}2329 \cdot \tau,$$
$$R = 0{,}8890 \quad (3)$$

Figures 2 and 3 show the dependences of the COR on the objects developed under natural conditions and with the use of water flooding, which are also described by a linear function with high correlation coefficients:

- in natural mode

$$КИН = 0{,}0169 + 0{,}5604 \cdot \tau,$$
$$R = 0{,}8983; \quad (4)$$

- using waterflood

$$КИН = 0{,}1346 + 0{,}1946 \cdot \tau,$$
$$R = 0{,}8700. \quad (5)$$

With the obtained dependences (4) and (5), it is possible to evaluate the technological effect (increase in oil recovery factor) from water flooding at various values of the degree of formation washing.

Based on the results of the analysis of the development of the main facilities of the NGF represented by terrigenous reservoirs, the following conclusions can be drawn:

- waterflooding development systems provide an increase in the degree of multiplicity of flushing the formation and the oil recovery coefficient;
- the process of oil recovery at facilities developed under natural conditions and with the use of water flooding occurs according to a single mechanism;
- as the activity of the water pressure system increases, providing a high degree of formation flushing, the recovery factor from the use of water flooding decreases;
- the greatest effect from water flooding is achieved at facilities where the natural regime does not ensure the achievement of a high degree of flushing of the reservoir.

V. CONCLUSION

In the considered ranges of changes in geological and production factors, the most powerful effect on oil recovery factor is exerted by: the ratio of the viscosity of oil and water and the average permeability of the layers; almost the same effect — formation temperature, effective oil-saturated thickness, sandiness coefficient and relative reserves of the oil-water zone; least impact is oil saturation, well grid density, water flooding system and fluid recovery rate.

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At the same time, a multivariate analysis found that at different stages of development, the degree of influence of geological and production factors on oil recovery factor changes. For example, in the later stages, the degree of influence of the ratio of viscosities of oil and water decreases, while the role of the density of the grid of wells increases. But, at all stages of development, the dominant influence on the oil recovery factor of natural factors remains.

Consider the effectiveness of the implemented systems for the development of facilities of the non-governmental educational institutions, which are in the late stages of development.

The structure of the Ferghana region involves Neogene, Paleogene, Mesozoic (Cretaceous, Jurassic) and Paleozoic sediments. The total thickness of the sedimentary cover in the central parts of the depression is more than $10.0\text{-}12.0 \cdot 10^3$m, in the instrument area $-2.5\text{-}4.0 \cdot 10^3$m and more [7,8].

A characteristic feature of the distribution of hydrocarbon deposits is a significant increase in gas content down the section. If the Neogene and Paleogene deposits are mainly oil-bearing, and the accumulations of free gas are associated with gas caps and individual gas deposits, then in the Cretaceous and Jurassic deposits mainly gas and gas condensate deposits are developed (Table 3).

In the context of the Paleogene, up to eight productive strata are distinguished. Strata I, III, IV are represented by fine-grained sandstones and siltstones. Formations V, VI, VII, VIII, IX-carbonate rocks (limestones and dolomites) [7,8].

The collectors of productive Mesozoic strata are, as a rule, sandstones with intercalations of siltstones. Only some horizons of the Upper and Lower Cretaceous are represented by limestones. The oil content of the Mesozoic sediments is limited. Known small oil deposits are of non-industrial importance, oil inflows from them are short-term and unstable.

As can be seen from table 4, the oils of the Paleogene deposits are mainly light (826-884 kg / m^3), low-sulfur (0.05-0.75%), paraffin (1.4-10.1%), highly resinous (silica gel resins 5,29-30.2). The viscosity of reservoir oils is small, 0.7-0.6 mPa · s, initial gas saturation from 2-5 to 100-150 m^3 / t.

Oil deposits are confined to narrow asymmetric folds, the length of which is 10-15 · 103 m, the width does not exceed $2\text{-}3 \cdot 10^3$ m, the dip angles of the formations are 20-30 ° C and more. Known oil and gas deposits are mainly of the stratum-vault type (Table 3). However, as a result of intense tectonic activity according to the degree of complexity of their disturbances, tectonically shielded deposits (Palvantash, Andijan, Khojaabad and other deposits) are also observed among them. Lithologically shielded deposits in the region are limited.

Productive deposits of the considered objects are heterogeneous, they are characterized by layered, zonal heterogeneity and uneven fracturing.

Almost all deposits are multilayer. The largest number of deposits is discovered in the context of the North-Sokh, South-Alamyshik, Andijan and Palvantash deposits. Oil deposits are characterized by low altitude, a small difference between the initial reservoir pressure and the gas saturation pressure of oil.

Table 1
Parameters characterizing the energy state of objects represented by terrigenous reservoirs
(as of January 1, 2017)

№	Deposit	Plast	Initial reservoir pressure, MPa	Pressure of saturation of oil with gas, MPa	Formation pressure at the beginning of flooding, MPa	Compensation of fluid withdrawal by water injection,%	Current reservoir pressure, MPa	Relative fluid withdrawal, units
1	Andijan	Neogen, KKC, I	3-3,5	3,0	2,9	42,12	0,62-2,44	0,652
2	Andijan	Paleogen, III	5,66	5,0	2,5	192,7	2,03-4,07	1,699
3	South Alamushuk	Neogen, I,Ia	3,6	3,5	1,2	55,6	1,37-2,74	0,947
4	South Alamushuk	Neogen, Ib	4,5	3,5	1,0	410,8	1,14	0,425
5	South Alamushuk	Neogen,KKC	4,2-5,6	1,5	1,72	130,5	1,54-3,6	0,999
6	South Alamushuk	Paleogen, III	5-5,5	5,0	11	84,9	1,09	0,378
7	South Alamushuk	Upper chalk, XVIII	10,0	4,0	9,3	60,8	6,65	1,923
8	South Alamushuk	Chalk, XIX-XXII	12-12,2	6,0	5,0	21,0	6,56-11,83	0,954
9	Sharikhan-Khojaabad	Neogen, BRS, I	4,0	3,5	1,0	11,7	1,5	2,212
10	Sharikhan-Khojaabad	Paleogen, III	5,2	5,0	1,8	338,4	1,96	0,383
11	West Palvantash	Neogen,BRS	8-14	6,0	6,5	2,21	8-12,1	1,033
12	West Palvantash	Paleogen, III	18,9	13,0	13,5	11,9	6,77	1,659
13	Northern Sokh	Paleogen, II	14,9	9,0	-	-		0,518
14	Northern Sokh	Paleogen, IV	15,5	12,7	10,81	28,6		0,410
15	Khankyz	Paleogen, II	10,0	2,6	3,8	24,1		1,000

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16	Changora Galcha	Paleogen, IV	4,55	4,0	3,68	131,2		2,822
17	Boston	Neogen, KKC, I+Ia+Ib	2,5-3,0	2,1	1,1	49,4	1,23-2,55	0,342
18	Boston	Paleogen, III	2,5-5,0	4,8	2,24	135,5	2,39	0,547

Table 2

The state of depletion of the approved recoverable reserves and the coefficient of extraction of geological oil reserves of objects represented by terrigenous reservoirs

(01/01/2017).

№	Deposit	Horizon	Approved COR, shares units	The depletion of recoverable oil reserves, %	Current COR, shares
1	Andijan	Ia	0,349	99,1	0,346
2	Andijan	I	0,380	97,2	0,369
3	Andijan	KKC	0,349	94,9	0,331
4	Andijan	III	0,453	98,8	0,447
5	Khojaabad	I	0,543	100,6	0,547
6	Khojaabad	III	0,220	100,4	0,220
7	Khojaabad	XX+XXI+XXII	0,885	98,6	0,873
8	Khojaabad	XVIII	0,398	15,4	0,061
9	Khojaabad	XXVIII	0,387	28,8	0,111
10	Boston	Ia+ I+ KKC	0,325	34,3	0,112
11	Boston	III	0,310	96,9	0,300
12	South Alamushuk	I+Ia	0,310	93,8	0,291
13	South Alamushuk	Iб	0,300	74,0	0,222
14	South Alamushuk	KKC	0,400	95,8	0,383
15	South Alamushuk	III	0,250	75,7	0,189
16	South Alamushuk	XVIII	0,362	96,9	0,351
17	South Alamushuk	XIX+XX+XXI+XXII	0,349	89,6	0,313
18	South Alamushuk	XXIII	0,202	50,0	0,101
19	Khartoum	III	0,299	66,1	0,198
20	East Khartoum	III	0,380	92,37	0,351
21	Palvantash	I,III	0,150	45,7	0,068
22	West Palvantash	БРС	0,280	87,2	0,244
23	West Palvantash	III	0,450	92,4	0,416
24	Hojaosman	XX-XXII	0,705	97,0	0,683
25	Northern Sokh	II	0,258	84,5	0,218
26	Northern Sokh	IV	0,450	57,1	0,257
27	Changora Galcha	IV	0,750	99,1	0,743
28	Khankyz	II	0,400	87,4	0,349
29	Varyk	II	0,251	8,49	0,021
30	Varyk	IV	0,281	109,6	0,307
31	Achisu	II	0,251	29,1	0,073
32	Khartoum	XXII	0,200	2,6	0,005

Table 3

The main characteristics of the productive strata of the Ferghana depression, represented by terrigenous rocks

№	Deposit	Horizon	Depth, m	Oil-bearing area, thous..м^2	Formation thickness, m		Formation temperature, ° C	Reservoir pressure, MPa		Type of deposit
					Total	Effective		initial	current	
1	Palvantash	Neogen I,III	450	5800	7	4	31	4,1		Oil and gas
2	Andijan	Neogen KKC,I	565	2210	90	38	15	3-3,5	0,62-2,44	Oil and gas
3	Andijan	Paleogen III	850-420	6000	9	8	25	5,6	2,03-4,07	petroliferous
4	South Alamushuk	Neogen I,Ia	550	3540	70	29,8	24	3,6	1,37-2,74	Oil and gas
5	South Alamushuk	Neogen Ib	450	2250	20	7	26	1,5	1,14	petroliferous
6	South Alamushuk	Neogen KKC	450	11300	125	34	30	4,2-5,6	1,54-3,6	petroliferous
7	South Alamushuk	Paleogen III	550	14670	5	5	38	5,0-5,5	1,09	petroliferous
8	South Alamushuk	Upper chalk XVIII	1100	1420	30	19	45	10,0	6,65	petroliferous

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9	South Alamushuk	Chalk XIX-XXII	1360	1800	70	54	45	12,0-12,2	6,56-11,83	petroliferous
10	South Alamushuk	Yura XXIII	1600	2250	20	16	48	13,0-14,0		Oil and gas
11	Sharikhan-Khojaabad	Neogen BRC I	400	850	20	12	-	4,0	15	Oil and gas
12	Sharikhan-Khojaabad	Paleogen III	580	2900	7,5	7,5	30	5,2	1,96	petroliferous
13	Sharikhan-Khojaabad	Chalk XX,XXI,XXII	2100	5	15	10	85			Oil and gas
14	Sharikhan-Khojaabad	Yura XXIII	2300	760	15	0,5	87			Oil and gas
15	Sharikhan-Khojaabad	Yura XXVIII	2500	940	18	8	89			Oil and gas
16	West Palvantash	Neogen BRC	1400	2020	17	7	57	8,0-14,0	8,0-12,1	petroliferous
17	West Palvantash	Paleogen III	1900	2250	6	4,2	63	18,9	6,77	petroliferous
18	Northern Sokh	Paleogen II	1350	1030	24	10	48	10,9		Oil and gas condensate
19	Northern Sokh	Paleogen IV	1500	5269	10	2,6	52	15,5		Oil and gas
20	Khankyz	Paleogen II	1350	1823	26	11	50	10,0		Oil and gas condensate
21	Changora Galcha	Paleogen IV	450	10006	5	1,6	37	4,55		Oil and gas
22	Varyk	Paleogen II	3200	670	14,3	7,7	50	24,0		Oil and gas
23	Varyk	Paleogen IV	3600	1130	14	5,5	110	38,0		petroliferous
24	Boston	Neogen KKC I+Ia+Ib	500	2610	16	11	28	2,5-3,0	1,23-2,55	Oil and gas
25	Boston	Paleogen III	800	4260	6,2	10,3	36	2,5-5,0	2,39	petroliferous
26	Boston	Chalk XX	2350	240	18	3	-			petroliferous
27	Boston	Yura XXX	2800	340	21	10,9	74			petroliferous
28	Hojaosman	Chalk XX-XXII	800	700	19	16	35	6,0		petroliferous
29	Khartoum	Paleogen III	2150	1100	23	10,7	66	20-25	6,53-14,84	Oil and gas
30	Khartoum	Chalk XXII	4200	2870	25	8,4	106			Oil and gas
31	East Khartoum	Paleogen III	2100	1360	34,5	92	66			petroliferous
32	East Khartoum	PaleogenIV	2380	240	36	12	81			petroliferous
33	Tergachi	Neogen KKC	3750	6760	8	1,9	-			petroliferous
34	Kasansai	Paleogen III	5090	19400	11	6,4	140			petroliferous
35	Achisu	Paleogen II	3500	560	9	4,4	90			petroliferous

Table 4

Filtration and Capacitive Parameters, Composition and Properties of Petroleum of the Productive Formations of the Ferghana Depression, Represented by Terrigenous Rocks

№	Deposit	Productive horizon	The coefficient of porosity, the share of units	The coefficient of oil saturation, the share of units	Permeability, microns ^{2}	Volume ratio, fractions of units	The density of oil, t / m	Oil viscosity in reservoir conditions, MPa · s	Oil content, %			Oil pour point, °C
									Sulfur	Paraffin wax	Resins and Asphaltenes	
1	Palvantash	I,III	0,18	0,60	0,005	0,9	0,830	5,0	0,18	2,7	45,2	-15
2	Andijan	KKC,I	0,20	0,65	0,300	0,9	0,865	3,0	0,45	5,2	32	3
3	Andijan	III	0,20	0,50	0,240	0,981	0,860	2,5	0,32	0,7	28	6
4	South Alamushuk	I,Ia	0,15	0,55	0,018	0,85	0,830	2,5	0,15	6,2	57,2	4
5	South Alamushuk	Iб	0,19	0,59	0,041	0,85	0,840	2,5	0,15	6,2	12,5	-10
6	South Alamushuk	KKC	0,19	0,70	0,030	0,88	0,843	2,3	0,06	6,9	12,2	7
7	South Alamushuk	III	0,16	0,50	0,130	0,92	0,860	4,0	0,04	9,6	22,5	5
8	South Alamushuk	XVIII	0,18	0,70	0,393	0,9	0,858	2,35	0,05	4,14	8,3	-6
9	South Alamushuk	XIX-XXII	0,18	0,70	0,239	0,9	0,815	1,2	0,06	8,8	5,1	-6

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10	South Alamushuk	XXIII	0,14	0,70	0,440	0,9	0,822	3,8	0,01	0,7	-	-6
11	Sharikhan-Khojaabad	БРС,I	0,12	0,50	0,070	0,985	0,855	3,0	0,21	6,3	23,0	-14
12	Sharikhan-Khojaabad	III	0,16	0,80	0,004	0,909	0,863	4,8	0,16	6,7	45,2	-14
13	Sharikhan-Khojaabad	XX,XXIXXII	0,11	0,67	0,030	0,7	0,809	0,9	0,22	8,1	5,2	-12
14	Sharikhan-Khojaabad	XXIII	0,13	0,70	0,076	0,85	0,830	0,8	0,07	3,4	5,1	-12
15	Sharikhan-Khojaabad	XXVIII	0,13	0,70	0,400	0,84	0,810	0,8	0,06	5,5	4,9	-12
16	West Palvantash	БРС	0,22	0,60	0,011	0,935	0,850	4,0	0,31	10	40,2	13
17	West Palvantash	III	0,13	0,56	0,043	0,933	0,872	9,5	0,20	5	7,45	13
18	Northern Sokh	II	0,20	0,63	0,086	0,85	0,856	4,8	-	10,7	24,9	6
19	Northern Sokh	IV	0,17	0,50	0,014	0,85	0,830	3,2	0,14	7,9	15,6	14
20	Khankyz	II	0,16	0,65	0,018	0,934	0,868	6,7	0,18	12	37,8	12
21	Changora Galcha	IV	0,11	0,67	0,012	0,915	0,872	3,7	0,14	5	30	-17
22	Varyk	II	0,14	0,40	0,017	0,806	0,880	6,0	0,66	18,2	33,7	17
23	Boston	IV	0,105	0,47	0,004	0,87	0,887	1,7	0,13	15,1	41,6	23
24	Boston	ККС,I+ Ia+Iб	0,16	0,70	0,060	0,859	0,860	2,3	0,3	10	37	12
25	Boston	III	0,16	0,70	0,006	0,875	0,854	3,44	0,32	6	36,6	2
26	Boston	XX	0,13	0,60	-	-	-	-	-	-	-	-
27	Boston	XXX	0,15	0,70	0,010	0,82	0,851	9,34	0,09	12,9	16,9	23
28	Khartoum	III	0,138	0,70	0,090	0,893	0,866	2,2	0,21	8,5	12,4	9
29	Khartoum	XXII	0,09	0,70	0,320	0,9	0,836	2,26	0,16	22,2	41,2	3
30	East Khartoum	III	0,16	0,70	0,070	0,893	0,851	2,43	0,38	17,9	48,6	12
31	East Khartoum	IV	0,10	0,75	0,004	0,888	0,844	2,44	0,38	2,2	10,7	14
32	Tergachi	ККС	0,12	0,79	0,002	0,805	0,825	2,0	-	-	8,3	-
33	Kasansai	III	0,14	0,75	0,020	0,9	0,825	1,24	0,3	5	-	-
34	Achisu	II	0,15	0,70	0,008	0,88	0,840	7,1	0,01	21	33,7	17
35	Hojaosman	XX-XXII	0,15	0,70	0,040	0,92	0,801	1,4	0,04	5	48	-4

The findings do not contradict, but confirm the results of many domestic and foreign researchers involved in improving the efficiency of waterflooding in various geological and physical conditions of oil deposits.

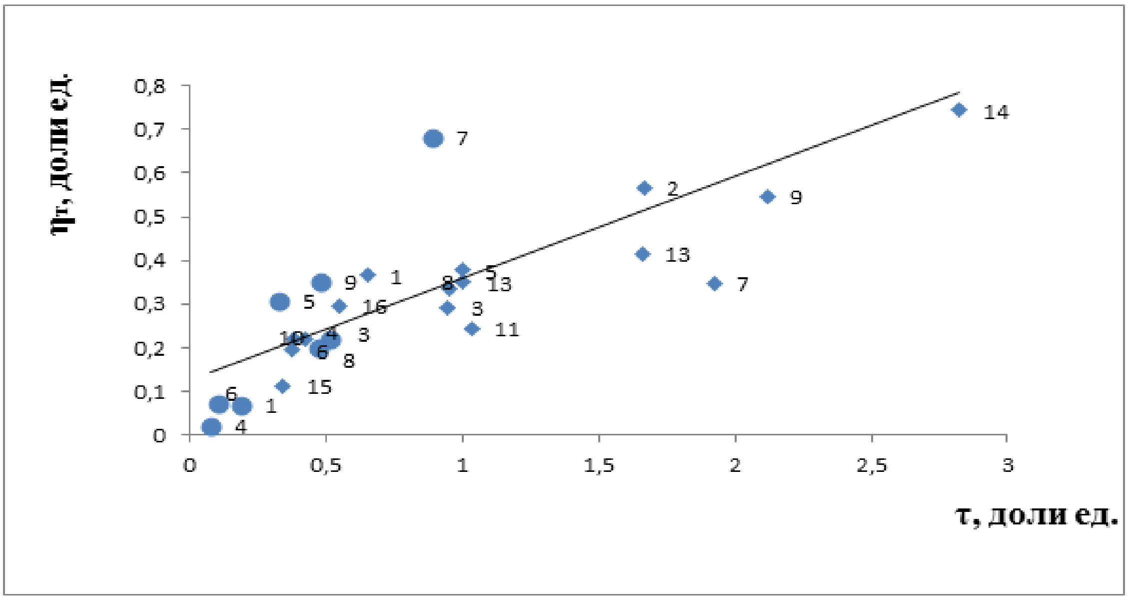

Fig. 1. The dependence of the recovery factor on the degree of washing the formation:

◆- Waterflood development projects: 1,2- deposit Andijan ККС+1, III strata; 3,4,5,6,7,8-South Alamyshik I+Ia, Iб, ККС, III, XVIII, XIX-XXII strata; 9,10- Khojabad БРС+I, III strata; 11,12- West Palvantas БРС, III strata; 13- Khankyz II strata; 14- Chongora Galcha IV strata; 15,16- Boston ККС+1+1а+1б, III strata.

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- objects developed without flooding:

1- deposit Palvantash I+III strata; 2- Shariham-Khojabad XX-XXII strata; 3- Northern Sokh II strata; 4,5- Varyk II, IV strata; 6- Acisu II strata; 7- Hojaman XX-XXII strata; 8- Khartoum III strata; 9- East Khartoum III strata.

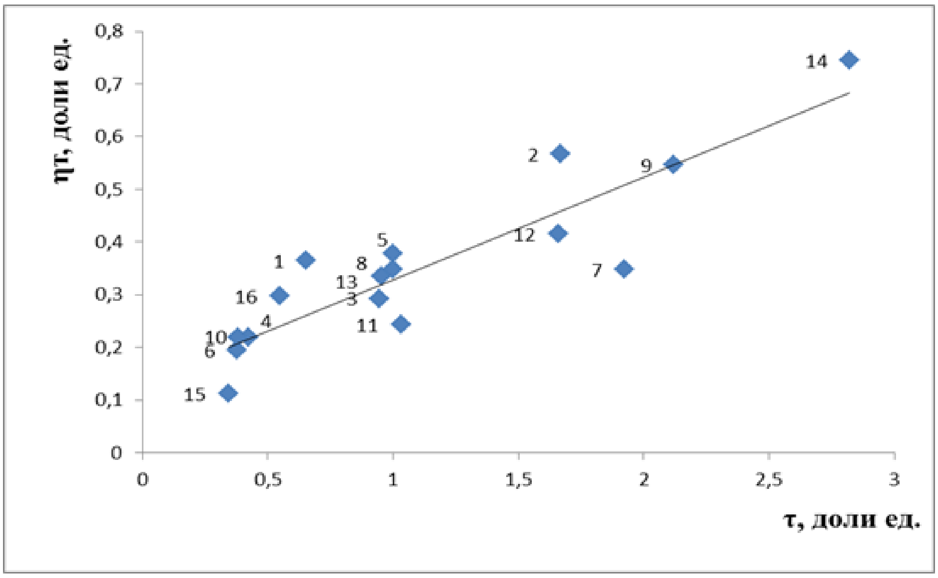

Fig. 2. Dependence of COR on for objects under development water flooding

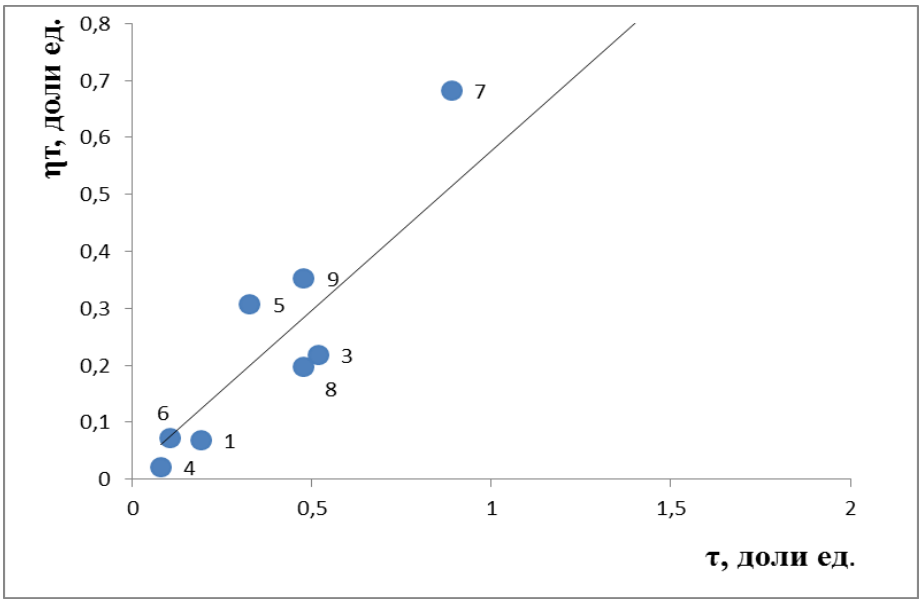

Fig. 3. Dependence of COR on for objects under development in natural mode

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