MINISTRY OF EDUCATION OF REPUBLIC OF AZERBAIJAN

KHAZAR UNIVERSITY

SCHOOL OF SCIENCE AND ENGINEERING

The code of the major	**60606 – Petroleum and Gas Engineering**
The name of the specialty	**Petroleum Engineering**

MASTER THESIS

Title: "İnvestigation of issues of increasing well productivity in the fields exploited under difficult conditions (in example of Buzovna-Mashataga field)"

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BAKU – 2019

ABSTRACT

The actuality of theme: Azerbaijan is not only one of the world's leading oil-producer countries, but also Azerbaijan is one of the world's oldest oil-producers. Hydrocarbon resources (oil and natural gas) play an important role in the economy of the Republic of Azerbaijan. In 1921, exploration works were expanded due to the decline in oil production, and following these events a number of new oil fields were discovered and put into operation in Azerbaijan (especially Gala, Buzovna-Mashtagha etc.) and oil extraction in 1941 reached to 23.6 million tons, which was about 76% of the Former Soviet Union's total oil production on that time.

In this Master of Science thesis, selection of appropriate measures against sand production formation in Buzovan-Mashtagha field, one of the oldest oil fields of Azerbaijan is being studied.

The field is located in the northern-east part of the Absheron Peninsula, 20km from Baku, between Mashtagha and Buzovna villages. Buzovna - Mashtagha oil field is located in the East Absheron OGR and forms part of the Kurdakhani- Gala – Zyra anticlinal fold. The studies carried out in the field have revealed that the Buzovna - Mashtagha belongs to the type of buried oil fields. The fold is divided into the northern-southern-central sections by single longitudinal tectonic fault with an amplitude of 200-250m.

The oil and gas resources of the field is mainly formed in the PK, NKP, NKG Suits of the Lower Productive Series and in X, VII, V, IV, and II horizons of the Upper Productive Series is distributed in separate tectonic blocks according to the local areas.

The field was first discovered in the Southern Buzovna area by the exploration well # 1/1056 drilled in 1940; the well was penetrated the IV KS horizon, with a daily oil production of 85.0 tones. Oil and gas content of other suits in the Mashtaga area

was discovered in 1944. By 1954, oil and gas resources of productive layers of the field and their contours were determined.

The porosity of reservoirs s varies between 19-24% for NKG, NKP, KS and PK suits, ranging from 0.100 to 0.300 mkm^2, respectively. Buzovna - Mashtagha field's oil belongs to the types of fluids that do not follow Newton's law due to its physical characteristics.

Especially, it should be noted that because of the fact that oil-gas reservoirs are very poorly cemented and very fragile sand productions are intensively developed while exploiting the wells, during the short exploitation period wells are disrupted for technical reasons and some major problems occur while trying to effectively development of the reservoirs. It was suggested that the classification model to be used to increase oil extraction considering that the field is at the stage of production decline.

Results concluded in this thesis can be practically implemented in planning of the development program of onshore fields.

XÜLASƏ

Mövzunun aktuallığı: Azərbaycan dünyada neftçıxarma üzrə liderlərdən biri kimi tanınmış, maddi və mənəvi sərvətləri ilə zəngin olan və neftçıxarma sahəsində ən qədim təcrübəyə malik olan bir neft ölkəsidir. Neft və qaz Azərbaycan Respublikasının iqtisadiyyatında mühüm yer tutur. 1921-ci ildə neft hasilatı azaldığına görə axtarış-kəşviyyat işləri genişləndirilir və bununla əlaqədar Azərbaycanda bir sıra yeni neft yataqları (xüsusilə Qala, Buzovna-Maştağa və s.) aşkar edilib istismara verilir və neft hasilatı 1941-ci ildə 23,6 mln. tona çatdırılır ki, bu da o dövrdə SSRİ-nin neft hasilatının 76%-ni təşkil edir. Azərbaycanın köhnə yataqlarından biri olan Buzovan-Maştağa sahəsində quyuların istismarında qum tıxaclarının əmələ gəlməsinə qarşı müvafiq tədbirlərin seçilməsi məsələsi tədqiq olunur.

Yataq Abşeron yarımadasının şimal-şərqində Bakı şəhərindən 20km məsafədə, Maştağa və Buzovna kəndləri arasında yerləşir. Buzovna – Maştağa yatağı Şərqi Abşeron NQR-da yerləşir və Kürdəxanı-Qala-Zirə anticlinal qırışığının bir hissəsini təşkil edir. Yataq ərazisində aparılmış tədqiqatlarla müəyyən edilmişdir ki, Buzovna – Maştağa yatağı gömülmüş yataqlar tipinə məxsusdur o, en qırışıqdan ibarətdir. Qırışıq 200-250m amplitudası olan vahid uzununa keçən tektonik pozğunluqla şimal-cənub-mərkəz sahələrinə bölünür.

Yatağın neftli-qazlılığı başlıca olaraq MQ-ın alt şöbənin QA, QÜQ, QÜG lay dəstlərində formalaşmış, üst şöbənin X, VII, V, IV, II horizontları üzrə neft-qazlılıq ayrı-ayrı tektonik bloklarda lokal sahələrdə yayılmışdır.

Yataq ilk dəfə Buzovna-cənub sahəsində 1940-cı ildə qazılmış 1/1056 saylı kəşfiyyat quyusu vasitəsilə kəşf edilmişdir; quyu gündəlik neft hasilatı 85.0 ton olmaqla IVQD horizontundan istismara daxil olmuşdur. 1944-cü ildə isə Maştağa sahəsində digər lay dəstlərinin neft-qazlılığı aşkarlanmışdır. 1954-cü ilə kimi yatağın məhsuldar layların neft-qazlılığı və onlarınsahələrininkonturları müəyyənləşdirilmişdir.

Kollektorların məsaməliyi QÜG, QÜQ, QD və QA lay dəstəsi üzrə 19-24% keçiricilik isə müvafiq olaraq 0.100-0.300 mkm^2 arasında dəyişir. Buzovna – Maştağa yatağının neftləri fiziki xüsusiyyətlərinə görə Nyüton qanununa tabe olmayan mayelərə aid edilir.

Xüsusi olaraq qeyd olunmalıdır ki, neftli-qazlı kollektorlar olduqca zəif sementlənmiş və çox kövrək olduqlarından quyularda istismar prosesində intensiv olaraq qum tixacları əmələ gəlir, quyular qısa istismar müddətində texniki səbəbə görə sıradan çıxır və layların səmərəli işləməsində böyük problemlər yaranır. Yatağın hasilatın düşmə mərhələsində olmasını nəzərə alaraq neft verminin artırılması üçün təsnifat modelindən istifadə olunması təklif olunmuşdur.

Tezis işindən əldə olunan nəticələr quru yataqlarında işlənmə proqramının planlaşdırılmasıda praktiki olaraq tətbiq oluna bilər.

CONTENTS

INTRODUCTION

Azerbaijan is an oil producing country with rich material and spiritual wealth and having the oldest experience in oil production is considered as one of the the leaders in this field throughout the world.

Oil and gas play an important role in the economy of the Republic of Azerbaijan. Favorable conditions for the development of the oil and gas industry have been created as a result of the successful "Oil Policy" carried out by government of Azerbaijan. The basis of this policy is foreign capital inflow and expansion of foreign economic relations.

At present, oil and gas industry is facing the following issues that need to be solved:

- acquisition of additional capital investments for expansion of geological exploration works;
- discovering and starting to exploit deepwater oil and gas fields;
- application of advanced techniques and technology for the exploitation of offshore oil and gas fields;
- to determine the routes through which extracted oil and gas will be exported to the world market.

In 2008, Azerbaijan produced more than 44.5 mln tons of oil and up to 7.753 billion m^3 of natural gas and it was a record amount for our republic. The State Oil Company of Azerbaijan Republic (SOCAR) has produced 8.65 mln tons of oil from the fields the company was exploiting[4].

At present, more than 75% of the oil extracted in our Republic has been produced from the offshore fields.

Guneshli field occupies one of the first places among the offshore oil and gas fields, for the estimated amount of oil it posses. About 190 wells are exploited in this field.

Development of oil and gas industry in our republic is mainly related with the offshore fields. Main part of the potential oil resources is on the shelf areas of the Caspian Sea.

Signing of the "Contract of the Century" played a crucial role in the domestic and foreign policy of the Republic of Azerbaijan. Contracts have been signed with the foreign oil companies in development of Azeri-Chirag- Gunashly (ACG) fields in the South Caspian basin. These companies represent more than 30 foreign countries.

Achieving stabilization in the exploitation of old oil fields has important significance along with the discoveries of the new fields and improvement in the operational capacity of the offshore oil and gas fields. It is a fact that, most of the old oil fields are located onshore. Wells in most of the fields operated onshore are exploited with the down hole pumps. Normal exploitation of these wells face many challenges for various reasons. The most important of these factors is formation of sand productions in the wells during the exploitation of weakly cemented layers.

In this MSc thesis, main focus is the study of sand control measures applied during the well exploitation in the Buzovna-Mashtaga field, one of the oldest oil fields of Azerbaijan. Choosing a normal exploitation regime can be a key for achieving stabilization in the oil production. In this aspect, topic of the thesis is notable for its relevance.

CHAPTER 1. GENERAL GEOLOGICAL AND DEVEVELOPMENT CHARACTERISTICS OF THE BUZOVNA – MASHTAGA FIELD

1.1. General geological-exploitation features of Buzovna- Mashtaga field

Buzovna-Mashtaga field was began to exploit in 1941. At first, drilling was carried out in the most efficient reservoir in the PK Suite at a 200 m distance between the wells with a triangular network system. Drilling of this suite was completed in 1948. In the following years drilling was carried out to restore the network instead of repairing wells damaged for technical reasons. Until 01.01.2014, 1258 wells were drilled in the field [14].

During the entire exploitation period, well network of PK Suit has been restored for several times due to new drilled wells. This is due to the fact that, reservoirs in the Buzovna- Mashtaga field have been very weakly cemented in comparison with the other fields of Absheron peninsula and they could be easily destroyed even with a small depression. As a result, due to technical reasons wells were intensively brought back from Gala suite (GaS) to Kyrmaki suite (KS), Overkyrmaki sandy suite (NKP) and Overkyrmaki clayey suite (NKG). Therefore, these suites have been exploited as returned targets. Such exploitation reduces the pace of development and prolongs its processing time. Therefore since 1948 drilling was carried out in both lower and upper parts of Kyrmaki suites and these works were completed in 1954. Over this period some wells were drilled in the NKP and NKG suites .

Most of the exploited targets were operating in dissolved gas regime. This situation was mainly occurring in closed blocks. For example, central block 4 in Buzovna area. In addition, low relative conductivity of the rocks and the resistance in water-oil boundary caused weak movement of contour waters. Nevertheless, water-influx of drilling fluids reached to 79% in 01.01.2004. This is explained by the fact that, contour waters were moving fast with highly permeable layers. As a result, overall water-oil contact for the target moved less and water-influx of the drilling fluid increased regularly[15,16].

I horizon of KS

Oil percentage of KS I target for the first time was determined in the southern part of Buzovna field, later in the remaining parts of Buzovna-Mashtaga field. Whole development of the field was started since 1952. Exploitation was mainly carried out through wells returned from the lower horizons. For the date of 01.01.2004, only 20 wells were drilled in the I horizon of KS which constitutes 3,6 percent of exploited wells.

The blocks differ significantly from one another in terms of oil saturation and oil recovery factor. Annual oil production increases up to 157 thousand tons if the number of exploited functioning wells are raised to 80. This is equivalent to 8.2 ha/well network density, 286 m average distance among the wells. Later, increasing the number of operating wells to 96 did not result in increase of annual production, which is explained with interference among wells in addition to other factors.

For the following years number of the wells decreased as a result of technical failure and reached to 6 in 01.01.2004. Starting from 1986, were began to emerge wells in the fund. Transferring one of them to the running background makes chaotic change in their dynamics.

Average daily flow rate of one well was 7,1 ton/day for oil, 9,7 ton/day for fluid in 1955 and then it gradually decreased to 1,3 t/d for oil in 1976. Average daily flow rate for oil was between 2,1-0,5 tons in 1979-1991 years, 0,90-1,9 tons in 1993-2004 years. For the last 3 years, average daily flow rate for oil was 1,6-1,9 t/g.

In order to prevent decrease of annual oil production, water pumping was executed to the fields in the southern flank of Buzovna structure in 1956 and northern flank of Mashtaga structure in 1957.

Previously, the number of water injection wells was fluctuating between 4-7, then their number reached to 23. Volume of the annual injected water was fluctuating between 76-610 thousand m^3. Water injection ratio was firstly 2,4 and then 3.4. 170,5 thousand tons (8,3%) oil was extracted as a result of water injection. Water injection was ceased in 1996 and wells were transferred to the inactive fund.

Even though the layer pressure was 17,2 MPa in 1945, it decreased up to 8,6 MPa in 1959. But in 1960 pressures rises up to 9.0 MPa. Increase of pressure continues up to 1972 (10,2). As a result of decrease of water injection in 1972-1991 layer pressure decreased up to 9,0 MPa and it remained approximately 9,1-9,2 MPa in 1992-2000 years.

Gas factor was about 25-97,6 m3/t in 1983-1995 years and it increased from 114 m^3/t up to 782,6 m^3/t during 1997-2003 years.

Even though the water-influx of product was 5,9% in 1951, it was 88,9% in 1991. However, it remained about 57,1-82,8% in the following years. In recent years, water-influx has not been observed depending on time.We can conclude from the facts mentioned above that, main regime of the layer is dissolved gas regime.

NKG Suite. This suite is one of the most productive target of the Buzovna-Mashtaga field. Its oil and gas content has been determined in all segments of the Buzovna-Mashtaga field.

Exploitation were started in the southern part of Mashtaga and central part of Buzovna in 1945, northern part of Mashtaga in 1948, southern part of Buzovna in 1953 and northern part of Buzovna in 1961. Development of the field was mainly carried out due to wells returned from lower horizons. Intensive drilling of the field was carried out until 1965. Number of wells operating in this year was 85. However, maximum annual oil production was achieved not in 1965, but in 1962, when number of wells was 79 or density of the well network was 7,76 ha and distance between the wells was 300m. Subsequently increasing number of wells did not increase annual oil production.

Number of operating wells gradually decreased since 1965 and it reached to 21 in 2003. At the same time annual oil production decreased from 119 thousand tons to 10 thousand tons.

Wells were being operated via fontane and compressor method in the first years. Their flow rate for oil was 4-111 t/day. Maximum average daily oil production for one well was 14,49 t/day in 1950. After 1965, average daily oil production of one well was approximately 0,81 t/day. Average daily oil production of one well was 1,5-2,2 tons in 2000-2003 years.

During first years of development wells were exploited without the water injection. For the first time water seepages was observed in 1953 (1,9%). Later, water-influx increased gradually and water level reached to 82.9% in 1982. In the following years, water-influx decreased up to 63,3%, increased again up to 78-79,1% in the years of 2002-2003[16].

In order to terminate dropping oil production, 59 thousand m^3 of water injected through 3 wells in 1958. This process was ceased in 1960 due to low effectiveness. Water-influx system was restored in 1981. Volume of annual water injection was 9-102,5 thousand m^3 and total volume of water injection till 1981 was 1802,7 thousand m^3, average water injection factor was 0,27 at the beginning of exploitation and it reached 1,04 in 1981.

Water injection caused to the stabilization of layer pressure. Layer pressure increased from 11MPa in 1981 to 11,9 MPa in 1986 and it remained in this level till 1991, and for the latest years it did not fall below 11.8 MPa. Presently, water injection is carried out through 3 wells and these 3 wells are in the inactive well fund. Volume of annual water injection is 97,7 thousand m^3, water-influx rate equals to 9,77.

In result of water-influx, totally 39,4 thousand tons (1,8%) of oil was exploited, additional 4 thousand tons of oil was obtained in 2004.

At present, daily average oil production of one well in a great area is less than 1 ton, even in most wells it is less than 0,1 ton. Water – influx of more than 60% is mainly available in surrounding zones of water wells. Water – influx of in remaining areas is less than 60%.

2221,9 thousand tons of oil, 6653,5 tons of fluid, 315,8 mln. m^3 dissolved gas were obtained from the field for the date of 01.01.2004. There 21 operating, 32 ceased productive wells and 4 ceased water wells. Current oil production ratio is 0,409, water-influx of product is 78,1%, gas factor 80 m^3/ton, layer pressure is about 11,8 MPa. Field is exploited through mixed, but mainly dissolved gas regime.

At present 17 wells are being exploited in horizon, daily average flow rate for one well is 0,9 tons of oil and 8,5 m^3 of water.

Technological part is wholly dedicated to difficulties caused by sand production in the wells exploited with downhole pumps and their elimination methods are studied thoroughly.

1.2. Geological characteristics of the Buzovna- Mashtaga field

Buzovna-Mashtagha oil field is located on low hill plains between the same named villages in the north part of Absheron peninsula, covered with sediments of Absheron stage and Old Khazar stage. The oil field is located 25 km from Baku.

Sediments of Diatom suite, in individual cases Pont, Productive series, Agchagil, Absheron and Old Khazar stages have been opened by wells (Figure 1). In some wells The sediments of Diatom suite were opened by some wells in the form of diapir hollows between offset of fault zone of northern-east periclinal parts of the field. . Lithologically, it consist of clay compounds [14].

The sediments of Productive Series consist of alternation of sand, clayey sand and clay rocks. They are divided into the suites of Surakhany, Sabunchy, Balakhany, “Fasila”, NKG, NKP, Kirmaky and PK. The overall thickness of Produvtive Series is 1550 m. In some of sand sediments contain thin black shale layers. Their thickness reach 110 m.

The sediments of Agchagil sediments mainly consist of clay rocks and its thickness is 35-40 m.

The sediments of Absheron stages consist alternation of sand, sandstones, clay and shell limestone, and are divided into upper and middle sub-stages. The overall thickness of Absheron sediments is about 700 m.

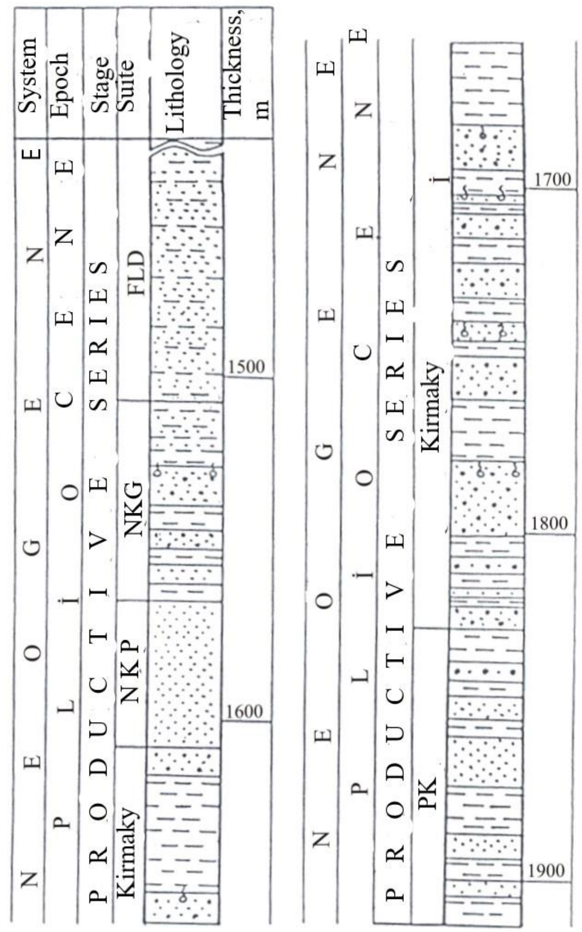

Figure 1. Buzovna-Mashtaga field. Generalized geological section[17].

The sediments of Old Khazar stage consist of alternation of less cemented limestone, sand and clay. Their thickness is up to 15 m.

The field refers to the compound embedded brachyanticlinal fold (Buzovna field area) that is not too big and separated by gentle saddle (Figure 2).

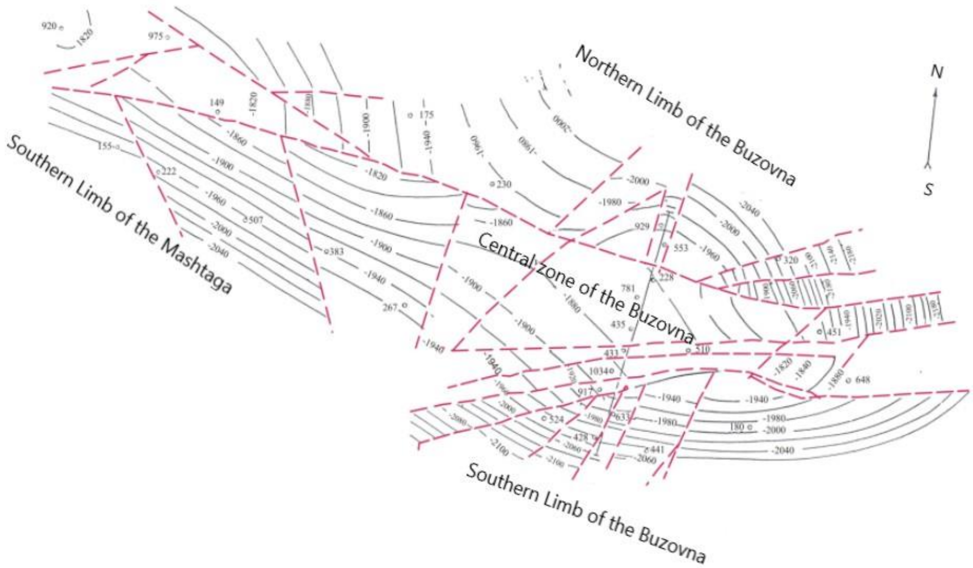

Figure 2. Buzovna-Mashtaga oil field. The structural map on the top of PK suite of the Productive Series. [17].

The structure has been complicated by longitudinal fault. The amplitude of the fault is 250 m (on north limb). In fact the Buzovna fold has different directions and been complicated with transverse faulting. Hinge zone of the fold, according to Productive Series sediments matches to old embedded protrusion composing the clayey sediments of Diatom suite. The main part of Pont layer and different individual layers of Productive Series till “Fasila” Suite , and in some places, till the bottom of Balakhany suite , connected to the steep protrusion of this slope. This fact indicates the formation of dry climate till Pont in here as a result of uplifting of Diatom-Qovundagh sediments during the lower Productive Series (Figure 3).

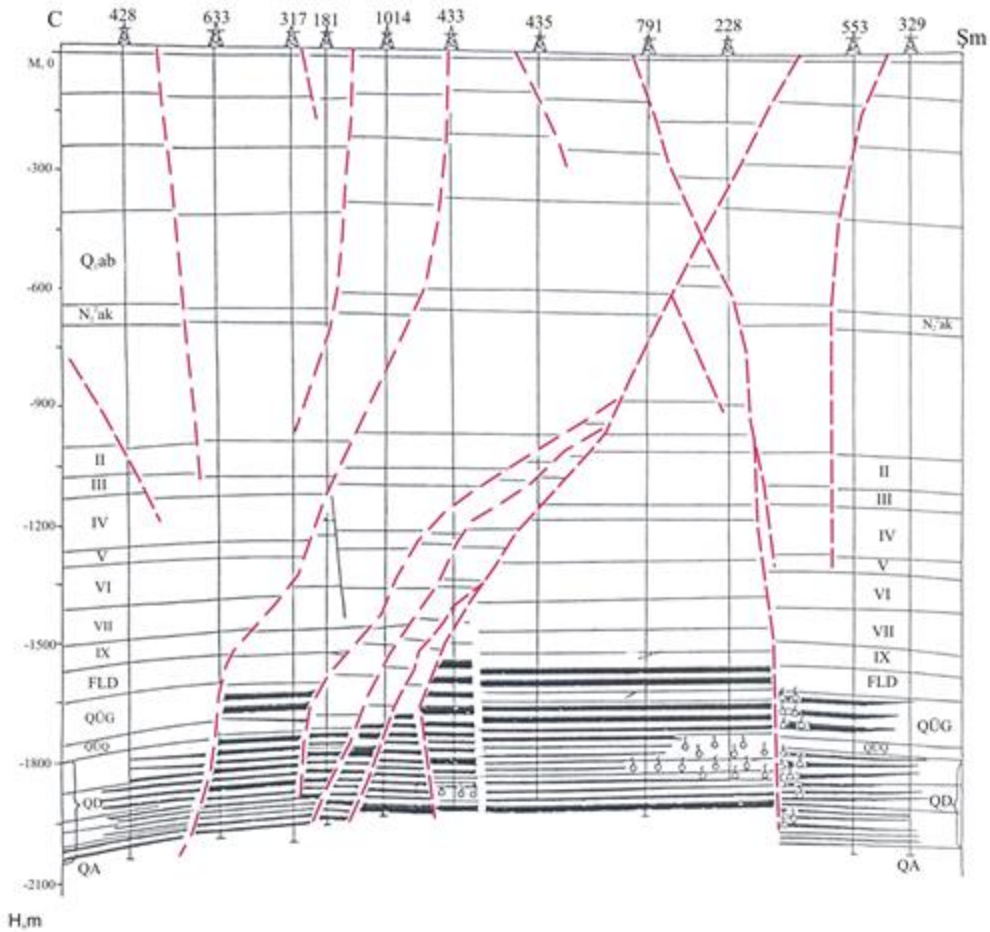

Figure 3. Buzovna-Mashtaga oil field. Geological cross-section [17].

Commercial oil resources have been determined in the IV, V and VIII horizons of Sabunchy Suite, in X horizon of Balakhany Suite and NKG, NKP, KS and PK suits in the Buzovna-Mashtaga field.

In the near hinge zone of southern limb part of the Buzovna fold, natural gas was obtained from II horizon of Sabunchy Suite. The oil pools belongs to tectonic screen type of trapping.

Different type of oil has been accumulated in the geologic section of the Productive Series. The oils of NKG an NKP Suites are heavy and the density ranges between 918-922 kg/m^3. Relatively light oil with a density of 899-905 kg/m^3 has been obtained from KS. The oil of PK Suite is heavy as well and the density varies between 912-919 kg/m^3.

12 exploitation targets have been opened in the geologic section of the Productive Series. NKP, KS and PK Suites are considered main reservoirs for accumulation of oil.

Usually more mineralized water has been accumulated in the upper part of the Productive Series in the Buzovna-Mashtaga field. Toward the bottom of reservoir gradually sweetening of the reservoir water occurs. Increasing of thickness of horizons and Suites of the Productive, the mineralization and different components of ionic saltiness in the water content changes .

The saltiness content of reservoir water in the upper part of Productive Series mainly consists of Chlorine Calcium. Their mineralization content ranges between 16.7-191 g/l. Maximum mineralization in reservoir water is noticed in the upper horizons (II, IV) and ranges from 50.2 to 191.6 g / l.

Starting from NKG, reservoir water contains hydrocarbonate sodium composition and ranges from 1.9 to 37.8 g/l. Large quantities of calcium and magnesium ions participate in the NKG Suite water. Further details on the field are given in Tables 1, 2, and 3[14].

Table 1

General information on Buzovna-Mashtaga field

Type of fluid	Type of structure	The age of oil-gas sediments	The number of targets	Year			The status of development
				The beginning of exploration drilling	The discovery of field	Beginning of exploitation	
Gas, Oil	Brachi-antyclinal with deformed hinges	Balakhany Suite (N_2^1B)	12	1940	1941	1946	İSM

Table 2

Characteristics of exploitation targets of Buzovna-Mashtaga field

Exploitat-ion targets On Suites and horizons	Fluid	The type of Trap	lithology of Reservoir collector	Overall thickness of the target, m	Open porosity, %	Conductivity 10^{-15} m^2	Beginning layer pressure , MPa	Beginning layer temperature, ^0S	starting gas factor, m^3/t	Current average daily flow rate - on 1 well, t/day	Density of gasless oil, kq/m^3	The amount of sulfur ,%	Viscosity of oil, mPua·z	
													Start	Current
The upper PS	Oil	flt	S,	430	26	166-811	11,7-14,4	52			918-922	0,13-0,15	14,2-18,5	
NKG+ NKP	Oil	flt	S	125	25	92-395	5,5-16,2	57		1,3-4,6	910	0,24	17,5-19,3	
KS	Oil	flt	S	235	23-24	164-269	6,4-18,7	60-68		1,7	900-910	0,28	10-11	
PK	Oil	flt	S	70	19	223-315	19,2	70	75	3,7	910	0,23	9,0	

Table 3

Oil reserves of Buzovna-Mashtaga deposit

Exploitation target facility	Initial oil reserves, min.t		Oil production ratio		Oil production, thouth.t	Remaining reserves, min.t	
	balance	extracted	current	last		balance	extracted
IV horizon of Sabunchy Suite	98	64	0,665	0,704	65	32,8	3,8
V horizon of Balakhany Suite	1139	299	0,218	0,262	248,3	890,7	50,7
VII horizon of Balakhani Suite	124	37	0,148	0,298	18,3	105,7	18,7
X horizon of Balakhany Suite	93	28	0,217	0,301	20,3	72,8	7,8
Acc. Balakhany Suite	1356	304	0,212	0,268	286,8	1069,2	77,2
Acc. to all upper PS	1456	433	0,242	0,298	358,0	1102,0	81,0
NKG	6390	2946	0,340	0,460	2177,5	4221,5	768,5
NKP	1931	576	0,207	0,298	399,5	1531,5	176,5
I KS	8454	2814	0,244	0,333	2065,3	6388,7	748,7
II KS	12572	5494	0,341	0,437	4283,4	8288,6	1210,6

III KS	7681	3424	0,333	0,446	2561,3	5119,7	862,7
IV KS	8619	3757	0,315	0,432	2718,4	5900,6	1038,6
V KS	10695	5132	0,368	0,480	3934,6	6760,4	1197,4
Acc. to all KS	48021	20621	0,324	0,430	15563	32458	5058
PK	21334	11512	0,489	0,540	10424	10910	1088
Acc. to all lower PS	77685	35655	0,368	0,459	28564	49121	7091
Acc. to the whole field	79139	68088	0,365	0,456	28916	50223	7172

CHAPTER 2. DİFFİCULTİES CAUSED BY SAND PRODUCTION , METHODS TO ELİMİNATE THEM AND APPLİCATİON OF NEW TECHNİQUES

2.1. Complications caused by sand production during the exploitation of oil wells

One of the most faced complications during the exploitation of the wells in the oil fields of Azerbaijan is the arise of the sand production. During the arise of sand production operation of the wells are ceased for a while and repairment of them takes a long time, which causes a significant loss of oil production. The sand that comes together with liquid from reservoir and enters to the bottom-hole of the well destroys the exploitation equipment and at the same time creates plugs[9].

Liquidation of the sand production requires heavy labour force. Meanwhile, together with heavy labour force for its liquidation, sometimes it also causes loss of the great amount of oil, leads to the distortion of the stability of the rocks and their collapse in the bottom of the wells, and deformation of the exploitation pipelines. Besides of casing deformation, landslide of the rocks in the bottom of the well divides the well from the productive layer, leads to unification of the different horizons with each other that causes pouring of the water of the upper layers to the well and creation of the sand production. At the result, great amount of sand that comes from layer causes great damage for the oil industry.

Today, the destruction of the rocks of the bottom-hole zone and prevention of the sand production are one of the most important issues of the oil industry. Although, many researches and field experiments were carried out for prevention of the creation of sand production, there are no sophisticated methods for fighting against it. The main complex reasons for creation of sand production in oil wells depend on the physical and geological characteristics of the reservoir rocks to adopting method and exploitation of the well. It is possible to divide the rocks into two main groups that create oil reservoirs:

1) Well cemented rocks (sandstone, limestone, dolomite);
2) Poor cemented rocks (sandy rocks, soft sandy rocks).

If oil-bearing layer consists of solid rocks, bottom-hole zone does not destruction during the exploitation process. Therefore, in the oil wells the cases of exploitation in the layers that consists of solid rocks are not observed. If oil reservoir consists of unconsolidated rocks (especially sand), bottom-hole zone faces destruction during the exploitation process. In this case, liquids and gases that move along th layers bring certain amount of sand to the well.

Sands that pervades from layers enter into the lifting pipe while moving along the pipeline. Determination of the weight over the protective pipeline at the result of the investigations shows that, the main reason for the collapse of the well at the result of deformation of pipeline in the level of exploitation object is the creation of the sand production during exploitation of the layers that have fragile, poorly -cemented reservoirs. The tight relation between the deformation of exploitation pipeline and the creation of the sand production in the well is an important factor, which requires consideration of geological-exploitation characteristics of the object used in the determination of the weight that affects pipeline. If the speed of the liquid is unable to lift the sand upward, in that case sands that precipitate bottom-hole of the well create sand pillar, which cover the face of the filter and prevent the flow of the liquid into the well.

Depending on the size of the grains of sand, velocity of flow, and the solubility of liquid sands lift upward together with liquid or defecate into the bottom-hole of the well. In this case, initially large grains, then medium grains, and at the end small grains of sand precipitation.

Due to the small size cross-section of the exploitation pipeline in the well, sand pillar that precipitated into the pipeline reduces the flow of the liquid into the well while resisting against the movement of liquid.

When the sand pillar completely closes filter it significantly reduces resistance. That is why, lack of sand in the well pipelines is one of the main preconditions to sustain the production of the well. However, pulling out of the great amount of sand from bottom-hole zone may lead strong sand production, destruction of upper rocks, appearance of outside waters, embedding of lifting pipe with sand, lesion of exploitation pipeline and other unpleasant accidents.

2.2. Challenges caused by sand plug in the wells exploited by downhole pump and methods to eliminate them

The struggle with sand during the exploitation of the wells is one of the main problems. The sand that comes from layer together with oil creates plug in the bottom-hole of the well and causes embedding of plunger in the pump of cylinder, deterioration of parts of pump and lifting pipes beforehand, disruption of the balance of pump jack machine, increase of hydraulic resistance, and so on. The small sand that enters friction part of the pump together with oil particularly has devastating effect; sand that falls into the gap between plunger and cylinder causes the collapse of the pump faster. The flow of liquid backward at the result of abrasive effect of sand decrease productiveness of the pump. Reduction of the flow rate of the well and creation of sand production leads to replace the pump and carry out repair work for the washing of plug beforehand. In case the amount of the sand in the well is 1g/l these wells are classified as "sandy" wells. It is possible to divide the struggle methods against sand into following directions[1, 3, 4]:

1. Preventing the entrance of sand into the well from reservoir; for this purpose special filters should be stationed in the bottom-hole of the well or bottom-hole zone should be strengthened;

2. Adjustment (reduction) of fluid production from the well; at the result of this, the entrance of the sand to the bottom-hole of the well is prevented or reduced;

3. Ensure that all sand (or great part of it) that entered into the well was drived out to the surface;

Researchers indicate [13]. that the condition of driving out of the sand to the surface is as follows:

$$\frac{V_m}{V_{f.f}} \geq 2 - 2.5$$

Here Vm is the speed of water rising through the tube, which equals to the ratio of water exhaustion to section cut width of the tube;

If it is a free gas, then the sum of liquid and gas exhaustion will be taken;

$V_{f.f.}$-free fall speed of sand particles; like the diameter of the particle, average diameter of the biggest fraction which is 20% of the whole sand mass must be taken.

4. Combining of scroll to the low end of the pump in the pump-compressor pipes; use of scroll reduces the hight of the plug that arises in the bottom-hole of the well while the well is stopped;

5. Application of various preventive means, filters (strainers), sandblasts and separators for reducing the amount of sand during the reception of pump (figure 4). The best result for the separation of sand comes from sandblasts. Sandblasts and filters are stationed during the reception of pump. The work of sandblast based on the gravitation principles. In strait and reverse effected sandblasts change the movement direction of liquid 180°C, sand is separated due to the influence of gravity and pour

into the blast ‘pocket’. After fill up of the sand ‘pocket’ blast is lifted to surface and cleaned.

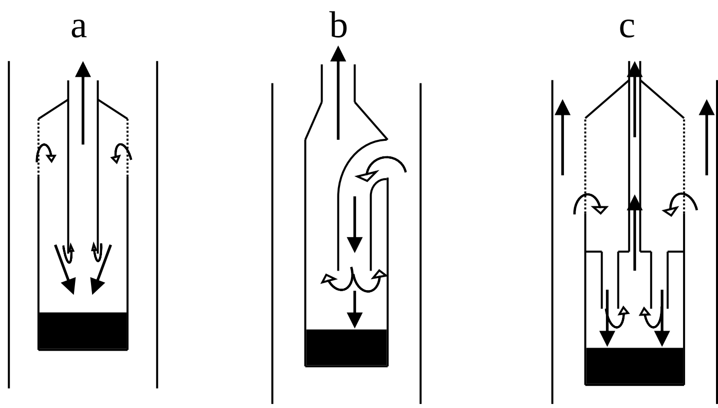

Figure 4. Principial scheme (diagram) of strait(a), reverse(b) sandblasts and gas-sand(c) blasts[13].

The main condition for the effectiveness of the work of sandblasts is that the speed of the sand defecate is smaller than the speed of the rising fluid flow. Researches indicate that reverse sandblast is more effective in comparison to straight sandblast. Because, the inserted tube that is used in reverse sandblast increases the declining speed of sandy fluid flow. Gas-sandblasts are used in the wells that produce output consisting of fluid, gas, and sand. The gas-sandblast at the same time fulfil the functions of two blasts, gas and sand blasts. Filters that are used against sand in pump prevent the entry of medium and large (higher than 0,01 mm) sand grains into pump. There are various types of filters, such as, perforated, wired, capron, gravelly, dissected, metalkeramic, cement-sand-salt, sand-plastic and others. These filters are not widely used because they are contaminated very quickly. For precipitation of sand it is necessarry to station filters into "pocket" corpus (in this case there will be no plugs in the bottom-hole of the well and the speed of the contamination will decrease) or apply them together with sandblast. Depending on the characteristics of sand the following tools are used in the reception of pump:

-in case there are few sand and gas-filter;

-in case there are few sand but more gas-gasblast;

-in case there are more sand but few gas-sandblast;

-in case there are more sand and gas-gas-sand blast.

If there is an entry of sand into the well from a layer, in that case it is necessary to take measures that the speed of the fluid flow that pump sucks is well enough not only for expulsion of whole sand fraction, but also for preventing of the significant increase in the thickness of the size of sand in comparison to the thickness of the expense of sand during the flow. The thickness of the expense is ratio of expense of sand to expense of mixture.Thickness of the size of sand in rising flow is always bigger than its thickness of the expense.Therefore, it is necessary to ensure that thickness of the size of sand slightly differs from thickness of the expense in its movement.The high level of thickness of the size of sand increase the abrasive erosion of the underground equipment and if sweep machine stands sand in the bottom-hole of the well and pipes precipitation in great amount sand plug is created, and pumps and barbells are caught. It is impossible to get needed speed in the big thickness of the expense of sand and in the little output of the well. In this case, the method of adding fluid to the annular space is effective. At this time there should not be sand in the added fluid. Adding viscose oil gives a better result. Sometimes, it is possible to add water from the layer (if no other means are available) (figure 5).

The result of the researches determines that for preventing of the precipitation of the sand the speed of its uplift in the wellbore and lifting pipes should be more than the speed of the sand that precipitate bottom[6, 7]

$$V_{measureless} = \frac{v_m}{v_0} \geq 2$$

υ_m – speed of the rising fluid flow, cm/sec;

υ_0 – speed of free fall of the sand grains, cm/sec;

$V_{measureless}$ – conditional measureless speed of fluid flow, cm/sec.

In the majority of the horizons in Buzovna-Mashtaga field, as well as in the wells of horizons NKG and I $GS_{measureless}$ is less than 2. Therefore, defecate of sand in this wells is observed[14]..

In order to influence bottom-hole zone in this group of wells one should think about the increasing fluid flow.

The avarage daily production, hydration level, and diameter of the exploitation pipeline of the wells in horizons of NKP and I KS in Buzovna-Mashtaga field where the created sand plug was given in the tables.

The tables 4,5,6 indicate that there is not any well that has production of clean oil among the analized wells and diameters of more than 90% wells that create sand plug are 6″ and 6″×4″. The size of the indicated factors has been determined in accordance to the field materials of the wells that has sand production.

It is known that, the thickness of the creation of sand production and decline of the well output at the result of sand plug depends on various factors: exploitation method of the well, physical-geological character of the exploited target, physical-chemical feature of fluid that is extracted from layer, character of sand plug and so on.

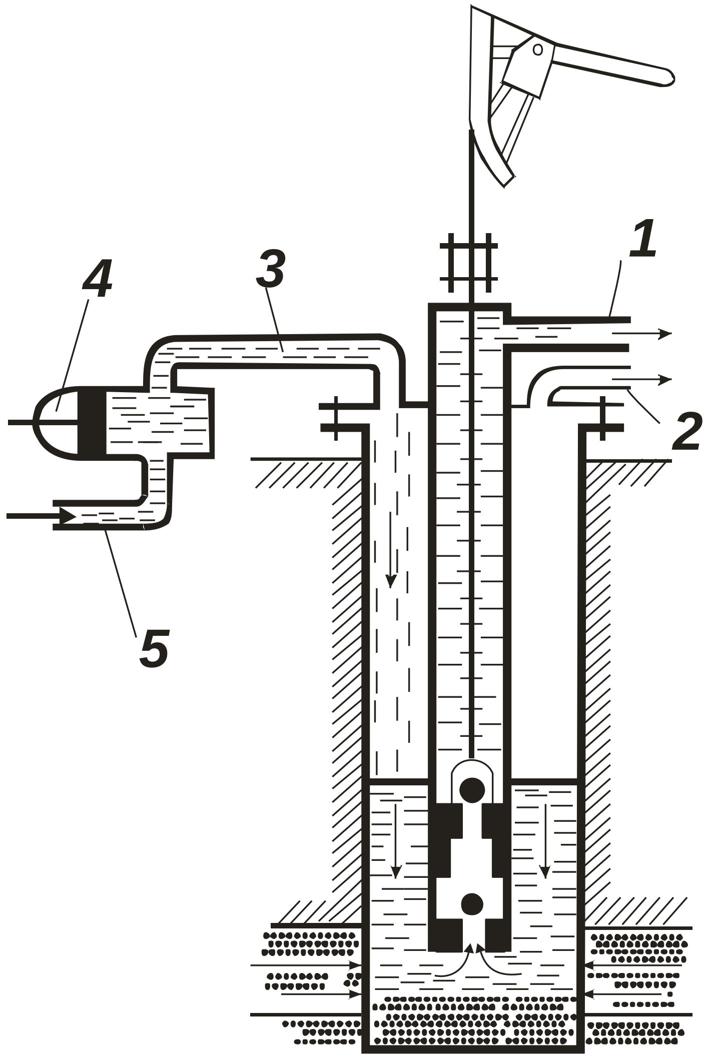

Figure 5. Scheme of adding of fluid into annular space of the well in the fighting against sand [10].

1. The discharge pipeline; 2. Exit line of gas ; 3. Pipe for adding fluid

4. Metering pump; 5. Pipe that comes from tonnage.

Table 4

Field	Horizon	Number of wells	Average daily oil production					
			Up to 1 ton	**1 - 3**	**3 - 5**	**5 - 7**	**7 - 10**	**>10**
Buzovna Mashtaga	NKP I KS	15 19	7 4	8 1	– –	– –	– –	– –

Table 5

Field	Horizon	Number of wells	Water-inflax % -i			
			10 - 30	30 - 50	50 – 80	>80
Buzovna Mashtaga	NKP I GS	15 19	– –	1 –	4 6	10 13

Table 6

Field	Horizon	Number of wells	Diameter of the exploitation pipeline			
			4″	**6″**	**6″∗ 4″**	**6″∗ 5″**
Buzovna Mashtaga	NKP I GS	15 19	1 –	9 14	5 5	– –

In the wells of horizons of NKP and I GS in the Buzovna-Mashtaga field the average thickness of the creation of sand plug is given in the following table 7 .

The thickness of the plugs is based on the lower holes of the filters. As it shown in the table, the average depth of lifting pipe in the horizons NKP and I KS in Buzovna-Mashtaga field is 934.0 – 1347.7 m, the average thickness of the sand plug in horizon NKP and horizon I KS is 238.6 m and 120.0 m respectively.

Table 7

Field	**Horizon**	**Low depth of sand plug, m**	**Medium thickness of sand plug, m**	**The nature of the sand plug**
Buzovna Mashtaga	NKP I KS	934.0 1347.7	238.6 120.0	medium solid solid

Coming to the character of the plug, its solidity increase while the depth of the well increase. It should be noted that the repair period of the wells decreases gradually while going deep, which is explained by the worsening of work.

The main factors for the creation of sand plug with the usage of wells are:

- Thickness of sand plug;
- Reduction in the production with the creation of sand production;
- Creation of sand production, depending on the usage of wells during repair period.

2.3. Application of new progressive sand control techniques during the exploitation of wells

To limit the amount of fluid produced from the reservoir is the best way to wash the bottom-hole of the well and to deal with forming of a sand production. This is achieved by adjusting the pressure drop in the bottom-hole of the well. The decomposition of the rock's frame is observed by bringing sand to the well and meantime the permeability of the bottom-hole of the well decreases continuously. The sharp decline of the wells' flow rate is not due to a decrease in permeability, but due to a high resistance created by the sand production which has small cross-section and blocks the filter.

If there is sand plug in the filter part of the wellbore, the lower part of the exploitation target is under greater opposing pressure than the upper part. Therefore the fluid flow from the lower parts of the productive layer takes place at a relatively small pressure compared to the pressure in the well. In addition the sharp decline in the wells’ flow rate occurs because of accumulation of sand in the well and formations of sand plug in the lifting pipe. The length of the pipes blocked by sand can reach up to ten meters. Although the permeability of the sand plug is several times higher than the permeability of the reservoir, due to the large difference in the side surface of the perforated part of the well and areas of pipe’s cross-section, the hydraulic losses formed by the liquid flowing through the sand plug can be compared with and sometimes be more than the losses formed in the reservoirs. It can be confirmed by the following simple estimation. The flow rate of the well is calculated according to the Dupire formula.

$$Q = \frac{2\pi kh\,(P_l - P_{qd})}{\mu \ln \frac{R_k}{R_q}},$$

Where k- conductivity coefficient; μ- oil viscosity; PL- Pq.d.- the difference of pressures between layer and the bottom of the well, ie rebound; Rk- the radius of the well’s feeding contour; Rq – the radius of the well.

According to the law of Darcy [2], when it crosses sand plug with conductivity of output k1, the height L, the area of cross-section F:

$$Q = \frac{k_1 F}{\mu} \frac{\Delta P_1}{L}$$

ΔP_1 - is the pressure loses during the friction in sand plug

The following uniformity arises from the equality of the left sides of these equations:

$$\frac{\Delta P_1}{\Delta P} = \frac{2\pi hL}{FLn\frac{R_k}{R_q}} \frac{K}{K_1}$$

Therefore, sand plug reduces the output by influencing as the regulator of the bottom-hole of the well when the layers are half-opened.

The prevention of the decomposition of the bottom-hole's rocks can be maintained at a certain level by limiting the outputs of the wells. However, limiting the outputs of the wells may not be economically suitable in most cases. Therefore, in order to prevent the sand formation other methods are used. One of the ways to prevent the sands dropping from layer into the bottom of the well is to solidify the bottom hole. At the moment, following methods are used primarily for the solidification of the bottom hole:

Processing with water-cement and oil-cement mortars;

Processing with special additives added to cement mortar;

Processing with the high molecular compounds (chemical method);

Carbonation of oil in the bottom-hole;

Applying filters.

The widest and simplest way of solidifying the bottom-hole is rendering cement mortar from the perforated holes of the pipe into the layer under or in the absence of the pressure. In this case, the cement mortar strengthens this zone and increases its durability against washing.

If the productivity ratio is small and the thickness of the reservoir layer is less (2-3 t), less cement is rendered. If the productivity ratio is large and the thickness is more (4-6 t), more cement is rendered. The analysis shows that pores and slits' fragile rocks with dimensions not less than 0.15 mm can be strengthened with cement solution. It is possible to reinforce the bottom-hole of well-watered and high-flow rate wells with cement solution that can increase production by extending the depression and improving the deposition.

It should be noted that cement mortar cannot penetrate deeply in rocks with small porous canal sizes. Most likely, the cement mortar enters into separate slots or cavities formed during exploitation and prevents the formation of wellbore by solidifying the soft rocks. This method may be applied to the bottom-hole of the wells containing considerable extent of drainage and significant amount of sand.

Rendering of oil cement solution to very well watered wells may give a better result. Meantime the oil is replaced by water in the watery part of layer that was more exposed to decomposition and the conductivity of the oil portion is maintained.

It is not recommendable to process in the wells with low layer pressure with cement mortar. Meantime after processing the extraction of liquid may be reduced and even cut off due to low permeability of the bottom-hole and impossibility of increasing the depression in the layer.

The application of this method to the wells with defective exploitation pipeline doesn't give a good result because sand enters the well with the defective part of the pipe from the above layers. As a result, pipe blockage may occur.

In order to eliminate the main weakness (contamination of permeable canals with solid cement mortar) in the solidification of bottom-hole with cement solution certain amount of coarse sand (up to 0.25 mm) is rendered into the cement solution.

Coarse sand is also used to reduce cement consumption. So, in some cases more than 100 m3 of sand is removed in the process of long-term exploitation of sand formed wells. Therefore, only cement rendering is not economically viable. When cement solution with coarse sand solidifies a mass with a certain permeability and sufficient durability to erosion is formed: the ratio of mixed sand and cement is 3: 1 or 2: 1, i.e. 3 or 2 parts of sand, and 1 part of cement is taken. Concrete volume prepared in such a ratio is more resistant to erosion and its permeability reaches 0.1 to 0.5 darcy.

The well considered for processing with sand-cement mix should be highly absorbed and well drainage. Otherwise, because of high pressure while rendering sand-cement mortar to layer the motion of the pipeline with mix may slow down and as a result the solution may become limpid and sand may sink from it.

If the density of rendered cement, sand-cement and other mix is more than the density of layer liquids and the bottom-hole has high drainage and holes, the lower parts of layer are mainly filled with mix and the whole thickness is not strengthened. In order to enhance the profit of cementation all of these gaps must be filled with a packing mix.

The method of cementation of bottom-hole with sand-cement mix is less applicable to the newly drilled wells or the wells returned to above located horizon and the wells that are not yet exploited because of often occurring sand plug. The best result is gained on the watered wells with high static level.

Joint running of measures on solidifying of bottom-hole with sand-cement mortar and struggle with sand plug gives good results. The well should be put into use after the solidification of bottom-hole with sand-cement mix. The sand used for the preparation of sand-cement mix should be coarse, well washed, chosen and without oil, it should not compose frictions of carbonate and silt. In the preparation of mortar, mainly sea water is used that reduces the efficiency of the process. Therefore surfactants (SAM) are added to the water.

Rendering coarse sand to the wells with highly displayed sand and well drainage bottom-hole for consolidation delivers good result. The main point of this method is as follows: coarse sand enters to bottom-hole and holds the existed gaps and drainage canals; thereby the lay prevents the subsequent decomposition of rock and its permeation to the well. Besides the filtration condition improves and the debit increases accordingly.

The friction of sand rendered to the well is taken as follows: 0,2-0,5; 0,5-0,85; 0,85-1,2; 1,2-2 mm. The amount of sand for one consumption is 12-15 t. At the beginning, the first fraction, then other fractions are rendered.

Substances that easily accessible to the lay are used in the strengthening of bottom-hole with the high molecular compounds (chemical method). These substances form resin due to the impact of lay temperature and the addition of catalyst. The resin holds the gaps of the bottom-hole and polymerizes in certain condition, and covers the surface of sand grains with solidified lay of resin and ties them together.

Carbamide and phenol formaldehyde are the most widely kind of resin. In order to obtain phenol formaldehyde resin crude phenol and 40% of formalin are taken as input material. The mortar of these substances is divided into components and forms solidified resin in the situation of water-soluble, damped sand and when there are both water and oil. The obtained resin is a red-pink liquid moving easily, with a density of 1,12 – 1,101 g/sm3. The resin parted from mortar is 50-60%. Corrosive sodium or hydrochloric acid is used for the partition and solidification of resin. As the temperature rises, solidification of resin accelerates considerably.

The temperature of bottom-hole, ^{0}C	70	60	50	40	30
Solidification process, day	4	8	14	20	30

The reinforcement of the bottom-hole with resin is more efficient in the following wells:

a) In wells where operation of drilling and restoring carries out: if studying of them is difficult because of often occurred sand production

b) In case where all wells with sand plug have been transferred to exploitation with depth pump;

c) In wells that do not have high drainage and where sand plugs are formed, the output is not less than 2 t/ day.

The following wells are not recommended in operation with resin:

Wells that have defective exploitation pipe;

Wells that enters outside water;

Wells that have low liquid column (less than 100m);

Wells that have collapse in the area around the well's bottom;

Wells that have scattered ceiling;

When using carbamide resin in order to decrease the solidification process of resin in the bottom-hole 15% hydrochloric acid in the amount of 2-2.5 volume of supplemented risen is injected.

The carbonation effect of oil is used in the bottom-hole for increasing the resistance of rocks to washing. The main point of this method is that when the oil in bottom-hole is heated at a certain temperature the oil oxidizes and cementing coke is formed in the surface of sand grains. The shortage of this method is that the oil may flame itself when heated weather is blown to bottom-hole.

Gravel filters are used in the bottom-hole of the lay beside the methods of strengthening sand. Filters made of coarse gravels with good conductivity prevent the sand from slipping into the sand and protects the bottom-hole from collapsing.

Despite of the various constructions of gravel filters, they can be divided into two main types:

Prepared by compression of gravel on the surface;

Prepared by compression of gravel in the well ;

In the first case, the filters prepared by compression of gravel on the surface are lowered to the well with NKB[17]. (figure 6).

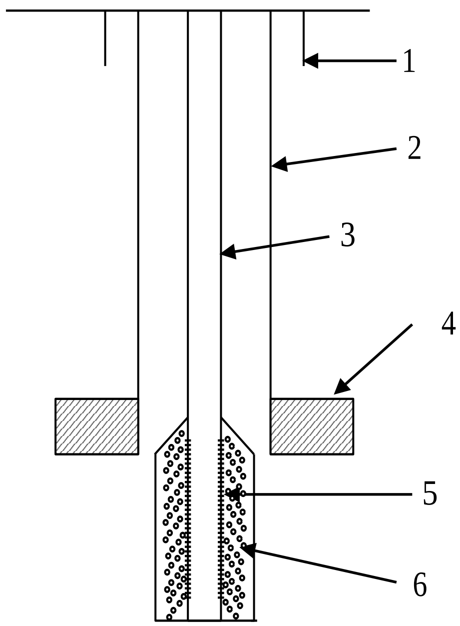

Figure 6. The filter prepared on the surface [17].
1- conductor; 2- casing ; 3- pump-compressor pipes
4- cement ring; 5- punctured holes; 6- gravel

In the second case, firstly protective bell is lowered to the well, and then the space between the protective bell and the wall of the well is filled in with gravel mixed with liquid (figure 7).

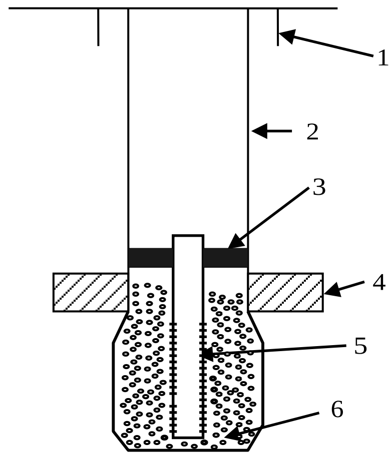

Figure 7. Filter prepared in the bottom of the well[17].
1- conductor; 2- casing; 3- paker; 4- cement ring ; 5- punctured tail; 6- gravel.

Filters prepared by concentration of gravel in the well are significantly less resistant to oil movement than the filters prepared by concentration of gravel on the surface. Despite this advantage, since the preparation process of the filters formed by concentration of gravel in the well is complicated, the use of the filters formed by concentration of gravel on the surface before hand is more widespread. Gravel that has spherical form with sufficient mechanical strength, resistant to salting of acids and alkali is used for the preparation of the filters. The size of the gravel is selected based on the granulometric composition of the sand. The size of the gravel must be such that no particles forming the skeleton of the rocks, i.e. the filter should keep 70 to 80% large particles of mass rocks, and leave small particles not more than 20 to 30%. Meantime, the firmness of the lay's skeleton will be provided. According to laboratory research[18], the most right ratio measures of gravel and reservoir's sand is as follows:

$$D \leq 12.9d$$

Here D- the diameter of the gravel, mm; d- the diameter of the reservoir's sand particles, mm.It is essential to follow the following two conditions at the same time for the removal of small particles:

-the dimension of the pores formed by coarse sand (or gravel) should be larger than the size of the small particles produced by the flowing stream. In the possibility of the removal of the small particles, the ratio of large and small particles is called as a structural criterion;

-the speed of the flowing stream should not only be sufficient to move the smallest particles from their place, but also to give them a speed equal to the average speed of the stream at a very small distance. The flowing speed that meets these conditions is called as the crisis speed of extraction (mechanical criterion of extraction).

The advantages of using gravel filters are followings:

- only fine grained sand can slip in the well, which is easily removed during the exploitation and thus sand doesn't sink and generate plug in the bottom of the well.

- erasing of ground and surface equipment, including filter with sand is decreased;

-remained coarse sand in the layer doesn't resist the movement of oil greatly, lets fine sand out and thereby increases the permeability of the reservoir.

- coarse sand remains in the layer and prevents collapse, water entry and other unwanted events.

- gravel filters allow the formation of wider bottom-hole in fragile, non-cemented rocks. As a result, the drainage area expands, the productivity of the wells increases, and the period of exploitation of the wells and in sum the duration of the operation extends.

The implementation area of gravel filters is very enormous in the deposits where sand produced with oil generates serious difficulties and breaks especially during the exploitation of the well. The experience shows that filling of all pores and rifts of the bottom-hole with gravel is much more productive. Otherwise, in the areas where the gravel is absent in the rocks of bottom-hole, the filter breaks up and is caught with small particles.

2.4. Types of well completion taking into account sand control

Turning of the drilled well into safely and effectively exploited injection well is called completion of wells. Completion of the wells in general is divided into 2 parts: Completion of the open hole and the upper part . Completion of the open hole of the well is divided into 2 parts:

1.Completion that was strengthened and perforated with safety casing;

2.Completion with keeping safety belt at the beginning of the productive layer.

Solidity, reliability, and productivity are important factors for the well. However, in order to provide all this factors it is important to choose right completion type. In particular, this process with flow of water in weak cemented layers is getting more difficult. It washes the cemented production in exploited layer and at the result the sand grains in layer become more active.Therefore, over time, along the exploitation of the oil, production of sand also occurs in weak cemented layers.The processs of the emergence of sand in well is a complex issue. Therefore, it is hard to prevent its emergence. At the moment, one of the most effective ways to fight against sand is the installation of bottom-hole (drainage) filters.One of the most effective and common types of bottom-hole filters is gravelly completion of open hole.

In order to increase effectiveness of the fighting against the destruction of the rocks of bottom-hole zone, it is advised to strenghten the bottom-hole of the well with resin before creation of the gravely filter.

The productive layers of some fields are consist of the poorly cemented sands. Normal exploitation of such fields may be disturbed with the entry of sand into the wall from layer and with the creation of sand plug in filter interval. The length of sand plugs may reach to 200-400 meters in wells with layers that consist of the weakly-cemented sands.Created sand plug in wellbore, usually is washed by water or cleanup by bailer. For cleaning sand plug completely it is better to use bailer and during that time permeability of the bottom-hole zone does not destruct. However, this process is limited to the wells with 1200-1400 depth. For this process great effort is required. Meanwhile, while carrying out this process the exploitation pipe (belt) may be damaged at the result of the friction of steel cables (kanat).

Many oil fields in Azerbaijan where the sand plug created are characterized with subnormal layer pressure. Layer pressure is often covering 10-50% hydro-static pressure. In that condition, it is not possible to wash all sand plugs from the corpus of the well with water. Part of the sand enters into the layer together with water at the result of strong absorption. This cause partly destruction of the bottom-hole zone and sometimes deformation of the exploitation pipe. Sand that entered into the bottom-hole zone, drops into the corpus of the well without any barrier during the exploitation of the well. At the result, after a while, the need for rewashing of sand plug emerges. The reason for having little repair period of wells may be explained by this:

For eliminating sand productions, it is possible to use drilling fluid, water, mixture of gas and fluid, foams, air strike. While choosing fluids for washing plugs following conditions should be taken into consideration - preventing open fountain while carrying out process in order to eliminate plug and avoiding pollution that causes decrease in the productivity of the bottom-hole zone of layer and well. The methods for eliminating sand productions in wells are as follows:

The pump-compressor pipes are draw down till the plug in the well. By these pipes or annulus space fluid is injected into the well. Under the pressure of the stream the plug get washed and goes to surface with fluid stream.

Pumping of the washing fluid into the central pipes, the method that mixture of fluid and washed rock rises along the ring space between NKB and exploitation pipe is straight washing method. In such washing method the lower part of the pipes is provided with special plug and by the help of this plug high pressure stream is created, which intensify washing process of plug. This washing method is mainly used for washing tight plugs.

Fluid is pumped to the pipes by pump through washing line, elastic hosem and pinwheel. Rising fluid flow rises along the annulus space together with washed rock and flow into special tank for getting clear (settle). Fluid that was cleaned from sand enter entrance tank of pump.While the plug of the pipe washed pinwheel let dropping down of the pipes until it reach entrance of the well. Only after this, washing continue until rising sand from annulus space to the surface. Pumping water is stopped after ensuring that there is no sand in annulus space. After this, new pipe draw down (or pipe is extended) for continuation of plug washing.

The disadvantage that reduce the efficiency of straight washing is that the speed of rising flow along the ring space between pump-compressor pipes and belt is significantly less than speed of the fluid in pipe. Therefore, the washed sand is raised to the surface gradually. Prevention of pumping of the fluid into central pipes at the result of unexpected events, such as breaking down of belt and disruption of pump cause creation of sand plug in ring space and eclipse of pump-compressor pipes.

During the process of reverse washing of sand plug in wells, washing fluid is pumped into ring space between pump-compressor pipes and belt and washed sand plug is raised to surface with central pipes together with washing fluid. During the reverse washing taking out of washed sand is more efficient, becasue in that case the speed of rising flow is bigger than the speed of straight washing.

The main difference of reverse washing from straight washing is that during reverse washing it is possible to extend the length of pipes without cutting the pumping of fluid into ring space. This action exclude the creation of plug in pump-compressor pipes while defecation of sand. Such washing technology is possible while taking measures for preventing flow of the fluid that raised from well into the surface around the well during the preparation process of well for repairing. This condition is deriver from the requirements for the protection of environment during the repairing period.

Reverse washing is often called fast washing, becasue during that process it is prossible to pump washing fluid without any break.

Deficiency of straight and reverse washing is that while sand plug is getting washed the solution geting heavy and pressure increase(figure 8). During the washing process of the well it is possible that when its filter open the pressure of bottom-hole may be higher than the pressure of the layer, which casue absorption of washing fluid by layer.

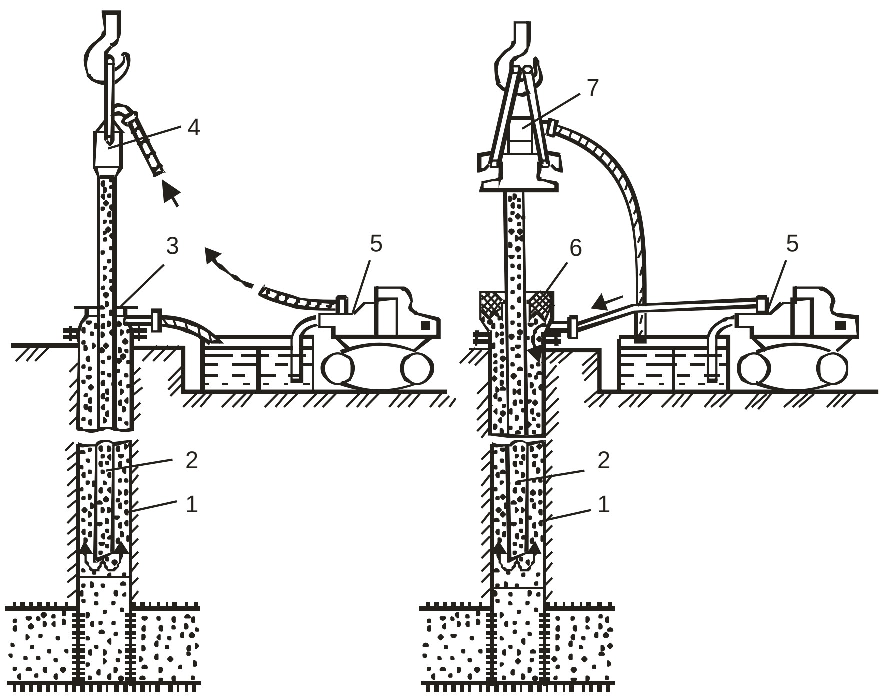

Figure 8. Scheme of straight (a) and reverse (b) washing [11].

1-belt (pipeline); 2- pump-compressor pipes; 3- Well mouth three way adapter;

4 -washing swivel; 5- washing pump aggregate; 6-Well mouth Gasket;

7-vehicle (conductor) provided with hose.

If drilling tincture or water is used as washing fluid, this leads to the reduction of the productivity of the well and deterioration of the filtration feature of layer.

It is advised to apply combined washing during scrubbing of special tight plug, where the strong washing effect of spurt is important. This method is consist of periodically change of direction movement of washing fluid. Fluid is injected into washing pipes for washing plug.After the washing of sand portion, for pulling it out fluid is outpoured along annulus space (reverse washing).

For combined washing the equipment (figure 9), which consist of dissected pipe (6)

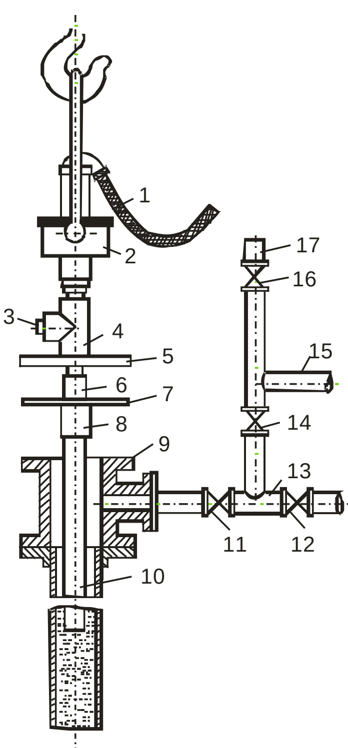

Figure. 9. The scheme of well mouth equipment for combined washing[11].

that has 1 meter length and diameter, which is equal tot he diameter of washing pipe, is used. One side of dissected pipe is standart rifled and get into faceplate (7), to other longer side of the pipe get into faceplate (5) and three way adapter (4).Three way adapter (4) connected to swivel (2). in the well mouth three way adapter (9) is stationed. Its side exit three way adapter pipes, dissected pipes, and set that consist of sliding is connected. Below the faceplate (7) upper sleeve (8) and belt of washin pipe is installed. After some preparatory works, washing fluid is outpouring from open sliding (11, 12 and 16) by pumping pump and washing is taking place. At this time fluid pass through pipe (15), sliding (16) and brace pipe (17) while entering from pipe, them etner into the washing pipes. The exhaused fluidspurt get out into outwards from slidings 11 and 12. This is notmal straight washing.

While discharging pipes gradually the plug that has length up to length of two pipe is getting washed. Without interrupring washing, faceplate (5) is stationed into flange of the way adapter pipe (9). This time fluid get out completely by the help of slidings (11) and (12) and three way adapter pipe. Then sliding (14) get open and at the same time the slidings 16 and 12 get close and the carving of plug (3) get open. Reverse washing begins like this. In order to prevent spring of fluid outside and fountain preventive sliding is stationing under the swivel.

Besides these mentioned methods, there is uninterrupted washing method; during this washing the flow of fluid is not interrupted. However, for this method it is necessary to apply special sleeve valve. In addition there is a need for washing brace pipe that has two hose. After ending washing it is important to remove all washing pipes. All these complicate washing and this is considered deficient character of this method.

Often, in the low layer pressure wells washing does not lead positive results. It is recommended to clean plug in such kind wells with compressed air. The mouth of the well is provided like in reverse washing. Pipes are lewered to 200-250 m below the fluid and compressed air is pumped into ring space. After the first fluid spring the length of pipes is increased and gradually draw down without interrupting air pumping.

After the opening of filter it is possible to say that well will war with single line compressor lifting.

In addition, for digging the sand plugs pipe-free hidrobur is also used that is draw down in steel rope(figure 10). It is possible to dig sand plugs in the wells that has not less than 125 mm diameter and 2000 m depth. Hidrobur is consists of digging chopper (1) that is aimed for destruction of plug, bailer (2) where sand is gathared, plunger pump (3) that creates circulation of fluid in bottom-hole zone.

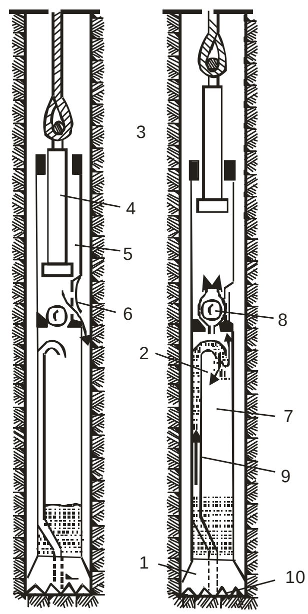

Figure 10. Working scheme of pipe-free hidrobur [12].

Working principle of hidrobur is as follows:

After drowing down of the equipment into bottom-hole of the well plunjer of pump (4) under the influence of its own weight and the inertia force during the hit move toward the bottom while compressing fluid from the corpus (5) and the hole of flatly valve. When the equipment is uplifted from the overhead of the bottom-hole first plunjer come forward and absorption of fluid from the corpus (7) of bailer via the valve with ball (8). At the same time, fluid is sucked into bailer via central pipe (9) from bottom-hole under chopper.The fluid that rises from the bottom-hole of the well bring sand grains with itself, and this sand grains defecate bottom of bailer at the result of the sharp reduction in the speed of flow of hydrocyclone. After few hit to bottom-hole of the well bailer fill up with sand. When the hidrobur get discharged the chopper is removed and the sand go outside from bailer by means of the created hole.After the end of drilling instead of chopper the reverse valve is linked up to hidrobur for pouring out puddled water from the well and equipment works as normal pneumatic bailer. It is hard to include low layer pressure walls into normal exploitation after washing out with water. In addition, during the washing the sand in the upper hole's space of filter is getting washed, howere, lower part remains plugged with sand.During the cleaning of plug spurt pump is applied for reduction of pressure over the bottom-hole of the well. To the complete set of spurt pump include spurt machine, pipes that has 75 and 55 mm or 63 and 38 mm diameters, and pump. The spurt machine is consist of diffuser (3), soplo (4) and washing machine (6). When he washing machine put into sand plug, the mechanical valve (5) getting open and fluid is transmit to washing machine from ring space via pupm.Water and washed sand is transferred to the surface via inner pipe. If the plug is getting washed in that case mechanical valve is getting closa and water does not enter into layer. In binary pipes (2) inner pipe is depend on out pipe with dotted brace that has not carving combination. Hermetisation of the inner belt of the pipe is carried out with the help of O-shaped rubber packing (1) that stationed in the sleeve of inner pipes. The lenght of the inner pipe is increased at the same time with drawing down outer pipeline. The productivity of spurt pump is ususally equal to or a bit more than the amount of the entered fluid for washing plug. Therefore, static level in the well does not change. Washing with spurt pump accelerate the process by 2-2.5 times on average in comparison to cleaning with bailer (figure 11).

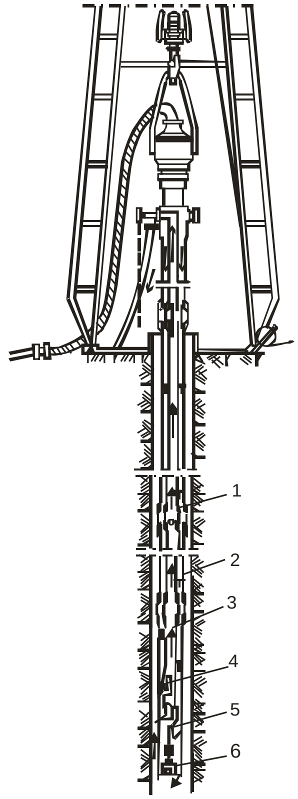

Figure 11. Spurt machine[11].

Along with the method regarding to fighting against sand, other method related to artificially reduction of sand consentration in fluid flow that poured out with the help of addition of the fluid (water of oil) into the wells where sand is created is also applied. Depending on the characteristics of the applied equipment there are following methods of adding of fluid into the wells where sand is created: a) private, b)combined, c) centralized.

The main conditions for the effective application of all types of fluid addition include:

-Drawing down of depth pump adoption or its scroll till the lower holes of filter or sump;

-Selection of theoretical yield that determined in accordance of technological regime of depth pump apparatus, which provides overall gathering of fluid from the well, and added fluid on the basis of report;

-Creation of conditions for light and accurate registration and regulating the amount of gathered and added fluids;

-Cleaning of added fluid from mechanical mixtures;

-Automation of addition method and provision of its remote access control.

In order to avoid negative effects of washing fluid over the productivity of wells aerated fluid or foam is used for cleaning wells from plugs. Washing wells with these methods have following advantages: the effect of absorption of washing fluid over the productivity of layer reduce significantly; accelerates the putting the well into operation after cleaning it from sand plug.

The scheme of the equipment while washing the well with aerated fluid together with addition of surface-active agent is showed as follows (figure 12).

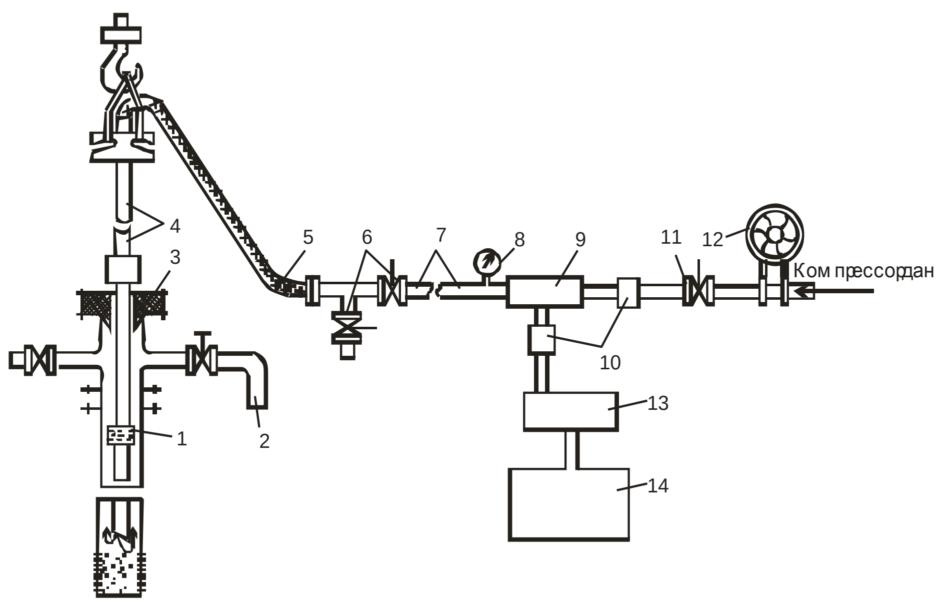

Figure 12. The scheme of the equipment while washing the well with aerated fluid together with addition of surface-active agent[11].

1- reverse valve; 2-manifold; 3-Well mouth packing; 4-pump-compressor pipes;

5- hose; 6- valve; 7-manifold;8-manometer; 9-Mixer-aerator; 10- revers valves; 11- valve; 12- flow meter;13- pump; 14-barrel (tank).

The pump-compressor pipes (4), is stationed 10-15 meter over the sand plug draw down to the well. Upper pipe, which was incorporated with swivel is provided with reverse valve (1). The reverse valve (10) also was stationed in line for giving air and water to aerator (9). The well mouth (3) pressurise with its gland.

Water (13) to which surface-active agent was added is pumped into aerotor with pump of washing aggregation (9) and at the same time air also entered into here. The exit of aerator is combined with washing hose. Regulation of washing and its control is carried out with valve (11), flow sensor (13) and manometer. The exit pipe serves to reduction of pressure to the atmospheric pressure in hiting line while the leng of the pipes is increased. Washed sand plug is pulled out to surface along annulus sapce and entered into tanks (14).

Before beginning to wash the well, surface-active agent tincture is prepared in tank (14) or tank of aggregation.

It is recommended to add surface-active agent in the following amount (with % according to weight of water): sulfanol: in the amoun of 0,1-0,3; OP-7, or OP-10 - 0,05-0,1.

The ratio of water and air regulated in accordance to the depth of well and pressure of layer.

The recommended degree of readibility (ayerasiya) is determined in accordance to the following assumptive data:

Pressure of layer, with % from hydrostatic pressure	60-40	40-25	25-15
Aeration degree of air-water system m^3/ m^3.	15-20	20-30	30-50

Technologically, washing of the wells with foam is carried out as a washing that is done by adding surface-active agent to aerated tincture.

2.5. Hydraulic calculation of sand cleanout

The following parameters that determine the assessment of required time and technological characteristics of carrying out of the works must be defined in order to carry out needed pressure and process during hydraulic calculation of cleanout:

1.The speed of rising flow of fluid must be greater than the falling speed of sand grains in it [3, 4]:

$$\nu_{sand} = \nu_s + \omega$$

Here $\boldsymbol{\nu_{sand}}$**-** is rising speed of sand grains;$\boldsymbol{\nu_s}$–is speed of rising flow of fluid; $\boldsymbol{\omega}$**-** is free falling of sand grain in water, the avarage speed of sand grains that determined according to its diameters.

Usually $\boldsymbol{\nu_s = 2\omega}$ is accepter, then

$$\nu_{sand} = \nu_s - \frac{\nu_s}{2} = \frac{\nu_s}{2}$$

2.General stress detriment during cleanout

$$h = h_1 + h_2 + h_3 + h_4 + h_5$$

Here h_1 - is stress detriment in washing pipes:

$$h_1 = \lambda \frac{H}{d} \cdot \frac{\upsilon_{аш}^2}{2} \rho_{maye}$$

Here, **H**–is length of washing pipes, m; **d**– is inner diameter of washing pipes, m; $\upsilon_{аш}$- is speed of falling flow in pipes, m/s; ρ_{maye}-is thickness of fluid, kg/m^3; λ- is hydraulic resistance coefficient (ratio).

3.The time needed for rising washed rock to the surface:

$$T = H / \upsilon_{qum}$$

Here υ_{qum} - is rising speed of washed rock.

CHAPTER 3. SAND PLUG WASHİNG AND HYDRAULİC CALCULATİON OF SAND CLEANOUT

3.1. Hydraulic calculation of sand cleanout with foam fluid in oil wells

Using water for revoking sand production in exploitation (operational) wells causes premature collapse of the wells, a significant reduction in actual outputs and decline in the ratio of final oil-bearing.

Therefore, washing the sand plugs with water in the wells that are at its final stage of operation can not considered a good idea.

It is necessary to use such a method for revoking the sand plugs in the wells, where the pressure of layer is smaller than the hydrostatic pressure, that during that process washing liquid does not enter into layer. In such conditions the most suitable method is washing with two-phase foam.

Two-phase foam is aerated aqueous solution of SAM. In a certain case depending on the pressure of layer and othere parameters of layer rheological characteristics of two-phase foam is regulated by the changing of the aeration level. However, it should be taken into consideration that in high level of aeration polytropic process (a thermodynamic process that characterized by constant warmth) of air may cause to the freezing of the corpus and the bottom-hole zone of the well and entrance of washing fluid into layer in small aeration corpus.

It is know that the decline of the temperature in the bottom-hole zone, reduction of paraffin (wax) crystals till the falling temperature gives non-newton characteristics to oil or leads to reduction of heavy components in the layer, and at the result flaw of fluid worsen. Therefore, it is utmost importance to learn changing of temperature in the bottom-hole zone and its effects over the rheological characteristics of production of the well during the washing of the sand plug with two-phase foam.

The technology of washing sand plugs with foam is as follows:

With the help of the washing pipe that stationed 10 meter higher than the level of sand plug the straight circulation of foam by using 1,5-3 l/s fluid and smaller aeration degree. Once the fluid column is replaced by foam tha aeration degree is determined in accordance washing regime.

It should be taken into consideration that during the washing of sand plug with foam the movement of foam continue (due to the elastic characteristic of foam) in the well after the compressor and pump stop. This leads to a reduction of pressure in the well.

Washing pipes draw down gradually with the stable cicrulation of foam and sand plug gets washed.

The ability of foam to keep solid particle in depending situation is bigger than water. Therefore, it is possible to remove solid particles after washing of sand plug that has 50-60 meter height.

At the result of laboratory investigations and industrial test it was determined that during the washing of sand plug with foam the thin dispers clay particles that was gathered in the space behind the filter get removed. It is necessary to wash filter zone with foam for 0.5-2 hours after removing all sand plug from wellbore and hanging of filter.

Once the sand plug has been removed at the result of the showed causes sand enters into the well intensively during the exploitation process of the wells.

However, when the sand plugs is getting washed with foam then all sand plug is raised to the surface and addition destruction of the bottom-hole zone does not happen becasue of the absence of strong absorption.

During the application of the foam washing to the washing process, foam washes sand plug better than water, cleans out the bottom-hole of the well and pulls out all sand to the surface.

It is important to know the pressure of the bottom of pump-compressor pipes during the washing of sand plugs in the oil wells with foam fluid. If we do not take into consideration of inertia forces, we can describe the change of pressure in the flow of foam with the deepening of the well as [2]:

$$\frac{\Delta P}{\Delta H} = P \pm \lambda\rho\frac{v^2}{2gd}$$

P-Hshows pressure of height, MPa**;** ρ-Pshows thickness of foam in pressure, kg/m^3; λ -shows hydraulic resistance coefficient; d- shows deimeter of NKB, m; v- shows speed of foam flow,m/s; g-shows free fall acceleration, 9,81 m/s^2; «+»sign shows upturn of foam,«-» sign shows decline of foam.

Thickness of foam:

$$\rho = \varphi\rho_q + (1-\varphi)\cdot\rho_m$$

ρ_q - thickness of gas; ρ_m - thickness of fluid; φ - actual amount of gas.

If ρ_m = accept as constant,

$$\rho_q = \rho_q^0 \frac{P}{P_0}\cdot\frac{T_0}{T}$$

Here $\rho_q^0 - P_0$ in atmospheric pressure and T_0 at a standard temperature (T_0=293 K) is thickness of gas. The speed of rising fluif flow should be more than the speed of the defecate of sand in fluid for pulling out of sand to the surface better. Rising speed of washed plug

$$v_q = v_a - v_{or}$$

Here v_q- is rising speed of washed sand; v_a- is speed of rising flow; v_{or}- average speed of defecate of sand in fluid.

The duration of the removal of the washed sand to the surface

$$T = \frac{H}{v_q}$$

H- is a depth where washing is carried out.

Total hydraulic loss during washing:

$$h=h_1+h_2+h_3+h_4$$

h_1- is time for falling fluid flow; h_2- is time for flow of the mixture of fluid and washed sand; h_3- is time adjustment of thickness in pipes; h_4-is losses from the pump to the washing pipes.

During reverse washing the pressure in the bottom-hole is higher than the pressure during straight washing. The reason from this pressure is the differences of hydraulic losses in ring space and lifting pipes. This pressure:

$$P = (H + h_2 + h_3) \cdot \rho_k \cdot q$$

H- is depth of washing, m; ρ_k - is thickness of washing fluid. If the washing is carried out with foam, then

$$h_1 = \lambda \frac{H_1 \cdot v_d^2}{2gd}$$

H_1- is length of washing pipes, m; d- is diameter of washing pipes,m; v_d- is speed of falling fluid in washing pipes, m/sec.

3.2. Selection of operational regime in downhole pumps

Deep Well Pump 602

Optimal technological regime should be choosen for lifting 7 tonnes of fluid from 1520 m depth with deep well pump.

Initial information;

Diameters of exploitation pipe D=6``

Filter 1516÷1524 m, release depth of deep well pump L=716 m, γ_{fluid}=0.7

1) If we accept hose column as two-stage

d_1=22 mm – 30% ; d_2=19 mm – 70%

Thus,

$l_1=0.3*716=214.8\approx215$ m ; $l_2=716-215=501$ m

2) $Q=\frac{7.0}{0.7}=1($ m^3 per day and L=716 m. In this sweep machine there are standart oscillation number of plunger.

3) $S_{pl.st}$=0.9 ; 1.2 ; 1.5 ; 1.8 ; 2.1 ; 2.4 ; 2.7 və 3.0 m

n_{st}=4.0 ; 5.0 ; 6.0 ; 7.0 ; 8.0 ; 9.0; 10 ; 11 ;12

3) Lets form production table of "S·n" for given condition

S / **N**	**0.9**	**1.2**	**1.5**	**1.8**	**2.1**	**2.4**	**2.7**	**3.0**
4.0	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0
5.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0
6.0	5.4	7.2	9.0	10.8	12.6	14.4	16.2	18.0
7.0	6.3	8.4	10.5	12.6	14.7	16.8	18.9	21.0
8.0	7.2	9.6	12.0	14.4	16.8	19.2	21.6	24.0
9.0	8.1	10.8	13.5	16.2	18.9	21.6	24.3	27.0
10	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
11	9.9	13.2	16.5	19.8	23.1	26.4	29.7	33.0
12	10.8	14.4	18.0	21.6	25.2	28.8	32.4	36.0

4)We can calculate "S·n" production in according to actual production while accepting yield coefficient of deep well pump $\eta = 0.76$

$$Q=F_{pl}\cdot S\cdot n\cdot 1440\cdot 0.76$$

$$10=0.78\cdot 0.032^2\cdot 1440\cdot 0.76\cdot (S\cdot n)$$

$$(S\cdot n)=\frac{10}{0.88}=11.4$$

In the table 11.4=1.8·6.5 sum is convenient. So I will chose S=1.8 m and n= 6.5 1/sec.

1) $Q_{theoretical} = F_{pl} \cdot S \cdot n \cdot 1440 = 0.78 \cdot 0.032^2 \cdot 1.8 \cdot 6.5 \cdot 1440 = 13.5\ m^3/day$

$$\eta = \frac{Q_{fak}}{Q_{n'z}} = \frac{10}{13.5} = 0.74$$

7)Now we can calculate the maximum weight over sucker-rod.

$$P_{max} = \frac{F_{pl} \gamma_m \cdot L}{10^4} + q_{or} L \left(b + \frac{S \cdot n^2}{1440} \right)$$

$F_{pl}=8\ sm^2$; $\gamma_m=700\ kg/m^3$; $q_{or}=2.67\ kg/m$ – weight of one meter cross-bar

$$b = \frac{\gamma_{st} - \gamma_m}{\gamma_{st}} = \frac{7850 - 700}{7850} = 0.91$$

$\gamma_{şt}$ – special weight of material of cross-bar

$$P_{max} = \frac{8 \cdot 700 \cdot 716}{10^4} + 2.67 \cdot 716 \left(0.91 + \frac{1.8 \cdot 6.5^2}{1440} \right) = 2243.5\ kg$$

$P_{max}=2243.5$ kq

Thus, choosen sweep machine may be used safely in given condition because maximum weight over sucker-rod SKN5 – 3012 is less than weight of sweep (2243<5000 kg).

8)Now, we can calculate maximum tension that occurs in the cross section area of cross-bar;

$$G_{\max} = \frac{P_{\max}}{f_{st}} = \frac{2243.5}{33.8} = 590\, kq/sm^2$$

It is known that in the cross-bar that prepared from different type steel the released tension changes widely.

$$[G_{max}]=(57\div80)\ kg/mm^2=(5700\div8000)\ kg/sm^2$$

Thus, it is possible to choose appropriate cross-bar.

9) We can calculate deformation of cross-bar and pipe kalon.

$$\lambda=\frac{q_m\cdot L}{E}\cdot\left(\frac{0.3\cdot L}{f_{1st}}+\frac{0.7\cdot L}{f_{2st}}+\frac{L}{f_{boru}}\right)=\frac{1.5\cdot 716}{2.1\cdot 10^6}\cdot\left(\frac{0.3\cdot 716}{2.85}+\frac{0.7\cdot 716}{3.8}+\frac{716}{11.9}\right)=0.13\ \text{m}$$

$$\lambda=0.13\ \text{m}$$

10) Process path of plunjer

$$S_{pl}=S\left(1+\frac{225\cdot S^2\cdot n^2}{10^{12}}\right)-\lambda=1.8\cdot\left(1+\frac{225\cdot 1.8^2\cdot 6.5^2}{10^{12}}\right)-0.13=1.67\ \text{m}$$

3.3. Elevation of sand particles to the surface with the method of fluid flowing to the annullar space of a pipe in depth pumping wells filled with sand

Deep Well Pump # 602

The main parameters in the selection of the wells for applying the method of flow of fluid into annulus spaces are the period of underground repair of the wells, the number of the washing and cleaning of sand plugs within one year, the thickness of sand particles in sand production and so on.

In order to ensure the pulling out the rock particles to the surface the soul of the mixture, the thickness of the particle and measureless speed are used in the reception of pump.

Measureless speed

$$v_{ol} = \frac{v_{m\ aye}}{v_0}$$

v_{fluid} – is the speed of fluid in pipe, v_0 – falling speed of particle in fluid.

According to the analyse of the fractional particles of rock in the production of the well it was determined that the diameter of particle d=(0.25÷0.17) changes in the border of mm. Avarage diameter of the particle

$$d_{or} = \frac{0.25 + 0.17}{2} = 0.21 \text{ mm}$$

d_{or}=0.21 mm

Initial informations; Q_n=1.2 t/day, Q_{su}=5.8 t/day=5.8 m^3/day, S=1.8 m, n=6.5 1/min

1) The thickness of the fluid mixture in the reception of the pump

$$\rho_{qar} = \frac{\rho_n \cdot Q_n + \rho_{su} \cdot Q_{su}}{Q_{maye}} = \frac{0.85 \cdot 1.2 + 1 \cdot 5.8}{7} = 1.0 \text{ q/sm}^3$$

2) Water factor

$$\beta = \frac{Q_{su}}{Q_{maye}} = \frac{5.8}{7} = 0.83$$

3) $\mu_{qar} = \mu_{su} \cdot 10^{3.2(1-\beta)} = 0.01 \cdot 10^{3.2(1-0.83)} = 0.025$

4) Defecate speed of particle in fluid

$$v_0 = \frac{1}{18} \cdot \frac{\rho_2 - \rho_{qar}}{\rho_{qar} \cdot \mu_{qar}} \cdot g \cdot d^2 = \frac{1}{18} \cdot \frac{2.65-1}{0.025} \cdot 9.81 \cdot 0.021^2 = \frac{0.03}{0.024} = 1.72 \text{ sm/sec}$$

v_0=1.72 sm/sec

5) Raising speed of fluid

$$v_{maye} = \frac{Q_{maye}}{F} \cdot \frac{100}{86400} \text{ sm/sec}$$

F=0.785·d^2=0.785·0.063^2=0.003 m^2

$$v_{maye} = \frac{Q_{maye}}{F} \cdot \frac{100}{86400} = \frac{7.0}{0.003} \cdot \frac{100}{86400} \approx 2.7 \text{ sm/sec}$$

6) Measureless speed

$$v_{ol} = \frac{v_{maye}}{v_0} = \frac{2.7}{1.72} = 1.6$$

The pulling out of the particle of rock to surface with fluid is not provided becasuev_{ol}<2. Therefore, I recommend to pour fluid into annulus space.

7) If we pour 5 tonnes oil per day into annulus space the productivity of the well will be

$$Q_{fluid}=7.0+5.0=12.0\ m^3/day$$

$$Q_{theory}=12.0/0.76=15.78\ m^3/day=16\ m^3/day$$

If we pour 5 m^3/day fluid into annulus space the result should be Q_{theory}=16 m^3/day

8) In this case

$$v_{m\ a\ y\ e} = \frac{12}{0.003} \cdot \frac{100}{86400} = 4.6 \text{ sm/sec}$$

Then

$$v_{ol} = \frac{4.6}{1.72} = 2.8$$

The pulling out of the particle of rock to surface with fluid is provided because $v_{ol}>2$.

CHAPTER 4. ECOLOGİCAL AND SECURİTY MEASURES TAKEN WHİLE EXPLOİTİNG WELLS WİTH DOWNHOLE PUMP

4.1. Security measures for exploitation of wells with down hole pump

To serve the surface equipment and repairment in deep well pump require more phisical work and is more risky in comparison to other exploitation method. For example, changing the rope hanger of sweep, flexion of sucker-rod up and down during underground repair is too risky. For this reason, in order to to decrease the effort of oil extracting operator and provide security special arrangaments were offered. Some of these arrangaments were brought to the well during repair and some were installed equipment relative to the well.

Periodic routine repair in deep well pump is too risky, because it is related to the hard physical work in height and in comfortless condition. In order to facilitate this works it is effective to use mobile lifting cranes. However, only persons, who have received special instruction are allowed to work with this kind of cranes.

Workers that handle sweep should be familiar with the energy safety and should know how to provide first aid during injury.

Power engineer of the relevant department is responsible for good repairs of electric equipments. Electric repairer could not work with equipment that is under high tension without dielectric gloves and other personal protective equipment.

Sweep machile should be illuminated at night. During underground repair sweep is stopped and metal plaque with underground repairs on the well is hanged.

Safety measures are particular important during the investigation of deep well pump. In the investigation of wells the level of the well is measured by exalot and pressure of the bottom-hole by depth manometer. There is a risk of fire and elektric shock in using exalot. In order to avoid such kind of risks following measures should be taken into consideration:

Before connecting exalot recorder to the power supply, it should be connceted to the ground with a copper wire not less than 6 mm^2. The wire that connect exalot with ground should be incorporated to the top of pipe with bolt or other squeeze;

It is necessary to use a dielectric shoe while working with exalot.

For checking the work of deep well pump dynamometer is placed between the traverse. It is too risky to work with dynamometer. In order to elimiate this risk the dynamometers in the well are obtained from telemetric devices. Therefore, a smaller dynamometer is placed on the rope hanger of sweep. This operation requires phisical effort.

When the plunjer embed in cylinder it also creates various risks.During daily service in deep well pump rubber is embarked to the three way adapter for creating frequent compaction. In this case, safety regulation must be obeyed. It means that well is stopped, the pressure is dropped to 1 atm, then the tap of gland is opened. After changing of the old compaction rubber with new one tap commingle with carving. After that, sweep machine is switched on and compaction is checked.

4.2. Environmental measures for the exploitation of wells with down hole pumps

The exploitation of the wells with deep well pump cause the pollution of environment to some extend.

It is not unknown that, great amount of the mineralized layer water extract together with oil from long-term used oil fields, thus, the amount of that layer water becomes ten times more than the volume of oil.

The layer water that seperated from the oil in watershed is transported to cisterns or water preparation installation with open channels. This is one of the main reason of the pollution of oil fields with mineralized wastewater. Somtimes, the presence of residuum oil in the mineralized layer water is observed. Therefore, great amount of various mineral salts, as well as oil residuum oil impegnate to the soil in the oil fileds. In addition, during the repair of deep well pump the zone around the well also get polluted with layer water and oil.

The topsoil of area around the some oild fields has been turned into solid mass due to the impegnate of wastewater and residuum oil for a long time. Therefore, in order to protect environment the following activites should be undertaken:

- reduction of volume of layer waters that are extracted with the exploitation of deep well pumps preiodically;
- clean out the oilfield waters from residuum oil;
- recultivation of polluted oilfield lands;
- utilization of wastewater discharges.

The first issue is solved with the selection of wells, which keeps average daily production and decreases the percentage of water in the produced products and relegates them to the periodic regime. Implementation of this measure, which means relegation of the low production wells to the periodic regiom massively decreases the extraction of layer water around 30-4-%. One of the other measures taken in this direction is the isolation of the lay waters.

There are a number of components in the oil industry that isolate layer water. They include: water-cement, water-cement-sand, oil-cement, oil-cement-sand, synthetic resin and others.

It should be noted that one of the main goals for cleaning out the layer water from residuum oil and mechanical mixtures is to reinject this water into oil layers, as well as use this water for technical needs.

In addition, cleaning out of wastewater and layer water from residuum oil and mechanical mixture has enabled the removal of in-depth technical water requirement and circulation of water supply at compressor stations. It should be noted that the use of waste water has significantly reduced the use of sea, river and lake waters.

At the result, the application of these measures caused the normalisation of seawater significantly as well as prevention of contamination in the coastline.

CONCLUSION

In deep well pumps filled with sand optimal technological regime has been selected and compared with current technological regime. It is possible to make following notes according to analysis:

1) The underground repairs for removing sand plugs in deep well pumps that filled with sand is 30% more than the general repairs.

2) The underground repair intervals in deep well pumps that filled with sand change in this frontiers (15÷20).

3) The height of sand plug falling to a well changes in this scale (97÷65).

4) In order to provide extraction of rock particle that brought to bottom-hole of the well with fluid it is offered to pour fluid into annulus space.

5) With te application of pouring fluid method the period for underground repair increases (4÷6) times.

6) With pouring fluid into annuler spaces in wells that filled with sand it is possible to exploit additional 150 tonnes oil from one well in avarage.

7)In NKG and I KS suits in Buzovna- Mashtaga field by flowing fluid to annular space, some additional 3000 tonnes of oil could be exploited.

8) 9) Three options of pouring fluid into annuler space are predicted:

a) reservoir oil

b) from water reservoir

c) part of the well production

References

1. Bradley, H. B., ed., 1987, Petroleum Engineering Handbook: Richardson, TX, Society of Petroleum Engineers

2. Craft, B. C., M. Hawkins, and R. E. Terry, 1991, Applied Petroleum Reservoir Engineering, 2nd. ed.: Englewood Cliffs, NJ, Prentice Hall, p. 210–263.

3. Golan, M., and G. H. Whitson, 1991, Well Performance, 2nd. ed.: Englewood Cliffs, NJ, Prentice Hall.

4. Mirzadjanzadeh A.H., Nagiyev F.B., Suleymanov A.A. Application of dynamic analysis principles for decisions on the development of oil and gas fields. Baku, National Oil Academy. №9, 2006, pp. 1-12

5. Mirzadjanzadeh A.H., Shakhverdiev A.H. Dynamic processes in oil and gas production. System analysis, diagnosis, prognosis. M: "Nauka" (Science) Publishing House, 1997; 254 p.

6. Mirzadjanzadeh A.H., Nagiyev F.B., Suleymanov A.A. Application of dynamic analysis principles for decisions on the development of oil and gas fields. Baku, National Oil Academy. №9, 2006, pp. 1-12

7. Petroleum Production Technology. Herriott-Watt University. Edinbourg. 2014.

8.Petroleum Reservoir Technology. Herriott-Watt University. Edinbourg. 2014

9. Zeynalzade Y.A. Forecasting of qualitative changes in the oil and gas production process. Baku, National Oil Academy, №4-5, 2001

10. Ибрагимов А. М. Нефтегазопромысловые гидротехнические сооружения. Москва, " Недра", 1996, с, 528

11. M. A. Kamilov, M. C. Nəsirov, M.R. Məmmədov. Neft və qaz qurğuları və texnoloji proseslər. Bakı-2003, s. 38-353

12 .Mustafayev C.D. Ştanqlı dərinlik nasos quyularının istismarı. Bakı, 2010.

13. K.Q.Mehdiyev “Результаты опытно-промышленного внедрения гравийно-щелевых фильтров на Бузовна-Маштагинском месторождении”, Азербайджанское нефтяное хозяйство, 2015, №3

14. S.F.Əhmədov, E.M.Əliyev, Ş.İ.Bağırov “Анализ состояния и оценка перспектив реализации извлекаемых запасов нефти на месторождениях Бузовна-Маштага и Гала”, Azərbaycan Neft təsərrüfatı jurnalı, 2002, №6

15. N.K.Kərimov, Z.S.Məmmədov, İ.Z.Həsənov, “Neftqazelmitədqiqatlayihə” İnstitutu, “Buzovna-Maştağa yatağında neft ehtiyatının mənimsənilməsinə dair bəzi tövsiyələr” 2008, №11, səh 74-83

16. V.M.Süleymanov, G.T.Abdullayev, S.O.Heydərli “Buzovna-Maştağa yatağında suvurma üsullarının səmərəliliyinin tədqiqi”, Azərbaycan Neftçi Geoloqları jurnalı № 12, 2017

17. Z.S.Məmmədov, K.Z.Qayıbov, Y.H.Kərimov, İ.Ə.Əhədzadə, “Buzovna -Maştağa yatağının neft-qaz ehtiyatlarının səmərəli mənimsənilməsinin təhlili”, (ARDNŞ-nin ETİ), 2009, I say, №12

18. S.Əliyev, Ş.İ.Mustafayev, S.İ.Allahverdiyeva, F.C.Mehdiyeva. “Ştanqlı quyu nasosu ilə istismar olunan quyuların iş rejimlərinin təhlili və səmərəliyinin artırılması (Buzovna-Maştağa yatağı timsalında)”, Azərbaycan Neft Təsərrüfatı jurnalı №6 , №7, 2011.